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A BRIEF GLANCE AT ELECTRICITY IN MEDICINE.¹

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It is, I confess, with considerable trepidation that I, a physician, touch upon electricity before an audience whose life work this subject is; but if there be one reason more than another why I esteem it a high honor and a privilege to address the members of this society upon the subject assigned to me, that of electricity in medicine, it is that I look upon the occasion as one which may serve to interest electrical engineers—experts in electricity—in the efforts which medical men are making, in these modern days of electrical science, to ascertain the possibilities of electricity to cure disease. Our certainties we ever have with us; they are a legacy from the fathers of science; it is the limitations that can be set to our knowledge that we would ascertain. And if by chance these limitations, like the horizon of an otherwise boundless plain, ever keep in advance of our pursuit, we have, nevertheless, left behind us an abiding knowledge of the new ground we have traversed.

In one sense a similar problem continually confronts the members of your own profession; you have your grand dynamos and the laws of economical distribution of power and light; you have your telegraph system, already pretty well worked out to its limits; you have your subtle telephone and telautograph, but you have also a thousand and one problems, whose limitations have yet to be determined. You have yet to run a train one hundred miles an hour; yet to distribute power and light on a Teslaic system without conductors; yet to make a practical telephone talk out loud; yet

1. By the action of Council in ordering the publication of this paper, the original Editing Committee, George A. Hamilton, *Chairman*, Franklin L. Pope and Francis B. Crocker, is relieved of all responsibility in the matter.

to communicate thought by electro-magnetic waves alone, and yet to tell us what electricity is. You have yet to ascertain what you can do by electricity and what you can not do.

But, your pursuit of truth, evasive as this ever is to all, is upon far easier lines than is ours as physicians, and therefore we ask your forbearance and your aid.

You deal with science—with electricity—applied to inanimate things. While the general laws of this science are open to all of us equally, you apply your laws to masses of metal, to wires, to carbon and to inorganic chemicals ; you express your applications or your theories in unerring mathematical formulæ or in graphic representation ; the work you claim to have accomplished may be verified by your peers, by aid of cunningly devised instruments of precision.

Not such is the position of the physician. While if highly gifted and accomplished, he may possess your knowledge of the physics of electricity, in his applications of his knowledge he is confronted with a problem the most perplexing that has ever been presented to the attention of mankind, and that is the problem of the laws which govern life in animate objects—the problem of biology. Perversion of these laws constitutes disease, and the physicians query is, can electricity avert and correct this perversion?

Electro-physics is indispensable to electro-therapeutics. The representative of the former is the electrical engineer, as is the physician the representative of the latter. What greater glory to the engineer than to turn at times from commercial and industrial labors, and direct the light of his knowledge in upon the highways and the byways where dwell the sufferings and sorrows of humanity.

SECTION I.

Electricity presents itself to physicians for medical use in three conventional modalities, termed respectively: galvanism, faradism and franklinism. The electrical engineer knows no such terms; to him electricity differs mainly in volts and amperes. And, practically, we also work upon the same lines. But time-honored uses and convenience justify us, I think, in retaining for the present our crude classification, since our apparatus consists almost entirely of voltaic cells, volta induction coils and electrostatic machines.

From the galvanic battery we obtain a high current strength and low voltage; the current is continuous or constant, though often used also as an interrupted current. Its effects upon the human tissue are mainly electrolytic and cataphoric—the tissue is affected chemically and physically, just as inert matter would be, and, in addition, is affected physiologically; the thousandth part of an ampere, viz., a milliampere, is the practical unit, and therapeutic dosage is expressed in terms of n milliamperes, passing for n^1 minutes. Current strength is measured by a milliampere meter. Administrations are percutaneous, and through the mucus membrane, or by needle puncture. In the former case, the resistance offered by the skin is high—varying from one thousand to forty thousand ohms—and we require from forty to sixty high voltage cells to overcome it. Two important features come into play, one current density, which is a question of the size of the electrode, and the other the practical fact that the degree of pain excited in the nerves of the skin with accompanying injury to the skin erects the real barrier to increasing the current strength. Ten milliamperes to a square inch of skin is about the limit of endurance, and from ten to twenty to two square inches an average percutaneous current. Current density is as essential an element of expressing the dosage as is the reading of the needle, and the superficial area of the electrodes should always be given.

From a faradic apparatus or induction coil, we obtain a current of much greater electromotive force, but of decreased current strength. The salient feature of this current is that it is an interrupted current; from the primary winding of the coil is obtained a pulsating current—its flow is always in one direction, thus resembling an interrupted galvanic current, plus the current of its self-induction, and that of the magnetic induction of the iron core. From the secondary winding is obtained an alternating current, whose electromotive force may be very high. An instrument to measure this current is greatly to be desired.

According to Harries and Lawrence an ordinary medical induction coil with seven volts E. M. F. supplied to its primary and a current strength of 500 M. A., gives in its secondary a voltage of about 216 and only 12 M. A.

From a franklinic apparatus or electrostatic machine, we obtain a current of enormous voltage and very low current strength. The physical and physiological effects are largely due to electro-

motive force and instantaneousness of current flow rather than to current strength.

There is still another form of electric manifestation of energy, which is a newcomer to electro-therapeutics, in fact, in its present guise a newcomer to electrical science—I refer to high frequency, high potential currents.

They fall out of line of our medical classification, for they are neither faradic nor franklinic alone—their production requires Ruhmkorff coils or alternating current dynamos, condensers and transformers; they far transcend our volta induction coil products in frequency of interruption and electromotive force, and our franklinic machines in current strength.

The fame of the high frequency, high potential current is already invading the quiet domain of electro-therapeutics, and it is to that branch of our subject that I shall ask some attention to-night.

From the great initial difference in voltage, amperage, and absence or presence of interruptions of the three forms of current in medical use arises a corresponding difference in their physical and physiological effects upon the human organism, and from a study of these differences the physician must decide upon which form of current to use in given cases.

To galvanism and faradism we will give but prefatory attention; but to franklinism fuller consideration, since its study is inextricably entwined with high frequency, high potential currents—in short, it is itself of this nature, and as such invites a vivid interest, for we have as yet no other apparatus for obtaining these currents in medicine.

SECTION II.

In confronting our subject of electricity in medicine, it is necessary to establish some data, and this we may do most briefly. We have to consider:

(a) The nature of the agency, electricity, we wish to apply.

(b) The nature of the gross substance, the human body, to which we wish to apply electricity, and the reactions of electricity upon it.

We are then in a position to examine the principles, the instruments and the methods of application, viz., the science and the art of electro-therapeutics, or, at least, that small part of it which may be examined in the brief time before us.

Electricity.—Electricity to-day is believed to be a vibratory or wave motion of the ether, that continuous, imponderable, and incompressible fluid that fills all space. By a state of motion either in it or of it, the ether conveys light and manifests the phenomena termed electric and magnetic. In this sense, that they are motions of the ether, light and electricity are identical—both are ethereal vibrations—both travel at the same rate of speed, and both have measurable wave lengths—both may be refracted and reflected by impact upon prisms and mirrors, and both are subject to wave interference. In submitting the human body to electricity, therefore, we are submitting it to a physical force, to a rate of motion of the ether—not to an entity or individual chemical element, like iron, arsenic, quinine or other medicine. We treat disease by ether vibrations. There is but one organ of the body capable of responding specially to ether vibrations, and this is the eye, just as the ear responds to air vibrations. The rest of the human body is affected by the electric ether vibrations just as is other gross matter of the same sort. That it is a form of energy that we apply to human beings may be illustrated by a crude parallel. Supposing one has given a quick snap by the hand to a rope attached to the ceiling of a room and imparted to the rope a wave motion easily visible; we have the exciting power, the hand, the electromotive force; we have the wave propagation, the rope, the current; and we have the energy of the imparted motion now exerted upon the ceiling, or, if attached to proper mechanism, capable of doing mechanical, chemical or other work. This is the sort of work that is done in the human body.

The importance of taking this fundamental view of the effect caused by ether vibrations is obvious, especially in connection with high potential, high frequency currents; but, to more immediately bring the general subject down to a working basis, we may start from a different standpoint, that of:

The Properties of Currents.—In using electricity to cure disease, the physician may be said to resemble a huntsman, who has a certain number of arrows in his quiver, each adapted to different purposes. He selects an arrow—a property of the current—some special thing it will do, and projects it against a disease or morbid condition. At least, this is what he should do, but it is unfortunately a fact that physicians are wofully ignorant about what electricity will do upon inanimate matter, and more so

upon what it will do upon animate. The general impression seems to be that electricity is to be injected into a human being by a small sponge electrode, much as one would inject a medicated fluid in through the skin by a hypodermic needle, and that the electricity was then to run about the system, hunt up the diseased spot, make a diagnosis, and chase out the disease, much as a ferret might run a rat out of a hole. I am not sure that this is not the idea of the electrical engineer.

The properties of the current useful in diseases are :

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| A. Physical. | { 1. Heat.
{ 2. Light.
{ 3. Magnetism.
{ 4. Induction (electro-magnetic).
{ 5. Chemical, or electrolytic.
{ 6. Cataphoric. |
| B. Physiological. | { 1. Contraction of protoplasm.
{ 2. Excitation of nerve and muscle.
{ 3. Electrotonus. |

1. Heat may be employed indirectly to heat small metallic loops, with which surgical operations may be performed. This is known as *galvano-cautery*.

The actual heat produced in the body by its resistance to currents of the current strength commonly in use is inappreciable.

The franklinic current modifies bodily temperature, according to my experiments, in a marked degree, probably by its action upon thermic nerve centres.

High frequency, high potential currents raise the temperature of the body.

2. Light may also be used indirectly in incandescent lamps to illuminate the cavities of the body—to transilluminate the tissues, and thus detect foreign bodies, or dead tissue; it has also been successfully used to cure neuralgia. The intense light of electric welding processes produces effects upon the skin which have been compared to those which are induced under the scorching of a torrid sun. The effect is, however, more far reaching than this explanation admits of, for those subjected to this intense light suffer from discharges from the nose and eyes, and from a dry cough, as well as from skin symptoms.

3. The magnetic property of currents is also indirectly made use of to actuate mechanism, like surgical drills and saws, and to cause mechanical vibration, transferred to tissue.

Magnetism, itself, whether from permanent magnets, the most powerful of electro-magnets, or from solenoids, seems to have little or no important effect upon human tissue. The wonder is that it has ever been expected to have such a great effect, since no one would select the ingredients of a human body as suitable ones to collect the electro-magnetic lines of force. I do not, however, accept as final, the experiments of Kennelly and Peterson, for the reason that closed conductive circuits were not provided for in their experiments, and that alterations in the excretion of carbonic acid and urea were not looked for.

4. Induction effects, due to the passage of currents through the body have received little attention. It must be supposed that there are a very great number of closed inductive circuits.

5. Chemical or electrolytic. This is one of the most important properties of the current, and in connection with it, a passing glance must be given to the nature of the electrolyte. The human body, for practical purposes of the administration of electricity, may be considered as a semi-fluid mass, whose conducting power is due to its salts, held in solution. As a conductor of electricity, it is, practically, about a two per cent. solution of common salt. It is at once evident how important a part electrolysis, or chemical decomposition, and cataphoresis, or electric transfer of fluids must play in this human electrolyte.

Representing by 1 the conductivity of muscle, it is ordinarily stated that the resistance to the current is as follows :

Muscle.....	1.
Nerve.....	2.5
Cartilage	2.5
Bone.....	6.
Skin deprived of epidermis	100. to 500.

Starting upon the fact that tissues behave as conductors like a solution of the salts they contain, I should prefer to arrange a table of the important tissues, as follows :

Blood.....	1.7 %.
Muscle.....	1.5 “
Brain and nerve tissue.....	1. “
Cerebro-spinal fluid.....	1. “

the resistance increasing as we read downward.

Obviously, by the law of derived currents, each component of the mass will receive its ratio of current, some more, some less, according to their conducting power, but none escape, and there is therefore, by the way, no evidence as has been recently claimed by a French observer, that electricity cannot reach the brain or spinal cord, because its flow would be completely diverted by the blood and the muscles. No one tissue of the composite mass will take all the current.

The simplicity of my comparison of the conducting capacity of the tissue to a two per cent. solution of the chloride of sodium requires some modification. Our electrolyte is not homogeneous like such a solution, but it is composed of millions of cells with membranous enveloping material, and of varying physical composition. We must, therefore, take into account the distribution of ions to secondary electrodes within the mass, constituting internal polarization and active chemical decomposition within the mass itself, as well as at the two principal electrodes. The salient and interesting feature I wish to bring out is, that the action upon tissue is electrolytic, that this electrolysis takes place in the intrapolar region as well as at the ministering poles, and that the electrolysis is at the expense of the inorganic salts of the tissues. Now these salts constitute but from one to two per cent. of every tissue, and yet they are absolutely essential to the health and the life of the tissue. And we may, hence, see how it is that a comparatively small current strength, even of a few milliamperes, conducted electrolytically by the solutions of inorganic salts, decomposing and diminishing them in amount, produces the profound effects seen in electro-therapeutics, for the function of the tissues depends upon its physical integrity, and it is its physical integrity which suffers by the passage of the current. In further proof of the reality of electrolysis, human tissue may be charged like an accumulator or secondary battery. Larat has demonstrated that when a charging current of about 25 milliamperes is applied by two electrodes to the arm, for instance, for some minutes, the charging battery may be removed, and a current in the opposite direction be detected of from $\frac{1}{2}$ to 1 volt.

Experiments upon animals demonstrate the profound structural changes set up in tissue by the passage of the current.

G. Weiss, taking a healthy frog, submitted one leg to a few milliamperes of current for several minutes, and placed the frog back in the aquarium. At the end of a week the frog's legs

were tested to determine their muscular excitability. The leg not submitted to the current gave contractions from ten to twenty times greater than the other. Again, having submitted the legs of a living frog to electrolysis, he killed the animal a month later, and discovered under the microscope that the muscles were completely altered. He says that recent experiments have shown him that a single application for five minutes of a current of two milliamperes suffices in the case of frogs to produce alterations visible by the microscope several days afterwards.

We may make a distinction between intrapolar electrolysis, as thus far described, and polar electrolysis. The former is medical, the latter is surgical. The former does not disrupt and destroy tissue, the latter tears tissue asunder and destroys it with acids and alkalis; it is an action directly at the electrode, which is commonly a metallic needle or needles, and its purpose is to destroy tumors and other diseased growths. In this surgical destructive procedure, termed often "electrolysis," or galvano-caustics, each pole forms a little chemical laboratory by itself, where the human tissue itself provides the chemicals for its own destruction. At the positive pole collect oxygen, and chlorine; at the negative, sodium, and potassium hydrate and hydrogen. Nascent oxygen directly oxidizes tissue, chlorine attacks the H_2O of tissue, takes the H_2 and leaves again nascent oxygen to oxidize them. Muscle tissue electrolysed gives sulphuric, hydrochloric, nitric and phosphoric acids at the positive pole, and sodium, potassium and ammonium at the negative pole.

Metallic electrolysis. Some recent advances in the application of electrolysis to medical practice are of great value and deserve to be better known. One of these I now have in mind may be termed metallic electrolysis of soluble metals. Long familiar as a feature to be avoided, or mentioned by authors in a desultory way, Gautier, of Paris, has seized upon this idea to erect upon it most successfully a method, the rationale of which is quickly appreciated.

An iron needle connected to the positive pole, plunged into human tissue, is quickly attacked by the oxygen and chlorine set free at this pole—is converted into oxychloride of iron, a double salt, and is soon completely destroyed. The same is true of any metal attacked by oxygen or chlorine. A copper needle or bulb or other conveniently-shaped electrode penetrating tissue or laid against mucus membrane, especially within the cavities of the

body, is converted into oxychloride of copper, zinc into oxychloride of zinc, and so on. Gautier terms these electrodes "soluble," in contradistinction to electrodes of gold and platinum, frequently employed to avoid these very effects. The benefits of this method promise to be far-reaching when fully introduced into practice. In gynæcological work the positive copper sound introduced within the uterine canal affords not alone the intrinsic advantage of the current, but also the further benefit due to an antiseptic salt whose permeation *into* the tissue sets up most active alternations in the nutrition of the mass. Usually, a solution of such metallic salt is painted or sprayed upon the mucus membrane, but by Gautier's method it is first topically applied, and is then driven inwards by the principle of cataphoresis—for, by happy chance, the decomposition of the metal and its propulsion inward are vested in the same pole, the positive. The same reasoning holds good in nasal catarrh or rhinitis atrophica and hypertrophica and ozoena. A copper bulb swept over the nasal, throat and mucus membranes deposits and drives in the copper salts. The results of this treatment, in my hands, at least, far surpass the most sanguine claim of any other treatment. By this means, also, gonorrhœa may be promptly cured, unhealthy ulcerations and discharging cavities may be antisepticized and healed, tumors be dispersed or caused to disappear, and the granular eyelids of conjunctivitis to assume a healthy state. The method has before it a brilliant future.

And, finally, we cannot close our leaflet upon electrolysis without a word in regard to one of the greatest extensions of electricity into the domain of medicine, that of the treatment of diseases peculiar to women, by the methods devised and advocated by Apostoli, of Paris. The labors of Apostoli have worked a revolution in gynæcological practice. By means of a dispersing pad electrode, whose current density is large, applied externally on the skin, and a small metallic electrode, whose current density is small, applied internally, Apostoli has been able :

(a) To apply currents of great current strength internally, viz., 50 to 500 milliamperes.

(b) To obtain internally the special action of either pole, the positive to control hemorrhage and to dry tissue; the negative to liquefy, soften and increase blood in tissue.

(c) To obtain a marked intrapolar effect (electrolytic, cataphoric and vascular) upon fibroid tumors, exudations and morbid growths.

These and other effects indissolubly associated with Apostoli's name have done more than any other modern work to place electro-therapeutics upon a sound basis.

I feel that I have scarcely touched upon the role of electrolysis in medicine; its proper elucidation would require a volume.

Cataphoresis.—Next to electrolysis, cataphoresis is undoubtedly the most important property of the galvanic or continuous current. By cataphoresis is meant the flow of a liquid with the current from the positive toward the negative pole. Physically, cataphoresis is demonstrable by many simple experiments. If a fluid is put in a U-shaped tube and electrodes enter the fluid in each arm, the fluid rises on the negative side. If a porous diaphragm is inserted in the tube, the fluid which is driven to the negative end cannot again descend by gravity, and soon gathers in large quantity in the negative compartment. If the fluids on either side of the diaphragm differ in saline density, then by the laws of chemical osmosis there is a flow from the less dense to the more dense compartment. In this instance, if a current is in the same direction as the osmotic flow, the latter will be greatly accelerated; if in the reverse direction, it will be retarded. Cataphoresis does not readily take place if the resistance of the liquid is too small or too great. Human tissue is well adapted to cataphoric action. Fluids flow to the negative pole and remain there, owing to the membranous character of the meshes of tissues which enclose them, and which resemble in this respect the porous diaphragm. Like electrolysis, cataphoresis is inseparable from every application of the continuous current. In inflammatory exudations of all kinds, in rheumatic thickenings of tissue, in tumors like fibroids of the uterus and others, the fluid in the mass is increased by the negative pole, thus creating a physical change, while by electrolytic decomposition the same diseased tissue is impoverished in the salts so essential to its vitality.

Cataphoric Medication.—The cataphoric property of the current renders available, also, a very interesting practice of introducing medicines into the human body and blood stream through the skin or mucus membrane. The process is termed cataphoric medication. In this manner iron, mercury, quinine, morphia, cocaine and a further great variety of medicines may be caused to affect the patient without entering the stomach. The practice is of great value to produce local anæsthesia by cocaine, and also in many cases, as in skin diseases, where a potent local effect of a

medicine is desired. There is no good reason why the "medicated bath" should be an adjunct of quackery. If the medicated water of the bath is made the positive electrode, a patient in this bath, with hands and arms out of it, and in connection with the negative electrode, will receive, by cataphoresis through his skin, a large amount of almost any desired medicine, and this, too, in purest and most active state of the medicine.

The reserve statement is interesting, and that is, that by cataphoric demedication, medicines like, for instance, arsenic and mercury, may be removed from the patient, and be visibly deposited upon the negative electrode, according to the usual rules of electroplating. In passing, we may for a moment indulge our imagination in a future practice in cataphoric medication or conveyance of, say, metallic substances into the body, which might constitute a new method of preservation of the bodies of the dead. Electrically permeated throughout its mass by an unoxidizable metal or metallic salt, the body would remain most lifelike, as well as practically imperishable. We may thus electrically, in truth, transform Croesus into his own gold—a sort of electrical petrification.

Electrolysis and cataphoresis are therefore prime physical factors in electro-therapeutics.

It is evident that we cannot alter the physical substratum of a living organism without in equal ratio allowing its function. Modern physiology, or the laws of vital function, concedes that vital phenomena are chemical changes subject to the conditions of similar changes in the chemist's laboratory.

To pursue this part of our subject further would be to enter upon the vast domain of electro-physiology, and this time forbids. I can only point out the general pathway of the

PHYSIOLOGICAL PROPERTIES OF THE CURRENT.

Muscular Contraction.—The gross physiological phenomena with which we are familiar is that muscles are caused to contract. If the electrical impulse is instantaneous, the contraction is instantaneous, and immediately subsides. Up to about 20 impulses per second this rule holds good, but beyond that the muscle has not time, between the impulses, to subside from its state of contraction, and remains in permanent contraction so long as the varying current continues to flow. The excitation of the muscle is primarily effected by means of the nerves which supply it, but

it may also be caused to contract independently of its nerves. Using a galvanic current, muscles contract more or less quickly to single impulses, according to which pole is used, and according to whether the circuit is made or broken. Employing the symbol *C* for cathode, *c* for closure, *c* for contraction, *O* for opening, and *A* for anode, the relative order of contraction, as established by Pflüger is :

$$Ccc > Acc > AOc > COc, \text{ viz.:}$$

cathodic closure contraction is greater than anodic closure contraction, which in turn is greater than anodic opening contraction, which likewise in turn is greater than cathodic opening contraction. This amounts to saying that neuro-muscular excitability is most marked at the negative pole. But that the law is not comprehensive, is shown by the fact that currents several times reversed excite muscular contractions far more actively than a negative pole does.

The muscles thus far referred to are made up of striped muscular fibre; they constitute the bulk of the human body. And while they contract to a varying current as outlined, they do not contract to a continuous or unvarying current, except it be very powerful.

Opposed to the striped muscular system, there is another composed of smooth, muscular fibres, which makes up the heart, the uterus and other important organs, and exists in the intestinal walls. This system contracts powerfully to a continuous current, and not so readily to a varied current.

And this distinction leads to a very important differentiation in electro-therapeutics, and one which is scarcely yet recognized in practice. Intestinal movements, for instance, in dangerous or other cases of occlusion and paralysis of the bowels, will be best set up by a continuous current, which would not cause a contraction of the biceps or other muscle composed of striped muscular fibre. The reduction of this physiological fact to a practice we owe to Boudet de Pâris.

Nerve Excitation.—The nerves of the body are mainly of two kinds; the motor, which convey outward from the brain and other centres those neural impulses which lead to muscular movement; and the sensory, which carry inward to the brain and other centres the sensations of pain, touch, temperature, etc., from the external world.

Electricity affects both classes of fibres, as well also as the special cellular nervous substance in which they start, or in which they terminate. The positive pole diminishes the excitability and the conductivity of a nerve, while the negative pole heightens them. The former is therefore sedative, as, for instance, in neuralgia, while the latter is stimulating, as in paralysis. This fact of the diametrically opposed physiological properties of a current at the points of its polar application also admits of a physical explanation. As Baron von Humboldt first demonstrated, acids which accumulate at the positive pole depress the excitability of nerve tissue, while alkalies, which accumulate at the negative pole, heighten the excitability.

The above facts, relating to nerves, are known as electrotonus.

Again, living muscular tissue becomes acid by fatigue, and alkaline in repose or rest. It is evident that a positive pole will increase fatigue by increasing acidity, while the negative pole will overcome fatigue by neutralizing the acid.

Electro-Diagnosis.—To every muscle of our body a nerve goes to set the muscle in motion and to maintain its nutrition. If this nerve is cut, bruised or diseased, so that the conducting pathway from the nerve centre in the spinal cord or brain to the muscle is abolished, or if the centre itself is destroyed by disease or otherwise, then the muscle suffers and actually degenerates. There are many of the most serious diseases of the nervous system in which the muscle thus suffers. Electricity enables the physician to decide if the muscle and its nerve are impaired, and adds greatly to the certainty of a diagnosis. The test is simple. An electrode is applied at a point on the skin, previously determined and mapped out on charts, by aid of dissections upon the dead subject, just over where the nerve plunges into the bulk of the muscle. If the faradic or induced current is turned on, it will be found that the muscle, if degenerated, has lost in a greater or lesser degree its power of contracting, simply because in its changed condition no single electric impulse of this current lasts long enough to affect it.

If the galvanic or continuous current is turned on, the muscle contracts to single impulses, because they last longer—but this singular fact now appears—viz: that, whereas in the healthy muscle the negative pole causes the greatest contraction, in the diseased muscle the positive pole causes the greatest contraction.

This law of excitability to rapidly varying currents (over 20 and under 5,000 per second), and reversal of the normal order of degree contraction to a single impulse of the galvanic current is termed the reaction of degeneration of erb. It is the physician's great reliance for prognosis or diagnosis in many most serious diseases of the nervous and muscular systems.

Nutrition.—No general fact associated with the administration of electricity is more familiar than that the general health—the nutritional processes—are promptly and greatly improved. The exchanges between the blood and the tissues are augmented—the patient absorbs more oxygen and excretes more carbonic acid and urea, and he gains in weight and comfort. But as these tissue exchanges are set up more especially by general administrations, like the franklinic, and by the sinusoidal current with large electrodes of D'Arsonval, we will defer their further consideration until later on.

In general, electricity has been found useful in diseases of the brain, spinal cord, and of the nerves, like paralysis, atrophy, spasm, contractions, anæsthesia, neurasthenia or nerve exhaustion, hysteria, migraine, melancholia, hebephrenia, epilepsy, and general paresis—in anæmia, rheumatism, gout, in many diseases of women, and in numerous surgical affections.

In all of these diseases, the pathology once established, either in fact or in hypothesis, a given property or properties of some given modality of the current is applied to effect a cure.

We have already said enough to point out the enormous power possessed by electricity over some of the functions of living tissue. There is no recess of our bodies so deep but what nerve fibres penetrate to it, or muscular fibre helps to make up its mass. No part of our material mass can escape its influence. And when we speak of high frequency, high potential currents, we shall have occasion to refer more specifically to special and important modifications of function.

The trouble is not that electricity does so little in our human bodies, but that it does so much—we cannot classify, systematize, and properly direct our power. We pause, confused, in the multiplicity and in the interwoven character of tissues and their functions—become bewildered in the problems of biology, the process of vitality—the process of disease. If we falter, let us not blame our noble agency, which is more than ready to do all that we require of it; but blame rather the shortcomings of our own knowledge.

SECTION III.

HIGH FREQUENCY, HIGH POTENTIAL CURRENTS.

In view of the prodigious progress of electrical science and practice in recent years, it is evident that medicine, conservative as it may be, cannot long remain without the pale of the new advances. No one science can stride forward without dragging the others with it. There is a correlation of sciences, just as there is of energies. To-day, medicine is occupied—is pre-occupied, with bacteriology. And no less fascinating is this study, than are substantial the benefits which it has already conferred upon humanity. Electricity in medicine has had one “innings,” and that an unsatisfactory one. Its advent was premature, the nature of the agency itself and its phenomena were uncomprehended, and electro-therapeutics became a synonym for a “vasty deep” of speculative deductions, ignorant methods, and, more unfortunately still, of crafty practices of charlatanism and quackery. The old electro-therapeutics still labors under antiquated physics, confused electro-physiology, and observations colored by the fancies of the observer; the new is being built upon experimentation in the physiologist’s laboratory, and in the electrician’s. The old relied upon *local* applications at the tip of small sponges—by local treatment it sought locally to cure disease; the new, while not neglecting the localizing method, goes further, and by a general application, affects the entire organism, the pulse, the temperature, the lung and the other excretions; in short, all that constitutes the nutrition of the individual. It seeks by exciting the highest degree of the health of the individual to make human tissue an unfit habitation for disease and morbid conditions.

Our antitheses may possibly make the line of distinction too strong, but they will answer our purpose as they serve to emphasize the fact that *general* administration of electricity as a curative agent is quite as, if not more, important than the exclusive local administrations so long in vogue.

This transition to obtaining general effects from electricity in medical use involves a corresponding transition in the nature of the apparatus employed, and in the method.

The new era of the introduction of general effects was initiated by the revival of the use of statical or franklinic electricity in 1879 by Charcot of Paris. The electrostatic bath and spark was a general treatment, and one, as we are only just now learning

with good evidence, of great power, if applied from large machines. But we must here, also give credit to Beard and Rockwell of our own country, who as early as 1868 recognized the nutritional value of general electric treatments and formulated their ideas in a valuable technique comprised under the titles of "central galvanization," and "general faradization."

Franklinism must furthermore be classified under high potential, high frequency currents, and it will be here considered from that point of view. This classification is based upon the self-evident potential and upon the oscillatory nature of spark discharges. What the physical effects in a circuit influenced by electrostatic discharges, particularly in a circuit acted upon inductively, may be, we have only learned in recent years from Mr. Tesla. His genius has flooded the scientific world with a new illumination of ideas and facts, and this illumination has spread backward and invested our older observations with a new and vital interest.

The writer, after a visit to Paris in 1880, and a study of Professor Charcot's work with statical electricity, introduced the subject—general electrostatic administration—to the profession in this country in a formal paper, read before the New York Academy of Medicine, March 3, 1881, bringing home machines and electrodes which served for models to American manufacturers of these instruments.

In this same publication, he first described a method of obtaining high potential, high frequency currents from the influence machine, and pointed out its use and value in therapeutic work, under the title of "A new induction current in medical electricity." Such a current had been hitherto unknown. Its physiological effects as then described, are the Tesla effects, as more recently produced, while its physical effects in the light of Tesla's subsequent investigation, are now seen to be similar. The current was named the "static induced current." But the writer's publication attracted but little attention, since it was confined to medical circles, and the time was not yet ripe for a comprehension of the peculiar effects and the action of currents of an induction circuit, produced by greatly increasing the frequency of the interruption in a primary circuit by aid of a small spark and condensers.

The mechanical means to secure great rapidity in the oscillations or alternations was identical with that pursued ten years

later by Mr. Tesla, and later on by D'Arsonval, Thomson, Hertz, and Lodge, viz:—the use of condensers and a small spark gap, across which a spark was continuously discharging.

Tesla's first publication appeared in February, 1891.

In March 1891, Elihu Thomson made the observation that currents whose current strength was fatal or dangerous to human beings at a slow rate of interruption, could be taken through the body with less danger when the rate was largely increased, and Dr. Edward Tatum, of Yonkers, N. Y., carried out physiological experiments and demonstrated this.

To M. D'Arsonval of Paris, we must accord the development of the physiological effects of high potential, high frequency current. To him we owe a systematization of the facts and a vast amount of original research, while to Messieurs Gautier and Larat, besides their own original labors, we are indebted for the promulgation of the sinusoidal current in its medical applications.

The peculiarity of the physiological effects of high frequency, high potential currents, is that:

a. Currents whose current strength is fatal or dangerous to human beings at a slow rate of interruption, may be taken through the body without danger when the rate is largely increased. One may easily verify this statement with an ordinary medical induction coil, whose primary is supplied from a small alternator. A slow rate gives painful shocks, and as the rate is increased, the current becomes more and more bearable up to a point where almost no effect is appreciated. At the high rates:

b. The sensory nerves are not affected—*i.e.*, little or no pain is felt. (Morton, Tesla, Thomson, D'Arsonval.)

c. The motor nerves are not affected—*i.e.*, little or no movement takes place. (Morton, Tesla, Thomson, D'Arsonval.)

d. Increased tissue changes are manifested by a freer absorption of oxygen, and increased elimination of carbonic acid. (D'Arsonval.)

e. No rise in the temperature of the more central parts of the body. (D'Arsonval.)

f. Dilatation of blood vessels, resulting in lower blood pressure. (D'Arsonval.)

g. Lamps become incandescent when placed in circuit with persons who experience no sensations. (Tesla, D'Arsonval.)

The writer's arrangement of 1881, for the condenser currents

from influence machines, may be calculated to afford 1,500,000 oscillations or alternations per second. Mr. Tesla employed 20,000 per second without Leyden jars, and the frequency with Leyden jars was calculated to equal from 1,000,000 to 1,500,000 per second.

Professor Thomson's alternating current was derived from an alternating dynamo machine, whose highest number of alternations was about 8,000 per second.

M. D'Arsonval's arrangement appears to admit of absolute accuracy in the rate per second up to 10,000 per second, since he employs a specially constructed alternating current dynamo, whose product is a sinusoidal or even wave current. He states, that by the aid of powerful Ruhmkorff coils, condensers, and induction coils, he carries the frequency of interruption up to 1,000,000 per second, while the current strength is five amperes. When we compare these figures with the 200 per second rate of the ordinary medical induction coil, it is plain that we are treading on different ground, and there is no doubt that in high frequency, high potential currents, that is to say in currents which are of high electromotive force, and which alternate or flow in opposite directions a great number of times per second, we possess in medicine an ally as valuable in the cure of disease as any other type or modality of current like the galvanic and the faradic or ordinary frequency of interruption.

To-day, then, we may obtain the currents under discussion :

1. From Morton's apparatus, viz., from the influence machine by condenser currents ; (1881.)
2. From Tesla's apparatus ; (February 21st, 1891.)
3. From Thomson's apparatus ; (March, 1891.)
4. From D'Arsonval's high frequency sinusoidal apparatus ; (February 24, 1891.)

But, since it is the Tesla experiments, performed with apparatus capable of affording an alternating electrostatic field of great energy, which have in reality brought into prominence not only the electrostatic phenomena of influence machines, but also all electrostatic phenomena of currents, I think it best to abandon the historical order in favor of one which has served, and continues to serve to demonstrate the subject most fully, and by effects utterly impossible to obtain in degree from any influence machine.

grasped in his hand; another to the triceps throws the arms violently backward; his fingers extend and flex, as the corresponding muscles are touched; a spark to nerve trunks produces the familiar hand postures, just as when the ulnar or median nerves are excited in galvanism or faradism. Before your eyes are taking place profound excitations of nerve and muscle, visible, objective evidence of the power of this current which has been said by some doctors to be superficial, and not to penetrate beneath the skin. Were our patient's temperature below the normal, as is more commonly the case than is suspected in many chronic diseases, you would find that it rose to normal. In fact, had we time to examine our patient more critically, we could determine with positiveness alterations in his pulse and temperature, and the amount of urea, and phosphates excreted. We could, in fact, establish great alterations for good in the chemical organic exchanges or oxygen combustions which are the essence of health, and equally the essence of cure. Evidently we have before us a medical instrumentality of great power, even though it be the ancient Holtz machine whose phenomena have been too long neglected, both by the electrician and the physician.

Striking as are the differences between the electric product of the influence machine and our small galvanic and faradic exciters of electric energy, in reality the differences are more apparent than real, and the kinship of the different modalities of electricity, however excited are most easily established.

With the electric product of this machine we may repeat in lesser degree any experiment which may be accomplished by the galvanic or faradic currents.

That form of electricity, known as statical, has an enormous E. M. F. and low amperage; that known as galvanic, an enormous amperage and low E. M. F.; but neither is without one element or the other; it is merely a question of degree or ratio.

The so-called dynamic or current electricity of the physician is also static, while the static is also dynamic or current electricity. While a Holtz machine exhibits a voltage of 100,000 to a spark one inch in length, or say, easily a total voltage of 1,000,000, represented by a spark ten inches in length, a voltaic cell exhibits a total voltage of only $1\frac{1}{2}$. But the cell represents many amperes, while the machine represents merely a very small fraction of an ampere.

In medical work no deductions based upon these facts can be justly cited for the purpose of making invidious distinctions as to

their respective curative value. Preponderating c. s. does its special work, and preponderating E. M. F. does *its* special work. It is merely a question of the work to be done. Knowing these differences, the physician selects one or the other, together with some one or more of its special properties, and pits a given producible effect against a known or presumed condition of disease; this is a scientific method in contradistinction to simple empiricism.

Historical.—The spark and frictional electricity have long held sway in medicine, beginning with the time in 1730, when Stephen Gray discovered conduction and insulation, and drew sparks from a boy suspended by strands of horse-hair. It was the Abbé Nollét, however, who shortly after drew the first spark with the idea of curing disease; that spark marked the dawn of electro-therapeutics. Then followed the brilliant discoveries of the older philosophers and of the doctors—both of science and of medicine—who floundered about in their attempts to establish the identity of electricity with nerve force, with vital force, with life itself, and thus hoped to find the elixir of life, and probe that deepest mystery. The miasm of their speculations yet clings to the purlieu of medicine. And yet to the mind unaccustomed to scientific thought, the modern view that electricity and light are identical, seems almost as marvellous.

In connection with early electro-therapeutics, it is interesting to us Americans to recall that Benjamin Franklin in 1752 in Philadelphia was treating paralytics by shocks from his Leyden jars. One patient, a young lady, who had for ten years been tortured with convulsions, thus quaintly describes her experience :

“ At length my spirits were quite broke and subdued with so many year’s affliction, and indeed I was almost grown desperate, being left without hope of relief. About this time there was great talk of the wonderful power of electricity; and as a person reduc’d to the last extremity is glad to catch at any thing, I happened to think it might be useful to me. Altho’ I could have no encouragement from any experiment in the like case, I resolv’d to try, let the e’ent be what it might; for death was more desirable than life, on the terms I enjoy’d it. Accordingly I went to Philadelphia, the beginning of September, 1752, and apply’d to B. Franklin, who I thought understood it best of any person here. I receiv’d four shocks morning and evening; they were what they call 200 strokes of the wheel, which fills an eight gallon bottle, and indeed they were very severe.

"On receiving the first shock, I felt the fit very strong, but the
 "second effectually carry'd it off; and thus it was every time I
 "went through the operation; yet the symptoms gradually de-
 "creased, 'till at length they entirely left me. I staid in town
 "but two weeks, and when I went home, B. Franklin was so
 "good as to supply me with a globe and bottle, to electrify my-
 "self every day for three months. The fits were soon carried off,
 "but the cramp continued somewhat longer, tho' it was scarcely
 "troublesome, and very seldom return'd. I now enjoy such a
 "state of health, as I wou'd have given all the world for, this

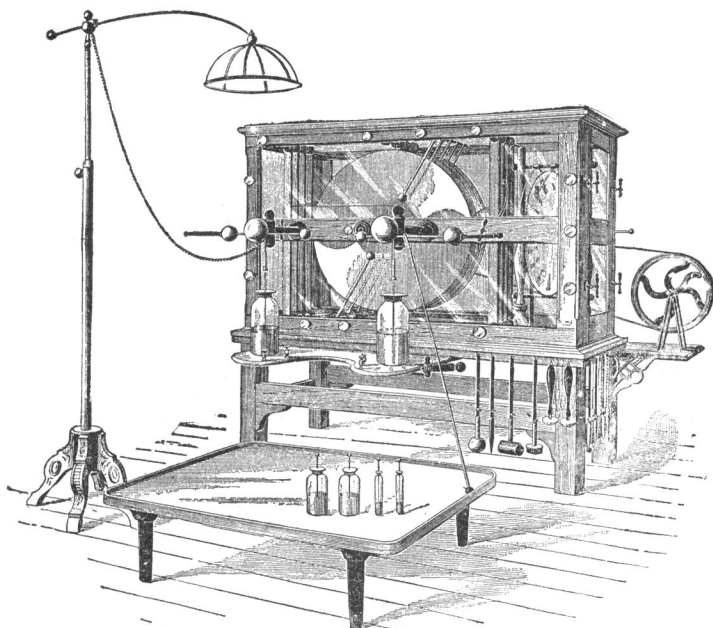


FIG. 1. Morton-Wimshurst Influence Machine for Therapeutical use.

"time two years, if it had been in my power, and I have great
 "reason to hope it will continue."

I will merely remark further in passing, that the discovery of the Leyden jar in 1746, the discoveries of Galvani and Volta about 1800, and of induction electricity, completed by 1840, each formed historical epochs which gave to medicine respectively, franklinism, faradism and galvanism.

THE INFLUENCE MACHINE AND ITS ADAPTATION TO MEDICAL USE.

It is here enough to say of an influence machine, that it, like any other device for exciting electricity, presents two polar terminals;

these are termed prime conductors. In the Holtz machine one vertical half of the revolving plates is always of one polarity, the other of the opposite, and the prime conductors in connection with each half are similarly of opposite polarity.

The machine I use I have had constructed by the Galvano-Faradic Co., of New York. It is in reality a Wimshurst-Holtz machine. It has eight 30-inch in diameter revolving disks, and six rectangular dividing plates. It easily gives a 12-inch spark.

Within the glass case is a small Wimshurst exciter to charge the large plates in humid weather. In addition to the usual

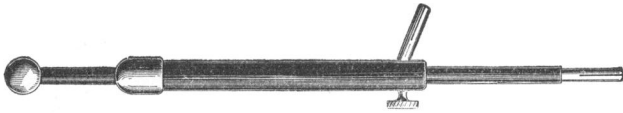


FIG. 2. Electrode for Bipolar treatment with induced currents from static machines.

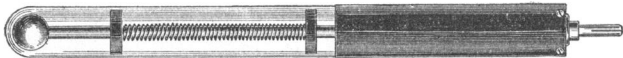


FIG. 3. Vaginal Electrode for applying static spark to the uterus or in other cavities of the body.

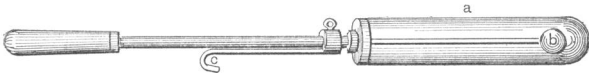


FIG. 4. Usual form of Bipolar Electrode especially insulated, is used with the Static Induced Current.

arrangements for spark and spray administrations, this machine has mechanical devices for the production of the Morton current from condensers, and furthermore a transformer for still further modifying this current. The machine is believed to embody all the modern improvements for medical and laboratory use.

Electrodes.—The electrodes most used are a brass ball and a point, one for sparks, the other for spray. The best working diameter for the ball is $1\frac{5}{8}$ inches. To apply sparks to a precise spot or within the cavities of the body, I have devised two electrodes, here illustrated. The brass ball is surrounded by a glass

tube like a test tube, and the rounded end is perforated with a small hole for the passage of the spark.

The usual form of bipolar electrode especially insulated is used with the static induced current.

METHODS OF ADMINISTRATION AND CONNECTIONS.

The patient is :

a. Placed upon an insulated platform by the older and classical method.

b. Uninsulated by my method of employing condenser currents.

Insulated.—The platform is connected to whichever prime conductor is desired, commonly the positive. He is now simply an extension of the conductor, and enlarges its static capacity.

In this position, the static charge escapes from the charged patient :

a. By leakage.

b. By a brush discharge, established by a pointed electrode.

c. By disruptive discharge or spark, established by a ball electrode.

The electrodes are provided with insulated handles, and their conducting portion is attached to a chain which is in turn :

a. Attached to the other prime conductor—direct method ;

b. Led to the ground—indirect method.

The direct method is commonly employed, but gives a painful, irritating spark, and should never be used. The indirect method, by grounding, gives a long, clear spark, and is by far less painful.

In working with electricity of this high E. M. F., the mere act of grounding seems to me to be superior, because it affords a large capacity surface in surrounding objects, rather than because it supplies an earth circuit in the ordinary acceptation of the term.

Many physicians have objected to this treatment by saying—“Yes, true, you communicate an electric charge to the patient’s surface, and you draw it off, but no effect takes place within the patient and beneath the surface.” A practical answer to the objector is to administer to him a spark, when his deepest groups of muscles will contract and convince him that the effect is not superficial. A physical answer is, that the patient is actually a charged insulated conductor, and since he constitutes a conductor, by a well known law of electricity, his potential at every point, within and without, is the same. But each spark drops his po.

{ May 17,
{ Sept. 20,

tential to zero, therefore, his potential within as well as without is equally dropped to zero and we must admit that instead of being superficial, no treatment could be more complete in its effects upon every molecule of the organism submitted to it. This is undoubtedly the reason why in electrostatical treatments the entire nutritional processes of the body are affected, and corresponding cures of disease produced.

Ordinarily, administrations are either by the spray, brush discharge, or by electric bath, as it is sometimes called, and by the spark. The former is used about fifteen minutes, the latter, from five to ten. The spark should be long, clean, and percussive when deep effects are desired; and frictional, caused by rubbing the metallic ball electrode over the body, when counter-irritant, revulsive and reflex effects are to be obtained. It is a great convenience of this method of treatment that it is not necessary to remove any part of the clothing.

When the patient is treated:

Uninsulated.—By the static induced current, the output of the machine at its terminals is simply a current and no longer a spark. The patient is not submitted to a “charge,” but is treated as if by a galvanic or faradic apparatus. The current itself will be referred to separately.

PHYSICS AND PHYSIOLOGICAL ACTION.

Any extended allusion to the physics of electrostatics would be entirely out of place. I shall merely ricochet, so to speak, over this territory, just touching ground at intervals where physics and medicine meet in some emphatic relation.

The experimental facts of the class-room are familiar to all. But from nature's laboratory we may derive a passing thought. We may call upon the lightning for an analogy to our spark, administered to our patient, and upon electrical conditions of the atmosphere for an analogy to his state of electric charge while sitting upon the insulated platform. In every thunderstorm we have a laboratory experiment; every day we bathe in a certain electric potential corresponding to the electrostatic bath.

What points then should be noticed? What deductions may we draw?

The lightning is a great spark; its effects are mechanical, physical and physiological. Mechanically, it often moves great masses, displaces and transports them ; it performs, in short, on a

large scale a cataphoresis, just as on small scale, we transport medicines through the skin, or move about fluids in the tissues. The spark of the influence machine produces a molecular perturbation at every point where it strikes, a sort of molecular gymnastics, so to speak, or displacement of tissue, accompanied by corresponding changes in nutrition—new blood flows to the part, the lymphatics increase in activity, and carry off effete material; there is a local revivification.

Again, the great spark kills people, and upon their bodies are found marks indicating mechanical rupture of their tissues. If they recover, there frequently remains extensive paralysis of parts of the nervous system; if they die, no evidence of the cause of death is ascertainable beyond the organic injury mentioned. What has caused their death? The same question has been asked, and not yet answered, in regard to the death of criminals “electrocuted,” and in regard to “linemen” who fall from a pole, shocked by the electric current. Picture to yourselves the amoeba, the little cellular organism, and recall the experiments which demonstrated that with successive severe shocks of a varying current, the amoeba first assumes a spherical form, and then perhaps regains it, but finally remains, as the shock is increased, without power of motion. Live protoplasm has in short become dead protoplasm; the living animal has become a dead animal; the effect of an electric shock has been to deprive the protoplasm of the power of contractility. No microscopical changes have been found in human beings who have been “electrocuted.” It is perfectly justifiable to conclude that the shock has deprived organs essential to life of their power of action. Such, it has seemed to me, on a small scale, and in a lesser degree, always consonant with the vitality of a part, may be, and undoubtedly is, the effect of a spark, an effect which, although always short of molecular death, is accompanied by profound changes in its nutritional activity.

Recently, D’Arsonval has thrown an element of terrible doubt into the conviction that most of us hold, that electricity kills the criminal at our State “electrocutions.” The criminal is not killed, he says, but his physiological functions are inhibited; that is to say, brought to a standstill by the action of the electricity upon the nerves. The criminal is not therefore dead, but is, as it were, in a trance from which he may be resuscitated by proper measures, and it is the surgeon’s knife at the autopsy table which in reality kills him.

He claims that many supposed to be dead from what appeared to be fatal shock have been revived by proper measures. There is but one reply to D'Arsonval's statement. It is to postpone the autopsy until it is positive from the evidence of decomposition that the body is actually dead.

And in this connection, should not the proper measures of resuscitation be studied in our emergency hospitals, and be applied to linemen and others who seem to have received fatal shocks? How many valuable lives have been saved of those who appeared to be dead from drowning? This phase of D'Arsonval's statement seems to me to be most worthy of attention on the part of this society.

The lightning has again a chemical effect, an effect of synthesis; it forces a combination of O_2 , the common oxygen of the air, into O_3 , or ozone, the odor of which is familiar to all during the course of thunder storms, and while our influence machine is working.

Again, the lightning has a directly physical effect in the fusion of metals, and the bearing of this fact is mainly interesting to us in establishing the fact that static electricity is kinetic, when it discharges, and obeys Ohm's law, viz.:

$$C. \text{ (current strength)} = \frac{E}{R}.$$

The fact illustrates to us the *amperes* of statical electrization, while the mechanical effects, just alluded to, illustrate the *volts*.

As regards atmospheric electricity more than one fact is of interest to us. Under a clear sky the air is always positive, and increases in the degree of its positivity as we ascend, as has been demonstrated in balloons, while the earth is always negative. Under a cloudy sky, the conditions vary; both the name of the electricity and the potential vary. Thus, we are continuously under the influence of unseen electric baths, either positive or negative. On a clear day, we are always in a negative bath; on a cloudy day, we may be in a negative or in a positive bath. The analogy to the state of the patient on an insulated stool is obvious. *Query*: Have these electrical conditions of the atmosphere anything to do with the variations in our health? It is well known that those who suffer from neuralgia, gout and rheumatism, and spinal cord diseases, and neurasthenia, and nervous people in general, feel worse on a cloudy day, or better on a clear one.

And since they are in their best health on fair days, in other words, when negatively electrified, may this not furnish some clue in general to the utility of the electric bath by insulation, and particularly, to a discrimination as to whether the positive or the negative bath should be used? It would seem that a negative insulation would be indicated in the diseases named. I will say that I have found those who are susceptible to these atmospheric changes are equally susceptible to the electric bath by insulation, and that many neurasthenics are rendered excitable and sleepless by the positive insulation, but are on the other hand soothed by the negative insulation. This in general coincides with the impressions of the older writers, who are in habit of alluding to the negative insulation as "depressing." These observations may teach us at least to be wary of attaching our patients indiscriminately to one or the other pole, as is too often done. Custom and the construction of their machines have led many continental observers to use the negative insulation, while the positive is the more frequently used in our own country. These differences in attachment may have led to the different reports as to the effect of the bath itself. While upon this subject, I should say that there is objective evidence based upon the experiments in my clinic at the Post-graduate Medical School and Hospital that the bath alone will produce an increase in the pulse, a change in the temperature, and a modification of the quantity of the urea and phosphates excreted in the twenty-four hours.

If we choose to attach importance to the electrical conditions of the atmosphere, it is interesting to note our position as human beings, situated in a strained dielectric—the air—and near a conductor, the earth. We may compare ourselves to a small spot in the glass of a Leyden jar, near the tin-foil coating. It cannot be denied that we are subject to alterations due to the differences of strain in the dielectric; it is quite another question whether this position has any important effect upon our health, and it is more than probable that like many others of the conditions under which we live, we have adapted ourselves by evolution to the relation which is said to be at the basis of life, that is to say, the adjustment of our internal organization to our external surroundings.

Can the human body itself exhibit statical polarity due to any changes or properties within it? If the skin is dry, statical electrification may be produced upon the human body, just as it is

upon that of a cat, by friction, but there is no evidence that the organism itself can produce statical electricity.

And again, we may call up points in physics which invest the powerful spark of our influence machine with a pregnant meaning in relation to our human organism. To Galvani is attributed the observation that paved the way to the magnificent discovery of the development of electricity by chemical action, but it is also related that the very first phenomenon which attracted his attention was that the frog's legs, skinned and prepared for supper, hanging not far from where the spark of a frictional machine was passing, sprung into contraction at each spark. Mrs. Galvani, it is said, by the way, was the first to notice this. Each spark, in the rushing downfall of potential which made it possible, let drop at the same instant the accumulated potential of surrounding objects, among them the frog's leg and its support, and living tissue exhibited its function, that of contraction. Are we, as similar living tissue, not affected every time a spark passes in our neighborhood? Like the frog's legs, our organisms constitute an apparatus capable of responding to the ether vibrations of each spark; how susceptible surrounding space is to the ether waves set up by the spark, is little realized. Stretched wires in the same room throb with each pulsation and spark, in unison at each little break in their continuity. Nodal points, as demonstrated by Hertz, may be found on these wires, and the wave lengths measured off in yards, or the waves may be focussed, reflected, or refracted. Joseph Henry observing that a simple spark, one inch in length thrown on to a circuit of wire, produced an induction sufficiently powerful to magnetize needles in a parallel circuit thirty feet distant, remarks, that "a single spark is sufficient to disturb perceptibly the electricity of space throughout at least a cube of 400,000 feet of capacity."

With this machine I have made a simple experiment, showing the far-reaching disturbance in the ether caused by the passing spark. Glow lamps, pierced by a single conductor may be laid about the room, upon the floor, upon tables and suspended, and as the spark jumps across a small air-gap, they light up with a purple glow. Edison 16-candle power lamps will answer the purpose admirably. A small strip of tin-foil is fastened around the outside of the bulb by a rubber band, while a few yards of insulated wire is similarly attached to the brass of the lamp. A condenser circuit is thus established. And had I here an influ-

ence machine large enough, we could, of course, light up this room with vacuum tubes suspended about it, not by single long sparks, but with the spark continuously crossing a small air-gap, as I used it in demonstrating my condenser currents in 1880. These are the effects that Tesla has demonstrated upon a magnificent scale. But they may be repeated on a lesser scale with the electrostatic machine, particularly the brush discharge and the vacuum glows. They are cited here merely to show us that the electrostatic machine is, as I have mentioned, in reality a high frequency, high potential current. It is the spark that is the key-note to these effects; we do not even need an artificial condenser like the Leyden jar; the objects about, furnish the electric capacity, and the impulsive rush of their discharge cause the phenomena in the space about.

It is evident that the principal effect of the spray and the spark is exerted upon the nervous system. Motor nerves stimulated by a spark, cause muscular contraction, and thus the entire muscular mass of the body is set into movement, causing quickened flow in the blood vessels and increased health of the muscle, and that while shunning the electrolytic or chemically decomposing effects of galvanic currents.

The sensory nerves, particularly those of the skin, are stimulated, and exert upon the nerve centres a remarkable influence by throwing in upon them their impulses, due to their peripheral excitation. The circulation is also quickened by direct action upon the nerves which supply the blood vessels; there is dilatation of the cutaneous vessels, so that the patient experiences a glow of warmth, a moderate and often an extreme perspiration, and on the whole a pleasant reaction similar to that following the bath, or moderate exercise in the open air. The normal pulse is usually raised from five to fifteen beats, but the pulse of disease is raised if slow, and slowed if fast. As a result of extended observations upon the temperature, I have deduced this law, which, I think, will stand the test of further observations for the spray, viz.: that a normal temperature is slightly raised; that a temperature below normal is raised to normal; that a temperature above normal is lowered. These changes in the temperature average from one to two degrees Fahrenheit. My researches, not yet published in detail, show that the spray produces, or tends to produce a normal rate in both pulse and temperature.

ALTERNATING CURRENTS OF HIGH POTENTIAL AND HIGH
FREQUENCY, VIZ.: TESLA'S APPARATUS AND CURRENTS.
"RAPIDLY ALTERNATING ELECTROSTATIC STRESSES."

It is characteristic of alternating currents, that their energy is manifested, not so much *in* the wire, as in the space surrounding it, and the greater the frequency and the potential, the more extensive do some of the phenomena outside of the wire become. In this space, energized by the alternating current traversing the wire, may be exhibited by the aid of proper devices arranged to capture and transform the electric energy, light, heat, mechanical motion and chemical action; lamps glow, metals fuse, motors are caused to spin, and chemicals to combine. And this space around the current conveying wire is not narrowed to minute fractions of an inch, but may be measured in yards. Here is a field of force within whose influence a patient may be readily brought. Such a field would be termed an alternating electrostatic field; it is most marked around the terminals of a secondary coil whose primary is conveying an alternating current. It is the same field as that associated with the spark discharges of electrostatic machines, and even in a lesser degree with our best constructed medical induction coils, as I have shown by glow lamp tests applied to them.

The electrostatic field was indeed familiar to all; but in a feeble and minor degree. In medicine it has been a prominent feature of administrations from the influence machine in both simple insulation of the patient, in the spark, and more particularly in my own method of the static induced or interrupted current, and has been in medical use in connection with that machine. But so far as relates to induction coils, little or no account has been taken of the electrostatic properties of the current. Our attention has been wholly occupied, as has been that of the electrical engineers, with the current in the wire, and not with properties of this current—the electrostatic field outside of it.

But in induction coils affording high frequency, high potential currents, for instance, from hand to hand, it must now be noted that we have to deal with two effects—1st. The effect of the direct passage of the current through the body, and : 2nd, the lateral, surging, wave impulses spreading out in every direction from the passing current. The former of these effects alone has hitherto claimed attention. That the latter effects now

claim attention alike in the industries and in medicine is due to the wonderful experiments of Nikola Tesla. We have, as he modestly says, the same apparatus, the induction coil, and the same phenomena, only the apparatus is operated differently, and the phenomena are presented in a different aspect. So different indeed is the aspect of the phenomena that the entire scientific world hails their presentation as a revelation.

Mr. Tesla's first publication was in the *Electrical World*, of Feb. 21, 1891, under the title of "Phenomena of Alternating Currents of very High Frequency." Referring to effects upon the human body he writes, "the discharge of even a very large coil cannot produce seriously injurious effects, whereas, if the same coil were operated with a current of lower frequency, though the E. M. F. would be much smaller, the discharge would be most certainly injurious." The writer's experiences tend to show that the higher the frequency the greater the amount of electrical energy which may be passed through the body without serious discomfort."

The Tesla Apparatus.—Mr. Tesla obtains the high frequency mechanically, and by the aid of a well known natural phenomenon—mechanically by a specially constructed dynamo machine giving a frequency of about 10,000 per second, and naturally, by aid of the intensely rapid alternating or oscillating discharge of Leyden jars or condensers. The latter carry the frequency up to anywhere from 500,000 to 1,500,000 alternations per second. Low frequency may, however, be employed when the condensers are in the secondary circuit.

How important an element the Leyden jar may be in increasing frequency both in the electrostatic phenomena of the influence machine already in medical use, and in the Tesla apparatus, may be judged of from a calculation of Dr. Oliver J. Lodge that a common pint Leyden jar discharged through an ordinary discharging rod will possess a rate of oscillation equal to about ten million per second.

Mr. Tesla's high potential is due to the frequency and to "step up" transformation by coils. It consists practically of a high frequency dynamo whose current enters a primary wire, a secondary wire within whose circuit is included a condenser and discharging rods, and again a coil to which a part of the secondary wire acts as a primary.

The Tesla effects, as they are now frequently termed, are obtained :

a. By direct connection with both terminals.

b. In the space intervening between the terminals, or in the space about either one singly.

Using the apparatus above described with alternating current dynamos of low or high frequency, Tesla obtains remarkable effects. Among them may be noted :

a. The brush discharge.

With two cotton covered wires arranged parallel and near to one another, the wires are strongly illuminated by streams of flame, spreading from one to the other. The brush led from a circle of wire, 30 centimetres in diameter, to a small brass sphere, is formed into a beautiful cone of light, or again, concentrated upon small, thin wires, greatly intensifies the light.

With two circles of wire, respectively 30 and 50 centimetres in diameter, a continuous circular luminous sheet is produced.

An increase of the molecular or atomic vibration changes the color of the discharges from purplish to white.

In these experiments, the molecules of air about the terminals are intensely agitated, and give rise to the light.

b. Rotation of a motor connected to one terminal wire only of the coil.

c. Illumination of exhausted bulbs or lamps containing a refractory substance sealed within them, and when attached only to one terminal of the coil, the molecular bombardment within the bulb incandescences the refractory substance, and emits light. Such substances are fused, disintegrated and dissipated by the intense electric bombardment.

Buttons of carbon, diamond, pumice-stone and carborundum were used. To protect the leading-in wire from the effects of the bombardment, a screen aluminium tube may be used, which acts electrostatically by reason of its conductivity, and also mechanically; the screen, becoming charged, economizes the energy supplied to the bulb by not taking it up after it is once charged. Again, the same exhausted bulbs are illuminated without the aid of a leading-in wire, the energy required being transmitted through the glass.

d. To excite vacuum tubes throughout the whole extent of a room, lighting up the tube wherever it is held in space, and at a distance from the conductor, the intense electrostatic field is set

up by converting the oscillatory current of a condenser to a higher potential. Such a field Mr. Tesla establishes between two sheets of metal several yards in area and several yards apart. A vacuum tube held within the space between the metal sheets, glows intensely.

It becomes an interesting question to determine to what extent high potential, high frequency currents may be of value in medicine. The shock from the secondary coils above described are very light and can be taken without inconvenience. This to many has seemed remarkable on account of the very high voltage. Much speculation has been indulged in as to why these currents do not produce great muscular contraction, and great pain, and dangerous results. It has been suggested that the rapidity of the alternations is too great to excite the nerves, or again, that the current thus generated does not penetrate the conductor, but traverses only its surface. An explanation would seem to me to be that the current strength of what seems to be a killing current is comparatively small, since it is reduced enormously by each "step up" transformation. But other explanations are advanced.

In the immunity from pain and muscular contraction observed by D'Arsonval with a low frequency and a current strength of 5 amperes, another explanation must be sought for, and this is the comparatively gradual rise and fall of potential characteristic of the sinusoidal current, and physiologically vastly different in its effects from the impulsive rush of the condenser currents of Tesla and myself. D'Arsonval's high rate of frequency is obtained from an alternator and from induction coils, and condensers.

Whatever effects are to be obtained from Tesla currents must be obtained :

- a. By the direct passage of the current through the person.
- b. By this means, and by taking into account the lateral electrostatic surgings outward from this direct current.
- c. By interposing the patient within the rapidly alternating electrostatic stresses constituting the field between the terminals, and yet not in contact with them.

Electro-dynamic induction effects need not probably be taken into account.

The extended physiological effects of the Tesla currents have yet to be investigated, since no apparatus has been available to

physicians or physiologists, but judging from the powerful effects upon human beings of the currents of electrostatic machines whose output is more feeble in total energy, even if equal in potential, these currents seem to me to promise most interesting and most fruitful results.

We can in our imagination picture a future group of patients pursuing any agreeable occupation, reading, conversing, playing games, and so on, in a room whose two opposite walls are of metal connected to the two terminals of a Tesla apparatus, and thus submitted to a furious molecular bombardment in the intervening space. We can imagine the surprise of the new comers, as they see the vacuum tubes carried in their hands burst into a glow of light when they are brought within the influence of the magical and invisible stream. We know that their temperatures would be raised by the bombardment, and we cannot help believing, though awaiting the proof, that profound alterations in their nutritional processes would be produced, whose influence would be far reaching in the cure of disease, particularly of the functional type.

ELIHU THOMSON'S HIGH FREQUENCY, HIGH POTENTIAL CURRENTS. THOMSON APPARATUS.

Professor Thomson's apparatus consisted of an alternating machine having 100 armature coils and capable of producing 8,000 alternations per second. This machine was placed at the disposal of Dr. Edw. Tatum, of Yonkers, N. Y., and he conducted extensive physiological experiments with it, bearing upon the action of high tension currents upon animal life.

Dr. Tatum's work upon the physiological effects of high frequency currents embodied in a letter to Professor Thomson, December 29, 1890, and published May, 1891, deserves much higher recognition than it has received. He established :

1. That the fatal effects of alternating currents upon animals was in inverse ratio to the frequency.
2. That the cause of pain, which limits voluntary toleration, lies chiefly in the muscular contraction produced.
3. That the cutaneous nerves were distinctly less painfully affected at the high rate.
4. That the vital mechanism was not excited at the high rate even at a pressure of fifteen volts, so as to cause a sensation of flames of light; although two or three volts similarly applied at 120 alternations, caused such flashes very energetically.

5. That the sensation of vertigo, produced by the low rate, was not produced by the high.

6. That sensations of taste were absent to the high rates.

7. That exposed motor nerves of frogs were less excitable to the high than to the low rate.

SINUSOIDAL CURRENTS.

D'ARSONVAL'S HIGH POTENTIAL, HIGH FREQUENCY CURRENTS.

Starting from this fundamental fact, that when a current passes through the human organism the excitations are due to variations in its strength, D'Arsonval first studied the effects of a single wave of known form, and then the effects of periodic waves. For careful physiological investigation his first form of apparatus was an alternating dynamo without iron, capable of furnishing 10,000 alternations per second. The current thus produced was passed through the primary of an induction coil, having no iron core. With low frequencies neither pain nor muscular contraction was produced, but the current thus generated increased the tissue absorption of oxygen and the excretion of carbonic acid. It also acted as a sedative to pain.

He next adopted the method involving the continuous discharge of sparks between the discharging rods of a powerful Ruhmkorff coil connecting two Leyden jars to each terminal by their interior tin-foil coatings and connecting their outer coatings by a thick copper wire solenoid of from fifteen to twenty turns. A wire led off from each end of the solenoid furnished the currents for his experiments in extreme frequency.

When the Ruhmkorff coil was replaced by an alternating dynamo, D'Arsonval sent through his body a current of more than three amperes without inconvenience, except for some feeling of heat in the hands.

The phenomena observed were :

1. No effect upon the organs of feeling.
2. No muscular contraction.
3. Diminution of the sense of pain.
4. Dilatation of the blood vessels.
5. Increased perspiration.
6. Increased tissue change, manifested by increased absorption of oxygen and increased elimination of carbonic acid.

7. No increase of bodily temperature.

The fact that when the number of oscillations is extremely high, there is no excitation of the nerves and muscles, D'Arsonval communicated to the Biological Society, February 24 and April, 1891.

D'Arsonval's view is, that the nerves and their centres, if not all of the tissues, respond only to excitations of a certain frequency, and that, therefore, if these currents fail to excite pain or contraction, it is because their periods do not coincide with the periods of the nerves, producing pain and contraction.

The changes in the human body above described, are of great value in electro-therapeutics. Their practical application demands an increase in the size of the ordinary electrodes, best met, probably, by using water as in a bath.

HIGH POTENTIAL, HIGH FREQUENCY CURRENTS FROM AN INFLUENCE MACHINE AND CONDENSERS, VIZ., MORTON CURRENTS.

In view of the interest which is now being attached to currents of a high rate of frequency and the methods of their production, the writer asks your forbearance in reading a brief quotation upon this subject, from an article by himself, "On Static Electro-therapeutics or Treatment of Disease by Franklinism," read before the New York Academy of Medicine, March 3, 1881, and printed in the *N. Y. Medical Record*, April 12, 1881.

"A NEW INDUCTION CURRENT IN MEDICAL ELECTRICITY.

"Thus far, in describing the methods of administering static electricity for medical purposes from the induction electrical machine, I have confined myself to what has been previously known on the subject. The three main methods of administration up to the present time have been by insulation, by sparks, and by shocks."

"I now venture to add a fourth method, that of the *induced current* produced by static electricity, and capable, like the currents induced by magnets and the voltaic circuit, of causing physiological tetanus. In other words, by a simple arrangement, the frictional machine may be converted into a machine which will do all the work of the best faradic machine."

"We thus have at command in a frictional machine all of faradism, in addition to the static electricity; for working purposes we have all the advantages of both systems."

"Taking the Holtz machine as it stands, the change may be quickly effected. We remove the connecting-bar between the two *outer* coatings of our Leyden jars, connect ordinary conducting wires and wet-sponge electrodes to each outer coating respectively, and, finally, connect the two *inner* coatings by the discharging rod. The patient, of course, need not now be insulated. As soon as the machine is set in motion and the condensers are filled, the discharging rod may be drawn out a very small fraction of an inch, and at once a current is felt between the two sponge electrodes, which in its general characteristics cannot be distinguished from the ordinary faradic current. Owing to its very high tension, however, it is necessary to have the handles of the electrodes well insulated and free from metal points, in order to avoid the fine prickling sparks which pass into the hands of the operator. It is soft and agreeable, and accompanied by no shock. This current is not to be confounded with the series of discharges taking place between the *inner* coatings of the jars. This latter, in silent current forms, produces no muscular contractions or sensations of any kind. In slight repeated discharges it is too painful to be borne. A superficial trial shows one difference in favor of the static-induced, as compared with the galvano or magneto-induced current. The static-induced both produces more efficient contractions and gives less pain to the patient, where pain would be produced by any of the three. With it the whole motor apparatus of the body may be called in action at its several points, nerves stimulated and other effects produced, just as with faradism."

"The current may be regulated to a nicety by means of the discharging-rod, ranging from an almost imperceptible tingle up to extreme and rigid flexion of the arms, should, for instance, the electrodes be held in the hands."

"This, then, is an entirely new current in medicine, and it is not a little curious that with all the experience with frictional machines, it should have remained undiscovered up to the present day."

And again:

"This current is more agreeable in its administration than ordinary induction currents;" "it has a record yet to make."

The writer continued his experiments with currents from influence machines with no further publication in the 80's, than a few lines by Dr. Ambrose L. Ranney, in his "Static Electricity in Medicine," published in 1887, in which he writes: "Dr. Morton has also been experimenting of late upon the effects of deriving currents from a helix of insulated wire wound upon each of the Leyden jars of a Holtz induction machine."

But on December 2, 1890, he read an extended paper upon this high frequency, high potential current, before the New York Neurological Society (published in the *New York Medical Record* of January 24, 1891), giving a second description of the apparatus and an account of the current's physical and physiological properties and its medical applications.

Of the apparatus it was said, "That the circuit-breaker is a pair of adjustable metallic ball electrodes, introduced at any point of the circuit, having a narrow air space between the balls; the circuit 'makes' when a small spark overcomes the resistance of the intervening air, and 'breaks' when it fails to do so, and the current is due to rapidly successive equalizations of the differences of potential of oppositely charged condensers."

"The circuit-breaker serves:

"1. To afford time to the condensers to charge."

"2 To regulate the frequency of the discharge."

"3. To determine the strength of the current. This latter may be varied at will and with the utmost nicety, from a just perceptible to a most powerful effect."

"The spark circuit-breaker now practically represents the vibrator in the primary of an induction coil; the specific inductive capacity of the air replacing the spring and its magnetic attractability, and I use it as in that example and in the same relations, *i.e.*, to interrupt the primary current and by reason of an interrupted primary to obtain a secondary current. Each impulse in itself consists of a vast number and range of oscillations or alternations (of one hundred millions, for instance, per second) and, we may doubtless willingly concede that a current, whose physical properties so positively differ from other currents, must possess equally positive and differing physiological properties."

The following diagram, among many others, was used to illustrate the condenser current, called at that time by the writer the "static induced current." [Fig. 5.]

And of the current it was said, "In the franklinic interrupted or static induced current, each impulse consists of a series of alternating opposite currents of almost inconceivable rapidity. Joseph Henry discovered that each discharge of a Leyden jar was oscillatory in character, not a single transfer of electricity from one side of a jar to another. In making his original statement, he wrote, there is 'a principal discharge in one direction, and then several reflex actions backward and forward, each more feeble than the preceding, until the equilibrium is obtained.' His discovery was corroborated, and the theory of it worked out by Sir William Thomson, Fedderson, Helmholtz, Schiller and others. As now stated by eminent physicists, the number of alternations to each spark is from one hundred thou-

“sand to one hundred million per second, according to the capacity and inertia of the circuit. Induction coils have been constructed, giving eight thousand vibrations per second; two hundred per second is probably an average of the medical faradic coil. We cannot, therefore, compare the franklinic interrupted current to such coils.”

“For computing the spark interruption to be at least two hundred per second, and the oscillations of each spark to be one hundred millions per second, we have a current giving twenty billions alternations per second. Vast as such a number may seem to our minds, familiar with two hundred vibrations per second, it pales before the desideratum expressed by Professor Elihu Thomson, who said in a recent lecture, ‘What is needed is a machine having an alternating current making five

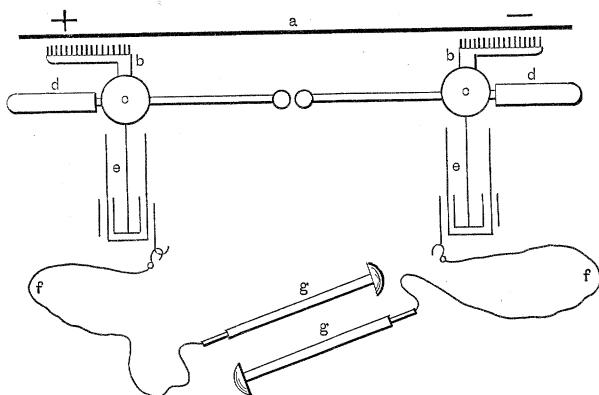


FIG. 5. Static Induced Current. Circuit of a Holtz Machine with or without Condensers.

a, Rotating plate; *b*, *b*, collecting combs; *c*, *c*, prime conductors; *d*, *d*, discharge rods; *e*, *e*, Leyden jars; *f*, *f*, conducting cords; *g*, *g*, sponge or other electrodes. Person, condenser, and circuit-breaker, in same circuit, connecting-rod between condensers removed, and discharging-rods of machine serving as circuit-breaker; but the circuit-breaker is in the primary circuit, and the person in the secondary. The make and break in the primary is accompanied with a current in the secondary.

“hundred trillions of vibrations per second, which would produce many wonderful results.’ If, then, I were to be asked how the franklinic current differs from the ordinary faradic coil, I should reply, that this one difference of rate of alternations alone placed the two far apart. But, it may be urged, the current of the induction coil is far greater than that of the influence machine in quantity. This is, of course, true. But at this point in favor of the franklinic interrupted comes in the element of time. ‘The motor nerve,’ says DuBois Reymond, ‘is not stimulated by the absolute density of the current density at any given moment, but by variations from one instant to the other, and the effect produced by these rapid changes, increases with their rapidity and their greatness in a given time.’ Thus, in

"the great rapidity of the alternating (oscillating) currents of the spark discharge, particularly in rapid series as in the franklinic interrupted, we find the reason, despite smallness in quantity, for accomplishing work in producing nerve and muscle stimulation, equal at least to the comparatively slow discharge of the interrupted galvanic, or the slowly oscillating induction coil."

"I have at least made it clear, I trust, that the new current is strongly differentiated from the galvanic or faradic currents, and taking into account its enormous voltage or pressure of 53,000 per linear centimetre, viz., its power of overcoming resistance in the human body conductor, and its other characteristics as above pointed out, we have a right to expect in its medical applications physiological effects differing from those of the other electric currents thus far brought into medical use."

"Among other purely physical experiments I have made, I will mention that it produces a loud and clear sound in a telephone resembling the sounds made by an induction coil."

"*Clinical Properties and Medical Uses of the Franklinic Interrupted Current.*—Since we are dealing with a current and not a spark, and with the familiar sponge or metallic electrodes, we may invade the entire field traversed by galvanism and faradism, and ascertain for ourselves such differences and similarities as may exist."

"Applied to a motor point, the franklinic interrupted current produces most vivid and persistent muscular contraction *with a minimum of pain*; applied farther back on the trunk of a motor nerve it throws large groups of muscles into contraction. The contraction is *peculiarly painless as compared with that of faradic coils, and the influence is remarkably diffusive*. Accompanying a contraction of a large group of muscles is a peculiar sensory sensation of lightness and buoyancy of the member. *The painlessness, diffusiveness and buoyancy* may all be experienced by holding the two electrodes in the hands, and taking a current as strong as possible. Most people will readily submit to flexions successively at the wrists, elbows, and even to the shoulders, before insisting upon taking no more. The arms during the passage of the current feel as if made of cork, and this feeling of lightness persists for some time. The quality of the current is such, that while energetically exciting the motor function of the nerve-filaments, it fails to excite or may even annul, to an extent, the sensation of muscular pain. Its penetrating, diffusive, painless effect, with strong muscular contractions, adapt it admirably to general application over the entire body as an electric in place of an ordinary massage."

"It is, of course, applicable to every form of muscular paralysis, for there is no practical stimulus to nerve and muscle except the electric, and none more energetic than this form of it."

"Its effects upon the Hallerian irritability of the muscular tissue necessarily includes an effect upon the local circulation of a part and upon the lymphatics, and to this may doubtless be referred many clinical results of relief, as in lumbago and all forms of muscular rheumatism, subacute and chronic rheumatic affections of the joints, ovarian or pelvic pain, sciatica or other neuralgias."

"The second prominent characteristic of this current is its power of relieving pain. Leaving out of sight the part, be it more or less, played by circulatory changes referred to, in this respect there seems to exist a specific analgesic quality in the current. The cotton feeling in the hands, and subjective sense of buoyancy in the arms, is in itself an evidence of this. But the effect upon pelvic pain, upon ovaritis, upon neuralgias, pleuritic 'stitches,' tonsillitis, and many other pain affections is still better evidence. In sciatica, for instance, the sensation of pain is frequently quickly relieved and a cure obtained, though I think in this case the cause is twofold, that is to say due to both the circulatory and the analgesic effect. The same I believe to be true in the pelvic and ovarian pains."

"The results in such cases, in my opinion, are far superior to anything attainable by a faradic or a galvanic application. As no observations on the purely analgesic effects of this current have hitherto been made, I must leave others to test the question for themselves. And as the paper is not clinical, but simply to outline the subject in a general way, I cannot burden it with cases."

These views, as to the peculiar properties and physiological effects of high frequency, high potential currents, were read December 2, 1890, and published January 24, 1891, while the electrical mechanism for raising and varying the potential and securing a high rate of oscillation by means of the spark gap and condensers was described and published in 1881, both publications being therefore prior to all others.

"The motor effect, including the circulatory, cannot be denied; the pain-annulling effect, though clinically demonstrable, is difficult to explain. Perhaps the extraordinary frequency of the alternations of the current per second may explain it. These alternations, it will be recollected, I computed might easily amount to twenty thousand million per second. My own view is that the great frequency, the fineness, so to speak, of the electric vibrations, which we know as a matter of fact are set up in the nerve-filaments, interferes with and annuls the pain impulse. The carbon filament of a glowing incandescent electric lamp, situated ten feet away from an influence machine discharging sparks, has been seen to break. It had evidently been thrown into violent vibration. If it had had a vibration

“of its own before being subject to the electric vibration, it
 “would have lost it and fallen under the influence of the stronger
 “vibratory influence. Again a vibrating tuning-fork may lose
 “its motions by reason of the interfering vibrations of another
 “more powerful one, and finally vibrate in unison with it. Or
 “electrically a stretched platinum wire may be thrown into
 “visible vibration by the alternating current which at the same
 “time heats it to redness. Medically, I venture the suggestion
 “that the nerve-filaments are set into similar vibrations, and that
 “these overcome the pain by simple agitation of the mass of the
 “constituent elements of the nerve-fibre, and thus an annulment
 “of its capacity to conduct pain impulses, just as concussion or
 “anæsthesia of brain-tissue may be said to annul its capacity to
 “respond to sensory impressions. The experiments of Mortimer
 “Granville with his percuteur taught us the benumbing influence

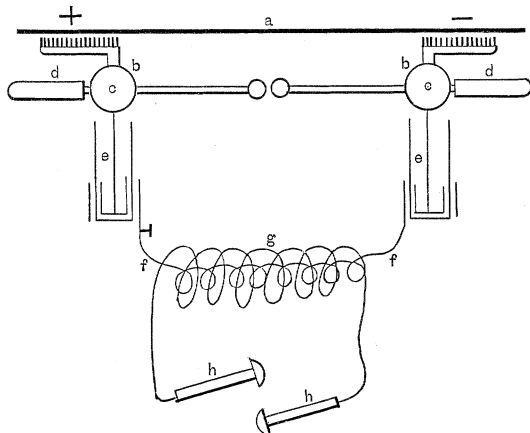


FIG. 6. Holtz Machine with Condensers.

a, Rotating plate; *b*, *b'*, collecting combs; *c*, *c'*, prime conductors; *d*, *d'*, discharge rods; *e*, *e'*, Leyden jars; *f*, *f'*, primary wire of induction coil; *h*, *h'*, electrodes.

“upon painful nerves of even coarse vibrations. With alternating electric impulses of twenty thousand millions per second, more or less, we may find explanation of the analgesic effect of the franklinic interrupted current. Furthermore, its static quality would enable it to set up an influence in anatomical parts regardless of the intervening medium, as witness the action of the Phelps-Edison induction telegraph, where an inductive circuit sufficient to work a telephone may be set up across an air-space of even forty feet. Surely the analogies of electrophysics are safe guides, and the only safe standpoint from which to study the action of electricity upon the human body.”

Fig. 6 represents a transformer for my condensed currents. Upon actuating the influence machine and approximating the

discharging rods to a point where a continuous stream of sparks crosses the air-gap, the current from the two outer coatings of the condensers is caused to pass through a primary, and is taken off from a secondary. One of my coils, now in use for several years, and made for me by the Waite and Bartlett Manufacturing Company, has a *primary* of No. 32 wire of 600 ohms resistance, and a *secondary* of coarse wire 2 ohms resistance. Such coils worked only with a very small spark, owing to the difficulties of insulation, until the advent of oil insulation, when their efficiency became greatly increased.

Exhausted bulbs provided with a single conducting wire within, and a condenser plate without, glow brightly when placed in the

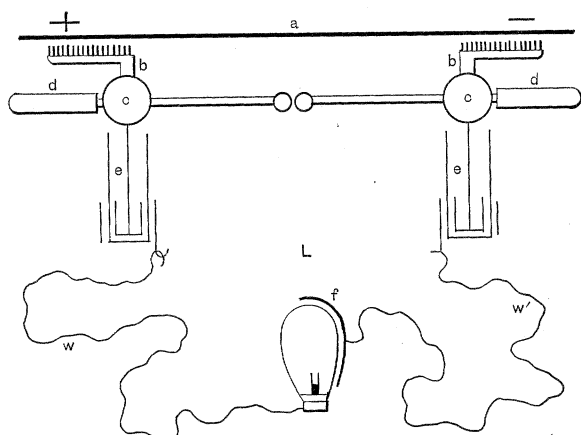


FIG. 7. Parts of Influence Machine and Condensers as before described.

L, an Edison 16-candle power lamp with broken filament; *f*, a piece of tinfoil laid against a portion of the bulb; *w*, wire leading to filament; *w'*, leading to tin foil.

secondary circuit. The physiological effects are most peculiar, and I must leave their description to another occasion. In some of my transformers I substitute flat spirals of wire for the solenoid form.

To illustrate the beautiful illuminating effect that may be produced with the condenser current, I will make but one simple experiment, first calling your attention to a diagram showing the connections.

Fig. 7, parts of influence machine and condensers, as before described, *L*; an Edison 16-candle power lamp with broken

and condensers in this circuit, and had pointed out peculiar physiological effects due to increasing the frequency of the current by this means.

CONCLUSION.

We are now entering upon the new era of the non-medicinal treatment of disease, especially chronic diseases. The leaven that has worked toward this end was implanted in this country away back in 1860 by one of the ablest men of his day, Dr. Jacob Bigelow, of Boston, in a treatise upon "Nature in Disease." It was a protest against expecting that every disease had its medicinal antidote. The days of a general and comprehensive antidotal treatment are numbered. The first dawns of light were the recognition that many diseases were self-limited, and could be left largely to Nature's processes. Then came the recommendations for fresh air, for exercise out-of-doors, for congenial surroundings, and appropriate food. Next the recognition of the importance of massage, of Swedish movement, of hydrotherapy and of electricity, viz.: of treatments which essentially produce an increased demand for the oxygen of the air, for an increased capacity on the part of the blood to convey it to tissue, and a correspondingly increased oxidation of the tissue and assimilation of food. The patient's "respiratory circulation" is improved—consequently his nutrition improves, and, finally, his so-called disease disappears. This remark applies most strictly to that great class of diseases which oppress humanity, viz.: functional diseases, so called. Electricity leads the way in the advance; its dosage is measurable with precision; its effects are equally precise; they constitute the objective evidence of the treatment, viz.: acceleration of the heart action, of the blood circulation, regulation of the temperature, and increased absorption of oxygen, with a corresponding increase of waste products, like urea, creatinin, carbonic acid and water—the ashes of the human system—while at the same time the poisonous by-products, like uric acid, etc., viz.: materials due to incomplete oxidation, are diminished.

A human body is an oxydizing furnace, and the draught is increased electricity. If the draught is good, the fuel is completely burned, the apparatus does not choke up, the ashes are at a maximum and the highest degree of energy is derived from the mechanism—in our case, a living, human, fuel-consuming and oxydizing organization.

In short, to put the matter tersely, if crudely, we shall live longer and be healthier, if we burn out rather than rust out.

The law of life is motion—light, heat, chemical affinity, all are motion; possibly material matter itself is ether in motion—the processes of life are chemical processes—the resultant energy developed, is the mechanical force displayed by our muscles—the neural impulses conducted by our nerves, and the action of what we call our mind. Muscles, nerves and brain are but organic foci for the development of these energies by physical processes.

Electricity, judiciously employed, promotes the activity of the physical processes underlying life and health. It may even constitute the motive power which drives the machinery of life. Be that as it may, we know that we can alter the running of the vital machine for weal or for woe by intelligently turning an electric current in upon it.

We physicians, when we use electricity, are also electrical engineers; but our workshop holds its problems of health and of life and death. Do you, the members of this society, ever pause to realize that you are relieved from this responsibility? Do you wonder that those who would grasp this problem are ever striving for aid—and that you, with your trained minds, and special researches, may be of vast aid?

Are not our pathways parallel and often harmonious? That they may be is my devout wish.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

NEW YORK, November 15th, 1893.

The eighty-first meeting of the INSTITUTE was held at 12 West 31st Street this date, and was called to order by President Houston at 8 P. M.

THE PRESIDENT:—The Secretary will please read the minutes of the last meeting.

[The Secretary proceeded with the reading of the minutes.]

DR. M. I. PUPIN:—I move that the reading of the minutes be dispensed with.

[The motion was carried.]

THE PRESIDENT:—Unless the INSTITUTE desires to take up other work we will proceed with the regular business of the meeting.

THE SECRETARY:—At the meeting of Council held this afternoon the following associate members were transferred to full membership:

[Approved by Board of Examiners, October 3, 1893.]

ARNOLD, BION J.	Consulting Engineer, General Electric Co., 4128 Prairie Ave., Chicago, Ill.
PARKHURST, CHAS. D.	Lieut. 4th Artillery U. S. A., Fort McHenry, Md.
DION, ALFRED A.	Supt. and Electrician, Chaudiere Electric Light and Power Co., Ltd., Ottawa, Ont.
UEBELACKER, CHAS. F.	Firm of E. P. Roberts & Co., Mechanical and Elec- trical Engineers, Cleveland, O.
LLOYD, ROBERT MCA.	Electrician, 2 West 36th St., New York.

Total 5.

THE PRESIDENT:—We will now proceed to the regular order. The first thing will be the discussion of the report of the special committee of Council appointed at the last meeting on "Local Meetings of the Institute." Mr. Herbert Laws Webb is chairman of that committee.

[Mr. Webb read the report, which is printed, as amended by the meeting, at the end of the discussion, see page 623.]

THE PRESIDENT:—Gentlemen, you have heard this report. What action will you take on it?

MR. TOWNSEND WOLCOTT:—I move the report be accepted.

[The motion was carried.]

THE PRESIDENT:—Will you now consider the report as a whole or seriatim?

A MEMBER:—I move it be considered seriatim.

THE PRESIDENT:—If there is no objection, it is so ordered.

"The first recommendation is that "it is the opinion of the committee that provision should be made for local meetings of the members at points inconveniently distant from New York for the reading and discussion of papers accepted by the INSTITUTE."

"The committee is of opinion that Section 6 of the Rules of the INSTITUTE, authorizing the secretary 'to call a special meeting on a requisition signed by fifteen or more members' was not intended to and does not cover local meetings of the character contemplated in this report."

Rule VI refers to meetings. The part under consideration reads: "Special meetings may be called whenever the Council sees fit; and the Secretary shall call a special meeting on a requisition signed by fifteen or more members."

MR. JAMES HAMBLET:—I move the adoption of that as read.

THE PRESIDENT:—It is moved that Sections 1 and 2 of this report be adopted.

THE SECRETARY:—Do I understand that this now becomes the official interpretation of Rule VI.?

THE PRESIDENT:—That particular part of Rule VI., certainly; so far as the calling of special meetings of this character is concerned.

THE SECRETARY:—I would like to ask, simply for my own information, if the committee, or others, in considering this rule, have taken it as based on its reading, or on what was intended by the authors of the rule that it should mean; and whether, when this meeting passes upon it, that it becomes the official interpretation of the rule. There have been prior decisions in regard to this rule—decisions by presidents and others. It is immaterial to me; but it would seem that the rule should be interpreted strictly as it is read.

MR. WEBB:—I do not see how there can be any difficulty of that kind, because we simply say that the rule does not apply to meetings of the character intended.

MR. WOLCOTT:—As I understand, the Secretary says there have been previous decisions on this same point; and if there is no objection I would like him to read the previous decisions, if they are available.

THE SECRETARY:—The decision is not in regard to meetings held anywhere in particular, because when the INSTITUTE was organized there was no really official place of meeting. The Rules of the INSTITUTE, as I stated in my paper, were based on those of the American Institute of Mining Engineers, which does not even hold meetings in New York City regularly—although its headquarters are here. Its meetings are held in various parts

of the country. At the meeting of the INSTITUTE held May 18th, 1886, when these monthly meetings of the INSTITUTE were first under consideration, the President said in regard to the discussion of holding meetings:

"The discussion is an informal one. There is no motion before the meeting. As far as this matter of dining together and arranging about a room is concerned, that is a matter that the individual members can do as they please about. They have the privilege of meeting here if they want to, and if they prefer to meet somewhere else, they can make their own arrangements. All we have to consider, so far as I can see is, what authorization from the main body of the INSTITUTE is necessary so as to give the proceedings an official character."

Later on, after a committee on monthly meetings had reported, Captain Michaelis, since deceased, but who was present when the rules were amended, made the following remarks in regard to the holding of meetings:

"I happen to have an intimate knowledge of certain questions of the constitution of the INSTITUTE, for the reason that I was present at the meeting when they were amended. I think it very well to have monthly meetings, but you can only reach them in one or two ways, without an amendment to the constitution. They can only be held as special meetings, unless they be social gatherings and do not partake of the formal character of authorized meetings where business can be done. The constitution provides that meetings may be called in two ways: by the Secretary on the written request of fifteen members; or the Council may call a special meeting. This committee can only make recommendations, and then either have a call signed by fifteen members of the INSTITUTE and presented to the Secretary, who would then call a special meeting, or they might recommend to the Council to call a special meeting at such a time as they saw fit, but that is the only way. This meeting cannot provide for the monthly meetings. In fact there cannot be monthly meetings until the constitution is amended. There can only be special meetings called in the manner indicated. I do not desire to make any point about it at all, but only to state what the constitutional provisions are."

MR. GEORGE M. PHELPS:—I take it that the development of our work during this last nine years has not been founded on any very precise organic or constitutional provisions, and whatever may be the fact in regard to the growth of our monthly meetings which we have held in New York, whether they were well or ill founded upon any rules at that time, they have become by prescription and use a recognized feature of the work of the INSTITUTE, and I can see no harm in determining one way or the other, yes or no, in respect to the interpretation put upon that clause of Rule VI referred to in the report of the Committee. It seems to me that whatever the relations of these New York

meetings that have been held may be to the rule, it would be very undesirable indeed to let the interpretation go forth of that portion of Rule VI referred to, which would permit fifteen members anywhere to hold a meeting that should have an official character as a meeting of the INSTITUTE. And it was with that in view that the committee thought it was in their province, since that point had been brought up by the Secretary and others—they consider it within their province to suggest an authoritative interpretation, or a limitation rather of the scope of that clause in Rule VI. It seems to me eminently desirable to have a decision on that point.

THE PRESIDENT:—Gentlemen, if you read Rule VI. carefully, I think you will find no difficulty whatever. I do not see how it is possible to put any such construction on the rule as appears to have been put on it by some. This is a special meeting of the INSTITUTE at which the regular officers of the INSTITUTE are to preside that is referred to in Rule VI. Rule VI. refers to other meetings of the AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS held under its regularly elected and constituted officers, that shall be held in addition to the annual meeting. It is customary in all by-laws of societies to provide means whereby other meetings than the regularly appointed meetings can be held on a proper call of the members. But to consider this rule as applying to other meetings held elsewhere, at which the regularly appointed officers of the INSTITUTE do not preside, would be folly, to my mind. According to that, it would be possible to divide the INSTITUTE into as many separate meetings, held in as many separate places, as you could divide your membership by fifteen or more. Clearly that meaning was never intended to be put on the rule. This would be a fair case: If in San Francisco or in Lynn or in any other city, fifteen or more members of the INSTITUTE wanted to hold a meeting at which the regular officers of the INSTITUTE could preside, it might be possible to hold it there, but I do not think it would be possible under the by-laws. If you ask for my decision that would be my interpretation of the by-law.

MR. WOLCOTT:—These meetings have no legislative power. I do not see how they could divide the INSTITUTE in any sense. They are not allowed to do anything except what is done at the other meetings—simply read papers and discuss them.

THE PRESIDENT:—I beg pardon, but what are you discussing now, Rule VI.?

MR. WOLCOTT:—This kind of meeting—I said that in connection with your remark.

THE PRESIDENT:—My remark applies to Rule VI. and not to these particular meetings. I was asked for a decision, and my decision was that the special meetings referred to under Article VI. were not the same as the local meetings.

MR. PHELPS:—If you will pardon me one moment, I believe the thing immediately before us is the adoption of clauses 1 and

2 of the report—the first committing the INSTITUTE to the declaration that it is desirable to provide for local meetings, and the second clause interpreting the clause in Rule VI. as not applying to such meetings. Am I right?

THE PRESIDENT:—Yes; and I understand the gentleman wishes to speak to that motion. Am I right, sir?

MR. WOLCOTT:—Yes, sir.

THE PRESIDENT:—You have the floor, sir.

MR. WOLCOTT:—If it is in order in that connection, I will ask who is supposed to interpret the Rules officially.

THE PRESIDENT:—I imagine, sir, that you elect your President for that purpose when he presides. In the absence of the President, I imagine that you elect the Council for that purpose.

MR. WOLCOTT:—I wanted to raise the question whether the Council is the official interpreter of the Rules.

THE PRESIDENT:—Perhaps you would be willing to express to the INSTITUTE what you think Council is elected for if it is not to interpret the Rules of your body.

MR. WOLCOTT:—It seems to have plenty of other duties.

THE PRESIDENT:—If there is no other discussion, Mr. Hamblet's motion is now before the INSTITUTE. Mr. Hamblet moved, that Sections 1 and 2 be approved. That question is now before the INSTITUTE. Are you ready for the question?

[The motion was carried.]

THE PRESIDENT:—I will now read Section 3. This consists of recommendations A, B, C, and D. I will read A:

“Third. The Committee presents the following plan for the holding of local meetings of members:

“A. When not less than twenty members in any stated locality shall in writing notify the Secretary of the INSTITUTE of their desire to hold local meetings, such request shall be presented to the Council at its first meeting thereafter. The Council shall then, upon the recommendation and nomination of the signers of the request for local meetings, appoint a local honorary secretary who shall be a member or associate member of the INSTITUTE residing in the specified locality.”

Section A is now before you.

THE SECRETARY:—In order to remove all question of doubt as to the interpretation of the rule, I would move that the number of members as fixed by the committee, be changed from twenty to fifteen; not because I am fully satisfied that a local membership of fifteen would be sufficient to lead to a healthy series of meetings, but because, in my opinion, which is respectfully submitted, there might be a question raised as to the interpretation of that rule in regard to the number, and I would be glad to hear from the committee as to any reasons they may have for changing the number.

MR. PHELPS:—It has just been interpreted by the meeting that that rule does not apply to this case.

THE SECRETARY:—Mr. President, I am fully aware of that. But we have with us thirty members, perhaps forty, and we have outside probably seven hundred members, and with all due respect to the gentlemen here, I presume that they are capable of reading the English language, and I simply offer that as a suggestion to remove any possible doubt as to the propriety of the report—not that the Rules be altered and made twenty to conform with the committee's report, but that the committee's report be amended to conform to the Rules.

MR. WEBB:—I should like to say that fixing the number at twenty was precisely with the object of cutting off all connection with that rule.

THE PRESIDENT:—A very sensible reason.

MR. CUTTRISS:—I cannot see that our worthy secretary's argument has very much bearing on this question—that there are only forty people present out of our membership in New York. It is the fault of the other people not being here to discuss it.

THE SECRETARY:—I am perfectly satisfied with that. It is a good and cogent reason. But at the same time it appears to me that this is a mere question of detail, and I do not wish you to think that I am insisting upon it because it was my interpretation of the Rule. I do not care to make any attempt that that idea should prevail. It is simply a question of removing this doubt, and it is a question between fifteen members and twenty members. It may be, as the chairman of the committee said, that that number was recommended to remove all relationship to the rule. So far as that is concerned, I would be just as willing to have it twenty-five as twenty or fifteen. I would not for a moment be inclined to listen to ten. I think it better to go up rather than down. It is simply in the interest of having it jibe, so to speak.

MR. MARTIN:—I think there is a great deal of wisdom and good sense in what Mr. Pope has advanced, if we remember the fact that when we started our New York monthly meetings we considered that the limit in the rules for New York was good enough if it was fifteen. Whether we consider the old rule or not, let us at least be generous enough to look at our fellows elsewhere and give them a chance to start their meetings, immediately on the same basis as we started our own. I think the committee is not particularly anxious about twenty. I do not know that it will make any particular difference as to the number of monthly meetings we could start, whether it be fifteen or twenty. Mr. Pope is willing to have the limit fifteen. If that will give him ten monthly meetings to look after instead of five, be it on his head.

MR. W. J. HAMMER:—When this matter came before the committee the original limitation was fifteen, and as Mr. Webb says, when the matter was thoroughly discussed it was decided to make it twenty in order that this might not in any way clash with the

words in Rule VI. There are two cities, Chicago and Boston, including the Lynn delegation, which could raise twenty members or more. Philadelphia has nearly that number, and probably in a short time they could get sufficient new members to get it up to twenty. I think the INSTITUTE should go a little slowly in this matter, whatever action is taken, and it seems to me twenty is low enough. I think it is just as well to steer clear of that point of fifteen, so that hereafter there will not be any discussion as to the interpretation.

THE PRESIDENT:—If there is any lingering doubt in the minds of the forty here, as there appears to remain in the Secretary's mind, as to Rule VI having any connection whatsoever with the calling of local meetings, I would urge on the INSTITUTE to make the number something else than fifteen, or we will find that will be urged as a reason—as an interpretation of the rule. Whereas clearly I think there can be no doubt that Rule VI has nothing to do with this case. It is a different kind of meeting entirely. Rule VI is intended to cover a special meeting of the INSTITUTE held wherever it may be held, under the direction of the regularly appointed officers of the meeting. No other than that can be a meeting of the INSTITUTE. To suppose for a moment that we could have ten or fifteen meetings of one and the same INSTITUTE is, to my mind, very illogical. If therefore there is going to be any question in the hereafter as to whether or not Rule VI applies to local meetings, I hope, if the INSTITUTE agrees with me in this very simple English, that they will carry out the recommendation of the committee in making it some other number than the number referred to in Rule VI.

MR. PHELPS:—I understand the Secretary to move, in order that we may have something before us to discuss—to move as an amendment that the number be changed from twenty to fifteen. Is that so?

THE SECRETARY:—That was my intention, yes.

THE PRESIDENT:—Is that motion seconded?

MR. WOLCOTT:—I second it.

THE PRESIDENT:—It is moved and seconded that paragraph A of Section third of the committee's report be amended to read "When not less than fifteen members" in place of "when not less than twenty members."

[The amendment was lost.]

A MEMBER:—I move that the recommendation A be adopted as read.

[The motion was carried.]

THE PRESIDENT [Reading]:—"B. The duties of the local "honorary secretary shall be in general to serve as a channel of "communication between local members and the general body of "members through the Secretary and Council. But no member "in any locality shall be debarred from direct communication "with the INSTITUTE."

A MEMBER :—I move the adoption of that as read.

[The motion was carried.]

THE PRESIDENT [Reading] :—"C. In any locality where a local honorary secretary shall have been appointed, local meetings may be held, the local members to elect their own chairman. Said meetings to be known as the meeting of THE ——— MEMBERS OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. Such meetings shall be for the purpose of reading, by the authors or by proxy, and of discussing papers accepted by the INSTITUTE, and such papers only. Such local meetings shall be held simultaneously with the INSTITUTE meetings or subsequently. That is to say no paper before the INSTITUTE shall be read or discussed at a local meeting in advance of its reading at the INSTITUTE meeting."

DR. CHARLES E. EMERY :—Mr. Chairman, I move the adoption of that section, and in connection therewith beg permission to present my views on the general subject very briefly. The plan proposed I consider an admirable one as a tentative movement. Action of this nature is necessarily experimental. You cannot at first say what will be necessary or what the outgrowth will be. I am much obliged to the committee for mentioning so prominently the plan I outlined at the previous meeting, and I venture to say, I think that something of that kind will eventually grow out of the present movement. At the same time I am moving to have the present matter tried, because it is simpler and it has in some respects an advantage in keeping the matter entirely within the hands of the INSTITUTE, which I can see the members would be pleased to have arranged. The difficulty about the membership of other societies is not brought up in any way so long as it is kept entirely within this society, and if the pressure for this additional class of members or a class of members having certain privileges, which were provided for in the other paper, comes up strongly enough here, some provision can be made for such distinction. I am very much pleased with the report of the committee as a whole, and would have no hesitation in moving that the rest be adopted. But I think we will do better to adopt it by sections, and I take pleasure in moving the adoption of this particular section.

MR. MARTIN :—Might I ask for the reading of the clause that relates to the presiding officers?

THE PRESIDENT [Reading] :—"The local members to elect their own chairman."

MR. MARTIN :—The only point I wanted to get at was, whether it was the intention of the committee that the chairman should be chosen month by month or whether it should be an annual office; because it seems they are creating two offices at once, within the scope of the report.

MR. WEBB :—The intention was that the chairman might differ from meeting to meeting. Each meeting would elect its chairman.

MR. HAMMER :—The only local officer the INSTITUTE recognizes is the honorary secretary.

MR. PHELPS :—I suppose that under the rules suggested by the committee it would be open to the local meeting to elect a chairman at each meeting or to take one for three months or six months as they pleased. It is their affair entirely. Mr. Hammer has covered it by reference to the fact that the local honorary secretary provided for, is the only official person created by the action of the INSTITUTE.

THE PRESIDENT :—Does that answer your inquiry, Mr. Martin?

MR. MARTIN :—Yes. But I think it would be a little more business-like to have some one whose duty it is to be there and attend to the running of these meetings.

THE SECRETARY :—I would like to inquire what would be the status for instance of a Vice-President in one of those cities where a meeting of this kind was held; whether his official capacity as an officer of the INSTITUTE would not give him a natural precedence as the presiding officer and cover the point Mr. Martin suggests.

DR. EMERY :—I would be glad to accept an amendment to my motion that a Vice-President present at the meeting shall preside, or that the presiding officer shall be selected by the meeting.

MR. HAMMER :—When this was before the committee I think I had the honor of recommending that if these local departments were organized in Chicago and other cities, thereafter the INSTITUTE could make their presiding officer a Vice-President of the INSTITUTE, or if there was a Vice-President located in that section that he would be recognized as the local officer. But the committee decided, and I think wisely so, that this ought to be left entirely to the judgment of the local members; that the INSTITUTE does not desire to dictate to them, and outside of desiring to endorse their nomination for an honorary secretary, that the government of the meeting was left entirely to the local members.

MR. PHELPS :—The chances are, I should say, about 100 to 1 that in any locality desiring local meetings and possessing among its members a Vice-President—the chances are about 100 to 1 that he will be selected as the local chairman, and that would seem to cover the matter entirely. Of course, so far as his status is concerned it is to be the same as that of any other member.

THE PRESIDENT :—If you will pardon the Chair for taking part in the discussion, isn't there just a little bit of difficulty here? That if you have a Vice-President of the INSTITUTE to preside always at a local meeting that that local meeting will come to assume a little different grade than some other local meetings?

MR. PHELPS :—I do not think so, sir.

THE PRESIDENT :—It is somewhat an unfortunate thing that in our discussions here everything is put down and printed. Still I will not hesitate to express myself freely. The question of local meetings is a very difficult question properly to handle. On the

one hand we have a large membership that finds difficulty in getting to New York and naturally wants to get all the advantages out of the AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS that it can. On the other hand we do not want to set up rival meetings which may and probably will in the near future raise the question as to which is the governing body and which is the offshoot. I would rather see, personally, these local meetings presided over by any officer that they may choose to select, and to let the plan as formulated by the committee that the local honorary secretary be the only official that the main body recognizes. There is no objection, of course, to the local body having a Vice-President as their presiding officer. They probably would select him if he was in the place. But I think it would be preferable not to say that they must have him. Else I fear this question would arise in the near future as to whether there was a difference in the grade between that kind of a local meeting and a local meeting in which they had only a presiding officer who was not a regularly elected officer of the INSTITUTE. Of course this is for you to decide. I think it is an important matter.

MR. PHELPS:—Precisely, Mr. President. A Vice-President residing in a given locality, if elected, will preside at those meetings, not as a Vice-President of the INSTITUTE, but as chairman of the meeting.

THE PRESIDENT:—It is moved and seconded that Section C be adopted as read.

[The motion was carried.]

THE PRESIDENT [Reading]:—"D. Wherever a local meeting shall have been provided for as in the foregoing section, the local honorary secretary shall be supplied by the Secretary of the INSTITUTE with advance copies of papers to be read before the INSTITUTE, which copies he shall distribute to the local members before their regular meetings. The local honorary secretary shall transmit to the Secretary of the INSTITUTE a report of the discussion or comments on papers that he may receive from members in his locality."

THE SECRETARY:—I wish to apologize for speaking too frequently on this subject, but I understand that this is the sole business of the evening, and the report is being read for the purpose of being discussed—

THE PRESIDENT:—Always glad to hear from you, Mr. Pope.

THE SECRETARY:—The Committee in recommending that advance copies be sent to the local secretary for distribution has perhaps failed to note one of the provisions of the postal regulations, and the conditions under which these papers are mailed now, and also the fact that it should be our purpose to relieve the local secretary as much as possible from the drudgery of an honorary office. I would therefore submit to the consideration of the INSTITUTE the fact that under ordinary circumstances the papers as now printed are mailed in advance direct to the mem-

bers and would probably reach them from one to two days earlier than if they were sent to the local secretary and distributed by him. By the plan of the committee the local secretary would not only have to go to the trouble of redistributing them, but of paying two cents local postage. We mail them from New York City at one cent per pound. When the regular mail edition did not go out, the general secretary even then could mail from this office direct to the members and save a day's time. That appears to me a technical objection to the plan suggested.

DR. EMERY :—I second the amendment.

MR. PHELPS :—I think Mr. Pope has presented an extremely valuable point and has corrected the committee in an important matter. As a member of the committee I can say that I believe the impression of the committee was—it was my own impression—that at present the advance copies of papers were only sent out within a restricted district. I was not aware that they went to the entire membership of the INSTITUTE. If that is the case I can readily see that some amendment to this section is desirable.

THE SECRETARY :—I would say further, Mr. President, that ordinarily it is my purpose to get them in the mail on Saturday night. In that case they reach Chicago, for instance, on Monday morning, at the same time that they are distributed in New York City, which is perhaps two or three days in advance of the meeting.

MR. PHELPS :—Then they are, as a matter of fact, sent to the entire list of members?

THE SECRETARY :—They are all mailed at the same time.

MR. HAMMER :—A change of a few words here would meet the difficulty, I think. "Wherever local meetings shall have been provided for, as in the foregoing section, the local honorary secretary shall be supplied by the Secretary of the INSTITUTE with a number of advance copies of papers to be read before the INSTITUTE, which copies of papers he shall distribute to the members 'at' their local meeting", using the word "at" instead of "before". It seems to me that the insertion of those three words would cover that point, and not at all interfere with Mr. Pope's suggestion.

THE PRESIDENT :—Mr. Hammer moves to amend as follows: To insert after the word "with" "a number of", making it read "with a number of advance copies"; and to strike out the word "before" and substitute the word "at", making the clauses read "which copies he shall distribute to the local members at their local meetings"; making the whole clause read as follows:

"Wherever local meetings shall have been provided for as in the foregoing section, the local honorary secretary shall be supplied by the Secretary of the INSTITUTE with a number of advance copies of papers to be read before the INSTITUTE, which copies he shall distribute to the local members at their local meetings".

MR. PHELPS:—I suggest the insertion of the word “suitable” —a suitable number.

THE PRESIDENT:—Do you accept that?

MR. HAMMER:—Yes, sir.

SECRETARY POPE:—I suggest the substitution of the word “may” for “shall”.

THE PRESIDENT:—Do you accept that?

MR. HAMMER:—Yes, sir.

THE PRESIDENT:—Gentlemen, are you ready to vote on the amendment?

Those in favor of amending Paragraph D of Section 3, as read, will signify their assent by saying aye—contrary minded, no.

[The motion was carried.]

THE PRESIDENT:—Now we will take a vote on the article as amended.

MR. MARTIN:—I would like to ask for information, Mr. President, about this very important point as it seems to me. The local honorary secretary is burdened with transmitting to the Secretary of the INSTITUTE the discussion at the local meetings. I would like to understand how that is to be done and what it would lead up to, and where we shall come out.

DR. EMERY:—There is a further point—who is to discuss the papers? That raises the question at once of local membership of this society. It was attempted at one time to get some revenue from such discussions, but it is not well to bring that question up now, but only to see that it must be met sometime. The question is whether we shall say the discussions shall be by members of the INSTITUTE only.

THE PRESIDENT:—We will take these two points up separately. Mr. Martin wishes to ask how the discussions shall be obtained by the local honorary secretary. Shall they be stenographic reports?

MR. MARTIN:—We have already decided, I think that is the understanding, that this Rule VI is not to have a great deal of influence upon us in the discussion of this matter, but it is provided in the rule that any member or associate may introduce a stranger in the meeting and that the latter shall not take part in the discussion except with the consent of the meeting. If we apply that rule to such meetings it seems to me we have protected ourselves with a safeguard against any such contingency.

THE PRESIDENT:—I think it would be well to put a clause in that no stranger shall take part in the discussions or proceedings of such meetings. Would you add without the consent of the meeting?

MR. MARTIN:—My idea is that as far as possible, without in any way limiting the liberty of the meeting, but in order to get harmonious and similar action everywhere, the conditions should be the same everywhere, so that the paper is discussed at each meeting under like conditions. Now we make a provision here

in this rule in regard to the people who should be allowed to take part in the proceedings, and such a limitation, it seems to me, would be just as pertinent anywhere else as it is here in New York. That is the point I am making. It seems to me that we do not want to dictate to any local meeting any more than is necessary, but it would be very awkward indeed to have a lot of discussion tumbling in upon the Secretary from people who have been invited to speak and then after their remarks have been accepted to have them ruled out at some subsequent time. Even chairmen of committees come under that ordeal occasionally, and it is not at all pleasant.

THE PRESIDENT:—Do you make a motion to that effect?

MR. MARTIN:—I would make a motion that that clause be added—that any member or associate may introduce a stranger to the meeting, but the latter shall not take part in the proceedings without the consent of the meeting.

THE PRESIDENT:—I understand Mr. Martin to have made this motion. That there be added to Section D of Article 3 of this report the following: “Any member or associate may introduce a stranger to any meeting, but the latter shall not take part in the proceedings without the consent of the meeting.”

[Mr. Martin’s amendment was adopted.]

MR. MARTIN:—There is a further question I want to raise here, and that is about getting that report. As I understand it, these local secretaries will do this work out of love for the INSTITUTE, and in one way or another there will be plenty of work for the secretary. Do we expect him to make us a *precis* of what takes place, or do we expect him to get a stenographer and send in a full verbatim report of whatever takes place there? Or what do we want?

THE PRESIDENT:—I think that would be left to them.

MR. PHELPS:—If I may be permitted, I think the committee was very desirous of not prescribing any very particular rule or method for these local meetings. It was desired to leave them as far as possible to their own devices. Now, it would be obviously to the interest of those local meetings to take their own measures for having accurate reports of what they do, and send them here. The publication being under the same restrictions as the publication of proceedings here. There would be very little difficulty on the part of the editing committee, to dispose of them. I think it would be best to leave them to their own devices in that regard.

MR. MARTIN:—As it stands, the remarks made in these meetings here in New York, are taken down in full and that is done at the expense of the INSTITUTE. We may consider ourselves a meeting of the INSTITUTE, and practically are, for all purposes, at the present minute. But whether we like it or whether we do not, we are simply the New York section of the INSTITUTE sitting here to-night, as a matter of fact, in the constitution of the

meeting to-night. Now I think we want to get these things as nearly as possible on an equal footing with equal liberty all around.

THE PRESIDENT:—Were it not for the fact that we are not discussing that, I would like to ask Mr. Martin's reasons for that statement.

MR. MARTIN:—Excuse me, sir. We have probably coming before us, at an early date, a paper by a Chicago member, and the discussion very likely may take place largely in Chicago. Now I think that we would like to have that discussion as full as possible, and I think we want to have a pretty clear understanding how that is going to be done; at our expense, or whether the local members who are to take part in that, having already paid their subscriptions to the INSTITUTE, are to make an additional subscription for the sake of getting their remarks into print, I really think it is a very material and essential point.

THE PRESIDENT:—I understood you to say that whether we like it or not, we are sitting here—will the stenographer read it? [The stenographer read Mr. Martin's remarks.]

THE PRESIDENT:—That I take exception to, as President of the AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. We are not the New York section, but we are the INSTITUTE.

MR. MARTIN:—Well, Mr. President, I like to hear such sentiments from yourself, being a Philadelphian. [Laughter.] But I am glad to stand up here to-night and say I believe that that feeling I expressed is largely the feeling of the members throughout the country, and in every word I say, and in every remark I make upon the subject, I am trying to consider the interest of these men. If there is anything we can do to-night that would give us a larger membership in any of those places than we have to-day, if instead of having thirty members in Chicago we can get three hundred, I think that, as members of the INSTITUTE, seeking its best and its largest interest, we should take just that action which will secure us that number of members.

THE PRESIDENT:—I am rather sorry that the discussion has taken this phase. Yet I never object to taking the bull by the horns when I meet him. It only shows that what I said early in the meeting, as to the danger I apprehended in the near future coming from this tendency to divide into sections, has come somewhat sooner than I thought it would. But that is the question that we have to meet. Now I question whether any very great majority of us here would at all like to be considered as the New York section, and I question whether the truest interests of the AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS would be at all subserved by any such feeling. There must be some ruling, governing body, and we are as competent to be that here—I do not say that out of any local pride—we are more competent to be that here, because the INSTITUTE had its birthplace practi-

cally here, and has had its home here for some time, and I do think, especially at the present time, when the INSTITUTE appears to be entering on a career of usefulness, that we ought to be exceedingly careful in our legislation how we permit anything to enter into our ranks which will tend to separation rather than concentration, to dilution rather than concentration.

MR. MARTIN :—I have had the pleasure of spending a month recently in Chicago, where I have spoken with many of our distant members. The one desire of those men is to have no division or separation, but to remain in the INSTITUTE and to get the most they can out of it, and they think they can get the most out of it, that they can help to increase its influence, its reputation, and its glory by having some such arrangement as we are working for to-night. What that may lead us to, I do not know. This a country where the federal system has won its greatest triumphs, and I think we can adopt that system in the INSTITUTE just as well as in our national government.

THE PRESIDENT :—I am very glad to hear Mr. Martin say that. For the point that struck considerable alarm in my heart was the statement which still rankles in my mind that we are the New York section.

MR. MARTIN :—I will say the New York and Philadelphia section, if that will please you, sir.

MR. A. E. KENNELLY :—Concerning the question raised by Mr. Martin, suppose that a paper from a section is brought to New York to be read, that by reason of the attendant circumstances most of the discussion of that paper will take place at the locality where its author resides; under the arrangement that is suggested in this report there is no provision for a stenographic report except at the expense of the local members. It would be impossible to make arrangements generally for stenographic reports. When all the local sections that meet under such a régime come into existence, that matter would surely have to be undertaken at the outset at least, by the local sections themselves, and if any such assemblage finds that it cannot undertake a stenographic report, surely the individual speakers are capable of writing their own reports and transmitting them through the secretary.

THE PRESIDENT :—Do I understand Mr. Martin wishes to add any further amendment to D?

MR. MARTIN :—I simply threw out those remarks for discussion. This committee's report, as a whole, is very wise and is so liberal, so broad in its scope, that there is really very little to improve upon. But at the same time I think we want to understand clearly and fully what we are doing. When we see these bulls we want to take them by the horns and throw them. If we simply let these points slide now, I think we will regret by and by that we passed them over in this graceful and elusive manner.

MR. R. O. HEINRICH :—The amendment of Mr. Martin is covered in the Rules of the INSTITUTE, and I beg to ask the question how

far the Rules of the INSTITUTE apply to these intended meetings, whether there is anything specified in the report of the committee how far the general rules, with all their amendments, apply to the meetings of the local sections. I refer to the amendment of the rule; the part of Rule VI which refers to the taking part in the discussion by a stranger. As I understand, it is contained in Mr. Martin's amendment.

THE PRESIDENT:—That has all been passed.

MR. HEINRICH:—I simply asked the question,—since this is contained in the Rules of the INSTITUTE, why is it put in there again? That would rather indicate that the general rules of the INSTITUTE would not apply to the local meetings if we have to put it in again here.

THE PRESIDENT:—I think it is perfectly proper to put it in. As I understand it, these local meetings are not actual meetings of the INSTITUTE. I do not see how they can be. We cannot have more than one INSTITUTE. They are meetings of members who cannot attend at the fountain head. We can get a repetition to a certain extent. You cannot regard these as absolute meetings of the INSTITUTE. As soon as you do you must have anarchy. There can be but one head-centre. I think it is perfectly proper to put that in. Now, gentlemen, these very discussions bring to my mind more clearly than anything else possibly can, at the very outset when we are trying to arrange for meetings which shall not absolutely be meetings of the INSTITUTE—somebody gets up and asks how are these going to be meetings of the INSTITUTE? They cannot be really meetings of the INSTITUTE unless you acknowledge that you have separated your INSTITUTE up into as many parts as there are separate meetings. Therefore you have something superadded, not so much as a part of the thing but as a place where the members can get an early account of what is going on at the INSTITUTE. Therefore I think it is perfectly proper to prescribe rules and very necessary to prescribe rules.

MR. WOLCOTT:—Then it is the ruling of the Chair that these Rules we have here do not apply to those local meetings unless they are adopted again for the local meeting.

THE PRESIDENT:—That would be my idea exactly.

MR. WOLCOTT:—It would seem to me that the way to keep the INSTITUTE whole would be to have those same Rules for all those meetings. Now as I understand it the meetings will be without rules, and they will go on without rules or will adopt rules for themselves.

THE PRESIDENT:—Gentlemen, you will pardon me. I must ask the members to have some consideration of rules of order. We are now discussing D. We stopped on Rule VI. some time ago. Those in favor of Section D standing as amended, will signify their assent by saying aye—contrary minded, no.

[The motion was carried.]

THE PRESIDENT [Reading]:—"E. The local honorary secretary

“shall transmit to the Secretary of the INSTITUTE all papers offered by local members, but any member may send papers directly to the Secretary of the INSTITUTE.”

MR. HAMMER:—I move that it be adopted.

[The motion was carried.]

THE PRESIDENT:—“F. The publication of the discussion at the local meetings in the TRANSACTIONS of the INSTITUTE shall be subject to the same regulations and restrictions as govern the publication of discussions at the regular meetings of the INSTITUTE. No publications of papers or discussions at local meetings in local or other journals or newspapers is to be permitted without the sanction of the Council, or the Secretary of the INSTITUTE.”

DR. EMERY:—I move its adoption.

[The motion was carried.]

THE PRESIDENT [Reading]:—“G. The expense of local meetings shall be borne by the local members and shall not become a charge upon the funds of the INSTITUTE.” Will you consider that in connection with the note? I will read the note: “Referring to Section G, above, relating to the expense of local meetings, the committee believes that when gatherings of local members shall assume large proportions, say to the number of one hundred, as they may well do in some localities, it will then be advisable to consider charging some portion of the expense of local meetings upon the funds of the INSTITUTE.”

DR. EMERY:—I would suggest that the words “in general” be put before the section, and that a clause be added modifying the previous words, at the discretion of the Council. I do not recollect the words well enough to put the words I propose in there. But I would like to have the discretion left to the Council to pay some expenses.

THE PRESIDENT:—I will read so that you can put in: “In general the expense of local meetings should be borne by the local members and not become a charge upon the funds of the INSTITUTE unless otherwise ordered by Council.”

DR. EMERY:—Except as specially authorized by Council.”

THE PRESIDENT:—Except it may be authorized by Council.

MR. PHELPS:—I fear the effects of that amendment. I fear it would lead to invidious distinctions. If we were to have special local meetings and the considering of bearing the expense was left to the Council, they might elect to pay them in one locality on one particular occasion and not in another locality and on another occasion. And I fear that a general rule would be the only way in which we could meet that thing.

THE PRESIDENT:—Is Dr. Emery’s motion seconded?

MR. HAMMER:—In Chicago I believe the Armour Institute has extended privileges to local members if they organize there, and I think the same thing would be done in Boston, and I think the Franklin Institute will offer similar facilities in Phila-

delphia, and the very important expense there will be assumed until the local membership becomes so large that they feel they want to have some special headquarters. The view of the Committee was to show the disposition of the INSTITUTE to meet that point, so that when these meetings grew to be an important factor or an important portion of the INSTITUTE in point of numbers that the INSTITUTE would then take some steps to assume a portion of their expense.

MR. MARTIN :—I would like to say that while in no wise do I take back what I said before about sharing the expense of the reports, Mr. Phelps' remarks strike me as admirable and weighty in this respect. We are going to leave upon these men locally the extra expenses, as I understand it, as they crop up, unless they happen to run up over a hundred. As a general thing it seems to me it is a better policy to help the weak rather than the strong, and perhaps a little handful of fifteen or thirty men would need and deserve our assistance more than a body that happened to be a hundred strong. Take, for instance, the little handful of thirty at Lynn at the present time. We have read a piece of poetry that tells us that even the Thomson Scientific Club cannot pay its rent. I think we should extend the light of our countenance to our friends at Lynn, and if they have a rattling good discussion, to chip in and pay part of the expense. But as Mr. Phelps thinks it is hard to choose in that way, perhaps they will tax themselves two or three dollars a head. I think in the long, perhaps in the short run, it will lead to a general toning up of the subscriptions. I know as a New York member I should not feel satisfied with paying ten dollars while some fellow member down South or out West is taxing himself an extra five dollars to get what I am getting in New York at his expense.

THE PRESIDENT :—I do not find that Dr. Emery's motion is seconded. Am I wrong? Will you take action then on Section G?

MR. PHELPS :—Although one of the committee who made this report, I can perceive a great deal of force in what has been said with respect to these financial questions, and if the other members of the committee think as I do, I would be willing to recommend that in all local meetings the charge for stenographic reports of discussions should be borne by the INSTITUTE. That would not be a very formidable charge. In respect to the place of meeting, as has already been said, in all places where we are at all likely to have any local meetings, there will be free quarters provided somewhere. As has been said, they are offered in Chicago, and they are offered in Philadelphia, and I believe in Boston. I can see the justice of the point, especially as Mr. Martin has presented it. We are trying to offer an opportunity to members to take part as we do here. I do not know that it would be fair to ask them to pay any more a year for the privilege of doing that than we do.

MR. CHARLES CUTTRISS :—I must say that I cannot agree perfectly with Mr. Phelps in saying that it will be a small item

although I allow that he has more idea of the expense of a stenographer than I have. But if any body of twenty members can get together and have their stenographer and get talking wildly as they very often do, that man will have considerable work, and we will find bills coming in monthly or yearly, as the case may be, that will amount up into the fifties, and I do not think that the INSTITUTE wants to burden itself blindly with any unknown expense of that kind.

MR. MARTIN:—That is not half so good a point as it sounds. If, as Mr. Cuttriss says, we did allow the stenographer to run away with the report, I do not doubt that we would have such bills. But, as a general rule, in most cities you can get a meeting reported for a flat rate sum—\$10 or \$15. If we are going to have six meetings, say \$10 or even \$15, that would be \$90. Suppose we had eight meetings a year—\$720 for stenographic reports is not such an awful load as to break this camel's back.

THE PRESIDENT:—You will pardon your Chair, sir, if he is a little obtuse. The discussion appears to me to take a direction as if it were a foregone conclusion that those members were never going to come here and meet any more; that they had absolutely gone out from us and that we were subjecting them to a very great hardship by asking them to pay more for what they get than for what we get. As I understand it, that is not the position at all. They willingly join this society because there is no other such in this country. They have asked in addition for some extra privileges. It is quite right in equity that they should pay for them. I think it would be very dangerous for this society to assume the expense of stenographic reports.

MR. W. B. VANSIZE:—In regard to this subject I should like to say that I heartily agree with the expressions and the opinions of the President.

MR. MARTIN:—It is, of course, very unfortunate that those men cannot be with us, men who have been in our fellowship and who can really appreciate and enjoy what they know as an INSTITUTE meeting. I cannot blame those men for desiring to establish with the old fire a new altar and a new hearth somewhere else. I have spoken with men who come from far Western States in some of the largest cities there, and I have no doubt they would like to be here and enjoy the fleshpots of Egypt. But they have taken their fleshpots in their hands and gone West. But I think we ought to want to be with them and wish them all the Godspeed we can, and simply because we happen to stay behind not to want to keep to ourselves all that happens to be left behind. These men are willing not only to stand up and be counted, but are willing to stand the expense that will come from this new régime. I think the reaction may be such as Mr. Phelps has said as to the New York members, that when we find these men are paying more we will not sit down quietly and allow them to do it.

PROF. FRANCIS B. CROCKER:—I think the idea of having stenographic reports of local meetings paid by the INSTITUTE at the present time, at the beginning of this experimental matter, is injudicious. In the first place it would be very expensive. I have had some little experience with stenographic reports during the last summer. How can you give the man who lives in a place where he is the only member perhaps, how can you give him the same for his money as the man who lives in New York? It is an impossibility. That is his misfortune. When I went to Chicago to the Fair, I was not paid my railroad fare by the citizens of Chicago. It was simply my misfortune that I lived in New York and had to go to Chicago in order to see the Fair. It seems to me that the geographical distribution of cities in the United States is not the fault of the INSTITUTE and cannot be rectified by it. [Laughter.] A thing like that is so self-evident, so palpable even to local members, that I think no one could possibly expect, especially a resident of a small town, that he could have equal advantages. The INSTITUTE now has all it can do to pay the necessary expenses of carrying on the main body. If in any way it can help out of town members, I should be heartily in favor of doing it. But when it comes to paying just as much in every place where they can raise twenty members as the main body pays here, it seems to me entirely unreasonable.

MR. PHELPS:—We have all of us talked to-night on the assumption that the moment we pass this legislation we shall be surrounded with a swarm of local meetings in all parts of the country and that they are likely to overwhelm us and ride over us and squelch us. As a matter of fact, I think we are talking about a man of straw. I do not think there will be, in a year from now, more than two local meetings, even if there be one, and the purpose of the committee was to offer a tentative scheme which could not be objected to by the people in two or three regions who have been talking of local meetings. This subject was first brought up last spring in respect to California. Every opportunity was given to the people out there to tell us what they wanted. I believe we have heard nothing definite from them since. At Chicago there has been some movement toward local meetings, which is likely to take some active shape after some action of our own. But any apprehension that we have of a multitude of meetings in small towns all over the country is a bugbear.

MR. NELSON W. PERRY:—I have been in Chicago about six months, and I think, so far as the feeling there is crystallized, the members out there do not want us to go to any extra expense. They are willing to stand whatever extra expense there may be. It seems to me that it is perfectly absurd for us to pay the local expenses there, because we cannot tell what they may be. We

are not asked to do that. I endorse the recommendation of the committee thoroughly from beginning to end.

THE PRESIDENT :—The question now is on Section G : “The expense of local meetings shall be borne by the local members and not become a charge upon the funds of the INSTITUTE.” Will you take a vote on the section as it stands? Those in favor of passing it as it stands will signify their assent by saying aye—contrary minded, no.

[The motion was carried.]

THE PRESIDENT [reading “H.”] :—The title, name and address of each local honorary secretary shall be printed in the publications of the INSTITUTE.

A MEMBER :—I move that it be adopted as read.

[The motion was carried.]

THE PRESIDENT :—Will you now move to adopt the report as a whole?

A MEMBER :—I move that the report be adopted as a whole.

[The motion was carried.]

REPORT OF COMMITTEE ON LOCAL MEETINGS.

TO THE COUNCIL.

Your Committee, appointed at the meeting of the Institute of October 18th, to consider the subject of Local Meetings, beg to report as follows :—

1st. It is the opinion of the Committee that provision should be made for local meetings of the members at points inconveniently distant from New York for the reading and discussion of papers accepted by the Institute.

2d. The Committee is of opinion that the provision in Section VI. of the Rules of the Institute, authorizing the Secretary to “call a special meeting on a requisition signed by fifteen or more members” was not intended to and does not cover local meetings of the character contemplated in this report.

3d. The Committee presents the following plan for the holding of local meetings of members :—

A. When not less than twenty members in any stated locality shall in writing notify the Secretary of the Institute of their desire to hold local meetings, such request shall be presented to the Council at its first meeting thereafter. The Council shall then, upon the recommendation and nomination of the signers of the request for local meetings, appoint a Local Honorary Secretary, who shall be a member, or associate member of the Institute residing in the specified locality.

B. The duties of a Local Honorary Secretary shall be in general to serve as a channel of communication between local members and the general body of members through the Secretary and Council. But no member in any locality shall be debarred from direct communication with the Institute.

C. In any locality where a Local Honorary Secretary shall have been appointed, local meetings may be held, the local members to elect their own chairman, such meetings to be known as MEETING OF THE ——— MEMBERS OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, and such meetings