

PRINCIPLES
OF
ELECTRO-MEDICINE
ELECTRO-SURGERY
AND
RADIOLOGY

A Practical Treatise for Students and Practitioners

With Chapters on Mechanical Vibration
and Blood Pressure Technique

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PREFACE



THERE are many large volumes published on the subject of *Electro-Medicine and Electro-Surgery* which are very valuable for reference to those who are familiar with the principles of this subject; but as far as the writer is aware, there is no book published which explains briefly, in a practical manner, all the essential points, from which the student and practitioner can easily acquire the knowledge of this comparatively new, but thoroughly rational and scientific method of treatment, which can assist the body in the performance of its physiological functions. On this account, the writer has decided to prepare this work.

Although this work is not a complete treatise on the subject, realizing that a successful electro-therapist must be an expert electrician, as well as a good physician, it was the writer's aim to make as clear as possible the production and the therapeutical application of all the different forms of electricity, and to include all the information which is essential for the successful application in the relief and cure of disease.

Those facts and experiments which are of value only to the research worker, and are not essential in the practice of electro-medicine, electro-surgery and radiology, are not included, as that would make this work too large, complex and impractical.

During several years of study and practice, having become fully acquainted with most of the literature on the subject, which has helped him in gaining the present knowledge and thereby enabled him to prepare this work, the author acknowledges gratefully the value of all the works published

in English, German, French and Italian languages, and considers their authors as pioneer workers in bringing the electro-medicine, electro-surgery and radiology to a science which will, in the near future, undoubtedly supplant both present method of surgery and treatment by drugs.

While reading this work, if one does not find full information upon some subject, the writer will esteem it a favor if his attention is called to the fact, so that in future editions he may try to clear up these points, thereby making the work more practical and interesting.

With the feeling that this work will be of service to the profession, the writer sends it into the world with the earnest desire that it may kindle the spirit of research along these lines, and serve to alleviate the sufferings of humanity.

ANTHONY MATIJACA

413 Cass Street,
Joliet, Ill., U. S. A.

May 1st, 1917.

INTRODUCTION



HISTORICAL

ALTHOUGH electricity has been mentioned by Thales (640 B. C.) Aristotle, Pliny, Largud, Claudius Galenus, and other celebrated Greek and Roman scientists long before, and after, the Christian era, the history of the application of electricity for the relief and cure of disease did not begin until 1600, when "the father of electricity," Dr. William Gilbert, physician to Queen Elizabeth, published in England a small treatise on the subject of magnets and electrone.

In 1672, Otto von Quericke, a German philosopher, and a burgomaster of Magdenburg, invented the static machine.

In 1749, Jallabert of Geneva published a treatise on the medical use of electricity entitled "*Experimenta Electrica Usibus Medicis Applicata*," in which he reported the successful treatment of various muscular and nervous diseases.

Between 1750 and 1757, cures of paralysis were reported by Brydone, Sauvages of Montpellier, Bertholin, Spray and De Hâen, the latter of whom also reported a large number of electric cures of spasmodic and nervous affections. About the same time also, Shaeffer and Nebel announced remarkable cures of rheumatism, toothache, paralysis of the eye, neuralgic pains, hypochondria, etc. This caused such an interest throughout England that in 1767 electricity was used as a therapeutic agent at the Middlesex Hospital (London) and a few years later at Saint Bartholomew's Hospital (London).

In 1780, Luigi Galvani, an Italian physician and professor of anatomy at the University of Bologna, after experimenting with frogs, accidentally discovered the galvanic current and muscular contractions produced by that current. Being unable to ascertain the cause of these contractions, in 1791 he published a treatise entitled, "*De Viribus Electricitatis in Motu Musculari Comentarius*."

Galvani's discovery attracted the attention of scientists throughout the world, and five years later Alessandro Volta, professor at the University of Pavia (Italy) discovered that the muscular contractions in Galvani's experiments were due to the difference in potential between the two metals (iron and copper, which were used in Galvani's experiments), and thus he gave his name to the science of Voltaic electricity, more frequently called Galvanism.

In 1831, Faraday gave to the world his discovery of "induction," or the production of electricity by the magnetic influence, known today as Faradic electricity.

In 1891, Nikola Tesla, a Croatian electro-engineer, in a historic lecture before the American Institute of Electrical Engineers, called the attention of scientific men throughout the world to the wonderful and peculiar properties of alternating currents of high potential and great frequency (High Frequency currents).

In 1895, Dr. William Conrad Roentgen of Berlin discovered the X (or unknown) rays.

PROGRESS OF ELECTRO-THERAPEUTICS

Like most of the great sciences and the great religions, electro-therapy was born among the humble and lowly, and until the eighteenth century the leading authorities in electro-therapeutics were physicists, chemists, priests, monks and others who, however eminent in other walks of life, knew very little or nothing of medicine.

All the experiments and cures brought about before the production of galvanic current were made with Franklinic or "frictional" (Static) electricity.

In those early days, and even later, the knowledge of physiology and pathology had not reached that degree of strength and breadth of sureness to furnish good foundation on which to erect the science, and in addition the apparatus for generating electricity was bulky and unreliable, and electrical measurements were not yet discovered. As a result, electricity was applied to the symptoms and not to the cause of disease; hence, frequent failures were inevitable.

The symptoms most treated were blindness, deafness, inability of motion, etc., which are now known to depend, in many instances, upon incurable pathological conditions. Considering the simple forms of electrical apparatus available at that time, there can be no question that remarkable cures were effected, and although the cures brought about by this treatment attracted crowds of invalids, yet by the ignorant and superstitious they were considered either as miracles or witchcraft.

When chemistry, physics, physiology, and later pathology, came to its assistance, electro-therapy attracted the attention of scientists and progressive physicians throughout the world, and although it had to fight its way, step by step, in the face of many difficulties, and the worst of them all, the passive resistance of narrow-minded physicians who could not realize that all the therapeutic methods are more or less limited, and that there is some good to be derived from every method of healing, this science has done more in conquering ailments which were considered incurable than any other branch of medicine, and it bids fair to unlock the door to a future medical era of which our generation has no reasonable conception at this time.

FIELD OF ELECTRICITY IN MEDICINE

Some have said that electricity is life, and although this is too altruistic a statement to make, there is no doubt that whenever the body is highly electrified, it is at the flood tide of vitality.

Matter cannot exist as such without the constant passage of electric currents through the substance of which it is composed, and the "physician" who realizes this, will be better equipped to combat disease. To practitioners who know how to use electricity scientifically, so as to influence pathological conditions in the human body in such a way that this force will assist nature or call forth the latent energies and thus hasten the restorative processes, electro-therapy becomes of real value and gives satisfaction to both the physician and the patient.

The effects produced by electricity may be classified as mechanical, chemical, thermic, actinic and psychic.

The field of application of electricity in the healing art is a large one, and the indications for its use in therapeutics are plentiful, but this is only to the practitioner who is well versed in this science, for the practitioner who is not acquainted with it will seldom, if ever, see any indications for its use.

By means of different electrical currents and modalities, we are able to cause powerful muscular contractions of voluntary and involuntary muscular fibres; stimulate the nerves and tune them to normal vibration, producing profound sensory effects; relieve pain or over-irritation and inflammatory conditions; dilate or constrict cutaneous blood vessels, and increase or stop hemorrhage; increase or decrease the blood pressure without producing heart depression; correct faulty metabolism, and hasten elimination of waste products, such as urea, uric acid, carbon dioxide, solidified lime deposits, etc; harden or liquefy the tissue; produce anaesthesia and artificial respiration; decompose and introduce through the unbroken skin various remedies, direct to the seat of pain with a view of obtaining the desired effect, etc.

Employing same in diagnosis, we are able to differentiate the forms of paralysis—whether due to a brain lesion, or to a lesion in the spinal cord—test muscular degeneration, etc.; locate foreign bodies, structural dislocations and malpositions within the body; differentiate various gynecological conditions, e. g., pyosalpinx from ovarian neuralgia, etc.

In addition to the above mentioned therapeutic properties, various electrical modalities have been found of special value in minor surgery, while the value of light, heat, ozone, and mechanical vibration produced electrically has been exemplified in the successful treatment of various nervous, rheumatic, respiratory, skin and other affections. Some of the future possibilities of electricity in therapeutics are the abstraction of metallic poisons from the body by ionization, safe local and general anaesthesia, with loss of consciousness and relaxation, relief of pain and the production of sleep, etc.

Electro-therapy is not a cure-all, and will not take the place of all other methods, but it is a single remedial agent of very wide range, leaving scarcely a condition of disease in which it cannot be used in some form, either as an adjunct or a remedy.

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**This Work is Respectfully Dedicated
by the Author to**

Nikola Tesla

"The Master Electrician"

Inventor, Scholar and Scientist



CHAPTER I

VOLTAGE, AMPERAGE AND RESISTANCE

VOLT, Ampere and Ohm are the first three measurements in electricity, and it is imperative to have a proper idea of them before it is possible to apply electricity judiciously for therapeutic purposes.

Voltage (V) or Electro Motive Force (E. M. F.) or Tension is the pressure or force produced by chemical or physical means which overcomes the resistance of the electrical circuit, and therefore maintains the current. The unit of this pressure is called a Volt.

Ampere (A) or Current Strength (C) is the rate at which electricity flows, or that part of electrical energy which is forced by the voltage over the resistance. The unit rate of current flow is called an Ampere.

The ampere, being more current than can be used for general application to the human body, is divided into one thousand parts called milliamperes (m. a.).

Resistance—For the reason that every substance offers more or less resistance to the passage of electricity, *Ohm (R)* is a standard by which the resistance of all material can be measured.

An Ohm represents the resistance offered by a copper wire two hundred and fifty feet long and one twentieth of an inch in diameter.

The resistance of wires or other conducting material changes directly as their length, cross section and conductivity, therefore, a long wire offers more resistance than a short one, and a thick one of the same length less than a thin one.

Conductors and Insulators

Silver, copper, gold, aluminum, zinc, platinum and other metals; carbon, acidulated water, etc., offer very little resistance to the passage of electricity and are called *good conductors*, while the human body, dry wood, cotton, etc., which offer more resistance and conduct but little current are called *poor conductors*.

Oils, amber, shellac, leather, rubber, wool, porcelain, glass, etc., offer very great resistance to the passage of electricity, and are called *non-conductors*, or *insulators*.

Table of Substances in Order of Their Conductivity*

Good Conductors	Poor Conductors	Insulators
Metals	Alcohol	Fat
Coal	Ether	Ice at 25 degr. C.
Graphite	Dry wood	Phosphorus
Acids	Marble	Chalk
Acidulated water	Straw	Rubber
Fresh water	Paper	Dry air
Vegetable matter, living	Ice at 0 degr. C.	Oils
Animals		Porcelain
Soluble salts		Leather
Linen		Wool
Cotton		Silk
		Mica
		Glass
		Wax
		Paraffin
		Sulphur

A **RHEOSTAT** is an instrument by which we are able to increase or decrease the resistance, and consequently increase or decrease the current strength.

WATT is the unit of work, or power, representing one seven hundred and forty-sixth part of a horse power (1/746), and is obtained by multiplying the voltage by the amperage.

Ohm's Law

About the year 1827, Dr. G. S. Ohm discovered by experiment that the difference in voltage between any two points in an electrical circuit, is strictly proportional to the current, all other conditions remaining constant, and on the discovery of this law the following formulas were elaborated:

Voltage is equal to the amperage multiplied by the resistance

$$(V=A \times R).$$

Amperage is equal to the voltage divided by the resistance

$$(A=\frac{V}{R}).$$

Resistance is equal to the voltage divided by the amperage

$$(R=\frac{V}{A}).$$

Examples:

1. What voltage is required to produce a current of 10 amperes in a circuit having a resistance of 10 ohms?

Solution: Voltage=10 (amperes) x 10 (ohms)=100 volts.

2. What amperage will be produced by the pressure of 100 volts in the circuit having a resistance of 10 ohms?

Solution: Amperage= $\frac{100 \text{ (volts)}}{10 \text{ (ohms)}}$ =10 amperes.

* This table has been prepared from a table which appeared in the American Journal of Electricity and Radiology, Jan. 1917.

3. What is the resistance of a circuit producing a current of 10 amperes at a pressure of 100 volts?

Solution: Resistance = $\frac{100 \text{ (volts)}}{10 \text{ (amperes)}} = 10 \text{ ohms.}$

(In the above examples, same voltage, amperage and resistance has been used, so that the reader may see at a glance that the above law is correct.)

From the above, we see that in order to increase the amperage or current strength in a conductor, we must either increase the voltage or decrease the resistance; while, on the other hand, if we wish to decrease the amperage, we must either increase the resistance or decrease the voltage.

CHAPTER II

GALVANISM

THE galvanic current is a direct, uninterrupted, continuous current, which can be likened to a stream of water, continually flowing in one direction. (Fig. 7)

For therapeutic purposes, this current is usually obtained from primary cells, direct current lighting circuit, or from a direct current generator which consists of a small dynamo, operated by a motor connected to the lighting circuit.

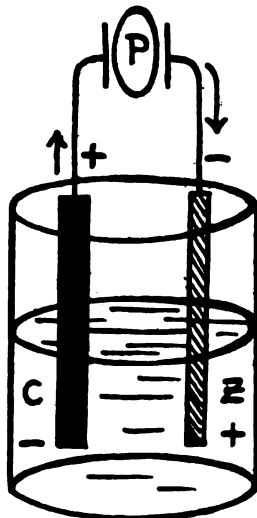


Fig. 1 — Laclanché Cell; + represents positive; — negative. P. patient; arrows show the direction of the current flow.

Primary Cell

A cell is a jar holding the elements and the exciting fluid necessary to produce electricity.

There are several kinds of cells, but the simplest form and one best adaptable for therapeutic purposes, is a Laclanché cell.

Laclanché cell consists of a rod of zinc and a plate of carbon immersed in a saturated solution of Ammonium Chloride (sal ammoniac), with a little Manganese Dioxide (MnO_2) as a depolarizer.

Internal and External Circuits

In order to bring about a passage of electricity, it is necessary to establish a *circuit*, or a path, in which electricity moves. This circuit consists of two parts, the internal and external.

The internal part of the circuit consists of the exciting fluid and the submerged part of the elements; while the external part consists of the conducting wires, the non-submerged portion of the elements, and the body which may be in the circuit.

When the circuit is established, the chemical decomposition takes place at the rod of zinc (which is of a higher potential than the carbon), and makes it a generating plate. Through the electrolyte, electricity flows to the carbon, and through it out of the cell into the conducting medium, which joins the carbon and the zinc together, returning again to the starting point.

As water flows from a higher to a lower level, so does electricity flow from a higher to a lower potential (positive to negative pole); *therefore the outside end of the carbon is positive and the inside end (submerged end) is negative, while the outside end of zinc is negative and the inside end is positive.*

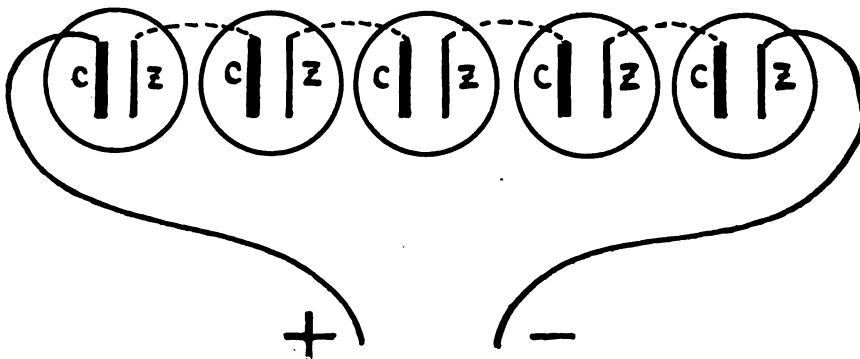


Fig. 2—Cells connected in series.

Polarization

All cells are subject to polarization; that is, the formation of bubbles of hydrogen upon the carbon, which in that case will also become the generating plate and cause the current to flow toward the zinc, thus partly neutralizing the original flow. There are various depolarizers, which are, in general, substances capable of fixing the hydrogen; e. g., a small quantity of Manganese Dioxide (MnO_2) added to the exciting fluid of the Laclanché cell prevents polarization.

Battery

Two or more cells, properly connected, constitute a battery.

To treat the human body, which offers great resistance to the passage of electricity, it is necessary that a battery furnishes a high voltage, and a low amperage. This high pressure and low strength is obtained by

connecting the cells in *series* by joining unlike elements together, that is the zinc of one cell to the carbon of the next, until all are connected.

If, however, it is desired to use the current for heating platinum electrodes or cautery work, it is necessary to obtain a high amperage and a low voltage. This is obtained by connecting the cells in *multiple* or *parallel*, by joining like elements together; that is, zinc of all the cells together and all the carbons together.

The voltage of a battery in which the cells are connected in series, is the sum of the voltage of all the cells connected, but the amperage output is equivalent only to the output of one cell; while with the cells connected in multiple or parallel it is the opposite.

For example: If we have a five-cell battery, and if each of these cells gives a pressure of $1\frac{1}{2}$ volts and a current strength of 5 amperes, then by connecting these cells in series, we will have in the circuit a current of 5 amperes at $7\frac{1}{2}$ volts pressure, while by connecting the cells in multiple or parallel, a current of 25 amperes at $1\frac{1}{2}$ volts pressure.

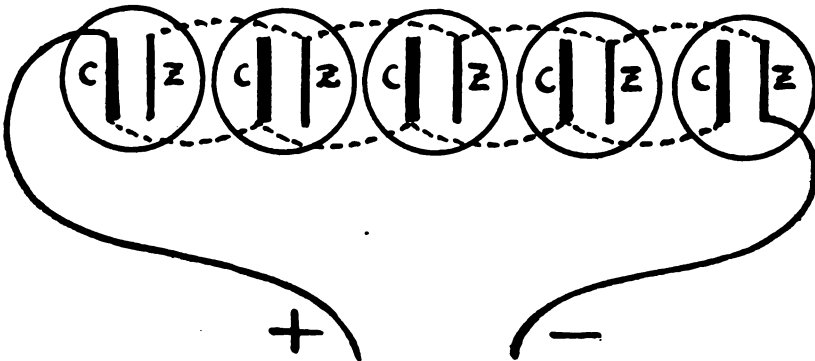


Fig. 3—Cells connected in parallel.

By arranging some of the cells in series, and some of them in parallel, we are able to obtain any voltage or amperage required.

Dry Cells are made on the same principle as the Laclanché or wet cells, with the exception that the electrolyte is in the form of a paste or cream instead of a liquid. Being more convenient than the wet cells, they are extensively used in portable batteries.

Polar Effects

The two poles (positive and negative) of the galvanic current produce on the tissue of the body certain physical, chemical and physiological effects, diametrically opposite to each other (so that if the application of the positive pole was indicated, the negative would surely do harm), and the following outline of the polar effects on the tissue is the gist of what the physician must know before he can administer it with any degree of success:

Positive Pole:

1. Accumulates Oxygen, Chlorine, Nitric, Phosphoric and Hydrochloric acids.
2. Is an acid caustic producing a hard and dry cicatrix.
3. Hardens tissue.
4. Rendering the adjacent tissue acid, it relieves inflammation and thereby relieves pain.
5. Being a vaso-constrictor, it stops hemorrhage.

Negative Pole:

1. Accumulates Hydrogen and alkalhydrates of calcium, potassium, sodium and ammonium.
2. Is an alkaline caustic producing a soft and pliable cicatrix.
3. Liquefies and disintegrates tissue.
4. Rendering the adjacent tissue alkaline over-stimulates and irritates.
5. Being a vaso-dilator, it increases hemorrhage.

Tests for Polarity

Since the polarity of the galvanic current is very important, in order to apply the galvanic current judiciously, it is essential to be able to distinguish one pole from the other, whenever necessary.

There are numbers of tests upon which we may rely, but the following two are most practical:

1. Place the two poles in a glass of water, about one inch apart from each other, and use about 10 volt current, when electrolysis or dissolution of water will take place and bubbles of hydrogen will be seen at each pole, but the greater number will accumulate at the negative pole.
2. Wet a piece of litmus paper, apply on it both poles and use about 10 volt current. A blue color will make its appearance at the negative, and a pink color at the positive pole.

Electrodes

All the electrical currents employed in medicine are applied to the body by means of electrodes, or instruments, connected to the apparatus by means of conducting cords. In the application of galvanic, faradic, sinusoidal, diathermic and some other forms of high frequency and static currents, in order to establish a circuit, it is necessary to use two electrodes. These two electrodes are distinguished as *active* and *indifferent* electrodes.

The *active* electrode is one which is brought near, or in contact with the parts to be treated, and is usually a small electrode measuring from $\frac{1}{4}$ to 4 inches in diameter.

The *indifferent* electrode is always larger than the active (so as to reduce the polar action to a minimum), and may be placed anywhere over the spine, abdomen or chest (or opposite to the active).

The electrodes are made of various shapes, sizes and material, so as to meet all purposes. Most of them are made of tin, copper or carbon, and are used bare or covered with some easily sterilizable material, the best being absorbent cotton or chamois leather.

Bare electrodes are used in direct contact with the tissues in electrolysis (while removing superfluous hair, warts, moles, naevi, etc., treating

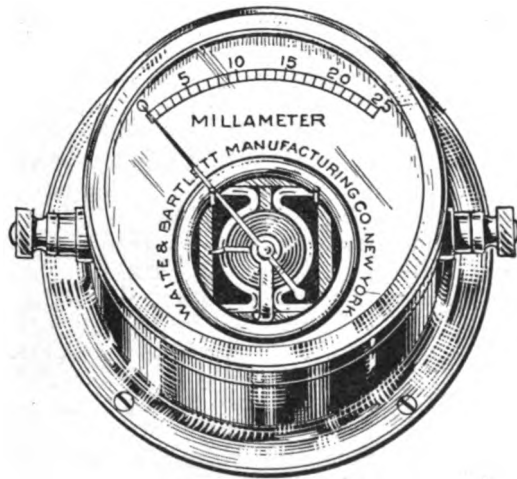


Fig. 4—Milli-ampere Meter.

cancer; dissolving stricture of the mucous tract, etc.) and in metallic cataphoresis.

Covered electrodes are used for surface work, and should always be soaked in a solution of bicarbonate of soda or sodium chloride (normal salt solution), which offers very little resistance to the passage of electricity.

Size of the Electrodes. The larger the electrodes, the larger the part through which the current passes.

The size of the electrodes govern directly the density of the current when a certain unit of current is passing; for example, employing 50 milliamperes with a pair of electrodes of even size, 3 by 5 inches, or 15 square inches to each electrode. If we retain the current strength of 50 milliamperes, but increase the size of the electrodes to 6 by 10 inches, or 60 square inches, our current density would be one-fourth that which it was before (because the current will be distributed over 60 square inches, instead of 15 square inches). The greater the strength of cur-

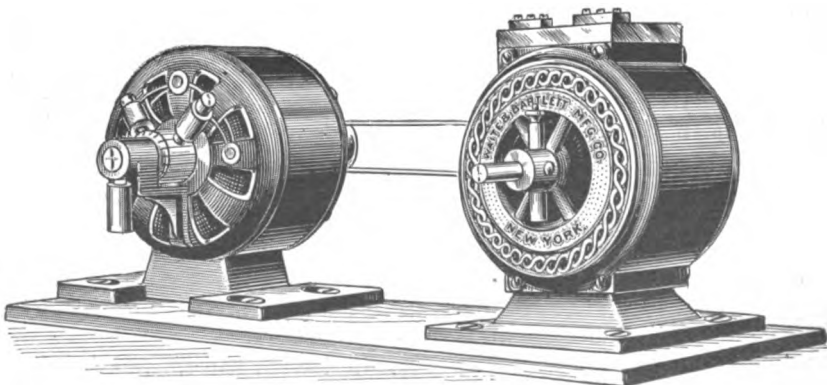


Fig. 5—Motor Generator.

rent passing, and the longer the time during which the current is flowing, the greater is the effect.

Application of Electrodes. In the application of electrodes to the body, we refer to terms *stabile* and *labile*. *Stabile* means that one or both electrodes are held stationary on the indicated part of the body.

Labile is opposite to *stabile*, and means that one or both electrodes are moved over the surface.

The electrodes should always be placed in position prior to turning on the current, and the current should be turned off prior to removing the electrodes. They should be applied in such a manner that the current must find its way directly through the part to be treated. If we wish to treat a knee, for instance, the electrodes must be applied to either side.

The terms *anode* and *cathode* are applied to the electrodes connected to the positive and negative poles, respectively.

(Glass vacuum and other electrodes will be described elsewhere.)

CHAPTER III

IONTOPHORESIS

ALL elements or ions have, by nature, a definite electrical charge (positive or negative). These elements follow the universal law that *likes repel and unlikes attract*, and combine in definite proportions, according to their electric attraction for one another; therefore, positively charged elements are repelled by the positive (like) pole, and attracted towards the negative (unlike), and vice versa.

The positively charged elements or electro-positive substances (hydrogen, sodium, potassium, calcium, magnesium, etc.) being repelled by the positive pole and attracted toward the negative, are called *cathions*; while the negatively charged elements or electro-negative substances (oxygen, chlorine, bromine, iodine, carbon, sulphur, phosphorous, etc.) being repelled by the negative and attracted toward the positive, are called *anions*.

Iontophoresis, *Ionization* or *Phoresis* is the generic term for that property, possessed by an electric current, by which it transports the ions or elements of a compound substance to the positive and to the negative pole.

Electrolysis

Electrolysis is a separation of a compound substance into its elements, or ions, by means of a galvanic current.

For instance, when the galvanic current passes through a solution of Potassium Iodide (KI) it gives to the potassium a positive charge, and to the iodine a negative charge. Following the universal law of attraction and repulsion, ions of potassium move toward the negative pole, and those of iodine toward the positive. When these ions arrive at the respective electrodes, they give up their charge and form new combinations.

The substance to be broken up (electrolyzed) must be a fluid or semi-fluid, a good conductor of electricity, and one of its elements must be a metal or the salt of metal. Hydrogen being considered a metal, it is supposed that any substance containing water, which is a compound of Hydrogen and Oxygen (H_2O), can be electrolyzed.

Fats and oils, although fluids, cannot be electrolyzed, because they are non-conductors.

(For application of electrolysis to the human body, see chapter on Electro-Surgery.)

Ionic Medication

Ionic Medication is the process of introducing medicines through the unbroken skin into the tissue of the body, with a view of securing a local effect.

For the reason that the practitioner who is familiar with the ionic medication will undoubtedly be able to modify and apply this method for the abstraction of metallic poisons from the body, this work would not be complete if this subject was not at least briefly described.

On account of the certainty of localization, a very minute quantity of medicine being required to affect the part under treatment, ionic medication is far superior to the external, hypodermic or general administration of antiseptics, anaesthetics, analgesics, and in fact all other remedies usually employed for the treatment of local affections.

Since every element has by nature a definite electric charge, any compound which can be electrolyzed, can be also introduced by means of the galvanic current directly into the tissues, where the local effect is desired.

In the application of ionic medication, the first thing to know is the electrical charge of the ion which it is desired to introduce, so as to be able to apply it on the pole from which it will be repelled; otherwise, the effect may be completely lost, and valuable time and patience be expended in vain.

Bases and metals (zinc, copper, bismuth, iron, magnesium, calcium, lithium, potassium, sodium, quinine, etc.) are electro-positive elements, or cations, and must be applied to the positive pole.

Acids and those substances which take the place of an acid (iodine, bromine, chlorine, phosphorous, sulphur, etc.) are electro-negative elements, or anions, and must be applied from the negative pole.

The term *Cataphoresis* refers to the introduction of cations or electro-positive elements (that is, those substances which are applied to the positive pole), while *Anaphoresis* refers to the introduction of anions, or electro-negative elements (that is, those substances which are applied to the negative pole).

The ions most frequently used in ionic medication are: Zinc, copper, chlorine, iodine, quinine, lithium, salicylic acid, magnesium, cocaine, etc.

Zinc, copper, quinine, lithium, magnesium and cocaine are introduced by cataphoresis (from the positive pole), because they are electro-positive substances.

Chlorine, iodine, salicylic acid, etc., are introduced by anaphoresis (from the negative pole).

Zinc Ionization (zinc sulphate) is used in the treatment of rodent ulcer, pustular eczema, lupus, varicose ulcer, and other superficial suppurative conditions. Also in conjunctivitis, corneal ulcer, purulent keratitis, rhinitis, chronic inflammation of nasal sinuses, diseases of the middle ear, carbuncles, boils, epithelioma, colitis, fistula, chronic urethritis, gonorrhea, etc.

If necessary, cocaine anaesthesia may be produced before the zinc ionization.

Copper (Copper Sulphate) is employed chiefly in gynecological conditions, such as cervicitis, endometris, dysmenorrhea following chronic endometritis, menorrhagia, etc. Also in ozoena, ringworm, etc.

Quinine (Quinine Bisulphate) is often employed as an alterative to the salicylic ionization in neuralgias.

Lithium (Lithium Sulphate) is used in the treatment of gout, rheumatism, arthritis and synovitis.

Magnesium (Magnesium Sulphate) is employed in the removal of warts, papilloma, etc.

Cocaine (Cocaine Hydrochloride) relieves pain and produces local anaesthesia suitable for minor surgical work. Anaesthesia thus produced will remain for a period varying from a few minutes to several hours, depending upon the strength of the current, the length of the application, and the percentage of cocaine in a solution.

Chlorine (Sodium Chloride) promotes the absorption of newly formed tissue, and gives good results in operations and severe burn scars, old ankylosed and hypertrophied joint, palmar contractions, corneal opacities, and apparently in sclerotic changes in the spinal cord (rheumatic scleritis, peri-scleritis, etc.).

Iodine (Potassium Iodide), like chlorine, promotes the absorption of adventitious material. It is usually employed in goitres.

Salicylic Ionization (Sodium Salicylate) is employed in the treatment of sciatica, neuralgia, chronic rheumatism, rheumatoid arthritis, painful swelling of knee joint, bruises, sprains, migraine, etc.

Menthol, thymol, thiosinamin, verbascum, hameamalis, sulphur, thuja, ichthyol, and numerous other remedies, are also being introduced by means of ionization.

The strength of the solution suitable for ionic medication is one or two per cent. In making up the solutions, it is preferable to use distilled water, as ordinary water containing many different salts may produce entirely different effects from those desired. If the electrode is made of the metal to be introduced (e. g., a solution of zinc sulphate applied at the zinc electrode, connected to the positive pole), a one per cent. solution is sufficient, as the supply of ions is constantly renewed from the electrode. Ordinary plate electrodes of pure zinc, copper or carbon, covered with several thicknesses of purest quality lint, or a glass cup electrode filled with cotton wool saturated with medicine, can be employed. The large indifferent electrode should be applied to the skin, close to the area which is treated (or may be conveniently connected to the foot or arm bath, in which one limb is immersed).

The whole effect of ionization depends upon the speed at which the ions penetrate the tissue, and this is entirely governed by the current intensity (milliamperage). There is no specified strength, but the stronger the current, the quicker the effect. (Usually from 1 to 40 milliamperes is passed for about 10 or 15 minutes, according to the size of the electrode, and the part treated.)

The larger the active electrode, the stronger must be the current (about 7 m. a. of current should be used for each square inch); hence, the value of the small electrode.

Metallic Cataphoresis

If an electrode composed of an oxidizable metal (copper, zinc, mercury, etc.) is used on the positive pole, oxygen that is evolved on the same pole combines with the metal electrode, and forms an oxide of the metal used on its surface.

This metal is taken into the tissues, and there it unites with the chlorine (body fluid), forming an oxychloride of the metal.

This oxychloride, following the law of electrolysis (chlorine moving towards the positive, and the metal towards the negative pole), is deposited into the tissues, where it exerts its germicidal and astringent properties.

These metallic salts (especially copper and zinc salts), are therefore of great value in all infective inflammations, especially in the treatment of gynecological and skin affections.

In applying this mode of treatment, in order to avoid the sticking of the metal electrode, it is advisable to cover it whenever practicable with absorbent cotton or chamois leather, and the metal will be deposited into the tissues through the covering.

CHAPTER IV

ELECTRO-MAGNETISM

THERE are three kinds of magnets, viz: the *natural magnet*, or *load-stone*, (a magnetic oxide of iron— Fe_3O_4 —as found in nature); the *permanent magnet*, or a piece of steel which, when once magnetized, retains its magnetism; and the *electro-magnet*, which is usually a bar of soft iron, or a bundle of soft iron wires (as these take and lose magnetism much quicker than the solid iron), surrounded by a coil of insulated copper wire, in which the electro-magnetism is induced by a flow of current through the wire. When the electric current passes through the insulated wire which surrounds the bar of soft iron, the electro-magnet rapidly acquires its magnetism, and as soon as the electric current ceases to flow, its magnetism is immediately lost.

As we have in electricity a positive and negative pole, so we have in magnetism a north and south pole, and all magnets possess a property of attraction and repulsion, magnetism obeying the same universal law that governs and controls electricity, viz., *likes repel and unlikes attract*.

The truth of this statement can be demonstrated by placing the like poles (north or south) of two bar magnets together, when there will be no attraction, and they will actually repel each other; but placing the unlike poles together (north of one with the south of the other), they will hold each other.

As a current of electricity flows from the positive to the negative pole, much the same *lines of magnetic force* are continually flowing around the magnet bar from the north to the south pole, as long as the bar is a magnet.

These magnetic lines around the magnet constitute a *magnetic field*, and the strength of this magnetic influence decreases as the square of the distance increases, until a point is reached where the influence is lost.

Magnetic substances are not magnets, but bodies which are attracted by the magnets (e. g., iron, steel, nickel).

Di-magnetic substances are bodies which are repelled by the magnets (e. g., bismuth, zinc and copper).

Faradism

In electro-magnetism, it has been explained how the magnetic influence can be produced by an electric current, and in faradism it will be explained how an electric current can be induced by a magnetic influence.

Faradic, or induced current, discovered by Faraday in 1851, is a rough, interrupted current, produced by means of the faradic or induction coil.

Faradic, or induction coil, consists of a soft iron core, a primary and secondary winding of insulated copper wire, and an automatic hammer or interrupter.

A primary winding, which is of a coarser wire than the secondary, directly surrounds the soft iron core; a secondary winding surrounds the primary, but is entirely insulated from it.

The interrupter is an automatic arrangement used for making and breaking the current. It is one of the most important parts of the faradic coil, since, by means of same the physiological effects of the faradic current are controlled.

Generation of the faradic current

The current from a galvanic cell, interrupted by means of an automatic hammer, passes through the primary winding of the faradic coil.

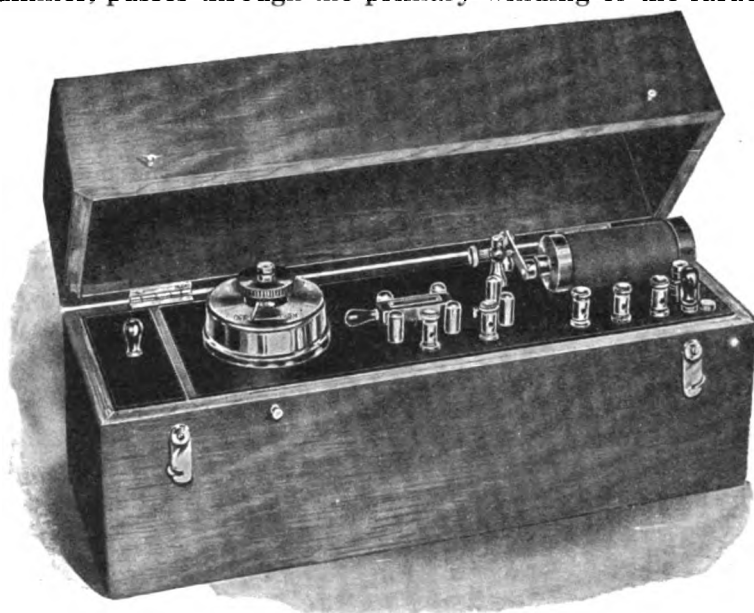


Fig. 6—Combined Galvanic and Faradic Battery.

This current, called the *primitive* or *inducing* current, magnetizes the soft iron core, forming the magnetic field, causing the magnetic lines of force to permeate into the convolutions of the secondary winding (which is in the magnetic field), thereby inducing the secondary faradic current.

The *primary faradic current*, obtained from the primary winding of the faradic coil is a greatly increased, interrupted galvanic current.

The *secondary faradic current*, caused by the magnetic lines of force, which permeate the convolutions of wire in the secondary winding, is obtained from the secondary winding of the faradic coil. This current is entirely independent of the primitive or inducing current, because the secondary winding has no connection whatever with the primary. On account of its interruptions, it resembles, in a manner,

static oscillations, but has a higher amperage and lower voltage than the static, and a lower amperage and higher voltage than the galvanic.

Voltage of the Faradic Current

The voltage, or electro-motive force, of the faradic current depends: (1) On the number of convolutions of wire in the secondary winding; the more turns, the higher the voltage. (2) On the voltage of the primitive, or inducing, current; the higher the voltage of the inducing current, the higher will be the voltage of the induced current. (3) On the frequency of interruptions in the primitive circuit. (4) On the presence or absence of the electro-magnet; its presence, that is, its magnetic influence increases the voltage of the induced current. (5) On the distance between the secondary and primary windings.

The voltage of the faradic current can, therefore, be regulated in several ways, e. g., by increasing or decreasing the primitive current (employing one or more cells); increasing or decreasing the frequency of interruptions; increasing or decreasing the magnetic influence, by pushing the iron core in and out, or slipping over it a metal cylinder, which acts as a shield between the magnet and the coil (this cylinder, however, must be of iron, steel or copper, as the inductive action of a magnet can only be cut off by a magnetic substance); by means of a series rheostat, or various other methods, according to the make of the faradic coil.

Application of the Faradic Current

Faradic current produces a tingling sensation. Being more mechanical than medicinal in action, it is beneficial in all functional paralyses (where there is no destructive lesion in the nerve tissues), neuralgias, headaches, constipation, rheumatism, anaesthesia (loss of sensation), etc. With it we can produce artificial respiration in drowning, asphyxia, opium poisoning, shock from accidental contact with heavily-laden electric wire, and in the resuscitation of the new-born infant.

Rapidly interrupted current tetanizes the muscles and produces sedative effect, while slowly and rhythmically interrupted current, by means of a rheotome, stimulates the voluntary muscular fibres, increases the circulation, assists metabolic action, and acts as a general tonic.

Galvano-Faradization

Galvano-Faradization is a very useful combination for the treatment of peripheral paralysis, nerve exhaustion, neuralgias, spasms, painful muscular affections, and most conditions in which both galvanic and faradic currents are of benefit.

Galvano-Faradic current is obtained by uniting the secondary circuit of the faradic coil in series, or in parallel, with the galvanic circuit. This is accomplished in series by joining the negative pole of one with the positive pole of the other; or in parallel by connecting the positive galvanic to the positive faradic, and the negative galvanic to the negative faradic.

In employing only faradic current, polarity is immaterial, but in the application of the galvano-faradization, special attention must be paid

to the galvanic polarity in the same manner as if galvanism was employed independently.

As some cases require more galvanism than faradism, while others more faradism than galvanism in applying galvano-faradization, it is necessary to be able to regulate the currents separately.

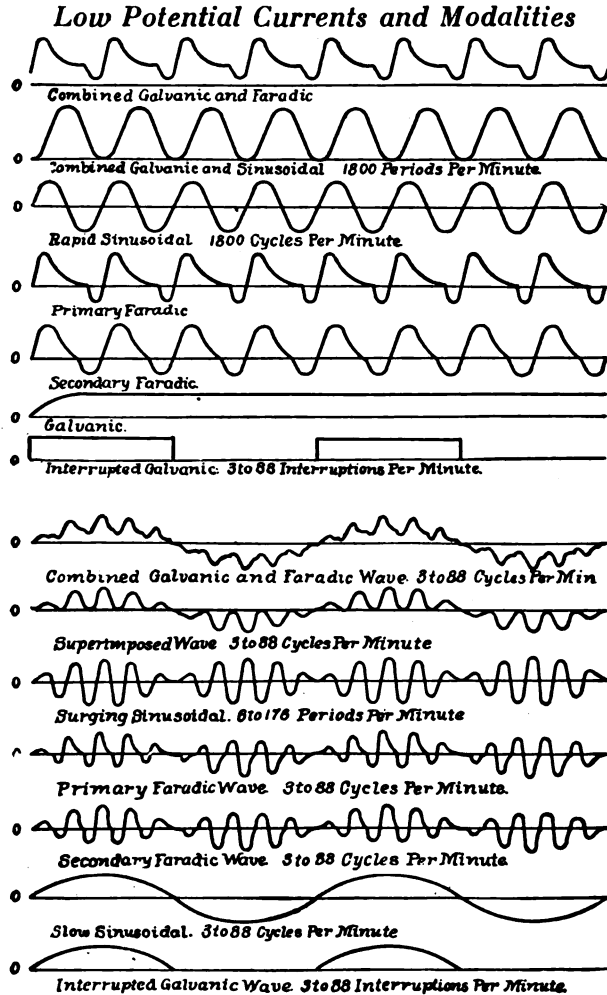


Fig. 7—The above tracings represent the rise and fall of voltage and comparative duration of flow of the various low potential currents and modalities. The zero line represents the neutral line; above zero is the positive direction; below zero, the negative.

CHAPTER V

STATIC ELECTRICITY

STATIC, or Franklinic electricity, is a unidirectional current, in which the voltage is enormous, while the amperage, on account of its oscillatory or vibratory character, is infinitesimally small (usually only 0.20 to 5 milliamperes).

There are two types of machines producing static charges—one the friction, and the other the influence machines. The friction machines

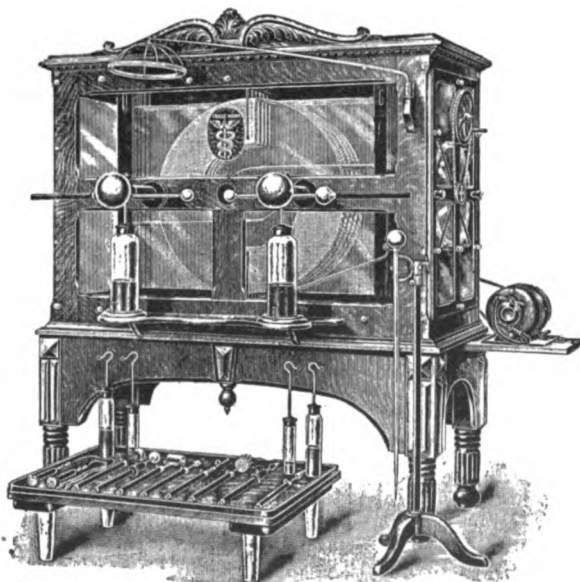


Fig. 8—Static Machine (Holtz type) with Leyden jars, platform and electrodes.

were the earliest type, and the electricity was produced by rubbing a revolving disc of glass or sulphur with the hand or a cushion.

At present, all static machines used for therapeutic purposes are influence machines of the Holtz, Toepler-Holtz, or Wimshurst type, and consist of two essential parts: one for producing electric charges and the other for collecting them.

Electric charges are produced by means of plates, inductors, carriers and neutralizing brushes. These charges are then collected by collecting brushes, and are carried to the discharging poles or prime conductors.

Machines of the Holtz and Toepler-Holtz type have a number of

stationary and a number of revolving glass plates, while in the Wimshurst machines all the plates (which may be of glass or mica) are revolving (some in one direction and some in another).

The stationary plates in the Holtz machine are made in two sections, while those in the Toepler-Holtz are circular.

On the outer side of every stationary plate of the Toepler-Holtz machine, are fastened two strips of metal, one on each side, known as field plates (which are its inducing plates), while on every revolving plate to the side opposite the stationary plates, are fastened small metal carriers.

Toepler-Holtz and Wimshurst machines have neutralizing brushes, attached at both ends of a rod, which runs diagonally throughout the

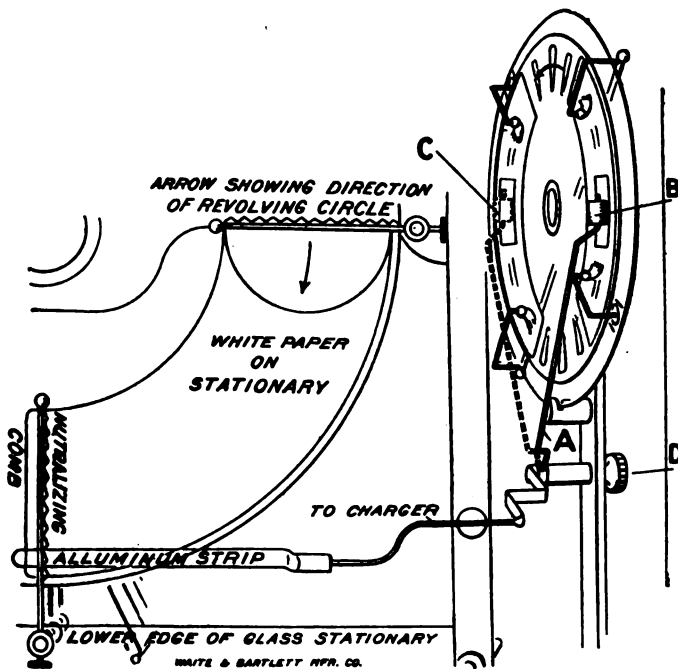


Fig. 9—Charger used to excite the Holtz machine.

center of the plate. Approximating brushes make a metallic contact with the field plates.

The Holtz machine differs from the Toepler-Holtz and the Wimshurst by not having metal carriers on its revolving plates, and no neutralizing brushes, and consequently it is not self-exciting, but has a special charger in the form of a small Wimshurst. (Fig. 9.)

The Wimshurst machine, for example, has from two to thirty or more plates of glass (or other suitable material, e. g., mica or ebonite) mounted on a horizontal axis about one-sixth of an inch apart. These discs revolve, some in one direction and some in another. Each plate has a number of sectors or strips of tin foil, which serve both as inductors and carriers, and a metallic rod with brushes, which make contact with sectors on the opposite plate. The electricity generated there is

collected by additional collecting brushes that rub against the tin foil sectors, and is carried thence to the discharging poles or prime conductors.

As soon as the plates begin to revolve, positive electricity collects at one prime conductor, and the negative at the other.

Static machines having glass or mica plates are enclosed in a dust and moisture-proof glass case, while the machines having vulcanite plates are not enclosed, because the ozone generated while the machine is in action, would set on the plates.

Voltage of a Static Machine

If the prime conductors of a static or other high tension machine are sufficiently but not too far apart, sparks will leap across the space between them.

To force a spark across the air space, which offers high resistance to the passage of the electricity, it requires about 20,000 volts for the first inch, and 10,000 volts for each additional inch; therefore, if a machine is producing a ten-inch spark, it indicates about 110,000 volts. Knowing this, we can easily ascertain the approximate voltage of the static or other high tension current (high frequency).

The Bureau of Standards of the U. S. Government and, also, that of New York, give the voltage of the high potential current as about 10,000 volts to the inch of spark gap. That has been accepted by all manufacturers and physicists.

The voltage and amperage of a static machine depend on the size and the number of plates and the velocity of rotation.

The greater the number of revolving plates and the greater the speed, the greater will be the amperage.

The greater the diameter of revolving plates, the greater will be the voltage, e. g., the Holtz machine will develop a spark equal in length to one-half the diameter of the revolving plates.

The voltage of a static machine also depends on the material of the plates—glass giving lower voltage than vulcanite, while mica lower voltage than glass.

Difficulties in operating a static machine

Difficulties in operating a static machine are due to several causes, most common being moisture within the case, dirt on the plates and a nitrous oxide (produced by the electric current within the case) which affects the working parts of the machine.

Moisture within the case may be overcome in several ways, most practical being the following:

1. Incandescent lamps placed inside the case generate heat and dry the air;

2. Jars containing cracked ice and table salt, placed within the case, dry the air by causing much of the moisture to precipitate upon the sides of the jars;

3. Four deep glass dishes, half filled with pure sulphuric acid or caustic potash, placed one in each corner inside the case, accumulate the moisture.

Dirt from the plates can be removed with a clean, dry cloth, or if the plates are very dirty, they may be washed with gasoline or kerosene oil.

Nitrous oxide can be collected by placing inside the case a dish containing linseed oil.

Location of the machine

In order to reduce to a minimum the difficulties due to moisture, the static machine should be placed in a sunny room. To avoid leakage, the position of the machine should be considered in relation to the walls and furniture of the room, and the machine should be placed so as to have the prime conductors as far as possible from walls and furniture. Setting the machine at work and darkening the room thoroughly, leakages show themselves as brush discharges, from a part of the machine, or from the corner of an insulated platform, if it is near a piece of furniture.

Earthing the machine

It is dangerous to earth the static or any high tension machine by means of gas pipes, which are of a composition of low melting point, and which may run within a short distance of the live wires of an electric lighting circuit.

The best way of providing earth or ground connection is to drive well into the ground outside a metal rod, connect an uncovered wire to it, and run it into the room where treatments are given. One of the prime conductors of a static machine or an electrode is often connected to this wire by means of a chain, and thus earthed. When both a prime conductor and an electrode are earthed at the same time, they can be connected to the same grounding wire.

Some operators never earth their electrodes, but the advantage of earthing one electrode is that it becomes the same potential as the operator, who then can touch the side of the machine without getting a spark. This is, therefore, of very great advantage in giving spark treatment.

Polarity

Since the static electricity is a unidirectional current, the patient must be charged, or the electrode connected to the positive or negative pole, according to the desired effect.

For the reason that different conditions cause the static machine to frequently change its polarity, it is necessary to be able to identify the positive from the negative pole.

There are several tests by means of which it is possible to ascertain the polarity of a static machine, most practical being the following:

1. If a burning candle is placed between the prime conductors while the machine is in action, the flame of the candle will be diverted toward the positive pole.

2. A small piece of ebonite electrified (negatively charged) by friction with a cloth or catskin, if suspended by a silk thread will be repelled by the negative pole.

3. Looking at a static machine in a dark room, a star appears at the positive and a spray at the negative pole.

Reversing the polarity. The polarity of a static machine can be reversed by earthing both poles and turning the plates a few times in the opposite direction before starting the machine in the usual way.

Insulated Platform and Electrodes

In order to be able to use static electricity for therapeutical purposes in addition to a good machine, an insulated platform, a number of electrodes and conducting cords are employed.

Insulated Platform. The patient undergoing the static treatment, in order to be charged, must be placed on an insulated platform, which is placed about three feet from the machine and surrounding objects. This platform is made of a wooden floor (about 5 x 2.5 feet in size), supported by four strong legs made of some insulating material (glass, porcelain, vulcanite, etc.).

Some operators have a brass plate on the platform, and on this a footstool free from nails, to serve as a seat for the patient.

Electrodes. In applying some forms of static and other high tension currents (high frequency from the Oudin resonator, Tesla secondary or hyperstatic transformer), only one electrode is applied to the patient, because these currents, on account of the enormous voltage, are able to complete the circuit through the air (in the form of wireless).

Most frequently used electrodes in the application of static electricity are made of metal, glass or wood. The metal electrodes are of brass, sheets of lead or other material. The glass electrodes are vacuum made in different shapes, according to the part to be treated (same as those used for high frequency applications).

Dosage

Dosage (strength) of various static modalities can be regulated by varying the speed of the machine, by the size of the terminal balls of the prime conductors (discharging rods) and by the length of the spark gap. Other factors entering into the problem are the size of the electrodes and the nature of the grounding.

Leyden Jar

Leyden jar consists of a glass jar coated in its lower half, inside and outside, with tin foil. It is closed with an insulating material through which passes a metal chain connected to the inner coating.

Leyden jar is a condenser in which the internal and external tin-foil surfaces are the conductors, and the glass between, the dielectric (insulator).

When the inner coating of the jar is charged with a positive electricity, the negative charge is induced on the outer coating, and vice versa.

When two Leyden jars are connected to the prime conductors of a static machine, they collect the electricity and cause between the discharging poles a less continuous but more vigorous spark; and the greater the capacity of these jars, the more powerful are the sparks produced. These jars are made use of in the application of static induced, Morton wave, and friction treatments.

CHAPTER VI

APPLICATION OF STATIC ELECTRICITY

EVERY time a spark passes between the prime conductors of a static machine, millions of oscillations per second are set up, and when the patient is included in the circuit, these vibrations are conveyed to the nerves.

Static electricity produces a sort of tissue massage, and is an equalizer of nerve force. It is a tonic, a stimulant, a vaso-constrictor or dilator, according to the polarity and the method employed. It helps in the elimination of carbon dioxide, urea, uric acid and all other waste products; increases the arterial tension; lengthens the diastole; increases the frequency and regularity of the pulse; stimulates the digestive functions; calms the nervous system and causes the return of sleep.

Contra-indications. Static electricity is contra-indicated in chronic or acute appendicitis, and in some cases which have gall-stones.

Static electricity is applied in the form of static charging, head breeze, induced current, Morton wave current, direct and indirect sparks, single or multiple sprays, etc.

Patients undergoing the static treatment may be fully dressed, but should remove all metal articles from their bodies (hat pins, hats, dresses containing metallic braid or gauze, etc.), as these cause such concentration of current locally, that they may produce unpleasant sensation.

Static Charging

THE POSITIVE CHARGE increases the pulse and arterial tension, the respiratory combustions, and the digestive functions; it stimulates nervous centers, promotes sleep, and produces general tonic effect; while the *NEGATIVE CHARGE* eliminates and disperses morbid and effete accumulations (urea, uric acid, etc.).

This refreshing and soothing treatment, which lasts from 15 to 30 minutes, is the simplest and most pleasant of all forms of static applications. It is indicated in all cases of nervousness, whether brought on by over-work, worry, trouble or anxiety, neurasthenia, melancholia, hypochondriasis, insomnia; also in depraved nutrition, anaemia, dyspepsia, chronic Bright's disease, and other conditions.

In applying this treatment, the patient is placed upon the insulated platform which is connected to one pole of the static machine by means of a brass tube or a chain. The other pole is earthed. Prime conductors are separated beyond the sparking distance, and the machine is started.

The patient is charged positively or negatively, according to the pole to which he is connected, and feels an agreeable sensation resembling a light breeze passing all around him.

Operator must be careful not to come too close to the patient, as a very unpleasant shock may be given.

Head Breeze

POSITIVE HEAD BREEZE, producing sedative effect and constricting the blood vessels, is indicated in migraine, cerebral hyperaemia, insomnia, etc.; while the **NEGATIVE HEAD BREEZE**, producing a stimulative effect and dilating the blood vessels, is of value in headaches due to anaemia, neurasthenia, chronic Bright's disease, etc.

In applying this treatment, which usually lasts from 15 to 20 minutes, the prime conductors are drawn out beyond the sparking distance. The patient is seated on an insulated platform and a few inches over his head a wooden disc or an electrode, having a number of metal points, is suspended from the telescopic metal stand on the floor.

For the positive head breeze, the negative pole of the machine is connected to the insulated platform, and the positive pole is earthed and connected to the telescopic stand; while for the negative head breeze the connections are reversed.

Caution: Patients undergoing the head breeze treatment should not be allowed to wear metal hair-pins which may cause burning sensation, or celluloid ones, which are inflammable.

Static Induced Current

Static induced current, elaborated by Dr. W. J. Morton of New York, in 1881, is not unidirectional and resembles the faradic current, although it widely differs from this current in physical and therapeutical properties, producing muscular contractions after both faradic and galvanic currents have failed. It relieves local congestion and local pain, increases secretions, produces local vibratory effect and is very useful in ovarian neuralgia, neuralgic sciatica, constipation, congestion of the liver, progressive muscular atrophy, poliomyelitis, prostatic hypertrophy, obesity, etc.

To produce this current, two small Leyden jars are employed (the greater the desired effect and the area of the electrodes, the larger should be the jars) and the inner coatings of these are connected to the prime conductors of the static machine.

By using different sized Leyden jars, by adjusting the spark-gap, and by regulating the speed of the machine, altogether different effects can be produced, from the finest tingle, which is indistinguishable from the faradic current, to a slowly-discharging spark from the condensers, which causes powerful contractions of muscular tissue.

In administering the static induced current, the patient need not be on an insulated platform, and no pole is earthed. Sponge covered, metal or glass vacuum electrodes are attached by means of insulated wires to the outside coatings of the Leyden jars, and are placed on the bare skin of the patient.

When the machine is started (at the lowest possible speed), the prime conductors are actually touching each other and are very slowly separated until the desired muscular contractions are produced, or until the patient receives the proper strength. (The prime conductors are usually separated from one-eighth to one-fourth of an inch.)

The average duration of each application is about 20 minutes.

Morton Wave Current

The static, or Morton wave current, elaborated by Dr. W. J. Morton, in 1900, is without doubt the most useful form of static treatment. It produces local vibratory effect and the alternate contraction and relaxation of muscular and cellular tissue; increases secretions and the excretion of urea, and by promoting oxidation, lessens the uric acid in the system; dissipates the infiltrations; lessens hyperaemia and congestion, and often gives prompt relief from pain even in cases in which heroic doses of morphine fail to give relief. This current is, therefore, the most efficacious remedy in acute and chronic non-infectious inflammations and is of great benefit in lumbago, synovitis, sprains, rheumatoid arthritis, sciatic neuritis, torticollis, visceroptosis, congestion of the liver, constipation, dysmenorrhea (due to congestion or spasm of the internal os), congestion of the uterus, sub-involution of the uterus, prostatic hypertrophy, locomotor ataxia, anterior poliomyelitis, insomnia, etc. *It is contra-indicated in all suppurative conditions.*

In applying this form of treatment, which usually lasts from 10 to 20 minutes, the patient is placed on an insulated platform (the platform is not connected with the machine). The negative pole is earthed, and a smooth electrode of the proper size and shape (composed of block-tin, sheath-lead, or pure silver), moistened with hot water connected to the positive pole is placed on the bare skin of the patient at a point where treatment is necessary. When the machine is started, the prime conductors are actually touching each other, and are very slowly separated by the operator, who is standing on the earthed (negative) side of the machine, until the limit of tolerance of the patient is reached (usually from one-half to four inches, depending on the sensitiveness of the patient, the electrode employed, and the relative humidity of the atmosphere). The speed of the machine should be regulated so as to produce alternate contraction and relaxation of muscular tissue so necessary in the relief of congestion and infiltration.

The contractions should be slow enough to obtain the periodical contraction and relaxation of the glandular and muscular tissue of which the organ is composed. This action depends principally upon the length of the spark-gap, the size of the terminal balls, and the size of the electrodes used upon the surface of the body.

"In humid weather, when the capacity of the output of spark from static machine in wave current applications is much diminished, by introducing a low coated Leyden jar in series with the negative ground connection, the volume and length of spark gap can be restored and frequency of the spark discharge controlled at will."—*Dr. E. C. Titus, of New York.*

Static Sparks

Static sparks produce counter-irritation, and are of special value in the treatment of sciatica, neuralgia, chorea, locomotor ataxia, constipation, neuritis of the rheumatic type, paralysis of the muscles, and all low and depressed conditions of the system where a general stimulating and tonic effect is desired.

Strong sparks drawn over motor points cause muscular contractions with reddening of the skin and burning sensation.

Caution: Spark treatments must be applied judiciously. Never bring an electrode near the face (especially the eyes), or treat a bony structure (elbow, knee, etc.) which is protected only by a thin covering of soft tissue, with any but short mild spark. It is better to apply the sparks to the bare skin than through the clothing, and as the spark causes a sensation of a shock, it is advisable to inform the patient beforehand where the sparks will be administered.

THE INDUCED, OR INDIRECT SPARK, is administered by placing the patient on an insulated platform, connected to the negative pole, situated as far away from the machine as possible; while the positive pole is earthed. The spark-gap is wide open (5 or 6 inches), and a wooden or metal ball electrode, connected with the floor or with an earthed pole, by means of a chain, is brought close enough to the patient to cause a discharge of sparks. The larger the ball electrode, the sharper the resulting sensation. The potential can be regulated by the operator approximating one foot to the insulated platform, so as to take part of the patient's charge, or by altering the speed of the machine.

THE DIRECT SPARK is administered in the same way as the indirect, except that the positive pole is not earthed, but is connected directly to the electrode.

The direct spark, being too severe a treatment, is now very seldom employed.

A STATIC ROLLER MASSAGE is a form of spark treatment applied with a roller electrode connected to the top of one Leyden jar, while the patient is on an insulated platform, connected to the top of the other. This treatment is applied through the clothing, and not on the bare skin. The thicker the clothing, the more severe the effect. The machine is started with the prime conductors actually touching each other; these are gradually separated until the resistance of the patient's clothing is overcome. The roller must be moved rapidly, and used for a few minutes at a time.

Using the Leyden jars, this treatment produces stimulation of and counter-irritation to cold extremities, while without the jars it is milder, producing an ordinary massage.

Static Sprays

Both single and multiple sprays relieve congestion, lessen local swelling, and diminish pain. They are applied by means of a single or multiple point electrode (respectively), connected with the floor by means of a chain, and held by the operator at a distance of from five to ten inches from the patient, who is on an insulated platform, connected with the positive pole of the machine. The negative pole of the machine is grounded.

CHAPTER VII

ALTERNATING CURRENTS

AN alternating current is one in which the rise and fall of voltage in a positive direction is immediately, without break, followed by a corresponding rise and fall in a negative direction. This rise and fall of voltage in both directions represents a *cycle*.

In every cycle there are two *alternations*, or *curves*, one positive and one negative; therefore, a 60 cycle current has 120 alternations.

Period is the time required to complete one cycle.

Frequency is the number of complete cycles occurring in one second of time, and is controlled by the velocity of the alternating current generator, or the rapidity of the oscillating rheostat.

Commercially speaking, a current of 25 cycles per second is called a low frequency current, and a current of 133 cycles per second, a high frequency current.

In electro-therapeutics, a current having less than 1000 cycles per second is called a low frequency; one having from 1,000 to 10,000 cycles per second, a medium frequency; and from 10,000 to many hundreds of thousands cycles per second, a high frequency current.

Sinusoidal Currents

A true sinusoidal current is an alternating current in which the rise and fall in voltage in the positive and negative directions is gradual, and represents a sine curve, or a horizontal letter "S" (—). (See Fig. 7). This current is produced by means of an alternating current generator, or by passing the galvanic current through an oscillating rheostat.

An *oscillating rheostat* consists essentially of a resistance coil so arranged that a sliding contact piece gradually increases the voltage by reducing the resistance, until the maximum voltage is reached; then again increasing the resistance decreases the voltage to zero; the polarity is then reversed without break and the second alternation is completed in the same way.

By controlling the number of revolutions of the alternating current generator, or the rapidity of the oscillating rheostat, it is possible to produce either a *slow* or a *rapid* sinusoidal current.

The *slow sinusoidal* (galvanic sinusoidal) current has a frequency of from 10 to 120 cycles per minute; while the *rapid sinusoidal* from 120 to 2000 cycles per minute.

Alternating current from the lighting circuit is usually 110 volt and 60 cycle (per second), and is, therefore, a strong and very rapid sinusoidal current. This current can be used by lowering the voltage with a reliable rheostat, but as the frequency of this current is controlled by the revolutions of the generator, at the electric power plant, it is im-

possible to lower the frequency, and such an arrangement will always deliver a very rapid sinusoidal current of 3600 cycles per minute (or 60 cycles per second).

Application of the Sinusoidal Currents

Sinusoidal current, being of an alternating character, has very little polar effects.

The slow sinusoidal current, due to the gradual rise and fall in voltage and a change in polarity, has great stimulating powers, producing painless rhythmical contractions and relaxations of the involuntary muscular fibres.

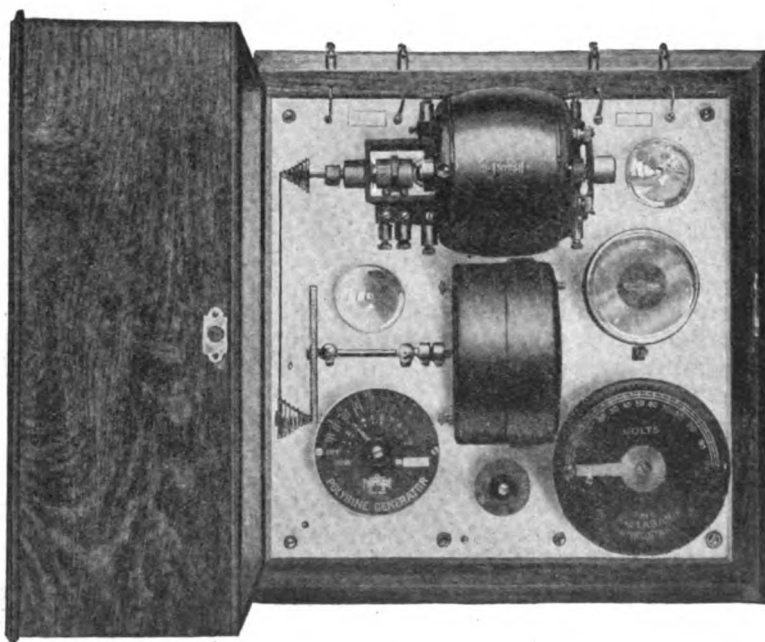


Fig. 10—Sinusoidal Current Apparatus.

Since the action of this current is similar to the physiological function of the involuntary muscular fibres, it is an excellent remedy for the affections of the involuntary organs, especially stomach, intestines, bladder and uterus, and is very soothing in excessive sensibility.

This current gives excellent results in constipation, diabetes, gastritis, gastrectasis, headaches, infantile uterus, insomnia, locomotor ataxia, lumbago, melancholia, muscular atrophy, obesity, ovarian neuralgia, paralysis, segmental analgesia, prostatic hypertrophy, etc., etc.

The *rapid sinusoidal current* may be employed in all cases where faradism is usually employed, and gives better results than faradism in eliciting vertebral reflexes and stimulating the muscular tissue.

This current is beneficial in bronchial asthma, insufficiency of mammary glands, visceral neuralgia, neuritis, pelvic diseases, pleurisy, vagus hypotonia, vomiting in pregnancy, etc.

COMBINED GALVANIC and SINUSOIDAL, or UNDULATORY GALVANIC CURRENT, is similar to the true sinusoidal, with the exception that it is undulatory in one direction only (there is no change in polarity). Besides the power of contracting the muscles, it possesses the polar properties of the galvanic current, and is especially indicated in cases of optic atrophy, anterior poliomyelitis, and various other conditions in which both undulatory and galvanic effects are of value.

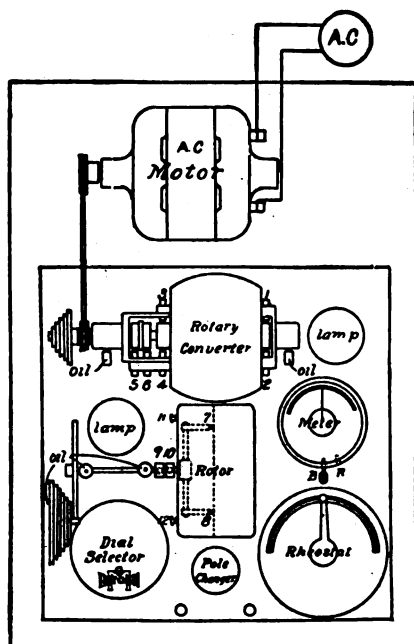


Fig. 11—Diagram of the Sinusoidal Apparatus shown in Fig. 10. *Rotor* is an oscillating rheostat consisting of a porcelain base wound closely with resistance wire, against the surface of which revolve two carbon brushes. *Rotary Converter* is a current generator, hence, all currents obtained from this apparatus are free from "ground" connection, and may be safely employed without fear of a shock.

Contra-indications

Sinusoidal current is contra-indicated in the same condition in which static current is contra-indicated, viz., cases of chronic or acute appendicitis, and some cases which have gall-stones.

CHAPTER VIII

HIGH FREQUENCY CURRENTS

THE high frequency currents are the alternating or oscillating currents in which the frequency rises up from ten thousand to several millions of oscillations per second, and are undoubtedly the most popular currents of the day.

On account of this high frequency, these currents, when passed through the body, cause no pain or muscular contraction, because the sensory nerves are perfectly insensible to stimulations of a higher frequency than that for which they are organized. For the same reason, it is impossible for the eye to see very rapid motion, or the ear to distinguish high sound vibrations.

These currents have been named after D'Arsonval, the noted French scientist, and Tesla, the famous Croatian electrical engineer, who have invented them, and have done more toward the production, perfection and possibilities of using them, than all other persons combined.

D'ARSONVAL CURRENT is one of high frequency, high amperage, and not very high voltage. Originally, it was produced as follows (Fig. 12):

The direct current from the lighting circuit, interrupted and passed through the primary winding of a large induction coil, magnetizes the soft iron core and induces a current of very high voltage (hundreds of thousands of volts, according to the size of the coil) in the secondary winding, which is in the magnetic field. The terminals of the secondary winding are connected to the inside coating of the Leyden jars. Between the outer coatings of the jars is connected a solenoid, or a coil consisting of twelve to twenty turns of coarse copper wire.

The Leyden jars (or any other type of a condenser employed) discharge themselves through an adjustable spark-gap, placed in the circuit between the two inner coatings of the jars, causing several millions of oscillations per second in the solenoid from which this current is obtained.

The frequency of the oscillations depends upon the capacity of the Leyden jars. When the jars are small, the discharges are quicker than from the large ones.

TESLA CURRENT is one of very high voltage, very high frequency, and a low amperage. This current is produced by means of an apparatus consisting essentially of a step-up transformer, a condenser, and a Tesla coil, as follows (Fig. 13):

The step-up transformer raises the electric lighting current of 110 or 220 volts to a current of from two to thirty thousand volts (according to the size of the transformer). This high voltage from the secondary winding of the step-up transformer charges a condenser. The condenser discharges at a very high frequency through the primary winding of the

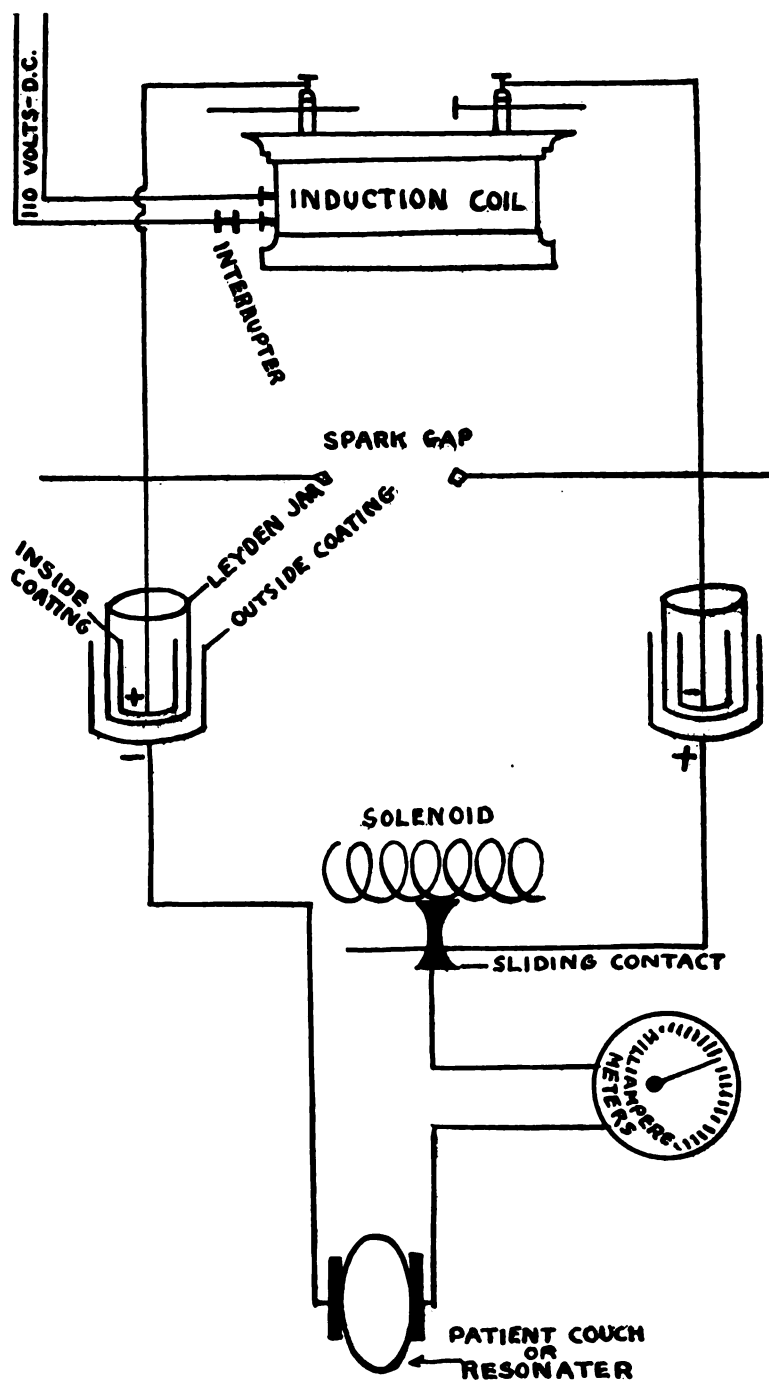


Fig. 12—Diagram of D'Arsonval Type.

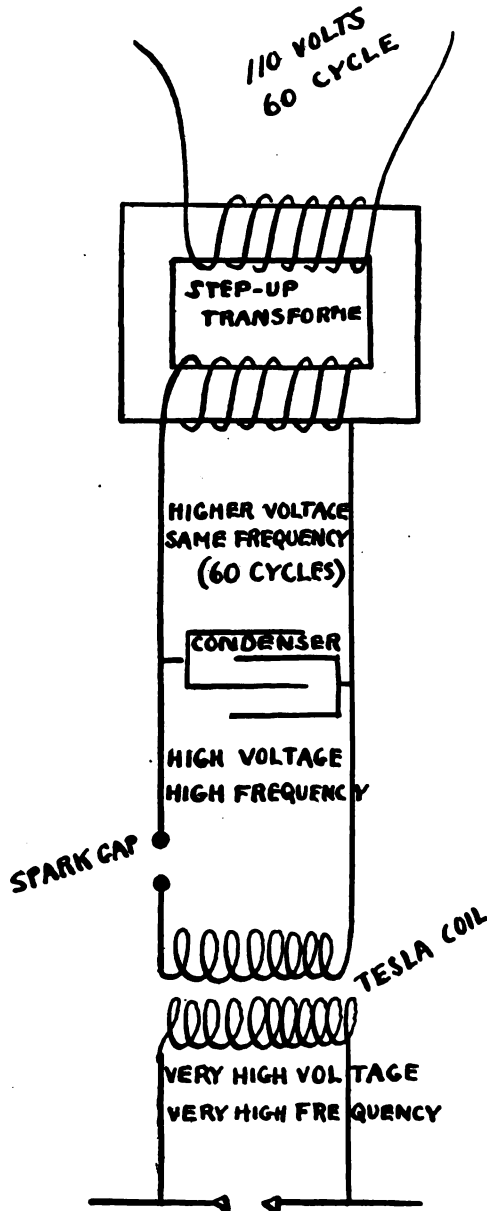


Fig. 13—Diagram of Tesla Type.

Tesla coil (a few turns of coarse wire wound around the outside of a secondary winding consisting of a large number of turns of fine wire) and as a consequence, a current of very high frequency, very high voltage and low amperage is generated in the Tesla secondary.

The Tesla coil is particularly adapted for the alternating current, and is employed in most of the portable high frequency machines.

Oudin Current

A current of high frequency, high voltage and a low amperage, resembling the current from the secondary winding of the Tesla coil, can be obtained from the D'Arsonval apparatus, by attaching and properly adjusting to the solenoid a large coil of fine wire, known as the Oudin Resonator (Fig. 14).

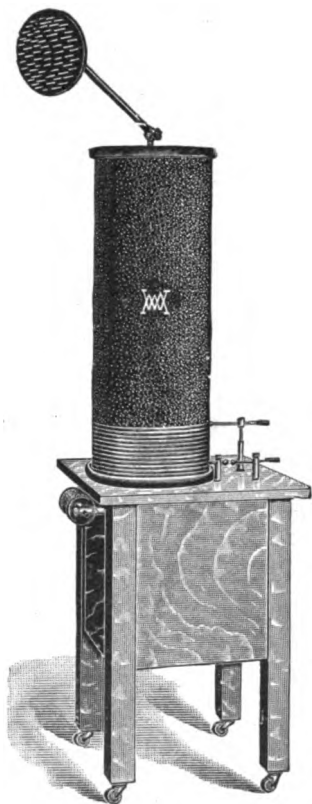


Fig. 14—Oudin Resonator.

High Frequency from the Static Machine

The high frequency currents can be also produced from the hyper-static transformer (Fig. 15) connected to the prime conductors of a static machine. The current thus obtained, does not give a sufficient amperage for the satisfactory application of auto-condensation or direct D'Arsonval method (Diathermy), but possesses advantages for destructive effect over the coil or transformer.

Application of High Frequency Currents

D'Arsonval current is administered in the form of "Auto-condensation," "Auto-conduction," and the direct application or "Diathermy"; while the currents from the Tesla secondary, the Oudin Resonator or

the hyperstatic transformer in the form of "Vacuum tube application," "Effleuve," and "Fulguration."

Auto-condensation and Auto-conduction

Auto-condensation and Auto-conduction increase general metabolism, glandular activity, temperature and bodily heat, oxidation and hemo-globin, secretions and eliminations, etc. These currents pass, by preference, along the paths of least resistance, along the blood vessels, and along the muscles. On account of the great frequency of oscillations, they heat the blood and thereby stimulate the great system of vaso-motor nerves. Exerting an important influence on the sympathetic

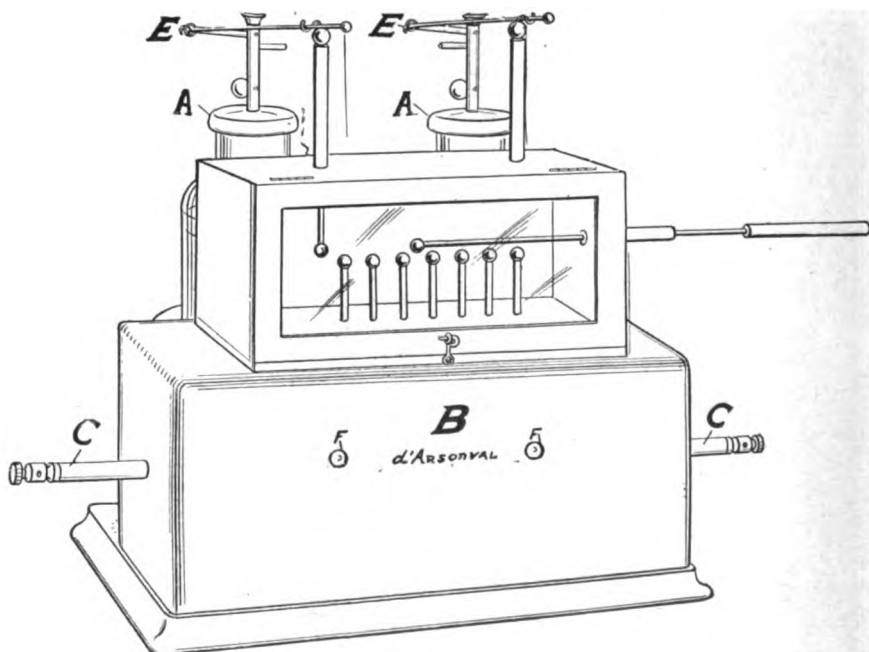


Fig. 15—*Hyperstatic Transformer*. This instrument used with a Static Machine produces the High Frequency Currents.

nervous system, they cause the peripheral dilatation of the blood vessels, the increased activity of the heart, and an increased depth of the respiratory excursions. As a result of peripheral dilatation of the blood vessels, the passive venous congestion of the internal organs is relieved, and the digestion and assimilation, to a large extent, improved.

Dilating the blood vessels, these currents reduce the high blood pressure when hypertension exists, which reduction progresses from one treatment to another, without being accompanied by the vicious cycle as occurs with drugs, and consequently are more effective and more desirable than drugs.

Indications: Auto-condensation and auto-conduction treatments are of great value in all cases of defective metabolism, particularly in diabetes, rheumatism, gout, asthma, kidney troubles (except acute

parenchymatous nephritis), arteriosclerosis, nervous diseases, and *all cases in which hypertension exists* (unless compensatory).

Contra-indications: These treatments are contra-indicated in acute parenchymatous nephritis (on account of their ability to liberate waste products more rapidly than the diseased kidney can carry away); general arteriosclerosis with low blood pressure; syphilitic and gonor-



Fig. 16—Patient undergoing auto-condensation treatment. (Victor apparatus)

reheal myocarditis; cerebral anaemia, excitement, and in *all cases in which hypotension exists*.

AUTO-CONDENSATION is administered with the patient (fully dressed) on a couch or a chair having a large metal electrode under the insulated cushion (which acts as a dielectric), connected to one end of the D'Arsonval solenoid (or other terminal of the transformer). The other terminal of the apparatus is connected to a metal handle which the patient holds in his hand.

Due to the large amount of current (300 to 1000 milliamperes) employed in this treatment, the patient feels a gentle warmth beginning at the wrists, gradually extending up the arm to the axilla and over the entire body.

The current traversing the patient can be measured introducing a special hot wire milliamperemeter in that part of the circuit which connects the metal electrode which the patient holds in his hand.

In order to demonstrate the amount of current with which the patient is charged, while under this treatment, it is only necessary to have the patient illuminate a 16 candle power, 110 volt incandescent lamp through his body, by introducing it into the circuit in the same way as a milliamperemeter.

AUTO-CONDUCTION is administered by placing the patient inside of a large solenoid, or a cylindrical wire cage, without connecting him in any way with it. (Fig. 18.)



Fig. 17—Patient undergoing auto-condensation treatment

The cage is connected to the apparatus, and the current travels completely around the outside of the cage. Thus travelling through the copper wire, this current discharges itself from all sides into the body of the patient, who thus receives a full body treatment.

Auto-condensation and auto-conduction treatments are usually administered for from 10 to 30 minutes, and are given daily at first in nearly all cases, gradually decreasing as the patient improves.

Direct Application of D'Arsonval Current

Diathermy

D'Arsonval current directly applied by means of two metallic electrodes in passing over a small cross section through the internal tissue of the body, generates a purely mechanical heat, by overcoming the resistance of the tissue, in the same way as electricity heats the resistance wire in passing through it. The higher the frequency and stronger the current, the greater the heat production.

This method of heat production recently elaborated by Dr. Franz Nagelschmidt, of Berlin, which will probably in the near future take the leading place in electro-therapeutics is called Diathermy, or Thermo-penetration.

Generation of Diathermic Currents

For the reason that the heat effect of the D'Arsonval current chiefly depends on the frequency of the oscillations, most of the apparatus

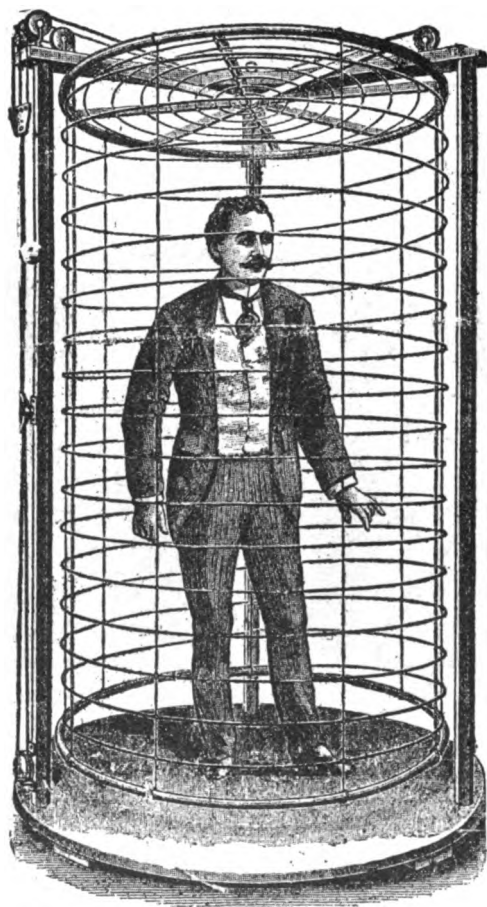


Fig. 18—Patient undergoing auto-conduction treatment.

generating this current for diathermic applications, have special condensers (mica-tin-foil, or Leyden jars) and a multiple spark-gap (which causes a discharge of a number of short fine sparks), so as to increase the oscillations to a very high frequency. Therefore, the D'Arsonval current for diathermy differs from the ordinary D'Arsonval, in being of a much higher frequency (100,000 to many millions of oscillations per second), a higher amperage (up to 3000 to 4000 milliamperes) and a lower voltage (250 to 1000 volts).

Localization of the current

Since the current passes directly from one electrode to the other, and since a small active electrode causes greater concentration of heat, with less current in a relatively shorter period than a large one, the heat can be localized and concentrated at will, by the position and the size of the electrodes, e. g., two large electrodes of the same size applied on the opposite sides of the part treated will produce the same effect at each electrode and the uniform effect between them; while employing one small and one large electrode, the heat will be concentrated only at the small electrode (which is therefore called active).

In order to prove that the heat produced by this current is more pronounced in the center of the tissues (between the electrodes) than at the points where the electrodes are applied, it is only necessary to apply two metallic electrodes to the opposite ends of a potato and to pass about 1000 milliamperes of current for three or four minutes. At the



Fig. 19—Application of Diathermy.

end of this application, it is found that the outside of the potato, where the electrodes were in contact, has remained unchanged (raw) but on cutting the potato in half, it is noticed that the center is cooked. Same experiment may be performed on a piece of beef, liver, egg, etc.

By means of diathermic currents being able to raise the local internal temperature (without producing muscular contraction or ionic action) to a moderate warmth, and thereby create a suitable condition for healing of various lesions; or, on the other hand, to increase the heat to such an extent so as to dessicate or even carbonize the tissue, the field of diathermy is very large, both in medicine and surgery, and its application has, therefore, been divided into two branches, viz., Physiological or Medical Diathermy and Surgical Diathermy or Electro-Coagulation.

Physiological or Medical Diathermy

The utilization of heat in the treatment of disease dates back to the very earliest days of medicine. Until the introduction of diathermy, all the applications of heat were from without. This was well enough, so far

as it went; but such external applications never succeeded in heating the blood structures within the body. By means of diathermic current, we are, however, able to heat the internal parts of the body at will, and thereby produce all the essential elements of an inflammation without injuring the cells of the body so as to stimulate them into reaction. Since the inflammation and fever (one is local, while the other constitutional reaction) are Nature's most powerful processes for the produc-

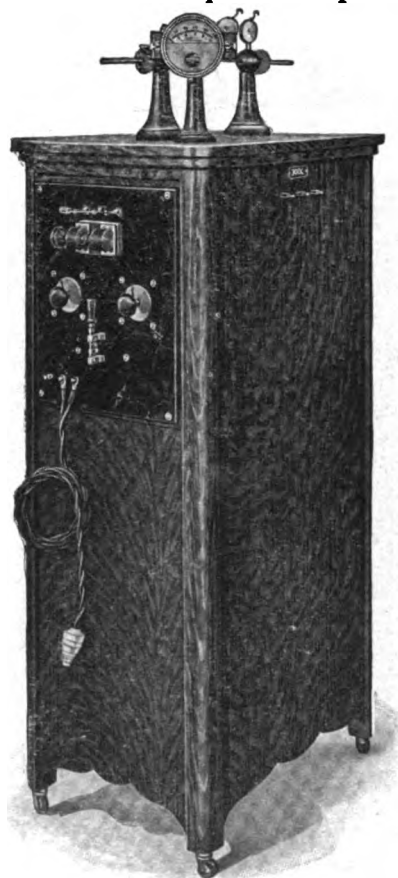


Fig. 20 — Combination apparatus delivering X-ray, High Frequency, Auto - condensation and Diathermy.

tion of a cure, diathermy is, therefore, a truly physiological measure, which does not relieve or obscure symptoms, but assists the body in the performance of its physiological function.

"The introduction of diathermic heat results in better cell function and an increase in the chemistry of the part. This warmth, introduced from without, is stored up as energy in every molecule of the cell protoplasm. There is neither any expenditure of the patient's reserve energy, nor is there any actual combustion of circulating nutrient.

“As a secondary effect of this local diathermatization, we have produced a local arterial hyperaemia, and as a further result, we have increased the *vis a tergo* on the arterial side, which, too, improves the pressure of the little venules. Consequently, we have done much to relieve the local venous engorgement, and we are directly aiding the removal of those used-up products resulting from tissue changes, which have a damaging effect on the cellular life, if allowed to remain.”
—*Frederick De Kraft.*

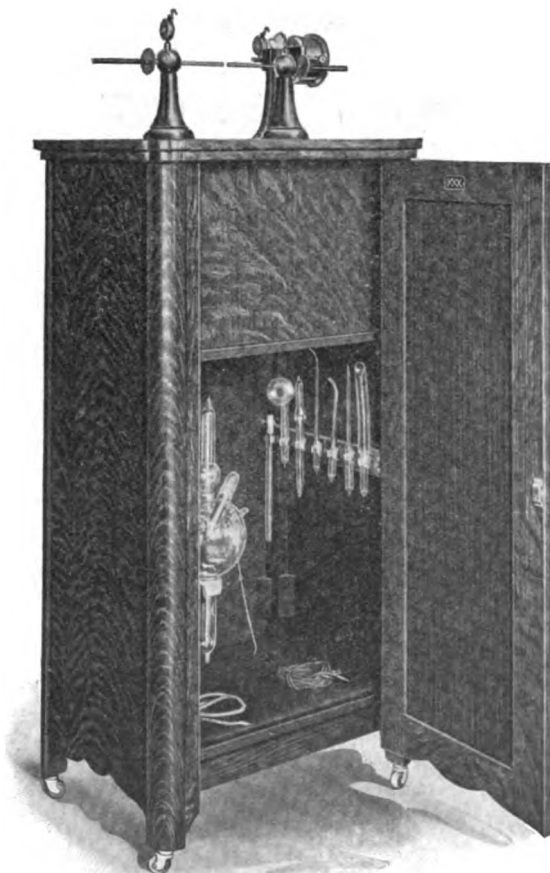


Fig. 21—Rear view of the apparatus shown in Fig. 20.

INDICATIONS: By raising the local internal temperature only a few degrees above normal and thereby producing an active hyperaemia in deep structures (which lasts for several hours), dissolving some crystalline deposits of urates, and destroying some infectious micro-organisms, remarkable results are obtained in the treatment of various local affections, particularly those due to defective metabolism, streptococcic and tubercular infections, uric acid deposits, etc.

Physiological diathermy is therefore indicated in chronic nephritis,

cholecystitis, pancreatitis, asthma, pleurisy, pneumonia, first stages of phthisis, certain heart diseases (particularly in cases where impairment of the muscular structure has taken place, as the result of changes of an arteriosclerotic nature in the coronary arteries), rheumatism, gout, lumbago, acute and sub-acute arthritis, synovitis, neuralgia, neuritis, sciatica, painful local affections, etc.

CONTRA-INDICATIONS: This method of treatment is contra-indicated in gastric ulcer (as it may cause violent hemorrhages), and in cases where there is possibility of the presence of walled in pus, (because the staphylococci and the streptococci contained in pus may be stimulated to greater activity and more rapid multiplication).

Method of Application

Diathermy is applied either as a strictly local or general application. It is, however, advisable to limit the heat effect, wherever possible, to that organ or organs which seem most likely to be benefitted; the heart, liver, kidneys, lungs, the splanchnic area, the spinal centers, etc. The object of a general application is to produce a general hyperthermia and to obtain those other physiological effects on the sympathetic nervous system, on the general and especially the peripheral circulation of blood and lymph, which only a general diffusion of high frequency currents can bring about.

At the present time, we have no reliable measuring device giving us an exact idea of the heat produced in the interior of the tissues, but if we take into consideration (1) the strength of the current; (2) the electrodes; (3) the duration of the application; and (4) the sense of temperature of the patient, we will not commit gross errors which may result in burns.

1. *Strength of the Current.* It is never wise to begin a treatment with the maximum of current that the patient can bear, for if too much current is employed, the heat near the electrodes will become unbearable, before the deep-seated tissues are heated as much as they should be. In order to obtain the best therapeutic results, it is advisable to slowly increase the current up to 200 or 300 milliamperes so as to gradually heat the tissues between the electrodes. After a few minutes, the current can be increased as much as the patient can bear with comfort. We must, however, be careful not to exceed that degree of warmth whereby too much heat will damage the cell. In other words, the heating must not lead to permanent changes in the protoplasm.

2. *Electrodes.* Diathermy is applied by means of bare or covered metal electrodes. The most suitable electrodes are of soft steel metal which are flexible enough to permit an even application, and good close contact. If covered electrodes are employed, they must be saturated with a sodium chloride, or ammonium nitrate solution.

In order to produce the uniform heat effect between the electrodes in the application of physiological diathermy, both electrodes should be of about the same size, and to prevent unpleasant sparking and burns, wherever possible, these should be securely fastened by means of a roller bandage.

Size of the electrodes govern directly the density of the current when a certain unit of current is passing. As we change the size of the elec-

trodes, we not only change the current density, but also the mass of the tissue which intervenes.

The electrode surface should be of approximately three by five inches (for each electrode), to one thousand milliamperes of current employed.

3. *Duration of the application.* The resulting quantity of heat is proportional to the duration which a certain current strength is acting.

The application should last enough to get a true physiological response and no more. Too long an application may do harm, while one too short may do no good. As a general rule, the application should last from 15 to 30 minutes, according to the intensity of the current.

4. *Toleration.* If the current is turned on to the point of comfortable toleration, the danger of injuring the intervening tissues is practically *nil*, as the heat at the surface application is practically the same as the heating of the intervening tissues.

General Remarks

I. "It is not always necessary to obtain an excessive rise of temperature in the deeper structures, nor even a demonstrable increase of heat. Even a very small diathermic effect may produce an improvement, both subjectively and objectively, and lead to functional changes in the tissues to which it is applied."

II. "One of the most important results of diathermy is hyperæmia."

III. "Diathermic currents appear to possess the peculiarity of inducing a dilatation of the blood vessels within the structure through which they pass. Co-incident with the dilatation of the blood vessels, a more rapid flow of blood to the part occurs, also an increase in the formation of lymph."

IV. "Excessive quantities of current and too long an application may easily lead to a temporary paresis of the capillaries, and thus indirectly to a pronounced local oedema."

V. "The bone marrow is the least to take part in the general warming process, taking up warmth from the surrounding tissues. As a result of its protected position, it holds the heat longest."

Vacuum Tube Applications

Vacuum tube applications promote local hyperaemia, absorption and heat; increase local nutrition and oxygenation; liberate ozone, which is inhaled by the patient and is locally germicidal; retard the growth of parasitic diseases, and decrease the virulence of the toxins produced by the bacteria, etc.

Local hyperaemia produced by this method usually lasts from 10 to 24 hours, according to the time of application, strength of the current and the physical condition of the patient.

These applications are indicated in all local chronic inflammatory conditions, e. g., neuritis, neuralgia, constipation, hemorrhoids, salpingitis, rheumatism, herpes, eczema and all other skin affections.

Mild and medium sparks stimulate or soothe, according to the length and character of the application. Strong sparks are caustic. Sparks to the spine and solar plexus increase the arterial tension.

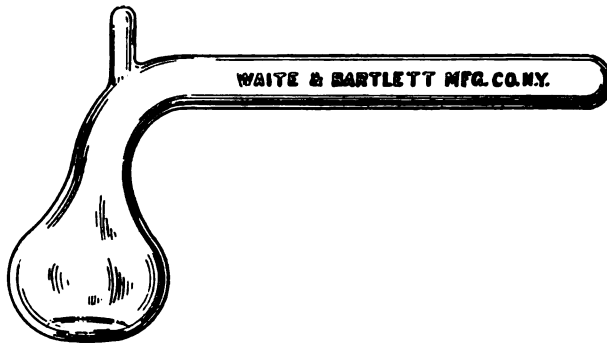


Fig. 22—Surface Vacuum Electrode.

Vacuum tubes

Vacuum tube treatments are administered by means of glass electrodes of different shapes and sizes (according to the part treated), and are applied by direct contact, by a fine spray (Effleuve) or by sparks.

For the reason that most of the current is discharged at the first point where the electrode comes in contact with the body, when treating various orifices, in order to administer a sufficient quantity of current within, it is advisable to use *insulated vacuum tubes*.

These tubes are far superior to the ordinary uninsulated electrodes, and consist of a vacuum chamber, surrounded all its length except the point, by a chamber filled with air, which acts as an insulator. (Fig. 24.)



Fig. 23—Vacuum Electrode for covering large surface.

Vacuum tubes used in the application of high frequency currents from an Oudin Resonator, Tesla secondary or hyperstatic transformer consist of a sealed glass chamber exhausted to a vacuum varying from one five hundredth to one millionth of an atmosphere.

Tubes exhausted at about one five hundredth of an atmosphere ($\frac{1}{500}$) are called low; those exhausted at about one thousandth ($\frac{1}{1000}$) of an atmosphere, medium; while tubes which are exhausted at a higher vacuum are called high.

Low tubes light with a rose-pink color and give more heat than those of a higher vacuum. These tubes produce sedative effect and are useful in all acute inflammatory and painful conditions.

Medium and High tubes give blue, blue-violet, or almost a blue-white light, and produce less heat and more chemical rays than low. These



Fig. 24—Insulated Prostatic Electrode

tubes give better results than low in the treatment of skin diseases and various chronic affections.

In administering vacuum tube treatments in order to avoid a painful discharge of sparks between the patient and the electrode, the glass tube must be in contact with the body, prior to turning on the current, and the current turned off prior to removing the tube.

Sterilization of Vacuum Tubes

Although the effluve from the vacuum tube is germicidal in action, in order to prevent the spreading of infection, it is advisable to sterilize these electrodes as much as possible, particularly after treating specific

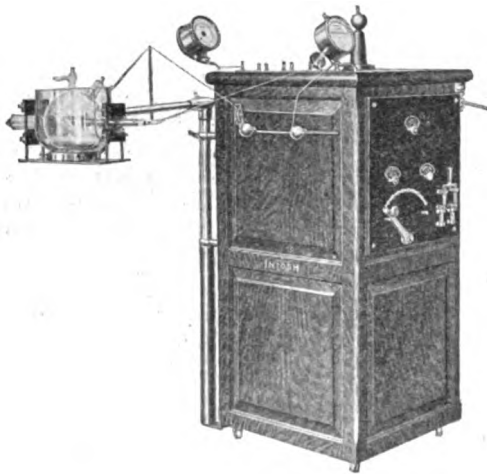


Fig. 25—A combination of X-ray transformer and high frequency apparatus.

diseases (skin affections, venereal diseases, etc.). This is accomplished by washing them in a strong antiseptic solution (such as bichloride of mercury, carbolic acid, lysol, etc.).

Vacuum Tube Burns

High frequency currents applied by means of vacuum tubes do not cause dermatitis comparable to that produced by the X-rays, but they are capable of causing surface burns. These burns are easily produced when mucous surfaces are treated; therefore, when giving vaginal, urethral, rectal or nasal treatments, never allow a vacuum tube to remain in contact with mucous membrane for more than seven minutes during one treatment, and rotate it frequently, to avoid sticking.



Fig. 26 — Electrical apparatus of extreme compactness, delivering almost all numbers of electrical modalities, including the new "R-rays" (X-ray, High Frequency, Cautery, Ozone, Vibration, Suction, etc.)

From "*The Electrical Experimenter*"

CHAPTER IX

HYDRO-ELECTRO THERAPY

SINCE water moistening the skin increases the electrical conductivity, and both hot and cold applications to the skin diminish the electro-sensibility, by applying simultaneously or successively the two powerful therapeutic agents—water and electricity—double aid can be rendered in a large number of pathological conditions.

The hydro-electric treatments consist of the application of galvanic, faradic, galvano-faradic and sinusoidal currents, in the form of a whole bath, local bath and electric douche.

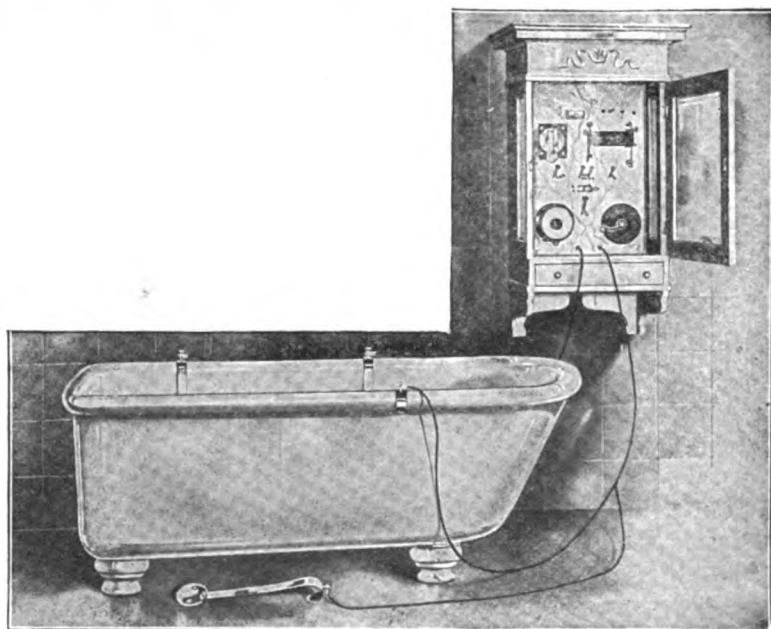


Fig. 27—Caution: If a current from wall plates is employed, the tub must not be connected with filling or draining pipes, and great care should be exercised to avoid accidents.

Whole Bath

The whole electric bath is administered with a patient in a wooden, porcelain or enameled iron tub, half filled with water at a temperature of from 85 to 95 degrees Fahr. It is a general body treatment and a most efficacious method of applying electricity when tonic effects are desired; and may be either mono-polar, or bi-polar.

In a *mono-polar bath*, the active electrode connected to one pole of the generator is immersed in water, and the indifferent electrode (which is a long bar of iron covered with chamois leather) held in both hands of the patient, is connected to the other pole.

In a *bi-polar bath*, both electrodes are immersed in water (one at each end of the tub), but the patient's body does not come in contact with either.

The water, being a conductor of electricity, acts as an electrode by which the electric current is applied to the body, while in the hydro-electric bath. In a bi-polar bath, for example, the current enters at one electrode, runs through the water surrounding the patient, and passes out at the other electrode.

Local Bath

In a local bath, a limb or a part of a limb is immersed. The active electrode (metal or carbon) connected to one pole of the current generator is placed at the bottom of the cell (the vessel into which the limb is placed), and the other pole is connected to the indifferent (sponge) electrode, and applied to some part of the patient's body outside of the water.

Dr. Schnee Bath

The *Four-Cell Bath*, designed by Dr. Schnee, is the most convenient method of carrying out the local and general electrization, without being necessary for the patient to undress. It consists of two foot and two arm cells, half filled with water. Two of these cells are connected to one pole of the generator, and two to the other. According to the connection of cells, the current can be localized in a desired part of the body, and made to travel in a desired direction, e. g., employing the galvanic current and connecting the two foot cells with the positive pole, and the two arm cells with the negative, there will be two distinct flows of current through the body, viz., one from the right foot to the right arm, and the other from the left foot to the left arm. If the arm cells were connected positively and the foot cells negatively, the flow would be from arms to feet, because electricity always flows from the positive to the negative pole.

Electric Douche

Electric Douche is used either as a local or general treatment, and is administered by connecting one pole of the current generator to a large indifferent electrode, on which the patient stands, and the other pole to an insulated metal nozzle from which the stream of water is directed against the desired point on the patient's body. This application is particularly suitable for hydrotherapeutic establishments.

Hydro-Electric Application

The effects produced by hydro-electric applications depend on the current employed. The mono-polar galvanic bath with the negative electrode immersed is stimulating, while the same application with the positive electrode immersed is sedative.

The bi-polar galvanic bath produces drowsiness and fatigue, and is useful in insomnia.

The faradic bath, stimulating the patient and improving general nutrition, is beneficial in various conditions, such as chorea, paralysis agitans, anaemia, hypochondriasis, etc.

The sinusoidal bath is far superior in its effects to the effervescent, or so-called Nauheim bath, and is of special value in chronic intestinal

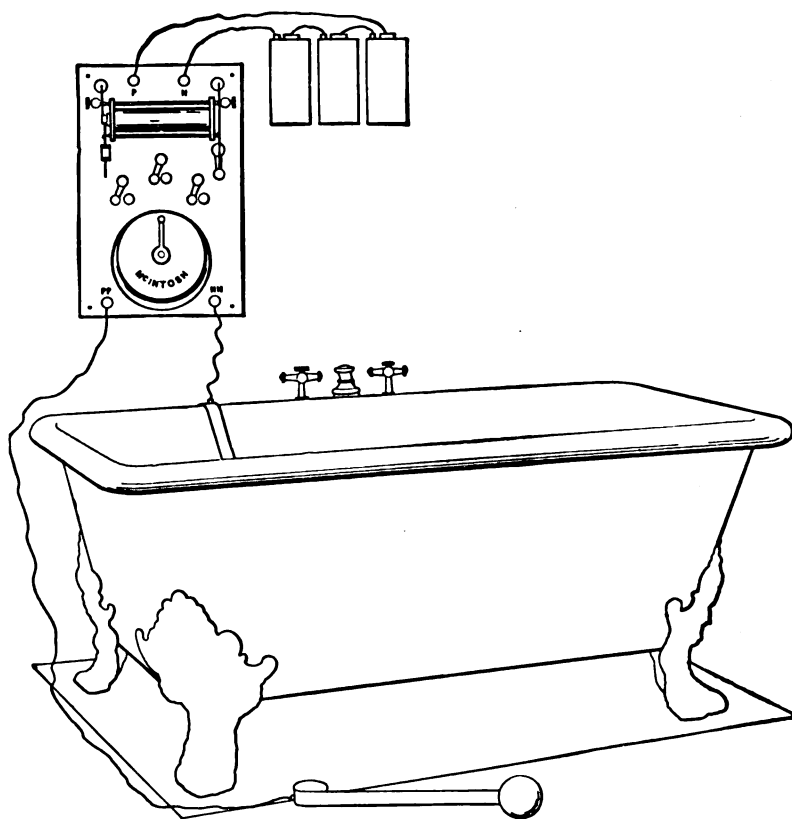


Fig. 28—Diagram showing a safe method of applying bi-polar bath. (Faradic coil is operated by dry cells and the current is regulated by means of a rheostat.)

auto-intoxication, rheumatism, gout and various forms of uric acid diathesis, gastric neurasthenia, arteriosclerosis, locomotor ataxia, spinal sclerosis, many cases of chronic cardio-vascular disease, obesity, diabetes (when the patient is in good flesh), etc.

General Remarks

Dr. Kellogg, of Battle Creek, gives the following general rules in the hydro-electro therapeutic application.

"First, increased movement of blood and accelerated functional activity of an internal organ may be induced by short vigorous cold application in combination with electrical stimulation. The latter may be either

simultaneously, or may immediately follow the cold application. The electrical application should, in general, be as strong as the patient can bear without pain.

"Secondly, congestion and undue functional activity of an internal organ may be diminished by a prolonged, moderately cold application (60 to 70 degrees Fahr., continuing from thirty minutes to several hours), combined with a simultaneous application of a current of moderate strength."

In a *galvanic* application, the current may be gradually increased up to 130 milliamperes; in *faradic*, according to the sensation of the patient; and in *sinusoidal*, according to the sensation of the patient and the rate at which the muscular contractions are desired. The hydro-electric applications should last from ten to thirty minutes, and should be administered two, three or four times weekly. Baths should not be given for at least a few hours after meals.

Apparatus

It is dangerous to use the current from the wall plates (which is the current from the lighting circuit reduced by means of resistance) in a tub connected with pipes, as serious accidents may result from such practice. An absolutely safe method is to obtain different currents from a generator (Fig. 5), (in which the current is produced independent of the current from the lighting circuit), or from the galvanic battery, or faradic cell operated by wet or dry cells (Fig. 26), and to administer the treatments in a wooden or porcelain tub, which is not connected in any way with either filling or draining pipes.

In order to avoid unpleasant shocks when administering hydro-electric treatments, the current should always be gradually turned on after the patient is ready in the bath, and gradually turned off before the patient gets out of the bath.

CHAPTER X

ELECTRO-THERMO THERAPY—OZONE— MAGNETIC THERAPY

Electro-Thermo Therapy

ELECTRO-THERMO THERAPY is the electrical production and application of heat for therapeutic purposes. Since heat has been employed as a therapeutic agent from time immemorial, partly because pain can be relieved by it, and partly because Nature herself teaches that to get rid of some diseases, the temperature of the body must be increased, this subject needs no recommendation nor much explanation.

In addition to Diathermy and Radiant Heat (described elsewhere), electro-thermo therapy embraces also the use of thermophores, super-heated air and some other methods of heat production and application.

Thermophores

Thermophores, electro-therm compressors, or electric heating pads are made of all shapes and sizes, for different parts of the body, and consist of insulated flexible resistance wires imbedded in a chemically-pure asbestos, or other non-inflammable material. Maintaining constant, desired heat, these pads are a convenient means to treat various parts of the body, and are superior to and take place of fomentations, hot water bags, hot air apparatus, and other of the inconvenient appliances usually employed.

In employing thermophores for the treatment of various conditions, a moist cloth is laid over the skin; over this a dry cloth, and upon this, the compressor connected to the electric lighting circuit.

The current passing through the resistance wire generates the heat, gradually increasing the temperature (up to 300 degrees Fahr.), and may be continued as long as desired. When the heat becomes intense, it is only necessary to employ less current.

Super-heated Air

Super-heated air is the most simple, convenient and painless method of producing local hyperaemia.

Although it may be applied externally for the treatment of various painful affections, it is of special value in the treatment of ear, nose, throat, teeth, vagina, uterus and other body cavities to which it is very difficult to apply heat, and produce hyperaemia by other methods.

Apparatus producing super-heated air consists essentially of air pressure (fan or pump) and a resistance wire heated by means of an electric current. The air is heated by being forced through the resistance wire.

Ozone (O₃)

All the high tension currents in passing through the air produce large quantities of ozone, but the greater the frequency and higher the voltage, the greater the production. Whenever it is desired to administer ozone for therapeutic purposes, it is necessary to generate and purify it by forcing the ionized air through the oils, which absorb, or through a simple alkaline solution, which neutralizes nitrous and nitric acids liberated with ozone, while the electricity is passing through the air.

This is accomplished by means of a glass vacuum ozone generator, connected to the Tesla secondary (Fig. 29), Oudin resonator, or one pole of the Static machine; or by a special ozone generating apparatus of which there are various types.



Fig. 29—Ozone inhalation.

A very efficient and pleasant combination of oil is one part of oil of eucalyptus, and two parts oil of pine needles.

Application

Since oxygenation is essential to life, the inhalation of ozone is beneficial in all diseases, but in some diseases it is of particular benefit. When inhaled, it hastens the oxygenation of the blood and tissues, increasing the number of red blood corpuscles (and decreasing the number of white corpuscles), and augmenting the proportion of urea in the urine; therefore, it is of value in anaemia, chlorosis and all conditions where there is imperfect oxidation and impaired nutrition. Being a powerful antiseptic, it is an excellent remedy in the treatment of bronchial and laryngeal affections, catarrh, hay fever, whooping-cough,

pulmonary tuberculosis, and all other diseases of the respiratory organs, etc.

Ozone treatments should last from ten to twenty minutes (according to an output of the apparatus employed), and may be frequently repeated, but for the reason that a large amount of ozone may produce serious symptoms, it is advisable to give shorter treatments at more frequent intervals.

Since we must be careful when using so potent a remedy, it is the safest rule to stop the treatment as soon as the patient feels a slight sensation of lightheadedness, which indicates that he has received a sufficient dose.

The oils after being used for some time to purify the ozone, owing to the large amount of ozone retained therein, may be used as a dressing for ulcers and chronic skin diseases.

Magnetic Therapy

(Bachalet Magnetic Wave Treatment)

When a living body is placed into a magnetic field, the magnetic lines of force permeate it to the maximum of exposure and raise the electric potential as high as thirty-three per cent. The magnetism thus imparted to the living body does not leave, but is transformed into vital energy, and is used in the vital processes. It is estimated that it takes, on the average, seventy-two hours, before this magnetic charge is completely absorbed, and until the body returns to its normal potential. Magnetization is applied by means of two co-acting magnets, energized by the commercial current or dry cells, adjusted to either side of a chair, couch or bed on which the patient (who may be fully dressed) is placed. The patient feels no sensation whatever, and when the full strength is desired, the magnets may be placed close to the patient's body.

Magnetization dilates the blood vessels, lowers blood pressure and reduces a too rapid pulse, stimulates tissue metabolism, raises temperature, increases oxidation, accelerates elimination, aids nutrition, increases the red blood corpuscles and hemoglobin; is sedative and anti-spasmodic, etc. It is, therefore, indicated in the treatment of anaemia, arteriosclerosis, chorea, convulsions, hysteria (with high blood pressure), insomnia, migraine, neuralgia, neurasthenia, neuritis, rheumatism, etc.

In acute conditions the treatment should last about thirty minutes, while in chronic, from one to two hours. Three treatments per week are sufficient.

If the application is carried to an excess, over-stimulation will cause deleterious results and loss of weight.

The patient should rest at least fifteen minutes after treatment, before going out in cold weather.

CHAPTER XI

ELECTRO-DIAGNOSIS *

IN addition to Radiography, by which we can easily detect fractures, dislocations, foreign bodies, hepatic and renal calculi, etc.; and the different electroscopes by which we are able to explore the body cavities, electricity is of further service in the diagnosis, as it enables us to determine the degree of pathological excitability, and to distinguish between the different forms of paralysis—central and peripheral; to tell whether disease is feigned or real; to distinguish between apparent and real death; to differentiate between nervous and inflammatory pains of the ovary, and thus prevent unnecessary surgery, etc.

As this subject is very broad, in order to avoid confusion, and to enable the reader to grasp easily the principles of electro-diagnosis, only those features which are of practical value to most practitioners will be described.

Reaction of Degeneration (R. D.)

When the galvanic current is applied to a muscle or a motor nerve, the contraction is produced, both on closing and on opening the circuit. (When the current is switched on, the circuit is closed or completed, and the current is allowed to flow, while when the current is switched off, the circuit is open, and the current flow is discontinued.)

The Normal Reaction of a Muscle

When the galvanic current is applied to a healthy muscle, the contraction produced with the active cathode (negative electrode) is greater than the contraction produced with the active anode (positive electrode) on closing the circuit; while the contraction produced with the active anode on opening the circuit is less noticeable than the contraction produced at the same electrode on closing the circuit. This normal reaction of a muscle is expressed as follows: The Cathodal Closing Contraction is greater than the Anodal Closing Contraction, while the Anodal Closing Contraction is greater than the Anodal Opening Contraction, and is designated by the following formula:

$$C. C. C. \quad > \quad A. C. C. \quad > \quad A. O. C.$$

The contraction of a healthy muscle to galvanism, whether the muscle is stimulated directly or indirectly through the nerve, appears very suddenly like lightning, while the faradic stimulation is always tetanic.

*See also Electrocardiography, Roentgenocardiography, and Reflex Diagnosis, in the appendix, which starts on page 141.

The Normal Reaction of a Nerve

In case of a healthy motor nerve, the Cathodal Closing Contraction is greater than the Anodal Opening Contraction, and the Anodal Opening Contraction greater than the Anodal Closing Contraction. This reaction is expressed by the following formula:

$$C. C. C. \quad > \quad A. O. C. \quad > \quad A. C. C.$$

Quantitative and Qualitative Changes

When there is a partial or total change of the above formulas, e. g., when the A. C. C. is greater than the C. C. C., etc. (which is a qualitative change); or when the muscle responds by a slow and sluggish contraction instead of by a sharp, quick jerk as in health (which is a quantitative change); or when the muscle does not respond to the direct stimulation of the faradic current or to the stimulation of the motor nerve, there is a Reaction of Degeneration.

When the Reaction of Degeneration is coming on, at first there is a short period in which there is a hyperexcitability (increased excitability) of nerve or muscle. About two weeks later, reaction to the faradic current ceases, and for some time (perhaps six or eight weeks) the muscle (but not the nerve) reacts only to a slowly interrupted galvanic current, until it finally ceases to react to any form of stimulation.

A galvanic hyperexcitability, therefore, means early degenerative changes; while a hypoexcitability (diminished excitability) of a nerve to both faradic and galvanic currents, generally indicates beginning of Reaction of Degeneration which will soon become complete.

Galvanic hyperexcitability is usually accompanied by faradic hyperexcitability, although it may persist after the faradic excitability has been lost. Galvanic hypoexcitability is found in most cases where faradic excitability is diminished or lost. It is characteristic of the last stage of nerve and muscle degeneration.

Faradic hyperexcitability occurs in most cases where there is exaggeration of the tendon reflexes. Thus, it is met with in tetanus, hemichorea, recent cases of cerebral paralysis, athetosis and writer's cramp.

Faradic hypoexcitability is usually accompanied by rapid fatigue of muscles, which after repeated faradic stimulation soon fail to react, unless the intensity of the current is increased. It occurs in chronic cases of cerebral paralysis, long standing tabes dorsalis, and primary myopathy, where it is associated with galvanic hypoexcitability.

Reaction of Degeneration is found in the following conditions:

(a) "In any disease or injury in which there is a break in the nervous link which connects the end plate of the muscle with its nucleus of origin in the gray matter of the anterior cornua of the cord.

"In any injury or disease of the trunks of the motor nerves, of the nuclei of the cranial nerves, or of the ganglionic cells in the anterior cornua."—*Dugan*.

(b) In neuritis and polyneuritis, where the nerve itself is primarily affected;

(c) In acute and chronic poliomyelitis;

(d) In myelitis, if the anterior horns are involved;

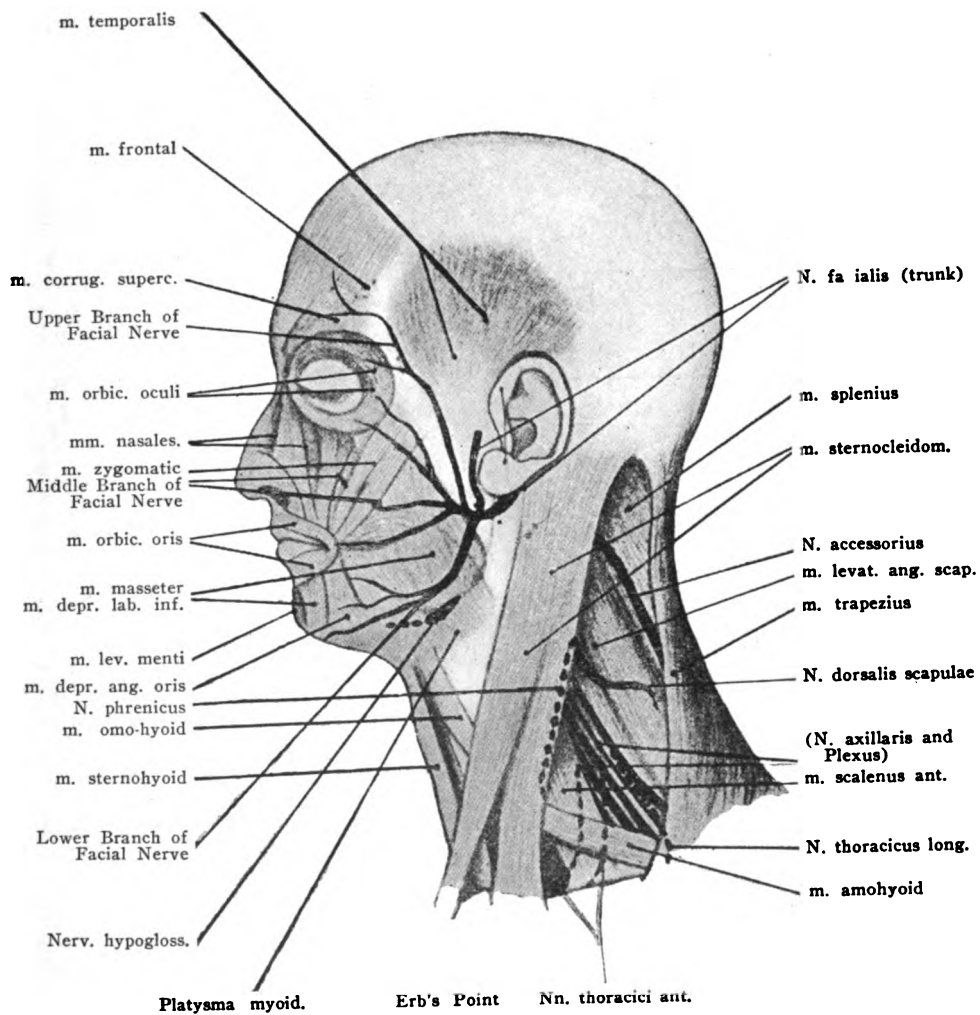


Plate I

From King's "Electricity in Medicine and Surgery"

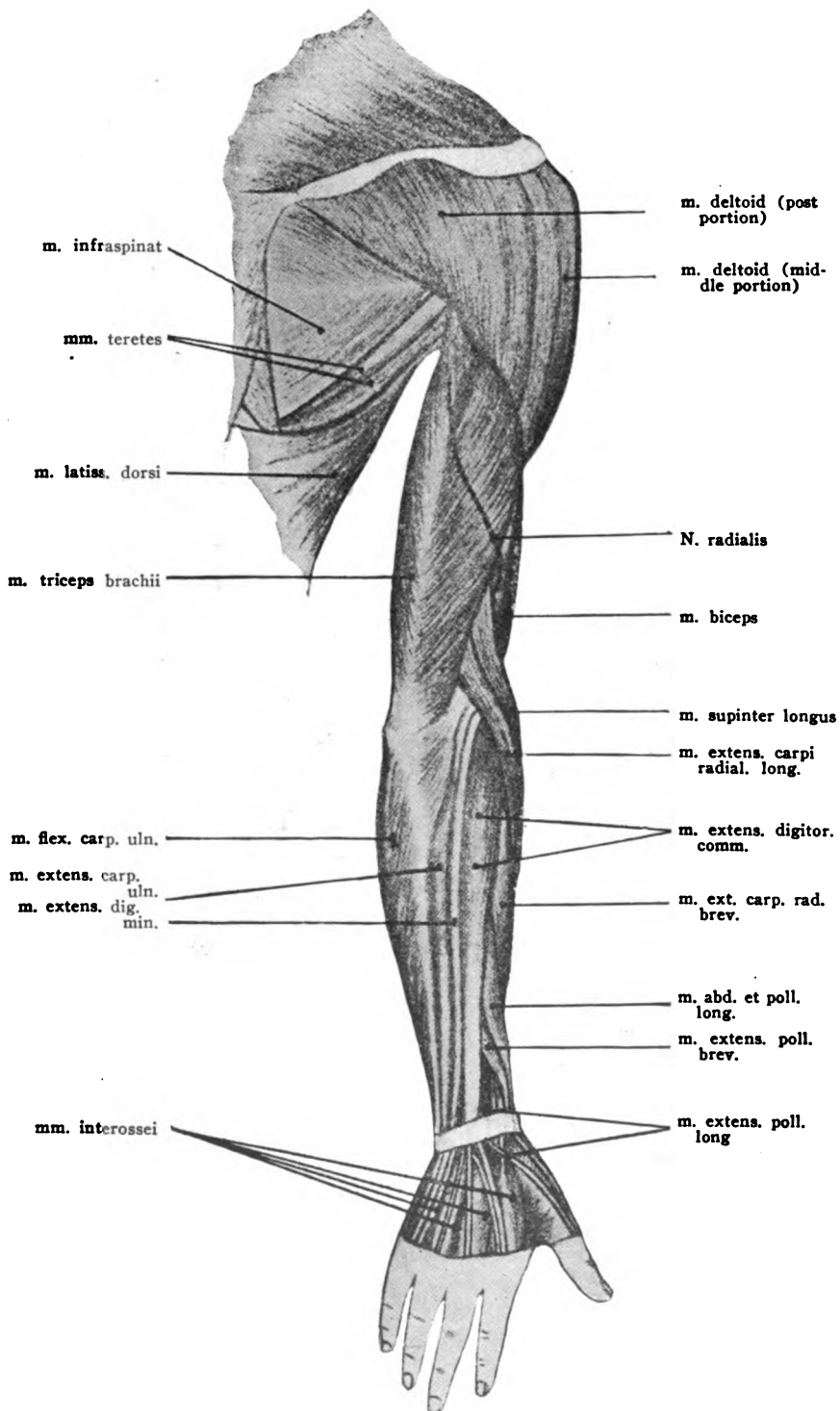


Plate II

From King's "Electricity in Medicine and Surgery"

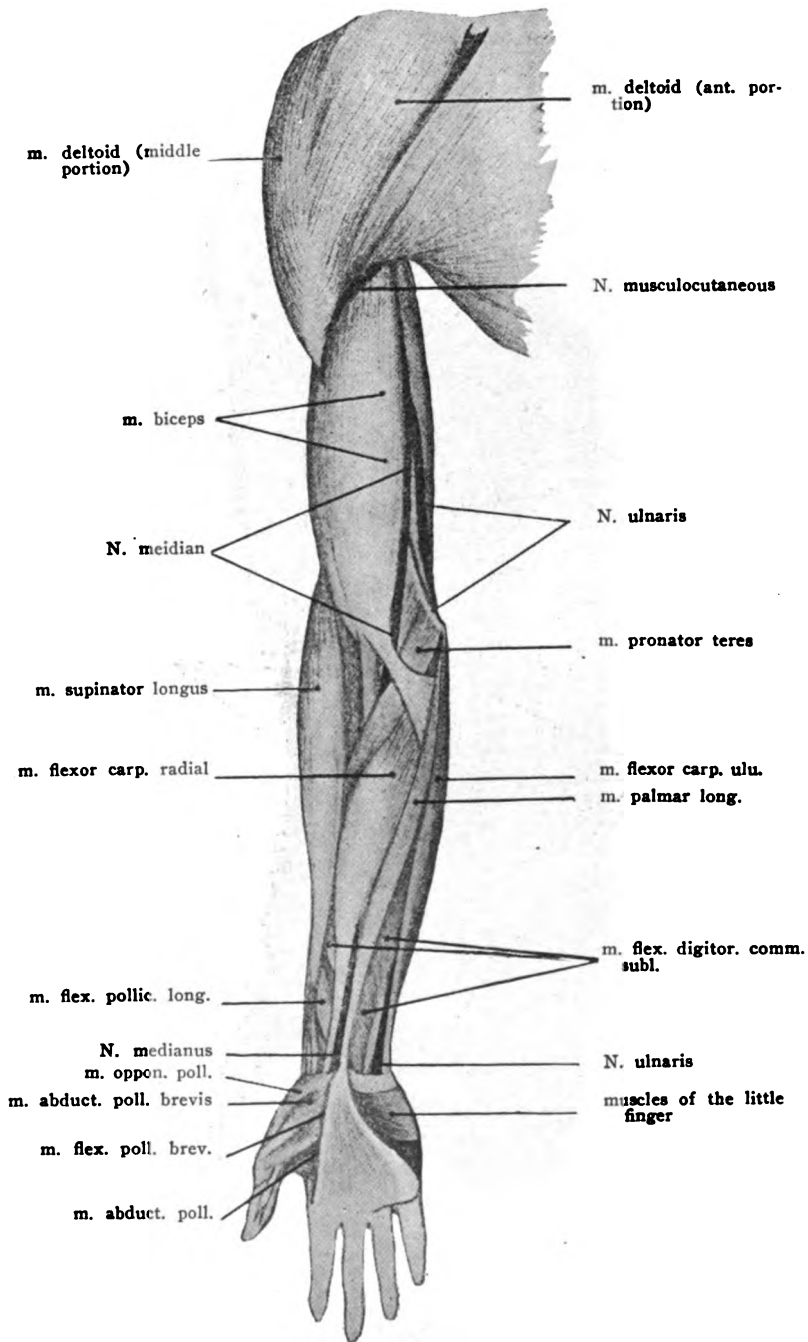


Plate III

From King's "Electricity in Medicine and Surgery"

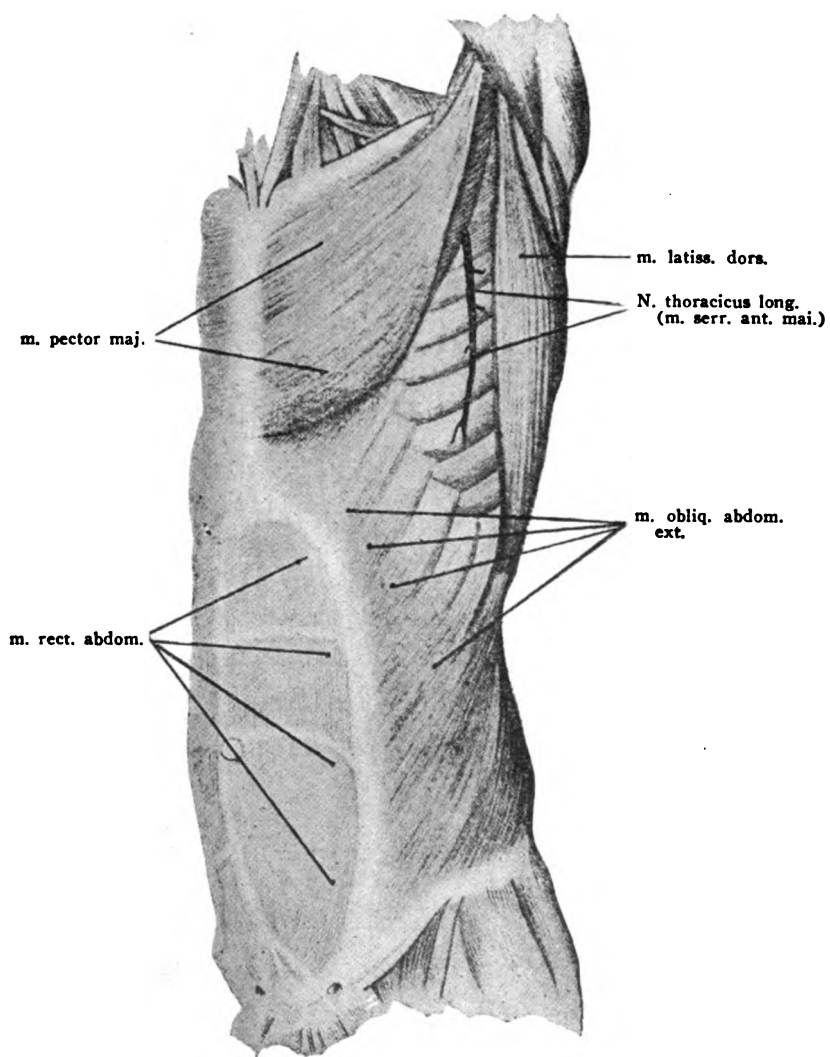


Plate IV

From King's "Electricity in Medicine and Surgery"

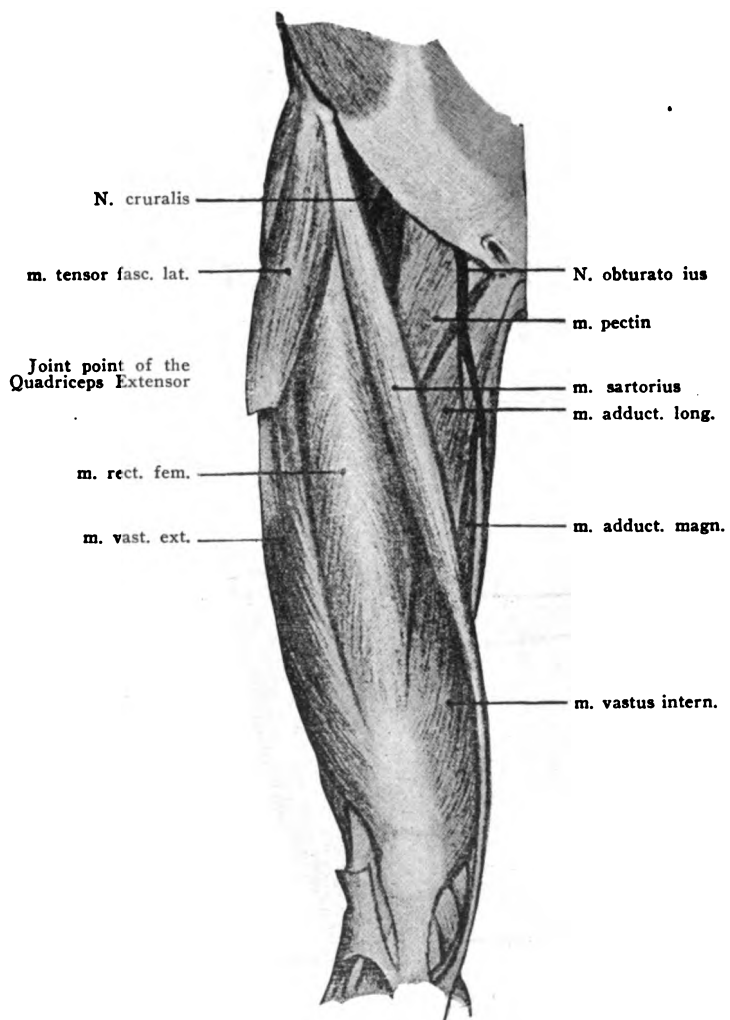


Plate V

From King's "Electricity in Medicine and Surgery"

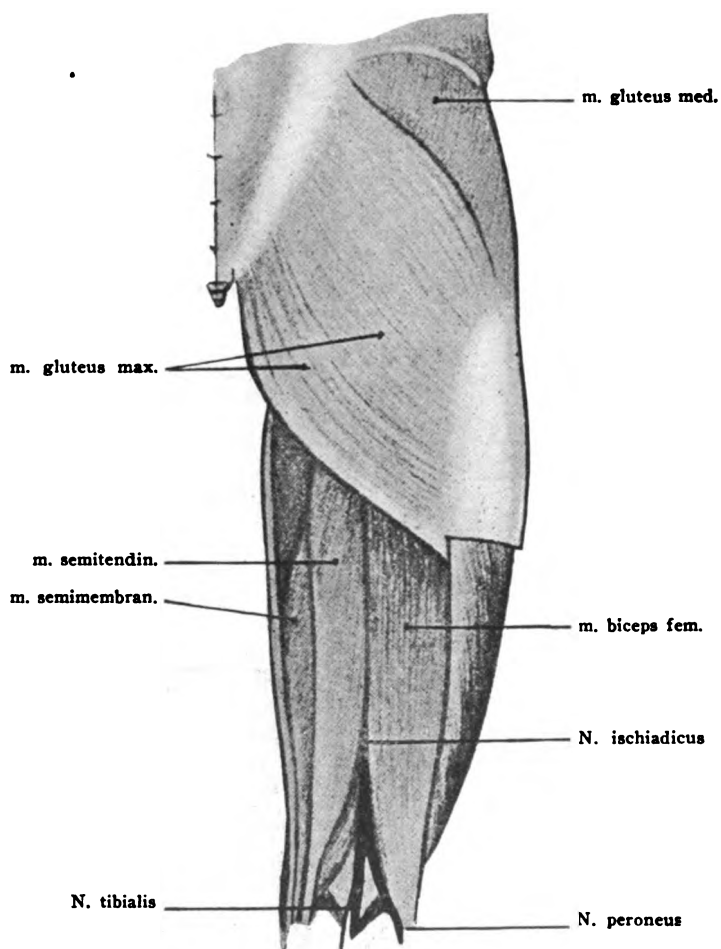


Plate VI

From King's "Electricity in Medicine and Surgery"

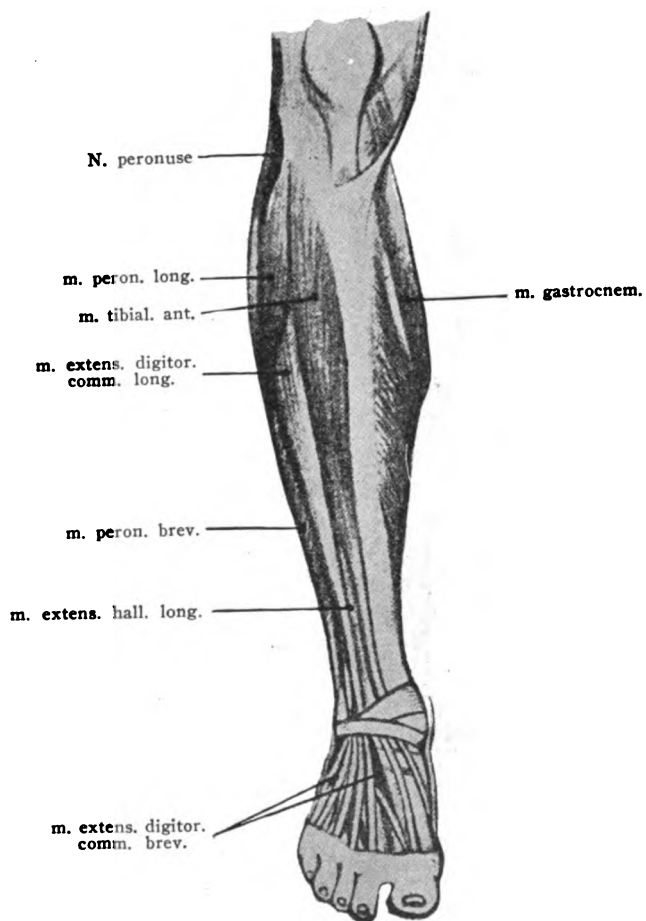


Plate VII

From King's "Electricity in Medicine and Surgery"

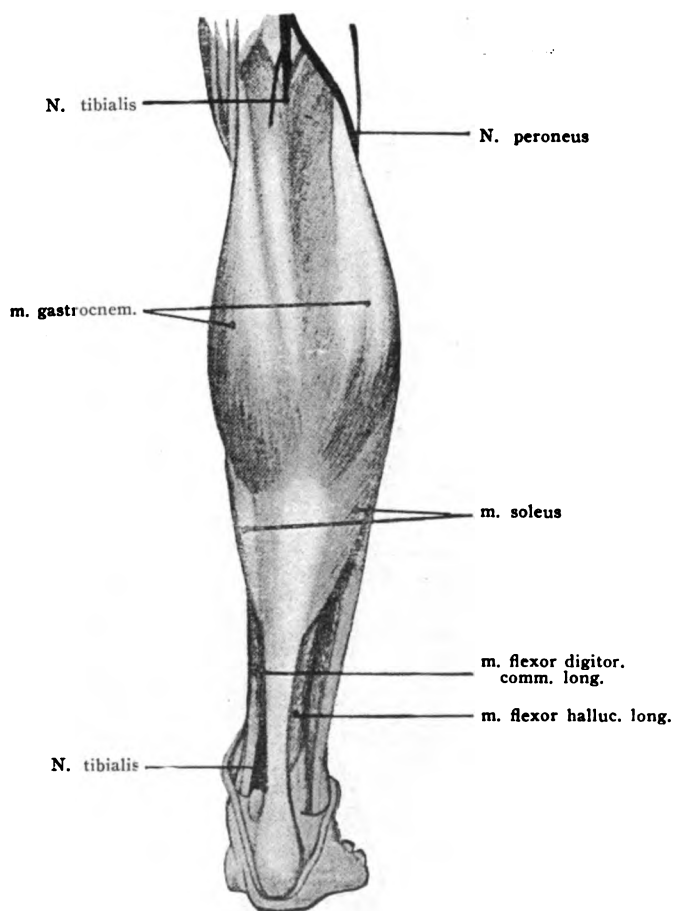


Plate VIII

From King's "Electricity in Medicine and Surgery"

- (e) In ophthalmoplegia, where the anterior horns or the nuclei in the pons and medulla are affected;
- (f) In diphtheric, bulbar and lead paralysis;
- (g) In diseases of the spinal cord, if muscular atrophy is present.

Method of Testing

In all electrical examinations, it is absolutely necessary to determine three factors:

- I. Whether both the motor nerve and the muscle react to the faradic and the galvanic currents;
- II. Whether the reaction to either current is increased or diminished (quantitative change);
- III. Whether there is a partial or total change in the formulas which denote the normal reaction (qualitative change).

In testing motor nerves and muscles, in order to decrease the intensity of the current, and to cause as little discomfort as possible to the patient, a large indifferent electrode (about 100 to 200 sq. cm.) covered and moistened with warm water should be placed upon the sternum, or the spine (at the cervical region if upper, or at the lumbar region if lower part of the body is to be tested) and moved about, so as to avoid a burning sensation. In some cases, as in testing the small muscles of the arm or leg, it is better to apply both electrodes near each other.

In order to condense the current, the active electrode should be small (1 to 2 cm. in diameter, covered and moistened) and should have an interrupter for both galvanic and faradic currents, so as to be able to close and open the circuit, in order to elicit with convenience the opening and closing contractions. The active electrode is applied at or near a motor point of the muscle or nerve to be tested, so as to produce the contraction with less current.

MOTOR POINTS, determined by Erb, Duchenne, Ziemssen, and others, are certain points scattered over the surface of the body (Plates I to VIII), which, when stimulated, cause the best response from a definite nerve or muscle. The motor point of a muscle is usually where the motor branch of the nerve enters its muscle. Most motor points for nerves are situated where the nerve lies superficially, and at some little distance from other nerves.

For electrical examination, the patient should be placed in a horizontal position, or in a chair with the back well supported, and should be told to relax his muscles. The faradic current should be used first (connecting the active electrode to the negative pole of the secondary faradic), employing just as much current to produce the smallest noticeable contraction. The strength of the current should be adjusted gradually by means of a rheostat, sledge coil or other method, noting the point at which the contraction has been produced.

It is very difficult to determine whether the contraction oversteps the normal limits, and if so, how much, as the irritability of different nerves and muscles, also of the same muscle or nerve, varies considerably in different individuals. The most practical and most accurate method of testing for quantitative change is to estimate the irritability, and then compare it with the reaction of a healthy side, but in such case symmetric points and the identical position must be selected.

If the faradic contractility is not altered, galvanic is probably normal. In some cases of nervous disorders, there may be no faradic response; therefore, if the current is increased to the point of being painful, and the contraction has not been produced, it means that there is no faradic response, and the galvanic current should be tried.

In using the galvanic current, we begin the test with about two milliamperes on the face and about ten milliamperes on the body, gradually increasing and stimulating first muscle directly, and then the motor nerve. The C. C. C. is first obtained, and then, reversing the polarity by means of a commutator (without changing the electrode), A. C. C. is produced, etc.

The direct stimulation of the muscle should be compared with the contraction produced by the stimulation of its motor nerve, and the strength of the current required with the character of the contraction, whether quick and sharp, or slow and sluggish.

General Remarks

1. In using galvanic current, the effect of each pole must be noted.
2. The irritability of motor nerves is subject only to quantitative changes, but with the muscles, quantitative changes are often accompanied by qualitative alterations.
3. The quantitative electrical irritability of a nerve or of a muscle is tested by estimating how strong a galvanic, and how strong a faradic current is required to produce the smallest contraction; therefore, the strength of the current employed must be always estimated in examining for quantitative changes.
4. If it is desired to compare the results of different electro-diagnostic examinations, it is imperative to employ electrodes of the same size, because the stimulating effect depends upon the intensity of the current as well as upon the strength; and it is also necessary to employ the same apparatus, as the physiological action of one induction coil cannot be compared with the action of another.
5. Apparatus employed for electro-diagnosis must be supplied with a reverser, so as to be able to quickly change the polarity, and with an appliance for increasing or decreasing the current strength (a rheostat or a cell collector).
6. If a muscle is cold, it takes more current to institute a contraction than if the muscle is warm. The colder a muscle, the more current it takes to produce a muscular contraction. If we warm a muscle either by friction, massage, electric light, or any other means, it takes a great deal less current, as the normal temperature of the muscle is restored, than it would when the muscle is cold.

Differentiating Cerebral from Peripheral Paralysis

To determine whether in a case of paralysis the lesion is in the brain or in the motor cells of the spinal cord, use the faradic current, interrupted with an automatic rheotome, as follows:

Place a large indifferent electrode on the sternum, and a small active electrode at the motor point of some muscle on the normal side, and employ sufficient current to cause a noticeable contraction. Leave the

indifferent electrode on the sternum, and place the small active electrode at the motor point of the corresponding muscle on the opposite side (which is supposed to be paralyzed); employ the same amount of current as you did on the opposite side, and note whether the contraction is normal, increased or decreased.

If the contraction is increased, the lesion is in the brain or upper motor tract (in such a case, the reflexes are also exaggerated). If the contraction is decreased, the lesion is in the motor cells of the spinal cord, or in some other part of the lower motor segment.

Malingering

If the muscles respond normally to the stimulation with the faradic current, after the patient has complained for two or three weeks, the case is one of malingering.

Electro-Bioscopy

(Test for Death)

Since no disease, poisoning, or asphyxia, during life, abolishes electric contractility in all the muscles of the body, we are able, by means of electricity, to determine definitely, within two or three hours after the occurrence, as soon as the rigor mortis sets in, whether the person is really dead or not.

Dr. Crimotel, of Paris, France, after long experimentation, has come to the following conclusions:

1. "Death is certain when all the muscles have entirely lost their contractility;" (although either faradic or galvanic electricity causes muscular contractions until a short time before a rigor mortis sets in):

2. "Faradization is an indispensable test whether life is extinct in all cases of apparent death occurring suddenly. When there are several victims of an accident, it enables the attendants to distinguish the dead from the living, and also the order in which the dead ceased to live." (The galvanic current produces contractions in a dead body for a short time after the faradism has failed. This enables us to approximate the time elapsed since death occurred.)

3. "In new-born infants, muscular contractility, under the influence of the faradic current, continues fifty to sixty minutes after the heart has ceased to beat. When they have never exhibited signs of life, the faradic test shows whether life is really extinct."

4. "In some cases of cholera, electro-muscular contractions cease within half an hour after death."

The Value of Electro-Diagnosis in Gynecology

Due to the fact that the secondary faradic current completely relieves ovarian neuralgia in but a few treatments, but that it only affords a temporary relief (for a few moments) in ovaritis and other organic changes of the uterine appendages, and also that strong galvanic currents may be applied to the uterus without causing severe pain or reaction when the uterine appendages are healthy, it may be concluded as follows:

If a strong galvanic current (75 to 100 milliamperes), applied to the interior of the uterus (with an indifferent electrode on the abdomen), causes no pain and is not followed by febrile reaction or aggravation of the symptoms, or if the pain is relieved by the application of the secondary faradic current, the uterine appendages are healthy, and the case is one of ovarian neuralgia.

If, however, the application of a weak galvanic current (50 to 75 milliamperes) causes severe pain, and is followed by febrile reaction and other unfavorable symptoms, or if the secondary faradic current affords but a temporary relief (for a few moments) the case is one of diseased appendages, ovaritis; or (if reaction is great) pyosalpinx.

CHAPTER XII

ELECTRO-SURGERY

IN surgery, electricity is not only valuable to arrive at a correct diagnosis (by means of X-rays and the different electroscopes, with which it is possible to explore the body cavities, such as urethra, bladder, esophagus, stomach, etc.) but by it, we are able to successfully coagulate the blood in hemorrhage and aneurysm; to remove tumors, hemorrhoids, warts, moles, naevi, etc.; dilate strictures (by absorption); remove foreign bodies from the eye and treat numerous other surgical conditions. Electro-surgery embraces electro-cautery, fulguration, high frequency desiccation, surgical diathermy, electrolysis, magnet operations, etc.

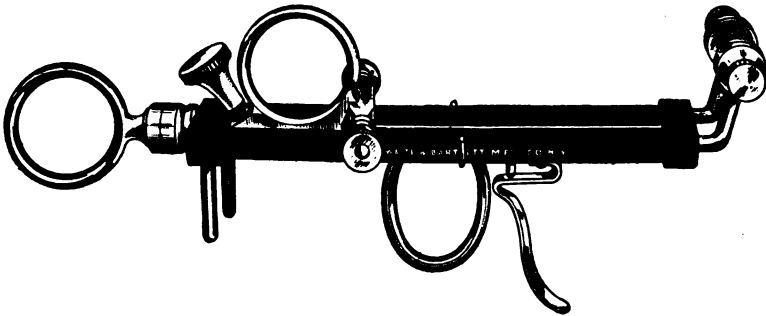


Fig. 30—Cautery electrode handle.

Electro-Cautery

Electro-cautery, performed with a platinum knife (electrode) heated to a cherry-red or white heat, enables us, on account of the obliteration of smaller vessels and coagulation of the blood, to sever tissue without hemorrhage.

The greater the heat of the electrode, the less pain is produced, but there is greater liability of subsequent hemorrhage; therefore, a cherry-red heat, which is a temperature intermediate between red and white heat, is usually the most satisfactory.

Electro-cautery is employed to remove polypi and tumors difficult to reach with the knife; to cut through the cervix uteri; to remove growths in the pharynx and larynx, and to cauterize laryngeal ulcers; to destroy the nerve in a hollow tooth; to arrest hemorrhage; to treat some cases of prostatic hypertrophy; to open an abscess in the lung after a rib has been resected, etc.

In order to be able to heat the platinum cautery electrodes (loops or knives) which have a very low resistance, (varying from 0.4 to 0.02 of an ohm, or even less) to a cherry-red or white heat, a current of a low volt-

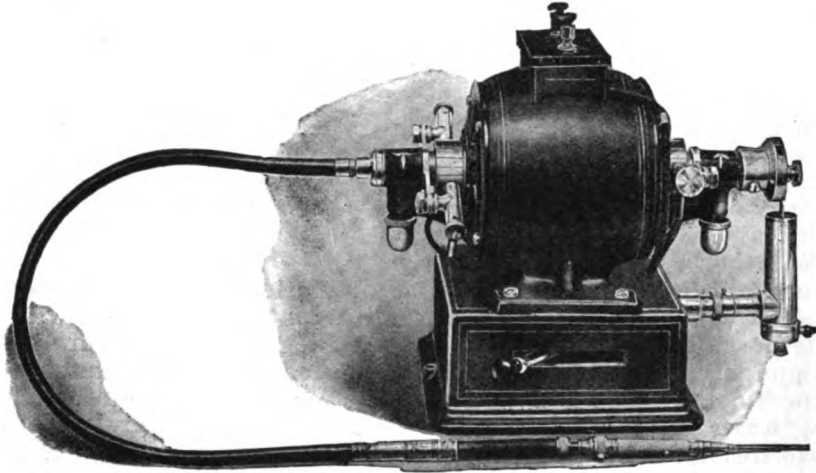


Fig. 31—Cautery generator.

age and high amperage (5 to 30 amperes) is required. This current is obtained from a galvanic battery in which the cells are connected in multiple or parallel, or from a cautery apparatus (Fig. 31) by which the commercial current of high voltage and low amperage is transformed into a current of high amperage and low voltage.

The strength of the current is regulated by means of a rheostat and is measured by means of an ampere-meter, which is of great value, especially when working in cavities when the knife is not readily visible, as it will warn us if we are in danger of fusing the wire.

Fulguration

Fulguration is a mono-polar discharge from a metal point electrode connected to the top of the Oudin resonator, Tesla secondary or a hyper-static transformer.

By means of this discharge, we are able to cause destruction of certain cells; change the color of pigmented spots and stimulate new growth

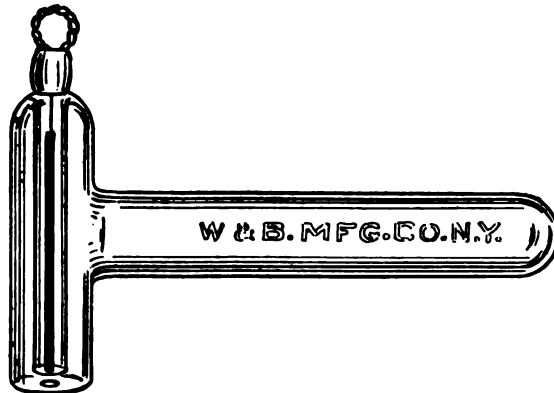


Fig. 32—Glass Fulguration Electrode.

without producing any appreciable necrosis of tissue; or to produce necrosis (which is perhaps due to a combination of heat, ionization and ozonation) according to the duration and strength of the application. On account of ozonation, the necrosed tissue becomes dry, without any ulceration or pus; remains for a time and comes off leaving a smooth healed surface. Although fulguration is a powerful application, it produces a subsequent anaesthetic effect, and through vaso-constriction causes cessation of surface hemorrhage. Fulguration has given good results in the treatment of lupus vulgaris, rodent ulcer, adenoids and similar conditions, and is far superior to X-rays and Radium in the treatment of malignant tumors of breast and face, or to electrolysis in the removal of naevi.

There are two methods of applying fulguration, viz., the *French or the Dr. De-Keating-Hart method*, in which the discharge is cooled by the cold, sterilized air, a current of carbonic acid gas, or water, which flows through the electrode during the application; and the *dry method*, in which the electrode is not moistened, and the part treated is wiped dry.

For blanching, a wet method is preferred, and the distance between the tissue and the electrode should be about one thirty-second of an inch; for necrosis, a dry method at the distance of one sixteenth of an inch, while for very deep action, a dry method at a distance of one eighth to one quarter of an inch.

The application usually lasts from three to four seconds, and as the sparks are apt to jump to the edges of the wound, care should be taken that the spark is directed to the region treated.

The important rule always to be observed in the employment of this method is that in malignant growths, the diseased cells should be fully destroyed, for otherwise it will stimulate a more rapid growth of the underlying, undestroyed, malignant cells.

Caution: Since sparks applied to the thorax have been known to cause failure of respiration, and later to stop the heart, fulguration is by no means an absolutely harmless treatment, and for this reason, in dangerous conditions, should be resorted to only when other methods have failed. The pneumo-gastric nerve should never be fulgurated.

When electro-cautery, or fulguration, are to be employed around the face, ether (on account of its inflammable vapors) should never be administered.

Surgical-diathermy (Electro-coagulation)

By employing a suitable (small) active electrode, and increasing the amperage of the D'Arsonval (diathermic) current, it is possible to elevate the temperature of the part to the coagulating point (158° Fahr.) and to carry out minor surgical operations bloodlessly, without the danger from absorption of poisonous products or burns. On account of a more reliable technic, more accurate dosage, and a perfect hemostasis, this method is preferred to the application of actual cautery.

Electro-coagulation is indicated in the removal of tumors, hemorrhoids, polypus, naevi, furunculosis, necrosis of bone, ulcerative tuberculosis, suppurating glands, warts, and other superficial lesions.

On account of absolute asepsis, it has been successfully employed in combination with surgery in a large number of cases of deeper origin.

As the diathermic current persists in water, various diseases, including bleeding papilloma, have been destroyed in the water distended bladder, and both hard and soft species of bladder calculi have been disintegrated with the spark applied by means of an insulated steel wire through a cystoscope.

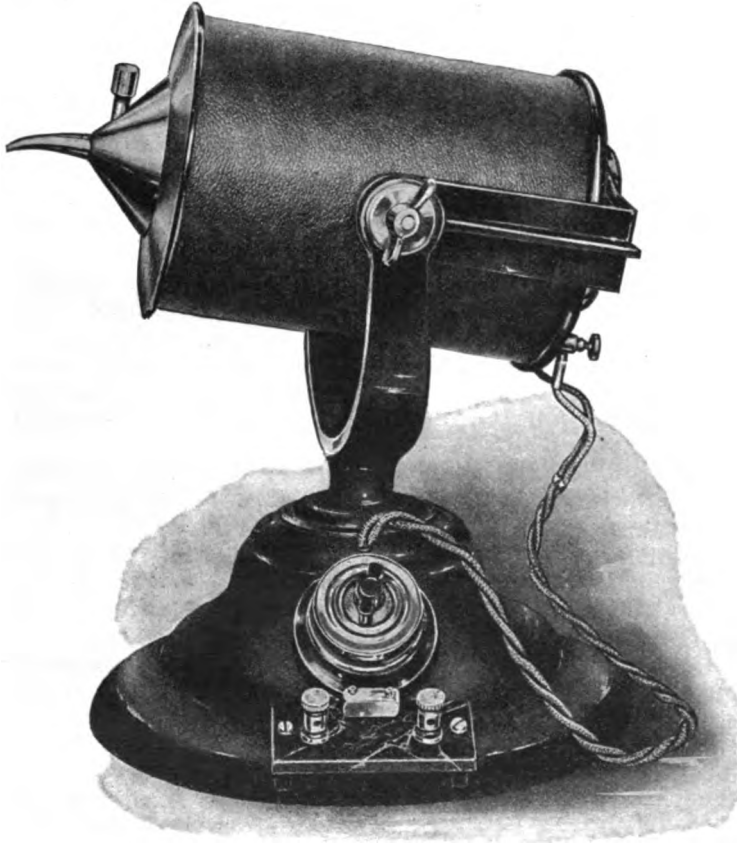


Fig. 33—Large Eye Magnet.

Electrolysis

Same electrolytic changes that take place in a compound substance occur in the human tissue (which is a semi-fluid) while an electric current is passing through it.

Electrolysis is employed in the treatment of tumors, angioma, carcinoma, aneurysm, hemorrhage, granulations, goitres, fungoid growths, keloid; strictures of the eustachian tubes, lachrymal canals, and urethra; removal of superfluous hair, moles, naevi, warts, etc.

In the application of electrolysis, bare, active metallic electrode is employed, and the following must be remembered:

I. Polarity is very important, and it must not be forgotten that the positive will coagulate fluids, arrest hemorrhage, decrease inflammation, etc., while the negative will do the opposite.

II. The galvanic current is most adaptable, because the electrolytic effect of a current is in proportion to its amperage; (therefore almost negligible in Faradic, Sinusoidal, Static, or High Frequency currents).

III. Strong current for a short time produces the same effect as a weak current for a long time; but as the object of electrolysis is to absorb, and never to hurt, burn or cauterize the tissue, weak currents should be employed.

IV. Electrolysis relieves strictures by enlarging the caliber of the canal, through the absorption of the fibrous tissue, and not through the dilation or a modified dilation.

Eye-magnet Operations

When a foreign body enters the eye (especially vitreous or retina) blindness will follow unless the splinter is extracted as early as possible. Metals can be extracted from the eye by means of an electro-magnet. (Fig. 33)

Diagnosis

Having the history of the case, and having examined the exterior and interior of the eye (by means of an ophthalmoscope), and by taking the field of vision, having determined whether there is any obscure area, the tip of the magnet is applied to various parts of the eye. If pain results, it is a positive indication that metal (steel or iron) is present within the eye, but the absence of pain is not conclusive evidence that no foreign body is present, for it may be too distant, or too firmly held to move.

Method of Operating

Dr. W. A. Fischer recommends the following method:

"When a foreign body is suspected, and the lens has become opaque, apply the tip of the magnet to the center of the cocainized cornea; increase the current slowly to full force . . . unless the body appears with a current of less intensity. If it does appear, turn the current off, and place the tip at the edge of the cornea, and turn on the current. If the iris bulges, change the position of the magnet to make the metal pass through the pupil. Apply the magnet to an incision in the cornea until the metal adheres to the magnet, when the operation is finished. If the body does not appear on the second application, turn on the current, and make and break it several times, to dislodge the foreign body. If the metal has entered the eye back of the lens, some operators prefer an opening in the sclera and removal at that point. I am of the opinion that all bodies should be extracted through the anterior chamber, although a foreign body that has entered back of the lens suggests removal through the enlarged original wound. The speculum and forceps and scleral retractors must be non-magnetic."

If the extraction is to be made through the sclera, in order to apply the magnet near the foreign body, it is best to determine its position by radiography before the operation, but as that causes delay, which favors infection, it should be employed only in the old cases.

CHAPTER XIII

RADIOLOGY

RADIOLOGY embraces the therapeutic use of radiant energy (ether vibrations of various wave lengths and frequencies) from natural and artificial sources, viz., sun's rays (helio-therapy), radium rays (radium-therapy), and the rays produced by various lamps (photo and actino-therapy), and the Roentgen apparatus (radio-therapy or Roentgenology).

In order to thoroughly master the subject of radiology, it is essential to consider the spectrum of sunlight.

Spectrum is a band composed of various colors obtained by passing the light through a prism.

Spectrum of Sunlight

The spectrum of sunlight is composed of seven visible colors, viz., red, orange, yellow, green, blue, indigo and violet.

Red	Orange	Yellow	Green	Blue	Indigo	Violet
Heat Rays		Light Rays		Chemical Rays		

At each end of the spectrum there are more rays; beyond the red there are the infra-red; beyond the violet the ultra-violet, and still further, perhaps, the X or Roentgen rays. These are, however, the invisible rays.

The various rays and colors of the spectrum are due to different wave lengths and frequencies of ether vibrations, which excite in the brain (through the optic nerve) the different color sensations, e. g., the red is due to comparatively long, infrequent vibrations (about 481,000,000,000 per second), while the violet is due to short and rapid vibrations (about 764,000,000,000 per second).

Refraction and Penetration

All the rays in passing from lighter to the denser (or from denser to the lighter) substances are refracted or bent, and the greater the frequency of ether vibrations, of which the ray is composed, the greater the refraction.

The penetration of various rays depends on their respective refraction. The red rays (due to infrequent vibrations) are least refracted, and consequently most penetrative, while the violet (due to rapid vibrations) are most refracted and therefore least penetrative. The orange,

yellow and green are more refrangible and therefore less penetrative than the red rays, but are less refrangible and more penetrative than the blue, indigo or violet rays.

Thermic, Luminous and Actinic Rays

The rays of the spectrum are divided into three groups, viz., the thermic, the luminous, and the actinic rays.

The thermic or heat rays (radiant heat) chiefly emanate from the orange, the red and the invisible part beyond (infra-red). Being least refracted, these rays penetrate the tissue (from four to six inches) instantaneously, and generate heat in the depths of the tissue and the deep layers of the skin, where its (heat's) therapeutic effects (increased metabolism, nutrition, phagocytosis, etc.) are desired. This heat is more penetrative than the heat from any other source (except diathermy) and is excellent to relieve pain and to improve the local nutrition of the skin.

The luminous or light rays (radiant light) emanate from green and yellow. Although more refracted than the heat rays, the luminous rays are able to reach the nerves, nerve centers, muscles, viscera, and other tissues lying two or three inches below the surface of the skin. These rays cause sunburn and freckles when directed for any considerable length of time on the uncovered skin.

The actinic or chemical rays are composed of blue, indigo, violet and the invisible part beyond (ultra-violet). Being of the greatest frequency and refrangibility, they are the least penetrative, but most useful. These rays produce fluorescence of the blood and serum, and thereby stimulate the chemistry of the tissues (that is, they improve metabolism), and are highly bactericidal.

The actinic or chemical rays, especially the ultra-violet, do not penetrate substances containing blood or red coloring matter, thin films of glass, thin dark cloth, or adhesive plaster. They, however, readily penetrate water, air, rock crystal and tissue (from one to four millimeters), when rendered anaemic according to Prof. Finsen's method.

In considering the therapeutic uses of light, from whatever source, we must, however, not consider light merely according to the divided rays of the spectrum, but collectively, and in conjunction with heat radiation.

Effect of Light on Bacteria

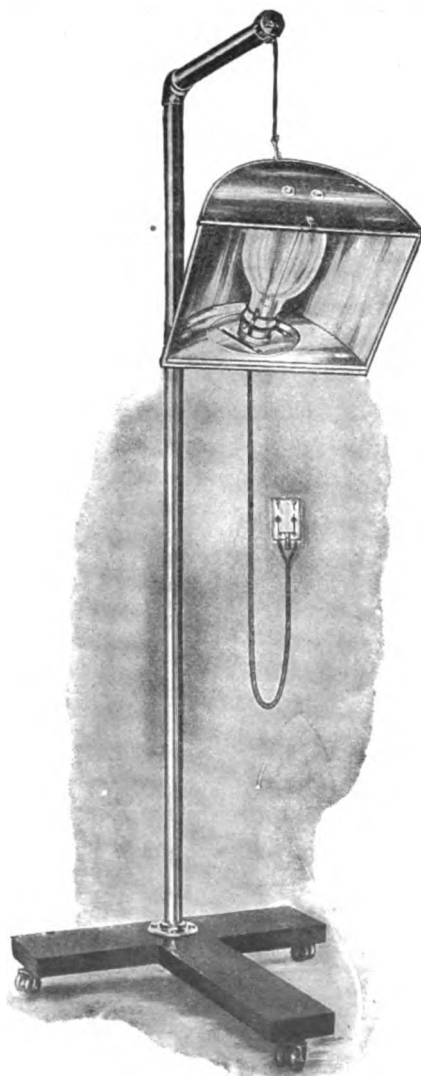
With the application of a sufficiently strong light, all portions of the spectrum are able to restrain the growth of bacteria, or to kill them, but the red rays possess the weakest bactericidal power; this power then increases as one approaches the other end of the spectrum, where it is strongest.

Only four per cent. of the bactericidal effect is ascribed to the red, orange, yellow and green rays, while to the blue, indigo, violet and ultra-violet about 96 per cent. of the effect.

The light energy, aside of the direct bactericidal action, is destructive to organisms within the body by the improvement in the cellular condition, promoting the physiological resistance to the growth and increase of bacteria.

Filtration (Cutting off rays)

Having seen that each class of rays produces distinct curative effects, in order to intensify these effects, it will be of value to know how to cut off those rays which are of no value in a given case. This can be accomplished by various methods, the most practical being by passing the rays through colored crystal screens, e. g., the red crystal does not appreciably reduce the heat, but cuts off the opposite colored rays, viz., the chemical rays, whereas the blue crystal (Bordier tints 1, 2, 4 and 6)



**Fig. 34—500 candle power
therapeutic lamp.**

considerably reduces the amount of heat—that is to say, it effectively cuts off a good proportion of the heat rays, but does not affect the chemical rays.

The yellow crystal (Bordier tints 2 and 3, especially 2) have a great transparency for the actinic rays, but very dark yellow (Bordier tint 4) cuts off nearly all the actinic rays.

Green crystal, Bordier tint 2, allows some actinic rays to pass, whereas tints 4 and 5 arrest all the actinic rays.

Frosted glass allows chiefly the heat rays of the spectrum, because the actinic rays are unable to pass through such a glass.

The colored screens or lamps employed to cut off certain rays for therapeutic purposes must be of colored crystal through and through, as painted screens or lamps are useless, since they keep back the essential rays.

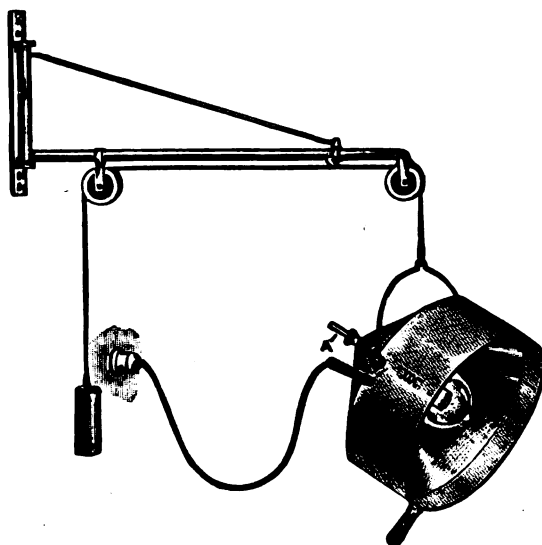


Fig. 35—Therapeutic Lamp suspended on a wall bracket.

Photo-therapy

Incandescent Light

The light from an incandescent lamp contains a large percentage of the red and yellow rays. The actinic rays, especially the ultra-violet, being almost entirely cut off by the enclosing bulb, the treatment by means of an incandescent light is largely a radiant light and heat treatment.

The treatment by incandescent lamps is manifestly inferior to a treatment which utilizes the whole spectrum, as does sunlight, but it is of great value in cases where the thermic effects are more essential than the effects of the chemical rays. Due to the penetration of the heat rays, it is far superior to other heating methods (except diathermy).

The incandescent light treatments are administered in the form of an electric light bath, therapeutic lamp, or other appliances for the local

treatment of arms, legs, trunk, etc., and are indicated in all conditions in which heat and light are of value.

Clear glass (uncolored) incandescent lamps, are mainly used for the purpose of promoting perspiration in rheumatism, obesity, arthritis, lumbago, sciatica, synovitis, skin diseases, etc.

Red lamps or *screens* warm and stimulate the arterial blood. They are indicated in all cold and pale conditions, but contra-indicated in all inflammations and hyperexcited conditions.

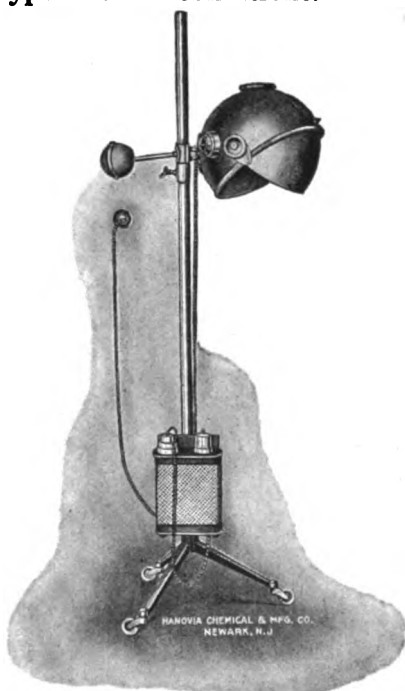


Fig. 36—The Alpine Sun Lamp. The lamp for the electro-therapeutist and general practitioner who wishes to practice intensive Heliotherapy in his office or clinic. An extensive literature records highly satisfactory results in all superficial skin affections, in surgery, nervous and constitutional diseases, also surgical and pulmonary tuberculosis.

Blue lamps or *screens* relieve congestion, inflammation and pain; reduce high blood pressure; cause better skin respiration; increase oxygenation and elimination of waste products, etc. They are superior to the clear lamps in the treatment of arteriosclerosis and neuritis, but are contra-indicated in cold and chronic conditions, unless considerable excitability exists.

Carbon and Tungsten Filament Lamps

"Carbon filament produces a small percentage of chemical rays and a large percentage of infra-red radiations."



Fig. 37—"Under the Alpine Sun Lamp." Wounded German Soldiers in Hospital in Baden-Baden. (From "Atlas of the World War," F. Bruckmann, Munich.)

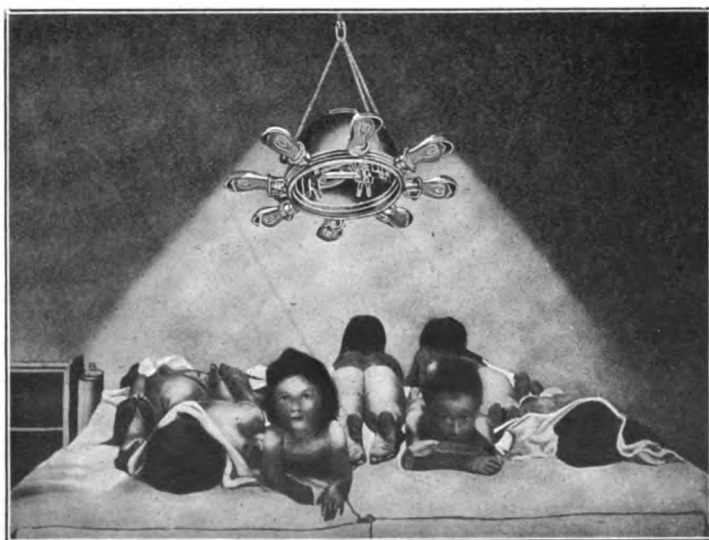
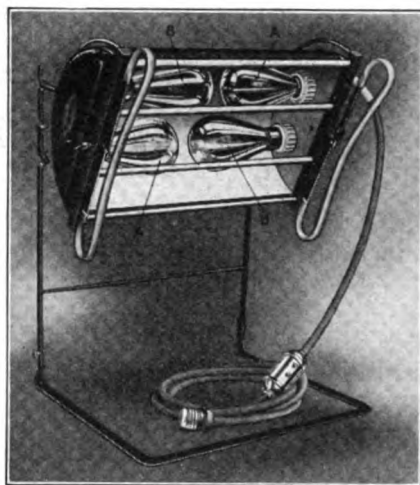


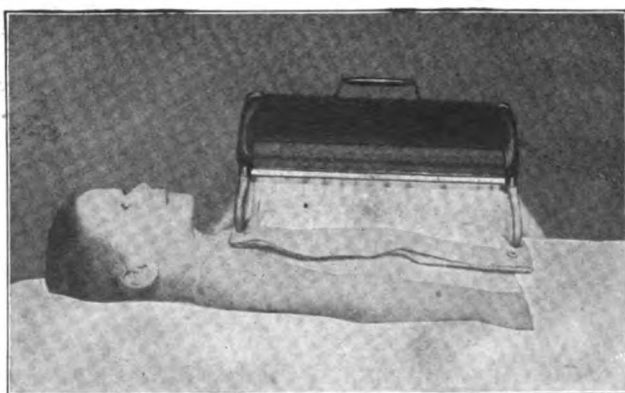
Fig. 38—Surgical Clinic, University of Marburg. Scrofulous children receiving last radiation before discharge. Objective symptoms have entirely disappeared.



**Fig. 39—“Radio-Vitant” Applicator
for the local application of radiant
light and heat.**

“In reducing local and superficial inflammation, the thermic action of the carbon filament of high candle power, added to its luminous and tonic qualities, renders it more efficient than the more luminous but less thermic tungsten filament, or than the action of convective heat.”

“*Tungsten filament*, either in the vacuum or nitrogen-filled globe, gives a whiter light, and produces less heat. Its luminous penetration appears to be greater than that from either of the other sources. Radiant energy from the tungsten filament as a source, is equal in therapeutic value, to that from the carbon, except in inflammation, and in the effect upon the lungs and skin.”



**Fig. 40—Abdominal application of radiant light
and heat.**

Therapeutic Application

Electric Light Bath

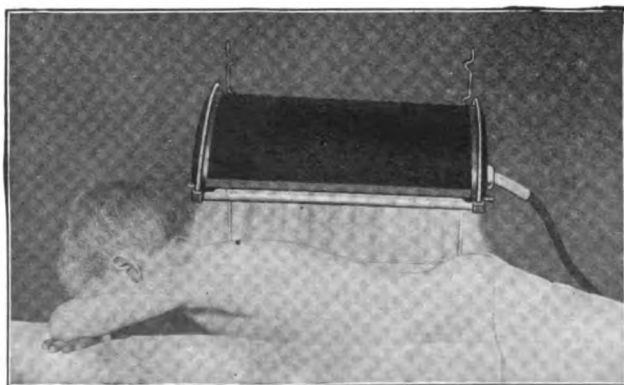
The electric light bath is either of a cabinet or reclining form, fitted with a number of incandescent lamps. These lamps are wired in sections, enabling the operator to switch on all or only some of the lamps, and thereby adjust the temperature of the bath and concentrate the light according to the patient's constitution and the state of his health at the time.

The electric light bath increases the surface circulation, dilates lymphatic vessels, and at the same time causes a diminution of the arterial pressure and augmentation of the pulse frequency.

Owing to the remarkable stimulus of light rays, this bath produces almost the same sudatory effects with a thermometer registering 195 de-



Fig. 41—Application of radiant light and heat to the shoulder and arm.



**Fig. 42—Spinal application of radiant light and heat.
(Applicator on stand)**

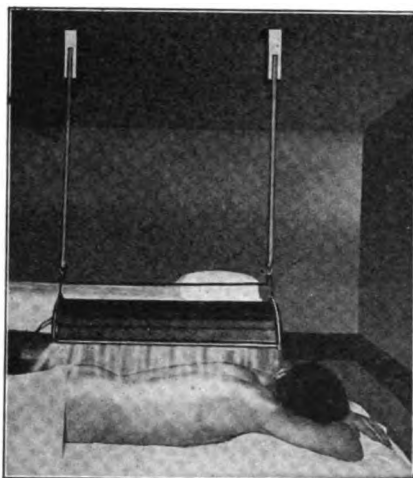


Fig. 43.—Spinal application of radiant light and heat.
(Applicator suspended)

degrees Fahr., as a Turkish, Russian or any other form of obscure heat, with the thermometer registering about 300 degrees Fahr., and the patient usually begins to perspire in five or ten minutes.

For the reason that a profuse perspiration can be induced at a very low temperature, and because the head remains clear and unoppressed, while the lungs breathe freely pure and fresh air, this treatment may be safely applied to patients afflicted with heart, head and lung complaints.

The electric light bath usually lasts from 10 to 30 minutes, according to the effect desired and the condition of the patient.



Fig. 44.—Spinal application of radiant light and heat.
(Applicator on adjustable supporters)

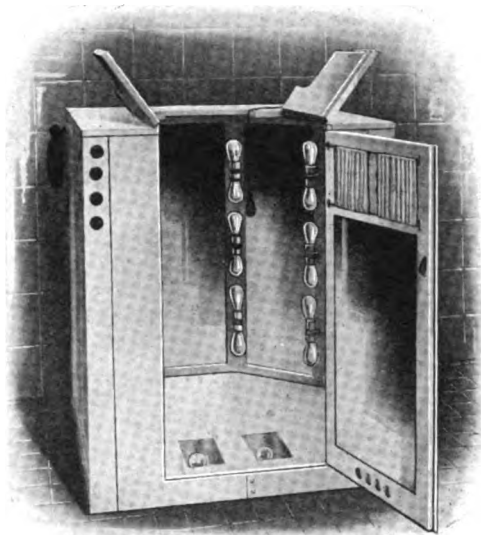


Fig. 45—Electric Light Bath (open).

Tonic effects are produced by a short bath (only to the sweating point), followed by a cold spray or vigorous exercise; while sedative effects, by regulating the lamps and controlling the temperature of the cabinet so as to induce sweating about 15 or 20 minutes after the patient has entered the cabinet.

Eliminative effects are produced by heating the cabinet gradually (turning on the spinal lamps after the patient has become accustomed

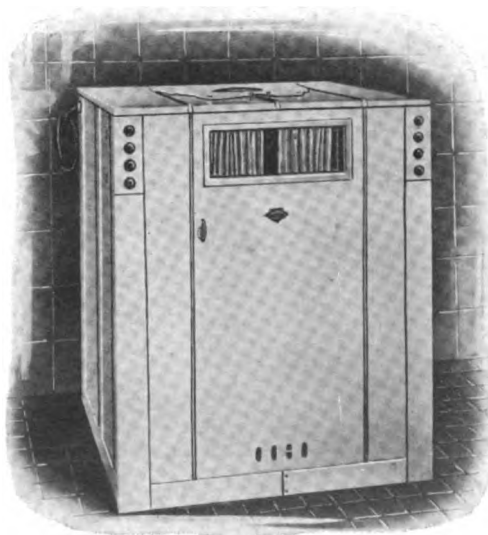


Fig. 46—Electric Light Bath (closed).



Fig. 47—Portable
Therapeutic Lamp
with screen.

to increased temperature), and giving the patient plenty of pure water or lemonade before and during the bath.

Local applications of light by means of a therapeutic lamp or special appliances for the treatment of arms, legs, trunk, etc., are the very best that is possible to employ, when general effect is not desired.

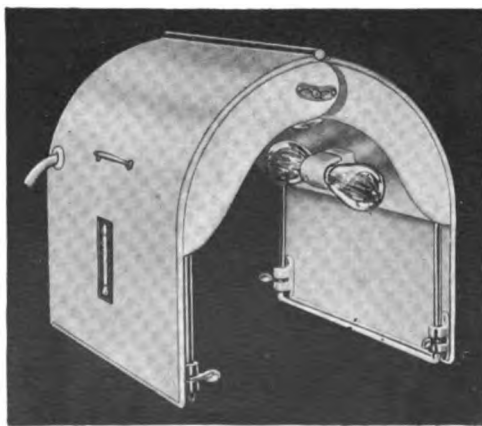


Fig. 48—Local Light and Heat Applicator
(closed), intended for the intensive appli-
cations to the various parts of the body,
as the pelvis, chest, hips, knees, etc.



Fig. 49—Local Light and Heat Applicator, shown in Fig. 48 (open).

Lumino and Actino-Therapy

Electric Arc

When the carbon points of an electric arc are heated to incandescence, they give off light which is rich in blue, violet and ultra-violet rays; the heat rays being decreased proportionally. The longer the arc, the larger the percentage of the actinic rays. (Arc is lengthened by separating the ends of the carbons.)

The electric arc has the same luminous power and contains more actinic rays than does sunlight. It gives a less steady light than the incandescent lamp, but it gives a light of greater intensity and bactericidal power.

If of a sufficient power, the electric arc will produce sunburn and tanning of the skin more easily than actual sunlight, with the same curative and stimulative effects that follow real sunburn.

Since the electric arc, in addition to chemical rays, gives off also a large percentage of the luminous rays when applied to the body, the brain, spinal cord, stomach, liver, lungs, heart, bones or whatever tissue that lies beneath the skin upon which the rays fall, are benefitted by it.

The distance at which the patient is placed from the electric arc diminishes the percentage of chemical rays as they are filtered by their passage through the atmosphere. The greater the application of light, the greater, of course, will be the effect upon the deep-lying tissues.

The arc light treatments are specially indicated in cases which are benefitted more by light than heat, such as neurasthenia, anaemia, lung complaints, all skin affections, etc. A substitute for the arc light is the high candle power incandescent lamp.

Finsen Treatment (Actino-therapy)

Most of the apparatus producing a large quantity of chemical or actinic rays for the treatment of lupus, ringworm and various skin diseases, according to the method of the late Prof. Neils R. Finsen, of Copenhagen, consists of the light, the cooling and the light-concentrating apparatus.

Finsen-Reyn Lamp, for example, consists of an electric arc and a short telescope fixed to a movable stand. This telescope contains rock crystal lenses, and is provided with a cold water circulation. This cooling arrangement not only serves to absorb the heat rays (and thereby prevents the burning of the patient) but also keeps the lenses cool and prevents them from cracking.

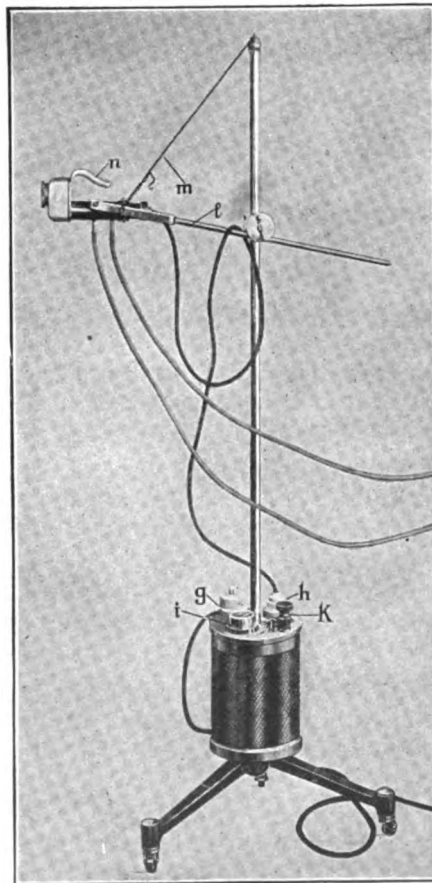


Fig. 50—The Kromayer Lamp. A powerful water-cooled lamp for the application of Ultra Violet Light in the treatment of Lupus, Nevus, Acne, Psoriasis, Eczema, Scrofuloderma, Alopecia, etc.

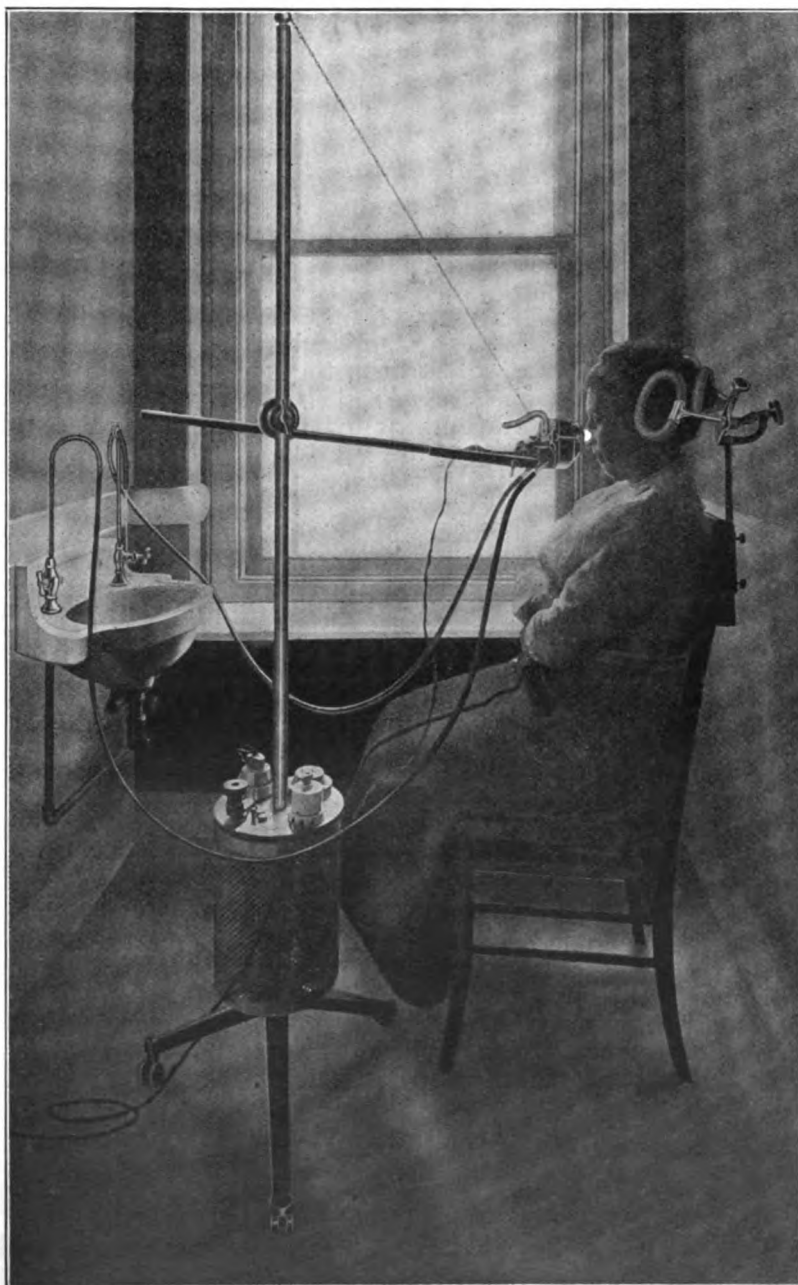


Fig. 51—The Kromayer Lamp. Treating small lesion on face with aid of Quartz lens applicator.

Emerging from the telescope, the rays again pass through a compressor, or a pressure-lens, which consists of two discs of rock crystal set in a metal ring, separated from each other, between which flows a second stream of cold water. This compressor, or pressure-lens, is not only used to further absorb the heat rays and keep the patient from burning, but also to produce anaemia of the part treated.

Application of the Finsen Treatment

In order to prevent the blood from absorbing the chemical or actinic rays, which are most important in this treatment, it is necessary to produce the anaemia of the part treated, so as to allow the luminous rays to penetrate deeper into the tissues. This is accomplished by placing a compressor or pressure-lens (or a piece of ice) against the part to be treated, and steadily pressing firmer and closer until all the blood is driven out of the part. In order to keep the part bloodless, it is necessary to maintain a continuous pressure. The cooling apparatus (water circulation) must be put into operation before the electric current is passed through the arc, so as to avoid breaking of the lenses.

The light from the apparatus is focused on the compressor, and the treatment is kept up for an hour.

If the application has been successful, eight or twelve hours after the blister will appear and must be protected from dirt and injury by a suitable dressing, which should be changed twice daily. If, however, there is only appearance of inflammation (redness, swelling, etc.) without a blister, the application has not been successful; and when such is the case, another application to the same area should not be repeated until all effects of inflammation have subsided.

Finsen treatment cannot be applied to an ulcerated part until the ulcer has healed. When treating the surface of the nose, the nostrils should be packed with absorbent cotton wrung out of boric solution, in order to obtain resistance to the pressure of the compressor.

Since the over-exposure of the crystalline lens to the chemical or actinic rays causes an early production of cataract when applying this treatment near the eyes, the patient's sight must be protected by dark green (Bordier tint 4) spectacles, or by covering the eyes with a double fold of brown or red paper. For the same reason, it is advisable that the operator, when administering this or any other actinic treatment, protect his own sight by wearing dark green spectacles.

If the patient complains that the rays produce a burning sensation, it means that the pressure-lens is applied too gently.

In order to prevent spreading of infection, the pressure-lens must be sterilized after each treatment.

CHAPTER XIV ROENTGEN OR X-RAYS

THE Roentgen, or X-rays, discovered in 1895 by Dr. William Conrad Roentgen of Berlin, possess the property of penetrating supposedly opaque bodies, but cannot be seen or felt as they pass through the body.

These rays are composed of considerably shorter waves than the shortest ultra-violet rays of light, representing a rate of frequency ap-

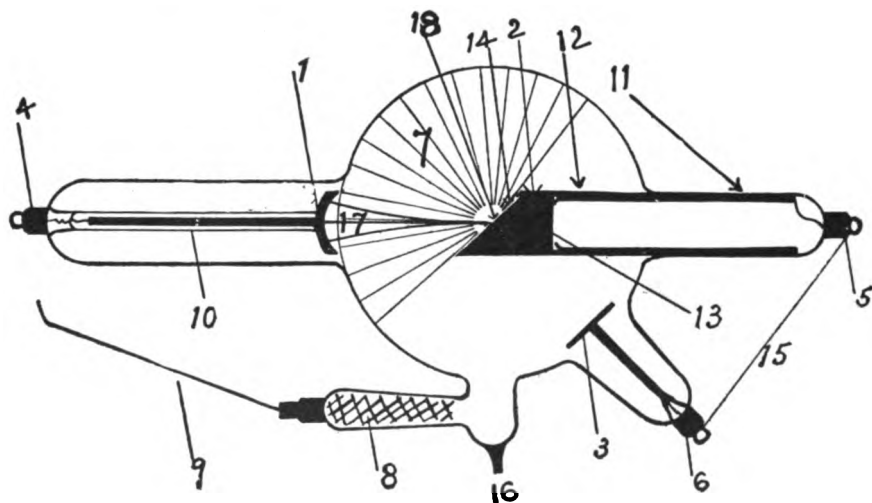


Fig. 52—Diagram of an X-ray tube.

proximately one thousand times greater than the higher frequencies of the visible spectrum. They are produced by means of an X-ray tube excited by an induction coil, interrupterless transformer, high frequency apparatus, or a static machine.

The X-ray Tube

The modern X-ray tube (Fig. 52) is a large glass bulb, varying from 6 to 8 inches in diameter (out of which lead two, three or more short glass stems) exhausted to a vacuum from $\frac{1}{100,000}$ (one hundred thousandth) to $\frac{1}{1,000,000}$ (one millionth) of an atmosphere. It consists of various parts, most important being the cathode, anti-cathode or anode, bi-anode and a regulator.

The Cathode (1) is a concave platinum disc, which serves to project a stream of electrified particles upon a focus point or a *target* (18).

The *anti-cathode*, or the anode proper, consists generally of a pure copper stem (11) upon which is a target set at an angle of 45 degrees to the cathode. When the electrified particles from the cathode (cathode rays) strike the target (at 18), they give rise to the X-rays (7), which are reflected from the target and pass through the walls of the tube, travelling in straight lines in all directions.

On account of the heat produced by the bombardment of the cathode rays, only platinum, iridium, or tungsten can be successfully used upon the target. The advantage of using upon the target tungsten, which melts at 3000 degrees C., or iridium, which has much harder density than platinum, and melts at 1700 degrees C., is at once apparent where the tube has to withstand very heavy currents for any appreciable length of time.

The *bi-anode* or assistant anode (3) is set at an angle above and connected to the outer terminal of the anti-cathode, or the anode proper. It is either a small aluminum rod, a flat circular disc, or a large metallic tube. The first two forms of bi-anode are the only practical ones to be operated upon a coil where an interrupter is used, while for the transformer the tubular form is preferred. The object of the bi-anode is to assist in the regulation of the vacuum.

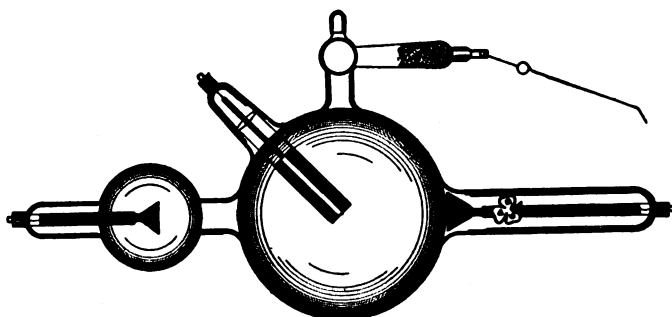


Fig. 53—High Frequency X-ray Tube.

The Exciting of an X-ray Tube

When first exciting a new tube, great care should be exercised, owing to its delicate nature, apart from the fact that it is constructed of thin glass. A tube may puncture from no apparent cause when the current is first switched on, and this is an accident which cannot be entirely guarded against, although it is not a very frequent occurrence. As a safeguard against this, it is advisable to see that a tube is as free as possible from dust and moisture on the surface of the bulb.

It should also be remembered that a new tube is more readily damaged by overheating than an old one, and care should always be taken not to over-run a tube so as to heat it beyond the point where a finger can not be held on it without discomfort.

With an induction coil, a transformer, or static machine, the tube should be connected by its anti-cathode (5) to the positive pole of the generator, and by its cathode (4) to the negative pole.

With a portable apparatus made with the double Tesla coil, it is

immaterial which of the two terminals are connected to the apparatus, but with the apparatus made with a single Tesla coil, it is important that the cathode of the tube is connected to the main terminal of the Tesla coil.

The current should be turned on gradually by means of a rheostat or other device, so that only a very small amount of current will pass. In radiotherapeutic work, the strength of one milliampere or less is employed (usually only from one- to three-tenths of a milliampere); while in radiography up to five milliamperes may be used.

Never allow to spark across the gap while exciting the tube.

When the current under three-tenths of a milliampere is employed, the ordinary platinum target may be used, but when it is raised to four or five-tenths of a milliampere, this target is liable to grow red-hot. When the strong currents are required, we must, therefore, use the tubes which are built with the anti-cathode and target able to withstand excessive currents. The so-called "heavy anode," or "water-cooled"

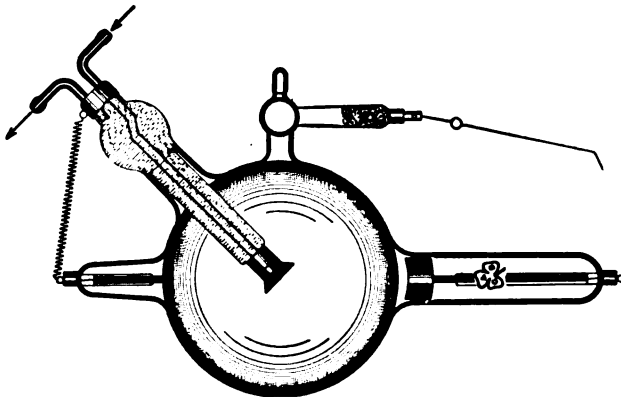


Fig. 54—Tungsten Target Water-cooled Tube.

tubes (Fig. 54), for instance, will stand up to 5 milliamperes for thirty seconds (150 milliampere-seconds) or more, or less current for a correspondingly longer period, say 2.5 milliamperes for sixty seconds (as this equals 150 milliamperes also), etc.

All tubes will carry safely at least fifty per cent. more current after they have been "seasoned" than the strongest current they will take immediately after they have been put into service. The tube is seasoned by passing about two-thirds of the full current through it a considerable number of times before working them at full power.

Penetration

Penetration of the X-rays depends on the rapidity (frequency) of ether vibrations, while the rapidity of vibrations depends on the vacuum of the tube and the voltage produced by the apparatus. The higher the vacuum of a tube and higher the voltage produced by the apparatus, the greater the rapidity of vibrations, and consequently greater the penetration. The greater the penetration, shorter the exposure.

Soft, Medium and Hard Rays

Tubes are called low, medium or high, according to the degree of exhaustion.

Soft or low tubes are exhausted to about $\frac{1}{100000}$ (one hundred thousandth) of an atmosphere. They give off *soft rays*, which, although rich in photo-chemical effects, are unable to penetrate the tissues to any great depth.

Medium tubes are more exhausted than low, and give off *medium rays*, which penetrate the tissues more deeply, retaining their photo-chemical effects.

Hard or high tubes are exhausted to about $\frac{1}{1000000}$ (one millionth) of an atmosphere. They give off very penetrating *hard rays*.

There is no absolutely accurate method for estimating the relative vacuum of a tube, but since a low tube offers less resistance than a high tube, by means of the so-called *equivalent spark-length*, it is possible to determine the approximate degree of its vacuum. This is carried

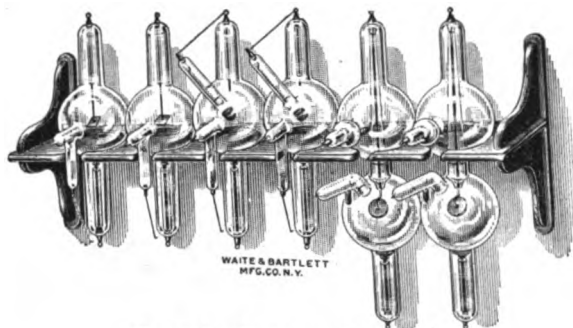


Fig. 55—X-ray Tube Rack.

out by properly connecting the tube and starting the generator with the prime conductors or spark points actually touching each other, then gradually separating them until the sparks cease to pass between them, which means that the resistance of the tube has been overcome, and that the current is now passing through the tube. The distance between the spark points, when the resistance of the tube has been overcome, is the equivalent spark length.

A tube is considered *low* when its resistance is overcome with spark length from one to three inches; *medium* with spark length from three to five inches; and *high* when the spark length is over five inches.

For the reason that a tube which is too high to use with the coil is oftentimes too low for the static machine, and vice versa, the testing should be always performed with the same generator which is to be used to excite the tube for the application.

There are also several instruments for measuring the vacuum of the tube and penetration of the rays. The *Qualimeter*, for example, is an instrument consisting practically of a special form of electrostatic voltmeter, which when connected with a single wire to the negative terminal of the generator, or the cathode of the X-ray tube, indicates any alteration in the vacuum of the tube whilst actually working.

PENETRAMETERS. Measuring of the approximate penetration of rays is a very valuable and convenient guide to exposure in radiographic work. This is accomplished by an instrument called penetrometer, of which there are various forms, the most practical being Benoist, Bauer, and Walter. These penetrameters tell instantly how many inches of human body the rays emanating from any tube will penetrate sufficiently to give a fully detailed negative when exposed to correct time.

Regulation of Tubes

With continued use, all X-ray tubes tend to become higher in vacuum, and eventually become so high as to be nearly useless. When this

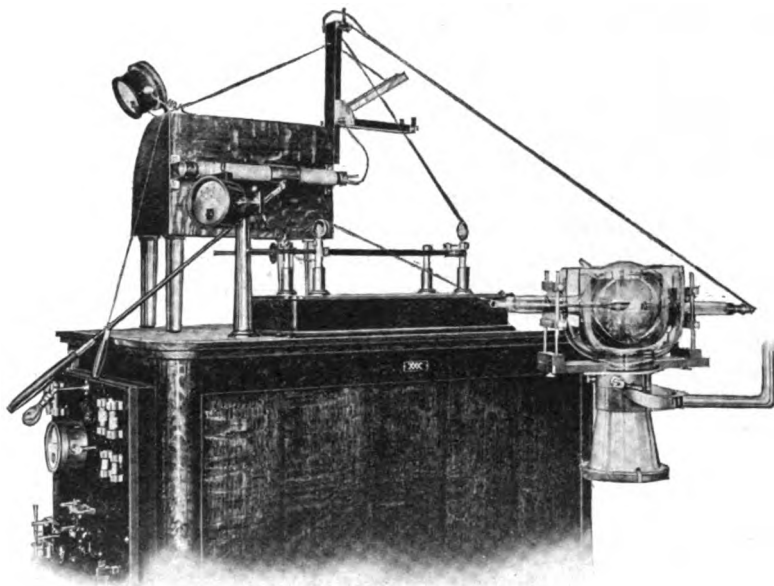


Fig. 56—The arrangement of the Coolidge X-ray tube and means of regulation of the storage battery with switch, the ammeter and rheostat. This tube stands the strain of six to eight milliamperes for from four to six minutes without risk to the tube and many times daily. It also carries three to four milliamperes for ten minutes with safety and regularity.

occurs, bright patches of green can be seen in different parts of the tube, and the current shows a disposition to the spray, on the part of the conducting wires.

In order to be able to use again these tubes the vacuum must be reduced. This is accomplished by means of a regulator fitted on the tube; or if there is no regulator by reversing the polarity and running the current backwards for about an hour, so as to drive a sufficient number of corpuscles from the cathode.

There are several kinds of regulators but most frequently used are the automatic spark or the Queen-Sayen Patent, osmosis and the air valve regulator. With whichever type of regulator and X-ray tube may be

fitted, it should be remembered that the tube will become unstable if regulated too frequently, and therefore the regulation should be resorted to only when absolutely necessary.

The automatic spark or the Queen-Sayen Patent regulator is generally the one most satisfactory. When this regulator is used, the X-ray tube is fitted with another secondary tube (8) mounted on a short stem, having a terminal to which is attached a regulating wire (9) capable of reaching the cathode terminal (4). To lower the vacuum, the tube is connected to a generator and the current turned on. Then, with a glass or ebonite rod, the regulator wire is moved slowly toward the cathode until a discharge of sparks passes between it and the cathode. This regulating discharge passes through a bunch of mica discs or chemically prepared asbestos fibre (8) in the secondary tube, heats them, and liberates occluded gas, which flows through the main tube and lowers its vacuum. After a few minutes the current should be turned off and the tube allowed to rest. If the tube is still too hard, repeat the process.

When using transformer tubes, it is advisable that the regulating wire be removed or cut off, because when the apparatus is turned on for the exposure the current is apt to jump from the negative terminal (cathode) to the regulating wire, and this may reduce the vacuum of the tube so far that it will be impossible to bring it back.

Osmosis regulator reduces the vacuum of the tube by allowing a small quantity of hydrogen into the bulb. This is accomplished by heating a little tube of palladium with an alcohol lamp.

The Air valve regulator which allows a minute measured quantity of air to pass into the X-ray tube although not very practical for the busy practitioner is sometimes employed.

The Coolidge Tube

The Coolidge X-ray tube is built and operated entirely different from the ordinary X-ray tube, and is far superior to other types having a perfect regulation of vacuum (by heating the cathode filament with a current from a storage battery or a step-down transformer) so that it can be made soft, medium, or high, and therefore satisfactory for fluoroscopy, radiography, or radiotherapy (Fig. 56).

Inverse Current

If the current is flowing in the right direction, the tube glows with an apple green light, perfectly equal in intensity throughout the luminous hemisphere (7), (that half of the tube through which pass the rays reflected from the target) and the other half of the tube "dark hemisphere" remains darker.

When a tube is excited by means of an induction coil, and specially when a high voltage is used, it is almost always found that there is a certain amount of current passing through the tube in the reverse direction. This arises from the making and breaking of contact in the primary circuit of the coil. This "inverse current" which spoils the radiograph and seriously shortens the life of the X-ray tube can be detected by the appearance of rings back of and usually running at an angle to the luminous hemisphere, and also by rings around the bi-anode

disc, or by means of an *Oscilloscope* (Fig. 58) which is a glass tube about eight inches long, exhausted to a certain specified degree of vacuum, having two electrodes of aluminum wire, connected in series with the X-ray tube. If there is inverse current, both wires of the Oscilloscope will glow; while if there is no inverse current, it will glow at the negative electrode only.

In order to do good work and to lengthen the life of an X-ray tube, this inverse current must be eliminated, and this may be accomplished by means of a *Valve tube* (Fig. 59), or a spark-gap connected in series with the X-ray tube.

The *spark-gap* for suppressing inverse current consists of a plate and an adjustable point, enclosed in a glass cylinder. When only small cur-

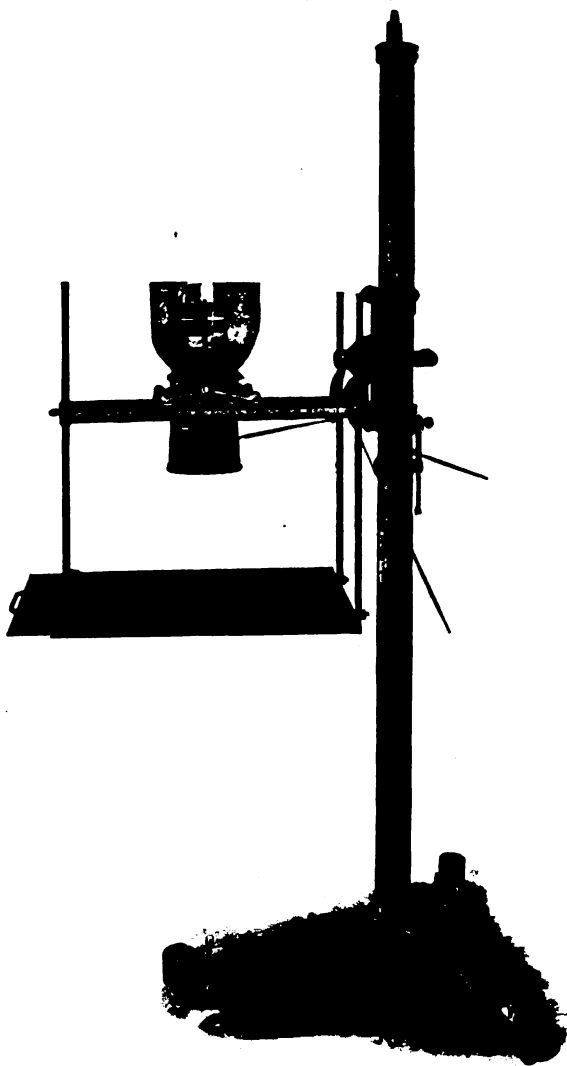


Fig. 57—X-ray Tube Stand.

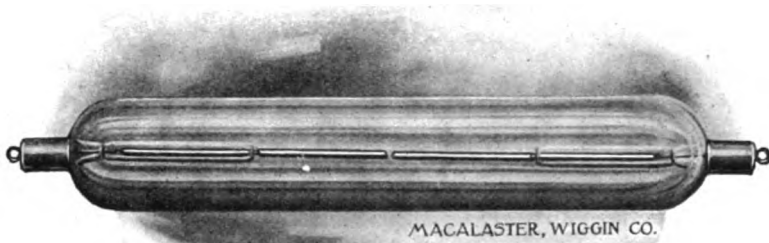


Fig. 58—Oscilloscope.

rents are employed, not exceeding about two milliamperes, if it is in the circuit, it will effectively cut out the inverse current.

The best rectifying action will be obtained when an adjustable point forms the positive pole of the gap and a plate the negative, because the current flows more easily from point to plate. The spark-gap is as good as a valve tube for most therapeutic work, and does not become worn out, the only objection to its use is that it not only offers a resistance to the inverse current, but also to the current which produces the proper ray in the tube.

Interrupterless Transformers

Interrupterless transformers consist essentially of a step-up transformer and a high tension rectifier which converts the high tension alternating current, generated by the transformer, into a pulsating direct current, which is fed to the X-ray tube.

The step-up transformer is wound for voltages up to 160,000, according to the size and make.

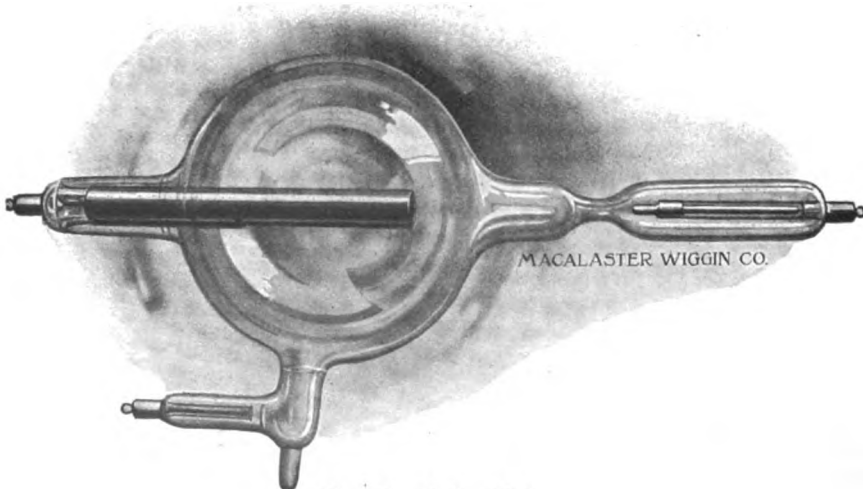


Fig. 59—Valve Tube.

The high tension rectifier consists of a revolving disc mounted on the shaft of the rotary converter (if the machine is to be operated on the direct current), or a synchronous motor (if for alternating current). When this disc revolves on the motor shaft, the two metal contacts on the disc (which are connected to the high tension alternating current) alternately pass the stationary electrodes fixed near the revolving disc. These stationary electrodes collect the converted current, which is fed to the X-ray tube. (Fig. 75)

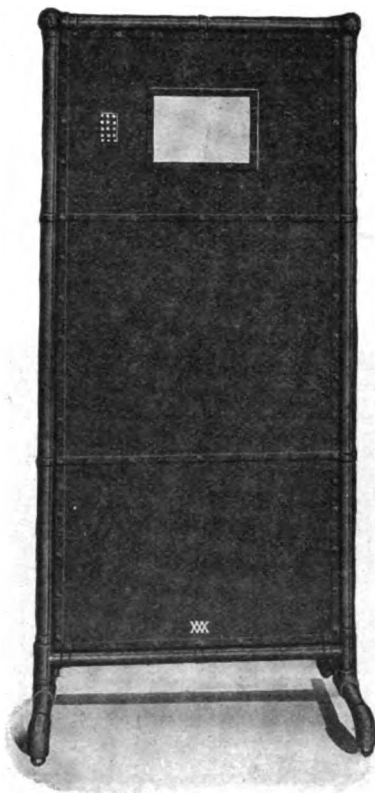


Fig. 60—X-ray Protective Screen.

The Protection of the Patient and Operator

An overdose of the X-rays being injurious, whenever using these rays it is absolutely necessary to protect the patient and the operator against indiscriminate exposure. There are two ways of protecting the patient: one, to surround the tube with an opaque covering, limiting the exit of the rays to a small opening, which can be regulated as required; the other is to cover, by some opaque material all parts of the patient and operator, which are within the influence of the rays and which require protection. The X-rays being unable to traverse lead or any substance containing lead, the first method is carried out by placing the tube in a bowl made of glass which contains a large quantity of lead (lead glass),

mounted on a metal stand (Fig. 57). The target of the tube is directed towards the opening of the bowl so as to allow the rays to come out. The second method consists in employing lead sheets with openings cut in them to correspond to the area which is to be exposed to the rays.

By the application of plain vaseline to the part exposed directly to the X-rays, the burning of the patient may be avoided or retarded. This substance, if applied before the exposure, retards the superficial irritation and is specially useful when treating the deeper tissues, and where there is no open ulcer.

The operator must not expose himself to the action of X-rays and it is advisable that he protect himself by lead lined screens, lead glass spectacles, lead lined gloves, or other appliances.

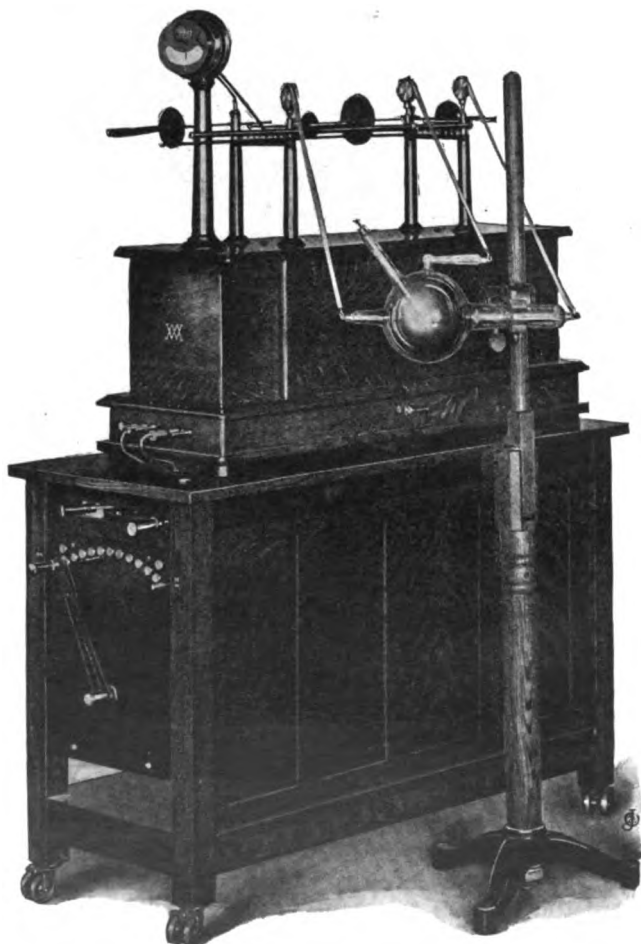


Fig. 61—Induction coil—X-ray apparatus

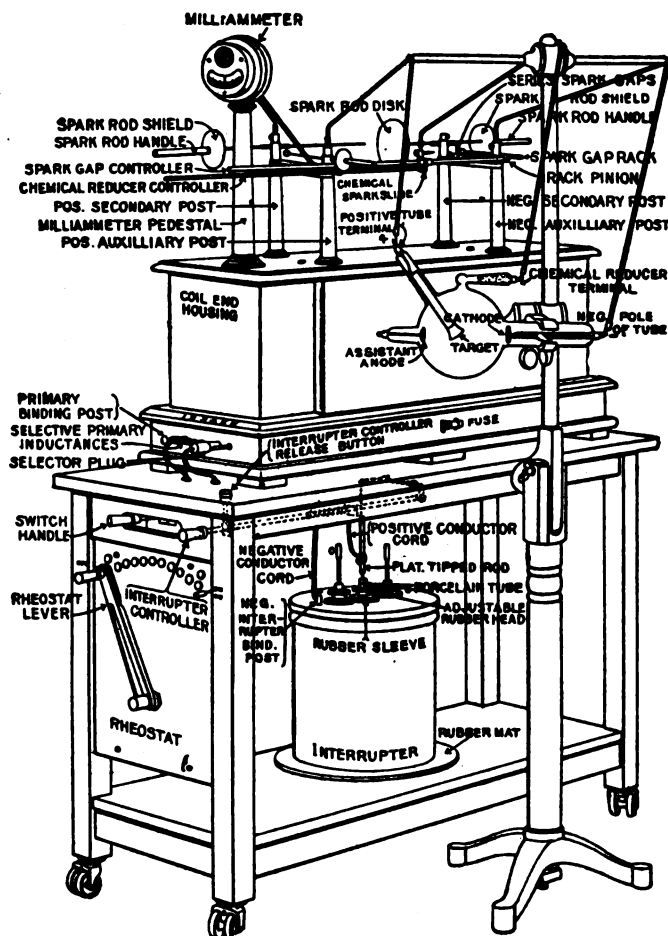


Fig. 62—Diagram of the induction coil, X-ray apparatus

CHAPTER XV ROENTGENOLOGY

Radiography

THE X-rays passing through dense objects (bones, bullets, stones, etc.) being prevented from reaching the screen or photographic plate cause a shadow to appear on it, which is proportionate to the density of the object traversed.

If an object is interposed between the X-ray tube and the *Fluoroscope* (Fig. 63), (a screen containing barium-platinum-cyanide, which fluoresces or shines when exposed to the X-rays) a shadow is produced on the screen, and we are able to see deeper structures of the body.



Fig. 63—Fluoroscope.

In order to protect the patient and operator, fluoroscopy should be performed with a hard tube, excited by high voltage, so as to eliminate the proportion of soft rays which are dangerous to the skin, and to reduce the current (milliamperage) as much as possible. If the photographic plate is substituted for the fluoroscopic screen we are able to obtain a picture called radiograph, or skiagraph, of the image which appeared at the fluoroscopic screen, because the X-rays act upon the photographic plate in the same way as ordinary light.

The X-ray plates have a heavier coating than ordinary photographic plates. They are the most sensitive of photographic plates and any exposure to light or X-rays will spoil them, and consequently will spoil the nicer detail of the picture.

The plates must be placed first in a black and then in a yellow envelope. This, however, must be done in a dark room, using only a good ruby light through which no white light will be admitted.

In placing the plates in the envelopes, the film side must be toward the front of the envelope so that the fold is closed on the glass side of

the plate. The glass side and the film side of the plate may be distinguished, holding the plate at an angle toward the ruby light. The glass side reflects brightly and the film side is dull. If there is no light used, the surface is tested with the wet finger—the glass side slips and the film side sticks. After placing the plate in the black envelope, this (envelope containing plate) is then placed into the yellow envelope in the same way as in the black, placing the fold of the black envelope at the bottom of the yellow, so as to prevent the leakage of light through the folds. The plates enclosed in this manner may then be handled in daylight.



Fig. 64—Fluoroscopy of the shoulder.

For the reason that black envelopes contain a certain amount of sodium hyposulphite, which causes deterioration of the film if the plates remain in them for several days, it is advisable to place the plates in the envelopes only a few days before they are used.

The plates should be kept in the dark room or a safe and should not be removed until the machine has been adjusted and the degree of vacuum of the tube has been established. When the penetration of the tube has been established, the plate is placed film side toward the target (of the tube) on the table; the part to be radiographed is resting on the plate or is brought into as close contact with it as possible and the tube some distance above, so that the target is directly over the center of the part to be radiographed.

THE DISTANCE from the target to the plate is usually from 16 to 24 inches, but the shorter the distance, the greater will be the magnification of the image on the plate.

THE DURATION OF EXPOSURE is a matter of judgment, and varies according to the generator employed, the distance from the target to the plate, the vacuum of the tube, the weight of the patient, and the size of the part being radiographed.

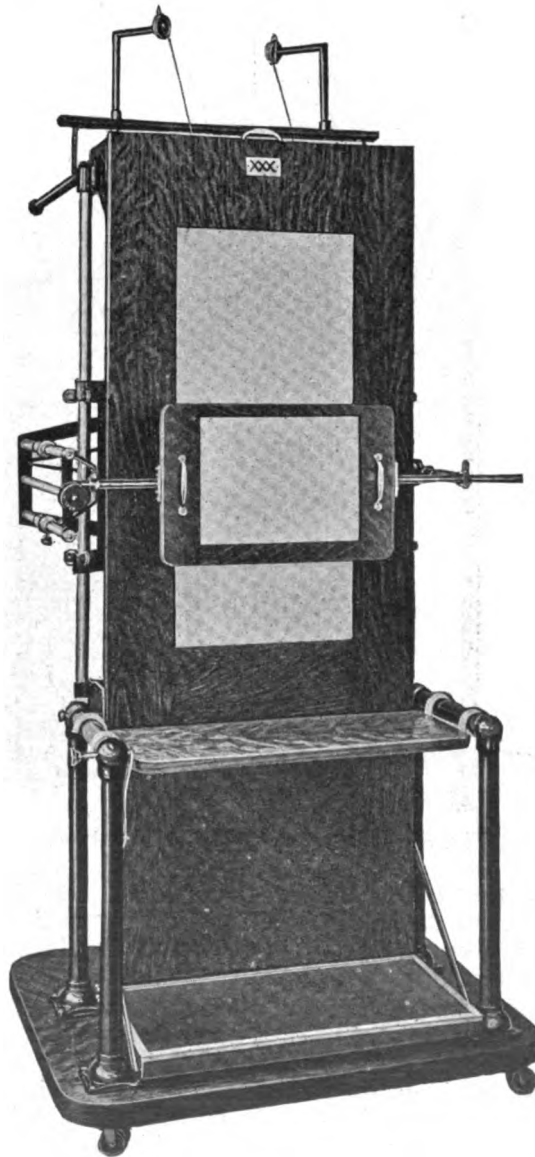


Fig. 65—Universal Klinoscope. Used for Fluoroscopy and Radiography

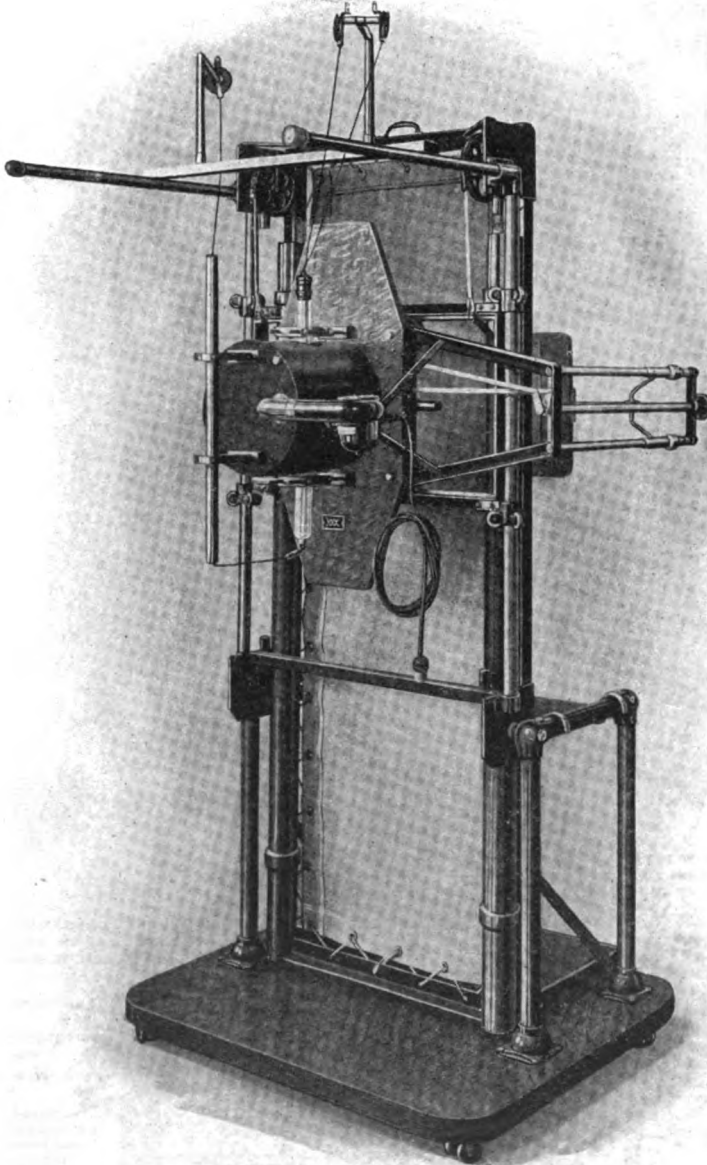


Fig. 66—Universal Klinoscope. Shown in Fig. 65 (rear view).

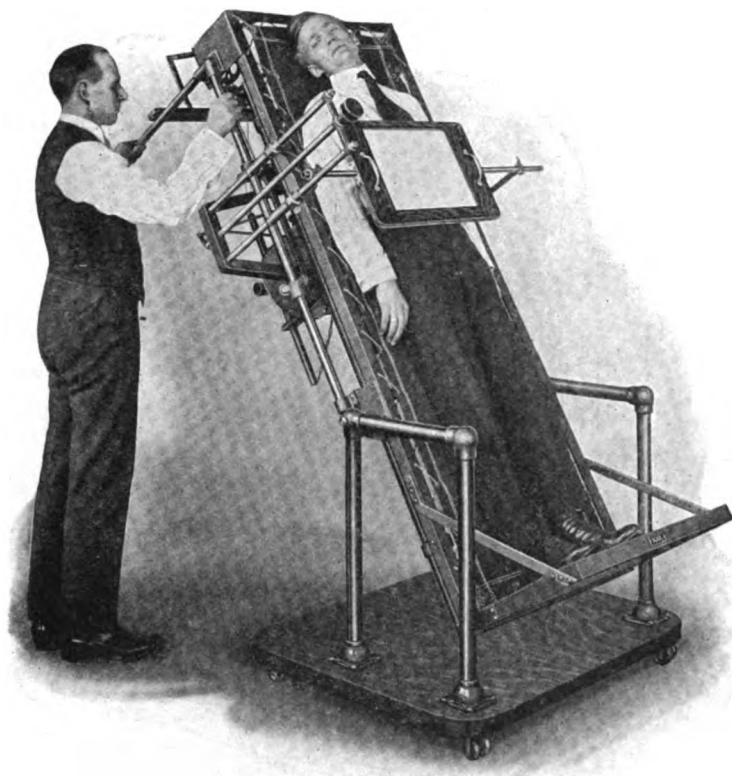


Fig. 67—Universal Klinoscope. (Vertical position).

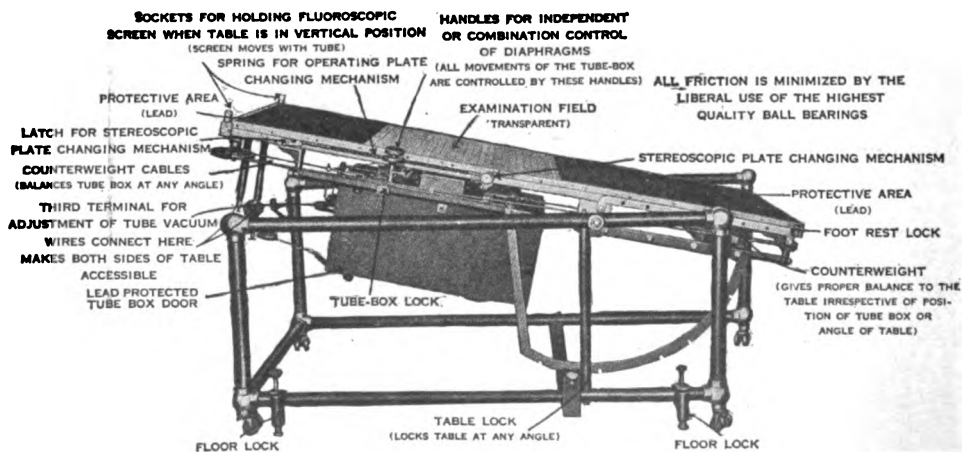


Fig. 68—Combination Table and Radioscope. (Used as Horizontal Radioscope)

The duration of exposure is expressed in *milliampere-seconds*, and these are obtained by multiplying the amount of current (in milliamperes) flowing through the tube with the duration of exposure (in seconds); e. g., if we are using 5 milliamperes of current for 10 seconds, it means 50 milliampere-seconds, and it is the same as if we used 10 milliamperes for 5 seconds, or 2.5 milliamperes for 20 seconds.

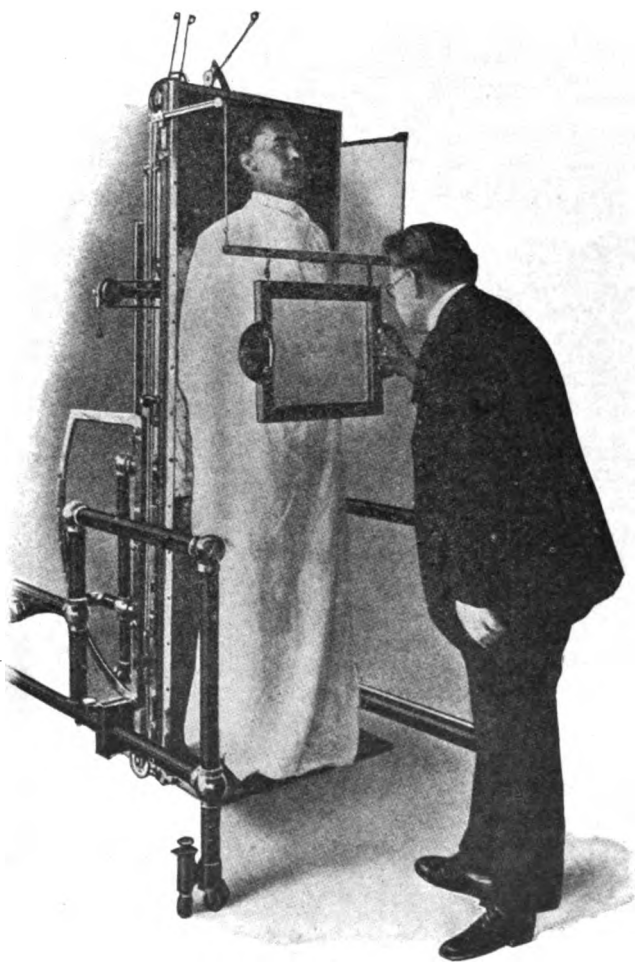


Fig. 69—Combination Table and Radioscope (shown in Fig. 68). (Used as Vertical Radioscope)

The best method for determining exposure, without a second's watch, is to count seven as fast as possible for each second of time.

The milliampere-meter is used in connection with a transformer to determine the current which passes through the X-ray tube, but is of no value with the portable coil or a static machine.

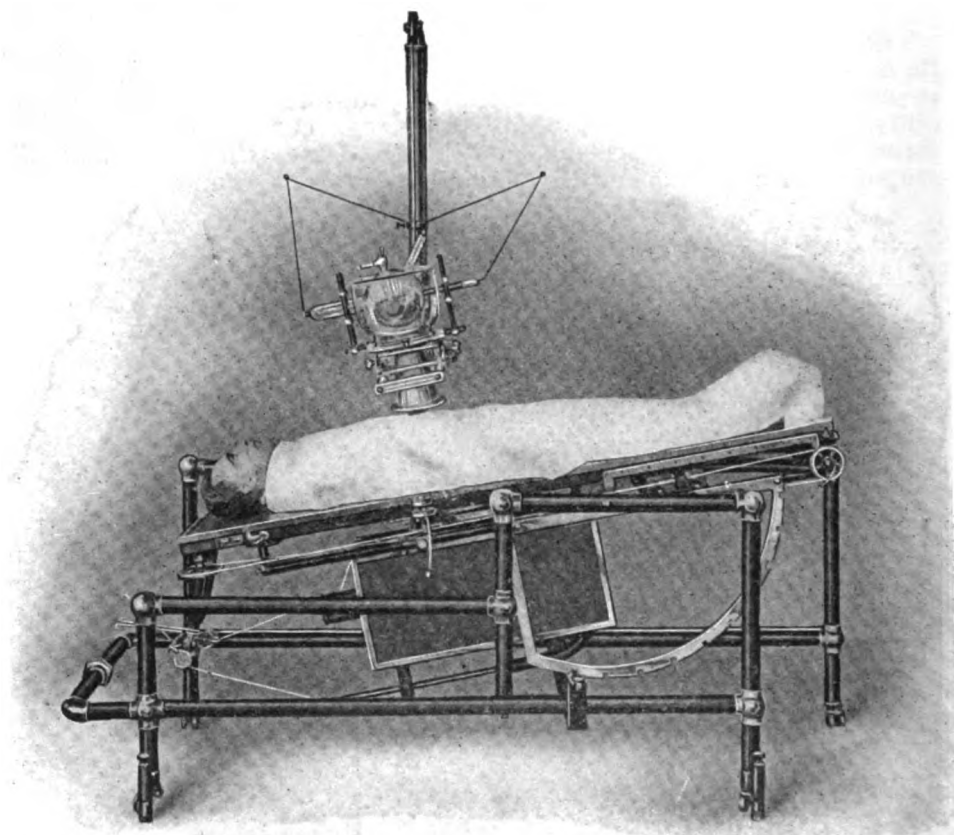


Fig. 70—Combination Table and Radioscope (shown in Fig. 68).
(Used as Radiographic Table)

Developing the Negative

Having exposed the plates, return them to the dark room and develop them in the same manner as if ordinary photographic plates.

The following formulae are exceptionally satisfactory in developing Paragon and other X-ray plates:

Developer

Solution A		Solution B	
Water	64 ozs.	Water	64 ozs.
Metol or Motol	60 grs.	Sodium Sulphite, dry, $3\frac{3}{4}$ ozs.	
Hydroquinone	2 ozs.	Sodium Carbonate, dry, 5 ozs.	
Sodium Sulphite, dry, $.3\frac{3}{4}$ ozs.		Potassium Carbonate, $2\frac{1}{2}$ ozs.	
		Potassium Bromide ..	180 grs.

Mix equal parts of solutions A and B, at a temperature of 65 to 68 degrees Fahr. Develop until the plates appear almost the same on front and back, or until the ruby light will not show through them.

Fixing Bath

No. 1

Water 120 ozs.

Hypo Crystals 4 lbs.

No. 2

Water 80 ozs.

Sodium Sulphite, dry, . . . 4 ozs.

Sulphuric Acid, liquid, $\frac{1}{2}$ oz.

Dissolve in the exact order given. Add No. 2 to No. 1 while stirring rapidly.

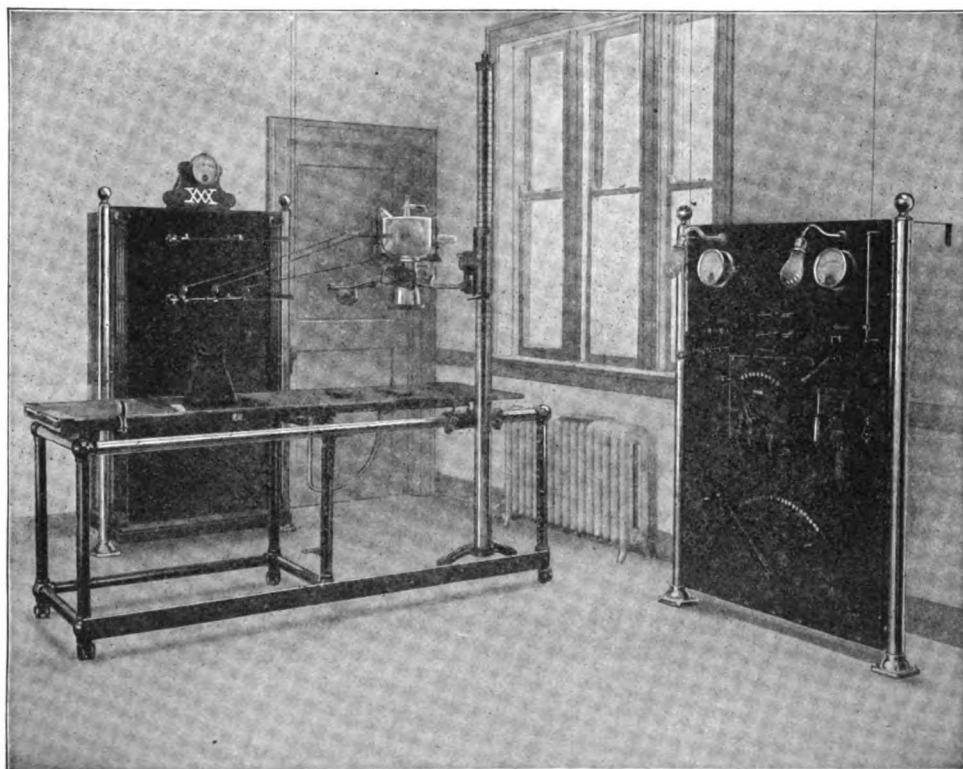


Fig. 71—Switchboard Type Interrupterless Machine

Radiotherapy

Radiotherapy, or the treatment by means of the X-rays, must be considered from two points of view: Stimulation and Inhibition.

Small doses (short or mild exposures) of the X-rays produce the stimulation of the tissue (increase the cytolytic growth activity with more rapid mitosis, and increase the number of cells).

Large doses (considerably long exposures) produce an intensely inhibitory action (cause pyknosis and nuclear disintegration, and later vacuolization and rupture of the cytoplasm, resulting in the death of the cell), arresting all active processes, and destroying tissues of varying resistance, relative to the character of the exposure and the susceptibility of the tissue to the overwhelming influence of the radiations.

The cells of low vitality are more susceptible to the action of the X-rays than normal cells (which have many times the resistance of diseased cells). Due to this fact, the diseased cells are destroyed and eliminated from the tissues, while the normal cells, being able to resist longer, after discontinuance of the exposure revive to their normal condition. Therefore, it may be concluded, that if rays of a correct penetration are employed, and the part is not overexposed, diseased tissue will be destroyed, and adjacent tissue will remain intact.

Indications

Radiotherapy increases leucocytosis and phagocytosis. It decidedly lessens hemorrhages and discharges, relieves pain, is of great value in treating post operative cases to prevent recurrence, and in all hopeless, inoperable cases by increasing the vitality, prolongs the life of the pa-

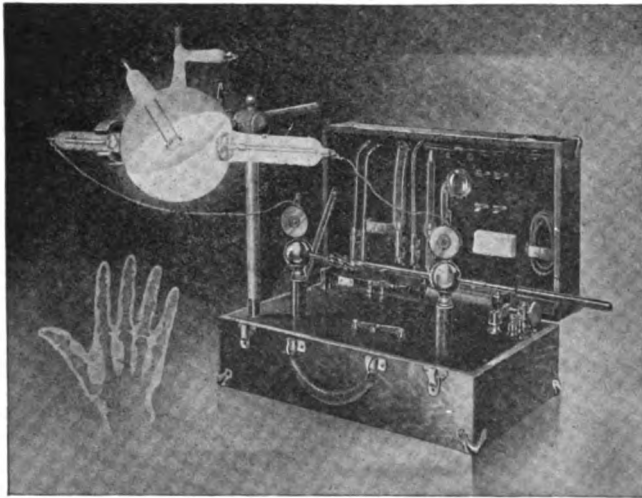


Fig. 72—Portable X-ray coil.

tient. Being able to cause disappearance of malignant masses, all cases of malignant disease should be given the benefit of any possible help that may be derived from it.

In menorrhagia and myomata, it should be employed in any case in which operation seems inadvisable.

In exophthalmic goitre, splenic leukaemia and pseudo-leukaemia, it is a valuable adjunct to other methods of treatment.

It is a remedy par excellence in acne, alopecia areata, blastomycosis, cancer of soft internal organs, eczema, epithelioma, favus, hyperhidrosis, hypertrichosis, keloid, lupus, pruritis, psoriasis, rodent ulcer, sarcoma, sycosis, trachoma, tuberculosis of the bones, etc.

Method of Application

Whenever using X-rays for therapeutic work, we must endeavor to get sufficient effect with the minimum risk of producing severe X-ray burns.

Tube.—It is absolutely necessary that the tube be of proper vacuum (penetration) to reach only the affected tissues, as the rays from a lower tube would not reach them, while the rays from a higher tube would penetrate undesirably deeper tissue. For radiotherapeutic work, only tubes which allow perfect control of vacuum should be employed. The ordinary X-ray tubes, which constantly change their vacuum, are useless.

Voltage.—When treating superficial lesions, in order to obtain a desired quantity of soft rays, low voltage should be employed, while for deeper lesions higher voltage is necessary.

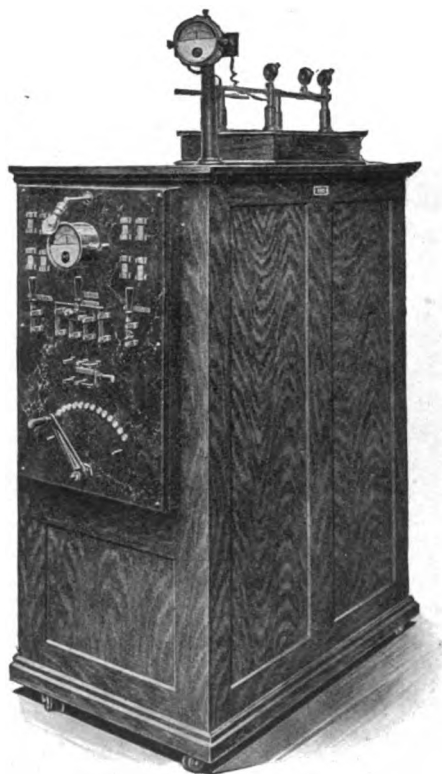


Fig. 73—Interrupterless Transformer.

Distance.—The higher the vacuum of the tube, and, consequently, the greater the penetration of the rays, the further away the tube must be placed from the part treated. The good working rule is to place the patient about five inches further from the surface of the tube than the greatest distance which the tube can force a spark across the spark-gap. Therefore, the distance for a low tube will be from 6 to 8 inches; for a medium tube, from 8 to 10 inches; and for a high tube, from 10 to 20 inches.

If there is no evidence of reaction, the distance should be reduced with every other treatment for one-half of an inch, until the tube is at a distance of about five inches.

Duration of treatment.—The duration of the treatment depends upon the generator employed. With an induction coil or a transformer, three to ten minutes; with a static machine, five to twelve minutes. The best procedure is to begin the treatment with the exposures not exceeding five minutes' duration, and if, after the end of two weeks' treatment, no symptoms develop, the length of exposure may be gradually increased up to twelve minutes, the maximum exposure recommended, except in some very rare cases.

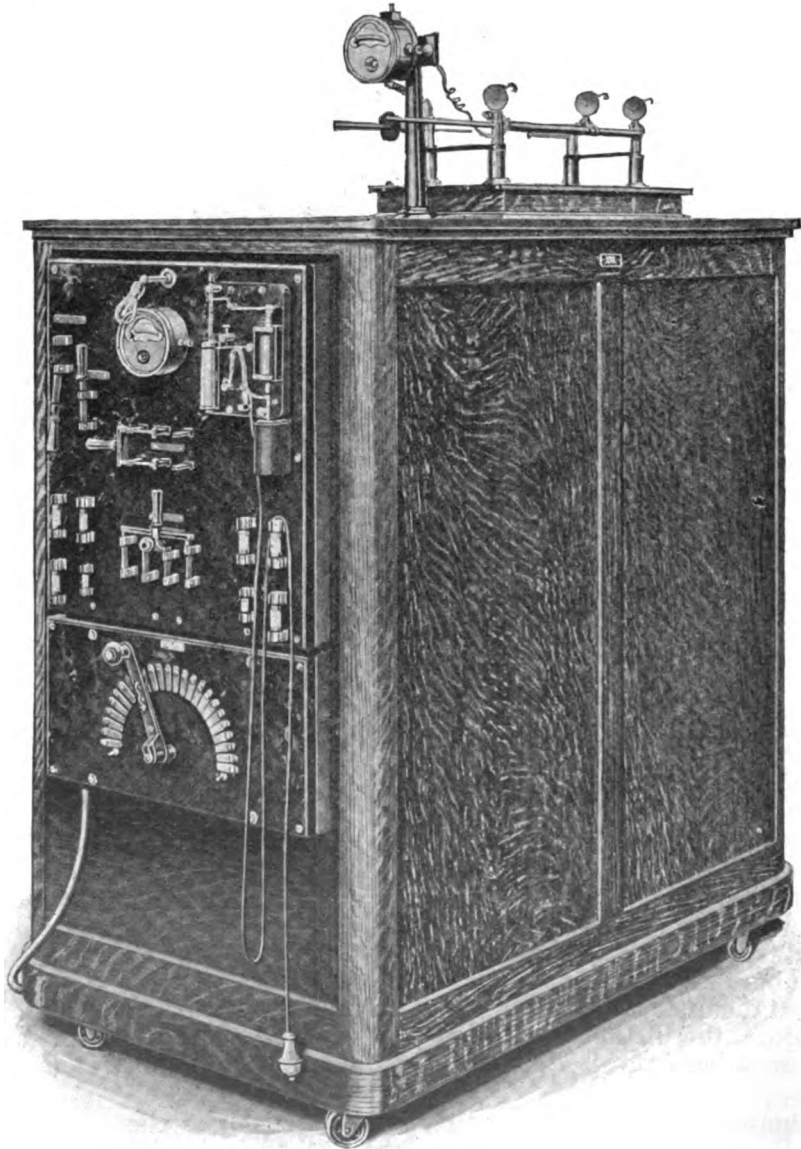


Fig. 74—Large Interrupterless Transformer.

Frequency of treatment.—It is safer to use low voltage and repeat the treatment several times, than to use more powerful exposures less frequently. With the usual low voltage, treatments may be given daily for one or two weeks, then every other day, without danger of producing any marked degree of dermatitis.

If the rays produce any local inflammation, second treatment should not be administered to the same area until the reaction has subsided.

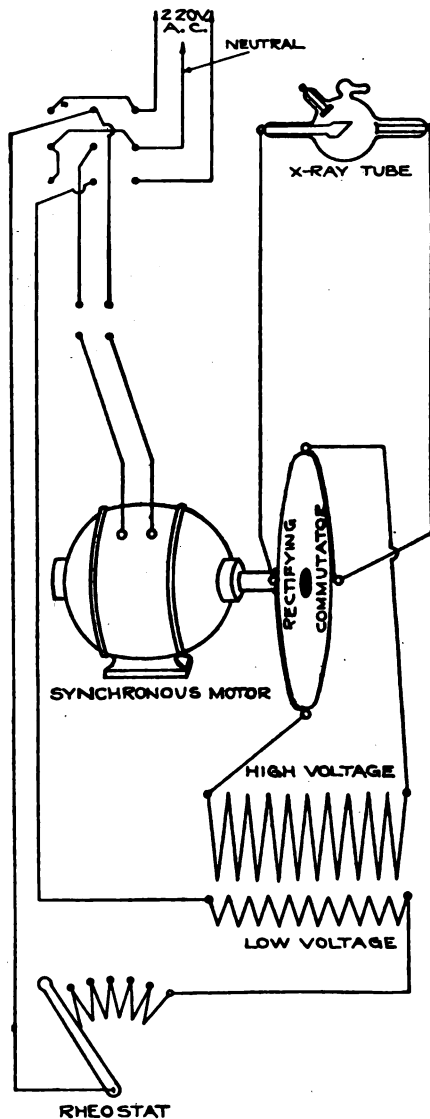


Fig. 75—Diagram showing the commutation of the high tension alternating current into a direct current, as it occurs in the interrupterless transformer.

Filtration.—In order to obtain results in the treatment of malignant diseases, fibroid tumors, and other deep-seated conditions, it is necessary to employ large doses of the penetrating rays. Owing to the danger of dermatitis, this cannot be accomplished with mixed radiations, and it becomes necessary to filter the soft or less penetrating rays of greater wave length, which produce a destructive action upon the superficial tissue, and to allow only the more penetrating rays to reach the tissue.



Fig. 76—Small Interrupterless Transformer.

Pfahler uses sole leather filter, and to this he adds aluminum from one to three millimeters in thickness. This is about the standard, as it is at present used. The absorption power of one millimeter of pure aluminum is shown to be equal to that of a layer of water or soft tissue of approximately one centimeter in thickness.

After-treatment.—If the treatment has been given to a deep-seated organ, or if the skin is unbroken, no dressing is required, but if an ulcerated area has been treated, a good dressing must be applied.

In order to prevent spreading of infection, the protective covering, or any other appliance which comes in contact with the patient, must be thoroughly sterilized before further use.

Dangers of the X-rays

The Roentgen, or X-rays, if administered in excess, produce at first dermatitis, which, if the treatment is continued, may pass on to ulceration, and sometimes the ulcerations may develop the so-called X-ray

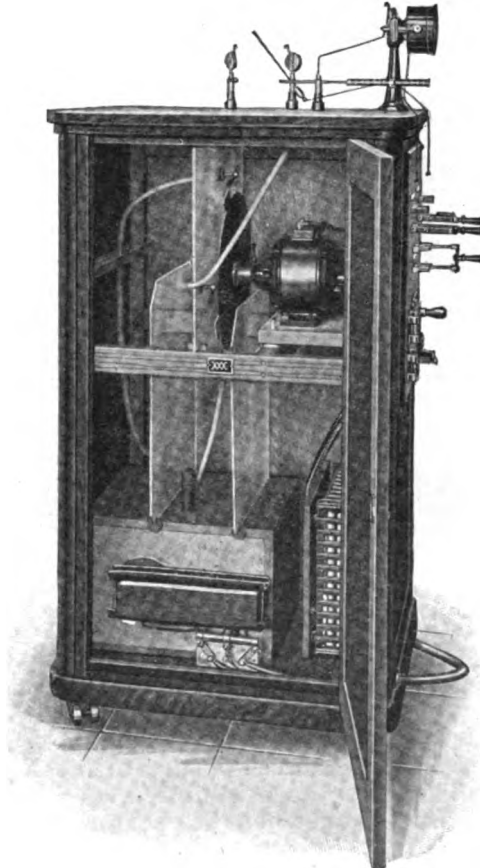


Fig. 77—Rear view of Fig. 76.

cancer, when surgical assistance is required. This may occur in either patient or operator.

The symptoms of over-exposure to the X-rays are: itching, burning, redness, swelling, pigmentation, loosening of the hair, etc. If these appear, the treatment must be immediately discontinued, unless it is desired to produce dermatitis.

These symptoms may appear at the time of exposure, or from a few hours to several weeks after exposure. In most cases, however, the symptoms appear in from three to fifteen days after exposure.

The inflammatory effects produced by the X-rays upon the tissues are divided into four classes:

First: Dry dermatitis, which, if properly produced, is harmless if the part affected is not irritated with the application of strong chemicals (especially carbolic acid, which of itself may cause gangrene), and if let alone will subside of itself;

Second: Dermatitis with the formation of vesicles and blebs, but without deeper involvement;

Third: Destruction of epidermis;

Fourth: Destruction not only involving the entire epidermis, but the corium as well, and also the underlying tissue to a great extent.

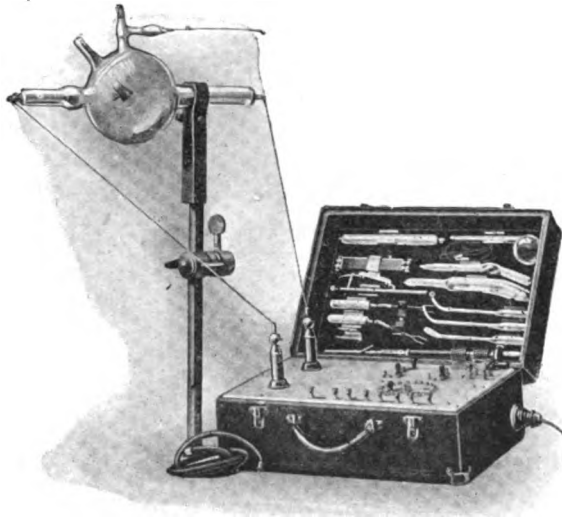


Fig. 78—Portable X-ray and Electrotherapeutical outfit.

Prevention of Burns and Other Conditions Arising from the X-rays

All the conditions arising from exposure to the X-rays in which the processes of metabolism have been inhibited, as when there is sterility, lowered vitality of tissues, or when the secretions or other functions have been suspended, may be relieved by the application of radiant light and heat from either an incandescent or arc light.

It is safe to say that there are few cases, indeed, who are exposed to the X-ray to the extent of producing marked dermatitis, that could not be controlled by the application of radiant light and heat with requisite energy. This is due to the fact that the stimulating effect of radiant energy from luminous sources neutralizes (corrects) the inhibitory effect of the X-rays.

Employing the high frequency vacuum tube (but not strong sparks) to the point of producing some reddening of the skin in conjunction with the X-rays, we are able to use a larger dose of the X-rays without the corresponding degree of danger.

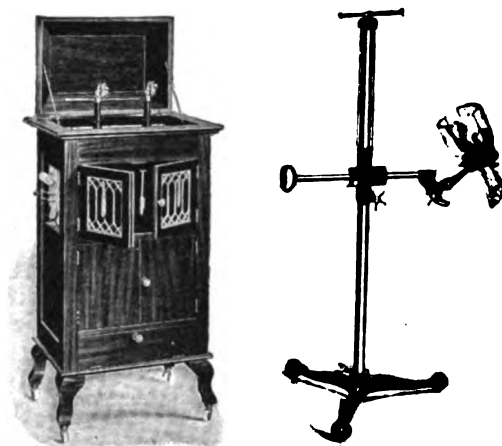


Fig. 79—Dental X-ray and High Frequency Generator.

Idiosyncrasy to the X-ray Burns

Most of the authorities agree that the tissues of different individuals react to the influence of the X-rays in different ways, certain individuals developing a decided reaction after the first treatment, whereas others resisting the action of these rays, so that we are able to develop reaction only after from one to two months of daily treatments. In order to exercise extreme caution, Dr. W. Franklin Coleman gives three preliminary exposures of five minutes each, with the tube at a distance of six inches, on three successive days, and then waits three weeks to see if any reaction appears.

General Remarks

"Cross-Fire" Method.—In the treatment of deep-seated conditions, especially in cancer of the uterus and fibroids, "Cross-Fire" method should be employed. This is accomplished by passing the rays through a num-

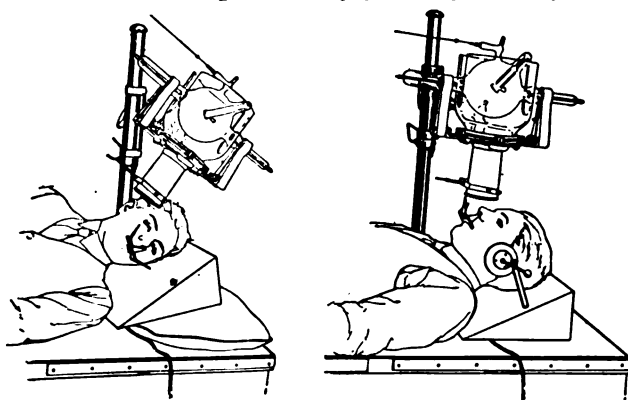


Fig. 80—Views showing how Dental Indicator is attached to Tube Stand, and how same is used in connection with Dental Film Tunnel.

ber of different small squares of exposure, all more or less concentrated upon the center of the tumor, so that the tumor itself will receive a great number of maximum doses (through the different square surfaces), and the superficial tissue will not be affected (because each square surface will receive only one maximum dose).

The different rays (soft, medium and hard) produce different biological effects, and for that reason many superficial lesions, which do not yield to treatment with rays of lower or medium penetration, disappear when rays of lower or higher penetration are employed.

The X-rays injure the protoplasm, or more frequently, the nuclei of the cells. This injury, however, differs quantitatively in accordance with the amount and character of the rays absorbed by the cells, and the specific susceptibility of the cells to the action of the rays. When only slightly injured, cells may completely recover, while if the injury is severe, the cell dies.

All the tissues of the organism may be killed by a sufficiently large quantity of rays.

"Any ray for deep penetration, or beyond eight or ten centimeters below the surface, is worth nothing for therapeutic effect, unless backed by a parallel spark-gap of at least eight inches."

CHAPTER XVI

RADIUM-THERAPY

RADIUM, a metallic radio-active element, discovered in 1896 by Madame Curie of Paris, is obtained in small quantities from certain Bohemian mines, where it occurs in the pitch-blende.

In addition to heat and light rays, radium gives off constantly and spontaneously *alpha*, *beta* and *gamma* radiations. The *gamma* rays, which are able to pass through many substances opaque to light, are similar to the X-rays, and when administered for a considerable length of time, produce an intensely inhibitory action. The *beta* rays have less penetrating power than *gamma* rays, and are similar to the cathode rays. The *alpha* rays possess very slight penetrating power.

Radium therapy embraces the consideration of both radium radiation and radium emanation.

The *alpha*, *beta* and *gamma* radiations exercise remarkable curative effects when used in the treatment of certain morbid processes of the gangrenous, inflammatory and cancerous orders.

The action of these radiations on the tissues is similar to the action of the X-rays, and varies according to the dosage and filtration, from a mere modification of the cells without ulceration to a destructive effect.

Although by no means a specific for the treatment of cancer, sarcoma, and other malignant and benign growths, as is erroneously claimed, radium acts better than anything else we have at present in a large number of such cases; and the more superficial the disease, the more hopeful the outlook.

In too advanced and inoperable, malignant cases, it alleviates pain, lessens hemorrhage, discharge and feter, and in many instances heals an ulcerated surface.

In the treatment of rodent ulcer, lupus, parotid tumors, cancer of the rectum and cervix uteri, affections of the ear, nose, mouth or other mucous surfaces where it is difficult to reach an ulcerated spot by any other means, it has proved of special value.

In non-malignant conditions, such as naevi, angioma, cicatricial tissue (resulting from burns), eczema, psoriasis, pruritis, tuberculous conditions of the skin, mucous membranes or glands, the results are even more gratifying than in the malignant conditions.

Since the action of radium is similar to the action of the X-rays, radium furnishes possibilities of application where the X-rays are not usable, either because it seems desirable to apply the rays continually for a length of time that could not be attained by X-ray tubes, or if a tumor cannot be reached by the X-rays.

Application

In therapeutics, radium is employed in the form of pure radium bromide, chloride, sulphate, carbonate, or nitrate and radium barium (which is a compound with barium).

In order to avoid alpha radiations, either of these (radium salts) is enclosed in a metal tube (the best for this purpose being platinum), which absorbs the alpha rays and allows only those of the highly penetrative order to gain access to the part under treatment.

Protection of the Patient and Operator

Since the action of radium is similar to the action of X-rays, the surrounding healthy skin should be protected from the action of the rays by a sheet of lead, paper or rubber laid over the part, with an opening cut in it, over which the radium is administered, and the operator should not handle radium with uncovered hands more than is absolutely necessary, otherwise a troublesome radio-dermatitis may be set up.

Dosage

The period of application depends upon the individual case.

The amounts of radium usually employed range from 5 up to 200 or more milligrams. The dosage of radium is usually expressed in *milligramme-hours*, and these are obtained by multiplying the milligrammes of radium employed with the length of the application in hours; for example, 100 milligrammes of radium applied for three hours would represent 300 milligramme-hours.

Method of Treatment

Radium is usually applied by placing the end of the tube (holding radium salt) against the part to be treated, and keeping it in place by means of an adhesive plaster, or a strip of bandage, from thirty minutes to an hour or longer, according to the effect desired, and may be repeated every one, two or three days.

Another method of applying radium is to place two or more tubes at the opposite sides of the tumor, so that the rays bombard the tissues in two or more opposite directions simultaneously. This method of application is called the *cross-fire method*. After the treatment, a dressing is applied. After an application, usually nothing is seen unless an overdose has been administered, in which case, two or three weeks after, the patient may show some reddening and itching of the skin about the seat of application, similar to that seen after an exposure to X-rays.

According to the reaction desired, one may produce further stages of desquamation, vesication, and ulceration.

Asepsis.—In order to prevent spreading of infection from one patient to another, after each treatment it is advisable to disinfect the tube with carbolic acid, or some other antiseptic solution.

Radium Emanation

Radium is continually giving off a gas called its emanation, which can be collected by special apparatus and enclosed in glass tubes or metal cylinders. These tubes and cylinders can then be used exactly as if they contained radium salts, for the emanation has all the effects of radium, but it loses these effects after a few weeks.

The emanation can be inhaled by patients, or it can be absorbed by saline or other liquids, and given by mouth, or by subcutaneous injection.

The great advantage in making use of the emanation is the remarkable fact that the original radium salt suffers no appreciable loss, though constantly giving off this gas.

The radium emanation introduced into the body by inhalation, digestive tract, or injection, leaves the body a few minutes later, together with the air given forth in exhalation, hardly anything of it being left behind. An extremely small percentage only is excreted in the urine. A very small quantity passes into and out of the body through the skin. So far, it has not been possible to perceive any injurious effect whatever produced, even by very large doses.

The blood carries the emanation introduced into the system as far as the cells of the organism, where the emanation and its constant resulting products of decomposition produce their biological effects.

Radium emanation not only increases and accelerates the body ferments (ferment of pancreas, pepsin, autolytic ferment, diastase ferment, etc.), but performs further essential service by converting insoluble waste debris, such as uric acid combinations, into soluble compounds which are easily eliminated from the system in the natural way.

This emanation has been used with success in the treatment of gout and diathesis caused by uric acid; chronic and sub-acute articular rheumatism, muscular rheumatism and all forms of arthritis, neuritis, neuralgia, especially ischiagra; bronchial asthma and catarrhal diseases of the respiratory organs; chronic gynecological conditions; arteriosclerosis; lancinating pains of locomotor ataxia; suppurations, inflammations, hypertension, etc.

Application

Radium emanation for inhalation is obtained from an inhaling apparatus, which usually consists of one or more cylinders with filings of radium or its solution, and a ventilator driven by the electric current, or a rubber bulb for the diffusion of the emanation.

For the reason that the emanation inhaled again leaves the body a few minutes later by exhalation, without being exhausted into its active effect, it is necessary to place the patient in an atmosphere which has a constant percentage of emanation. This is achieved by placing the patient in a small room, the doors and windows of which are kept closed during the treatment, generally lasting about two hours.

Radium is also utilized in the form of water baths, mud baths, compresses, injections, drinking solutions, etc.

Meso-thorium

Meso-thorium, a newly discovered radio-active material, possesses chemical properties very similar to those of radium. It emits alpha, beta and gamma radiations not very different from those of radium, and from the therapeutic point of view, its use should be equally as serviceable as radium itself. On account of its lower cost, meso-thorium bromide has been largely used, of late, in place of radium, for the treatment of skin affections and growths, and for superficial conditions; it is reported to be quite as good, or even better, than radium.

CHAPTER XVII

MECHANICAL VIBRATION

OF all the apparatus of mechano-therapy, the vibrator is the only one which accomplishes something which cannot be accomplished by any other means. No human hand is capable of communicating to the tissues such rapid, steady and prolonged vibrations, and certain kneading and percussion movements, as the vibrator.

A good vibrator consists of a motor rotated by means of an electric current, which can be regulated to produce slow and rapid vibrations, as desired.

There are two types of motor vibrators employed, viz., pedestal (Fig. 81) and hand vibrators. In the first, the motion is conveyed from a motor to the vibrator by means of a flexible shaft (this is the more powerful, and more easy to regulate, but is less convenient). In the second, or portable type, a small motor is placed within the vibrator itself.

Application

Vibration is applied either centripetally or centrifugally.

Centripetal vibration is applied toward the heart, following the course of the large veins particularly (e. g., the course of the median vein on the median line of the anterior surface of the forearm, and the ulnar along the inner side of the forearm, both anteriorly and posteriorly, the basilic on the inner and the cephalic on the outer side of the arms.)

Centrifugal vibration is applied away from the heart in a circular direction.

Centripetal vibration enlarges the vessels, increasing the flow of blood and accelerating the circulation of lymph fluid, thus very thoroughly renovating the parts concerned, flooding away waste matter or debris, relieving the abnormal condition, and permitting the continuance of normal circulation.

Centrifugal vibration lessens the flow of blood and lymph, and produces soothing and derivative effects on organs, e. g., relieves oedema.

Slow, vibratory stroke (frequently interrupted) applied for a short period, is stimulating, while *rapid* and prolonged vibration is inhibitory.

Indications

Mechanical vibration is valuable as a preventative of disease, as well as a treatment of disease. It is indicated in cases where ordinary massage would be of service, especially in the treatment of constipation, gastric dilatation, slow digestion, enteroptosis, hepatic and splenic congestion; catarrh of the nose, throat, larynx and stomach; affections of the heart; gout, rheumatism, lumbago, sciatica, neuralgia, neurasthenia, obesity, insomnia, spinal curvature, locomotor ataxia, deafness, headache, female ailments, muscular atrophy, injuries to nerves, contrac-

tures, etc. It is also employed in the treatment of sprained muscles, distended tendons, fractured bones, etc.

Contra-indications: Mechanical vibration is contra-indicated in aneurism, arterio-sclerosis, acute inflammations, erysipelas, malignant tumors, pathologic changes in the blood vessels, purulent local conditions and tuberculosis.

Spinal Vibration

Vibration applied to the spine thrills every nerve center of the spinal cord, restoring them to normal vibration, and applied to the abdomen stimulates digestion and intestinal activity.

Best vibratory effects are, however, derived reflexly, applying vibration to the various ganglia of the sympathetic nervous system. In this connection, it is essential to remember the following:



Fig. 81—Vibrator
(Pedestal Type)

I. That the sympathetic nervous system is largely inhibitory in action, while the vaso-motor is stimulating;

II. That the stimulation of the sympathetic causes vaso-constriction (contraction of blood vessels), while the stimulation of the vaso-motor causes vaso-dilation (dilatation of blood vessels).

A slow vibratory stroke applied over the posterior nerve roots in the intravertebral spaces between the VII C. and I D. vertebrae, corrects and strengthens the heart's impulses (overcomes an irregular or intermittent heart action); opens the nasal passages and shrinks the congested membranes (therefore indicated in acute sinusitis, acute coryza and hay fever); affects the arterial supply of the thyroid gland (indicated in goitre); lowers the blood pressure, etc.

When vibrating between the VII C. and I D. vertebrae, it is, however, necessary to carefully observe the effects on the heart, for it is possible

to overstimulate the cardia and produce depression. If there are no signs of weakening observed at the pulse, or no noticeable dyspnoea, vibration may be continued up to five minutes. If such a condition should occur, it may be corrected by vibration for a few minutes in the intravertebral spaces from the IX D. to XII D., thereby causing cardiac dilatation. Too long (over two minutes) or too heavy vibration between the VII C. and I D. vertebrae will cause extreme dryness of the nose, throat and mouth. Vibration at the intravertebral spaces between the transverse processes of the VI D. and VII D. vertebrae raises the blood pressure. Slow vibration at the IV L. vertebra contracts the bowels, bladder and uterus.

Vibration may be employed in exciting any other reflex equally as well as concussion.

General Remarks

When treating an organ or a group of muscles with vibration, the application usually lasts about five minutes, and when the whole body is treated, from fifteen to twenty minutes.

General vibratory treatment is, however, very rarely indicated, but when used should be exceedingly short. The patient should be clad in a loose robe, and all parts except that to be treated should be covered. The order preferred is that used in general massage, viz., (1) Arms; (2) Chest; (3) Legs; (4) Abdomen; (5) Hips; (6) Back; (7) Head; (8) Neck. At the first signs of fatigue shown by the patient, the application should be discontinued.

CHAPTER XVIII

BLOOD PRESSURE

SINCE some forms of electrical treatment reduce, while others increase the blood pressure, in order to apply electricity judiciously, the practitioner must be familiar with the patient's blood pressure.

A complete examination of the blood pressure involves a determination of the systolic, diastolic and pulse pressure, because in many instances high or low systolic pressure are compensated, and in others, what is apparently a normal systolic pressure may prove to be pathological when viewed in its relation to diastolic and pulse pressure.

The information gained by complete blood pressure examinations indicates the proper treatment, the dosage, and the interval of administration.

Systolic or Maximal Pressure (produced by the contraction of the left ventricle) represents the total heart energy, and is the highest blood pressure in the aorta after the contraction of the left ventricle.

Diastolic or Minimal Pressure represents the pressure maintained solely by the elastic recoil of the whole arterial system at the end of diastole. It is the resistance which the systolic pressure must overcome before it can propel the blood over the body.

Pulse Pressure is the excess of pressure over and above that required to overcome the diastolic pressure, and represents the amount of force which actually carries on the circulation.

Normal Blood Pressure

Under normal conditions, the vaso-motor system maintains a reciprocal balance between the systolic and diastolic pressures, while in disease this relation is disturbed. *The normal systolic pressure*, in male adults between 20 and 60, ranges from 120 to 140 mm. Hg. According to Faught, the normal average systolic pressure can be determined for any age by considering the normal systolic pressure of a healthy male adult at the age of 20 to be 120 mm. Hg. Then for any two years of life over twenty, add 1 mm. Hg.

In females, the pressure is about 10 mm. Hg. lower than in males. In children from 73 mm. Hg. at one year to 105 mm. Hg. at twelve years.

The normal diastolic pressure equals approximately two-thirds of the systolic pressure, and ranges from 60 to 105 mm. Hg.

The Normal Pulse Pressure equals approximately one-third of the systolic pressure, and ranges from 25 to 50 mm. Hg.

The normal blood pressure being modified by a number of normal or physiological conditions (position, excitement, digestion, exercise, time of the day, etc.) is therefore subjected to some variations.

Abnormal Blood Pressure

Any sustained systolic pressure below 100 mm., or above 150 mm., should be considered pathological. It should, however, be remembered that as one grows older the systolic pressure increases, because the hardening of the arteries increases (and consequently the diastolic pressure maintained by the elastic recoil decreases); therefore, that a person of over 60 may be comparatively healthy with a systolic pressure slightly over 150 mm. Hg.



Fig. 82—The Auscultation Method with the Mercurial Sphygmomanometer.

A sustained diastolic pressure of 110 mm. or over, and a pulse pressure below 25 mm. or above 50 mm., indicates a diseased condition, or at least approaching disease.

It should be remembered that:

(a) A low systolic pressure (110 mm. Hg. or under), especially if accompanied by a low pulse pressure (below 25 mm. Hg.) suggests tuberculosis;

(b) In nephritis and arteriosclerosis, the diastolic, as well as systolic, pressure is ordinarily increased;

(c) In fevers, usually the diastolic pressure is low, while the systolic pressure is more frequently high;

(d) In disturbance of compensation, systolic and diastolic pressure are both low;

(e) The high pulse pressure may be due to a fall of the diastolic pressure, or to a considerable rise in the systolic pressure with relatively little change in the diastolic;

(f) That there is a very intimate relation between the pulse rate and the diastolic pressure, e. g., in a strong heart the pulse is slow, diastolic pressure is low, and the pulse pressure is high, while in a weak heart the pulse is rapid, diastolic pressure is high, and the pulse pressure is low.

The abnormal blood pressure is classified into *Hypertension* or *High Blood Pressure*, and *Hypotension* or *Low Blood Pressure*.

Hypertension (High Blood Pressure) is usually found in Arteriosclerosis, Angina Pectoris, Aortic Insufficiency, Cerebral Hemorrhage, Cirrhosis of Liver, Eclampsia, Emphysema, Gout, Migraine, Nephritis (chronic), Lead Poisoning, Toxemias, Uremia.

Hypotension (Low Blood Pressure) is usually found in Acute Diseases, Anaemia, Chlorosis, Cardiac Dilatation, Cholera, Delirium (alcoholic), Diabetes, Diarrhea, Exhaustion, Hemorrhage (internal or external), Pulmonary Tuberculosis, Rheumatoid Arthritis, Shock and Collapse.

Sphygmomanometry

Method of Determining Systolic, Diastolic and Pulse Pressure

Systolic, diastolic and pulse pressure is rapidly and accurately obtained by means of an instrument called a *sphygmomanometer*, of which there are two principal types, viz., the mercury, and the diaphragm type.

The action of the mercury sphygmomanometer depends on opposing the pressure of a column of mercury in a U-shaped tube, with the pressure of the blood in an artery, while in the diaphragm type, the pressure of the blood in an artery causes an indirect, internal pressure on sensitive diaphragm chambers, and shows plainly every action of the heart by the hand on the dial.

There are two methods of determining blood pressure by means of a sphygmomanometer, viz., the method of auscultation, and the method of palpation. The auscultation method, originated by Karatkov, of Russia, is, however, the only accurate one by which the practitioner can exactly determine diastolic pressure.

Directions for Examination

Place the patient in a comfortable sitting or reclining position, with the arm on a desk or table, and the forearm semi-flexed and supinated, so as to entirely relax. Place the band (sleeve) containing a flat rubber bag over the bare left arm, over the brachial artery (above the elbow); wrap it around the arm as if it was a bandage, and tuck the last few inches under the preceding fold. Connect the rubber tubes leading from the band, one with the instrument, and the other with the bulb or pump, and examine either by auscultation or by palpation.

Method of Auscultation

Place the stethoscope over the brachial artery just below the line of the band (Figs. 82 and 83). On gradually inflating the band, the first and second sounds of the heart will be plainly heard, and as the pressure is increased, a point is reached where all sounds cease. Gradually release the air pressure until a loud, clear thump becomes audible. At the instant the sound is heard, the point upon the instrument marks the *systolic* pressure.

Having obtained the systolic pressure, continue to listen over the artery and release gradually the air a few millimeters at a time, and you



Fig. 83—The Auscultation Method with Diaphragm Sphygmomanometer.

will hear the thumping sound replaced by a murmur, which in turn is followed by a second thumping sound, becoming louder, then fainter, which finally disappears. At the instant the second thumping sound is the loudest, the point on the instrument marks the *diastolic* pressure.

Method of Palpation

With one hand, locate the patient's pulse at the radial artery (Fig. 84), and with the other, inflate the band until the pulse is obliterated. Gradually release the air pressure until you feel the first pulse beat return. At the instant the pulse reappears, the point on the instrument marks the *systolic* pressure.

Having obtained the systolic pressure, in order to obtain the diastolic, gradually release the air a few millimeters at a time. As the pressure falls, the needle fluctuates in rhythm (oscillates) with the pulse; after a time this movement becomes less, and eventually disappears. At the instant after the greatest fluctuations have occurred, the point on the dial indicates the diastolic pressure.

Cautions

A complete examination of the systolic and diastolic pressure should not last more than two minutes, as prolonged pressure affects the ac-

curacy, and causes disagreeable sensations. During the examination, the patient must not move the arm, forearm or body. In order to determine accurately the progress of the condition, all examinations on the same patient must be taken with the patient in the same position.

Pulse Pressure

Pulse pressure is obtained by subtracting the diastolic or minimal pressure from the systolic or maximal pressure.

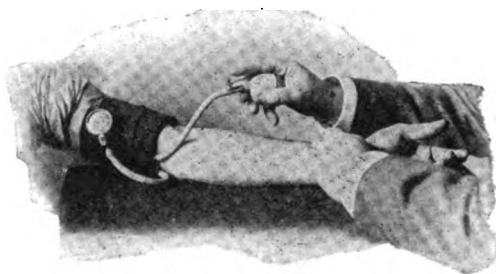


Fig. 84—The Palpation Method with Diaphragm Sphygmomanometer.

By pulse pressure alone, it is possible to determine correctly whether a diseased condition is compensated for or not, and as soon as the practitioners realize this fact, they will also realize that vaso-dilatation is not indicated in every case of hypertension. When there is a normal pulse pressure, with a corresponding diastolic pressure, harm will be done by vaso-dilatation, because vaso-dilatation lowers the systolic pressure, while diastolic pressure (due to the rigid arteries and the increased pulse rate, caused by the dilated heart) may remain high, and as a result, pulse pressure will be very low (so that the systolic pressure will not be sufficient to carry on the circulation).

APPENDIX

IN FOUR SECTIONS

SECTION I

Electrocardiography

Roentgenocardiography

High Frequency Desiccation

Electrocardiography

ELECTROCARDIOGRAPH is an instrument which records graphically the electrical changes of the heart muscle during its activity.

Electrocardiograms are precise and permanent records of cardiac phenomena produced by the electrocardiograph. From these valuable records which are as characteristic as photographs or fingerprints (no two persons' hearts beating alike), we can form certain conclusions in regard to the nervous control of the heart, the rapidity of impulse formation, the rhythmicity of their discharge, the conductivity of the cardiac structures and perhaps of their contractility, thereby frequently determine the site of certain cardiac lesions; form a definite opinion in regard to the prognostic importance of certain heart abnormalities; establish the action of various remedies, etc.

Apparatus

Electrocardiograph is one of the most complex and delicate of modern clinical instruments. It is a modified Einthoven galvanometer, consisting of the following parts:

- 1) a powerful electro-magnet, excited by a continuous direct current, such as the current produced by a storage battery of five to six amperes, furnishing about ten volts;
- 2) a delicate filament (string) of platinum or of silvered quartz (having a diameter of from two to four microns and a resistance of about 5000 ohms) stretched between the poles of the electro-magnet;
- 3) condensing lenses and projecting microscopes;
- 4) an arc light (behind the filament); and
- 5) a photographic apparatus consisting of a film (placed opposite to the arc light which is moved at a definite and uniform speed, by an electric motor, with convenient devices for numbering, exposing, cutting off, and removing the films according to the length desired.

When there is no current passing through the filament of the galvanometer, the filament (string) is at rest. When, however, the electric current passes through the delicate filament at right angles to the magnetic lines of force produced by the electro-magnet, the filament is slightly displaced to one side or the other according to the direction in which the current passes. (This is the Ampere's Law.)

Since it is known that every contraction of the heart is accompanied by certain definite changes in the electrical potential* it is evident that this slight addition of current (generated by the heart) to the circuit of such a sensitive instrument as Einthoven galvanometer will cause a deflection of the filament. This deflection in turn displaces the small diaphragm, forming a small opening or slit (running at right angles to the filament) through which the light (from the arc) is focused on a photographic film on which these deflections are printed as waves varying in height and length.

* The heart of the average individual causes a deflection which indicates the passage of a current of approximately one to two one-thousandths of a volt.

For the reason that the real amplitude of the deflection of the filament between the field magnets is exceedingly small, the shadow of the filament is magnified by the passage of light (before it reaches the film), through the projecting microscopes.

Method of Examination

a) Connect the sensitive galvanometer with the patient (enclose the patient in the circuit) by means of flexible electrodes (made of german silver, covered with felt), bandaged to the right arm, the left arm and the left leg, or by immersing the extremities in metal vessels containing a solution of sodium chloride;

b) Estimate the resistance in each of the three leads;

c) Standardize the galvanometer by adjusting the tension (sensitiveness) of the filament (by means of a micrometer screw), so that a current of one-thousandth of a volt will deflect the shadow on the film one centimeter in both directions. Since the shadow on the film is deflected, a definite amount for a known voltage (one centimeter for each one-thousandth of a volt), it is easy to ascertain the amount of current that caused the shadow;

d) Neutralize the "skin current" which causes a deflection of the filament when the electrodes are attached to the patient. This "skin current", which is probably due to the glandular activity of the body, if not compensated may obscure the delicate differences of electrical potential caused by the action of the heart. This can be accomplished by introducing into the circuit of the galvanometer in the opposite direction, by means of a rheostat, a sufficient portion of the current from a single dry cell to exactly counter-balance the "skin current."

e) Record the deflection of the filament of the galvanometer (caused by the current generated by the heart) upon a photographic film;

f) Develop the film and print the record.

As the character of the electrocardiographic shadow varies with the parts of the body from which it is derived, it is customary to take three records from each patient, designated as follows:

Lead I current from R. A. and L. A.
Lead II current from R. A. and L. L.
Lead III current from L. A. and L. L.*

General Remarks

Since the contraction of any muscle generates an electric current during examination the patient should be warm, relaxed, and perfectly quiet. Muscular contractions, shivering, coughing, sneezing, talking, etc., will cause irregular movements of the filament and mark it on the film. For the same reason patients suffering with paralysis agitans, exophthalmic goitre or any other disease associated with involuntary muscular movements are not suitable for electrocardiographic examination.

The position of the heart in the chest is also of the greatest importance. A preponderance of heart muscle to the right would reverse an electrocardiogram.

The Interpretation of the Electrocardiogram

When the filament of the galvanometer is at rest, that is, when no current is passing through it, the shadow on the electrocardiogram presents a base line. When the filament is deflected (by the passage of the current through it), these deflections are shown as waves of different height and length. Einthoven interpreted the principal features of the normal electrocardiogram (shown in Fig. 85) as follows:

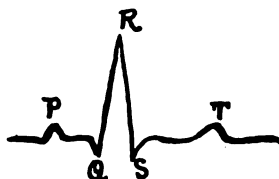


Fig. 85—Scheme of the normal electrocardiogram.

*R. A. signifies right arm; L. A. left arm; and L. L. left leg.

P represents the systole of the auricles;

QRST represents the systole of the ventricles;

The distance between the waves *P* to *R* represents the time occupied in the conduction of the impulse from the auricle to the ventricle (0.12 to 0.17 of a second);

Q which may be absent in the electrocardiogram of the healthy subject, represents the first evidence of the ventricular contraction;

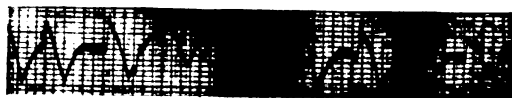
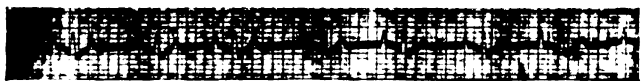
R which is the most constant and the best understood wave of the electrocardiogram, represents the contraction of the basal portion of the ventricle;

S which may be absent in the electrocardiogram of the healthy subject, represents the contraction of the apical portion of the ventricle;

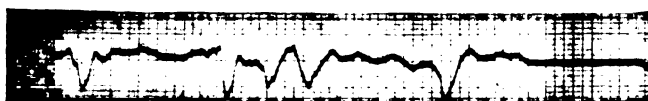
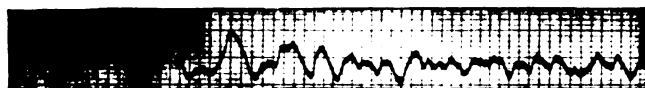
T which is always present, represents the final ventricular contraction, probably the basal portion near the exit of the great arteries;

T to the following *P* represents the diastolic period.

Electrocardiograms



From "The Electrical Experimenter"

Electrocardiograms

Figs. 86 to 98—The Foregoing Electrocardiograms Represent the Most Remarkable Scientific Analysis of Just What Happens in a Person's Heart Shortly Before and at the Exact Period When Life Ceases to Exist, or Death. By Inspecting These Charts of the Heart's Variations During the Last Moments of the (Female) Patient, a Victim of Broncho-Pneumonia, One Can See How the Heart Started to Fluctuate Progressively, Finally Stopping Action at the Right End. (Fig. 98)

From "The Electrical Experimenter"

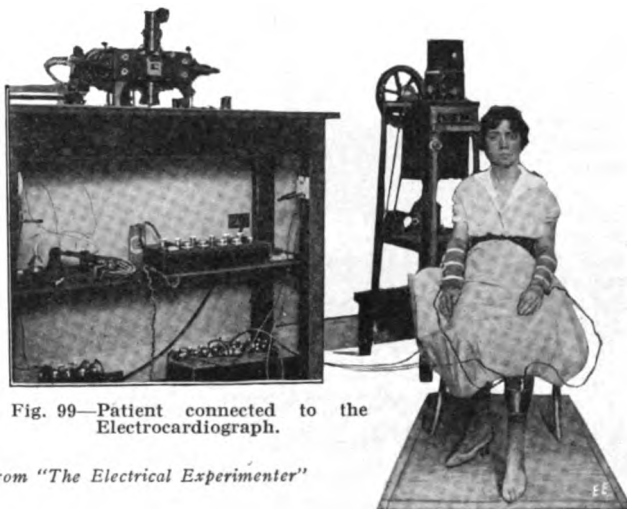


Fig. 99—Patient connected to the Electrocardiograph.

From "The Electrical Experimenter"

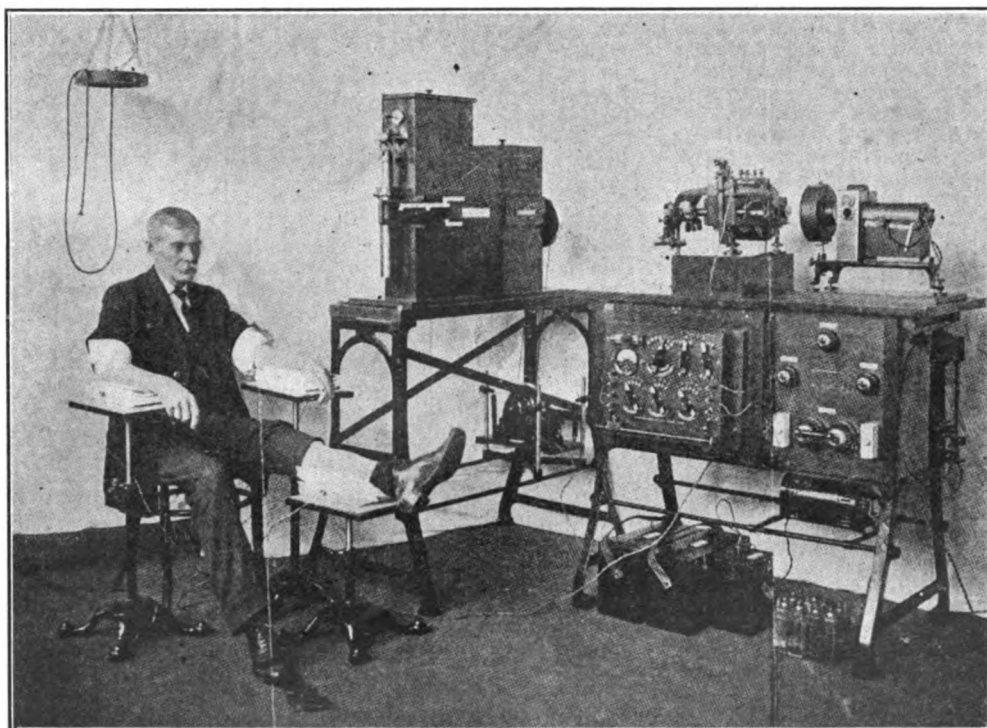


Fig. 100—Cambridge Electro Cardiographic Apparatus in Position for Operation.

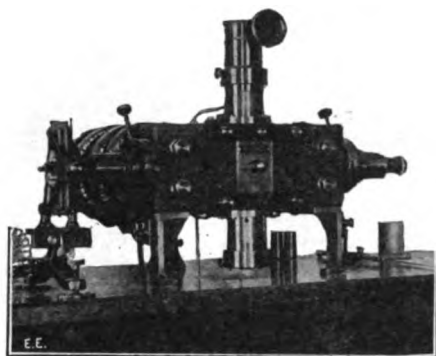


Fig. 101—Close View of the Einthoven String Galvanometer Used in Actually Measuring and Analyzing the Infinitesimal Electrical Currents Produced by the Human Heart at Every Beat.

From "The Electrical Experimenter"

Roentgenocardiography

ROENTGENOCARDIOGRAPHY is the recording (tracing) of the cardiac pulsations (heart beats) by the Roentgen, or X-rays.

Roentgenocardiograph is an apparatus capable of producing a separate and permanent record of the cardiac pulsations of each chamber of the heart. These records, called *roentgenocardiograms*, are similar to electrocardiograms, and although recording different data than electrocardiograms enable us to come to the same conclusions in regard to cardiac irregularities and recognize auricular fibrillations, heart block or auricular flutter, etc.

Roentgenocardiograms are obtained by covering the heart with strips of sheet lead arranged in such a way that a narrow opening (slit) in the lead (about two centimeters wide) can be adjusted over the pulsating margin of the cardiac silhouette as viewed through the fluoroscopic screen.

Several of these openings (slits) can be adjusted at the same time over different areas of the heart, the aorta and the pulmonary vein.

Apparatus

The additional appliances necessary for the average Roentgen-ray equipment in order to be able to obtain roentgenocardiograms is very simple, viz; a) a lead lined cardiographic table, having in the center a square opening of about 8 inches; b) a cassette containing photographic films, operated over the opening in the table by a motor or a clockwork; and c) a Coolidge tube.

Method of Examination

1) By means of a fluoroscopic examination, cover the heart with strips of sheet lead, so that the opening in the lead will be over the pulsating area of which you desire to obtain the roentgenocardiogram. For this (fluoroscopic) examination, adjust the tube for 7 or 8-inch spark gap and two or three milliamperes and in order to be able to observe for a longer period without danger of erythema, filter the rays through an aluminum filter of three millimeters;

2) Place the patient in a recumbent or standing position, under or behind the lead lined cardiographic table so that the opening with the cassette containing the photographic film will be over (but not in contact with) the heart area;

3) Set the Coolidge tube (adjusted for a 5-inch spark gap and 33 milliamperes) behind or under the patient, at a distance of about 24 inches from the film;

4) Run the cassette over the opening at an average speed of 5 centimeters to the second and excite the tube and you will produce a tracing of the cardiac pulsations or a roentgenocardiogram.

Disadvantages of the Roentgenocardiograph

Dr. A. W. Crane, an exponent or rather the originator of roentgenocardiography cites the following disadvantages of the roentgenocardiograph:

"1) Very large, heavy patients offer resistance to the passage of Roentgen rays. This is overcome by using wider slits, a slower movement of the carriage and a ray of higher penetration.

2) Some patients with cardiac disease cannot lie in the horizontal position. This difficulty can be overcome by the sitting position, in which case the patient is placed with the back against the lead screen of the cardiograph and with the tube in front. Each slit must then be adjusted over an interspace between ribs, and especial pains must be taken to immobilize the patient.

3) Patients with advanced tuberculosis, pneumonia or pleuritic or pericardial effusions are not suitable for Roentgen tracings, because the outline of the heart is obscured or actually concealed. Dense deposits of the hilum of the lung running downward along the heart border usually are an advantage rather than otherwise, because there is a narrow clear space between the heart and the deposits which improves the tracing."

High Frequency Desiccation

HIGH frequency desiccation is a method of destroying benign growths, such as vascular nevi, acne, pigmentations, X-ray keratosis, chronic varicose ulcers, angiomas, warts, moles and other superficial neoplasms by rapidly desiccating (dehydrating) the tissue. This method, described by Clark of Philadelphia in 1911, which sterilizes and desiccates the tissue without burning and without opening blood or lymph channels, differ from high frequency fulguration (which devitalizes by drying the tissue), and from high frequency cauterization (which shocks and produces hyperaemia without destructing the tissue) in heating the tissue to a point somewhere between a simple hyperaemia and burning. In order to determine this point, Clark projects the sparks through paper upon a piece of soap. When the soap is dehydrated sufficiently to be readily pulverized between the fingers without discoloring the paper, the current is of proper strength to desiccate the tissue without burning.

Apparatus

High frequency desiccation cannot be performed with a current from a coil, which on account of the interruptions in the primary, delivers the current in a series of hot discharges which render the thermic degree inconstant.

In order to produce a steady flow of current it is necessary to employ a static machine of about twelve plates, capable of 2000 revolutions a minute, producing from 2.5 to 3.5 milliamperes, and pass the current thus obtained to the transformer composed of Leyden jars (each having a capacity of 0.00042 microfarads), and a resonator. The electrode by means of which the tissue is desiccated consists of a fine metal point (about the size of a needle), having an insulating handle and a mechanical interrupter.

Method of Operation

The desiccation spark penetrates into the tissue from a small fraction of an inch or more, depending upon the frequency, distance of the electrode from the body, length of the application and density of the tissue.

When treating superficial lesions the electrode is connected to one pole of the apparatus while the other pole is earthed. This electrode, however, must not come in contact with the tissue but should be held at a short distance from the part so that the sparks of great frequency will strike upon the lesion through an air space. When deeper destruction is necessary, no pole is earthed, but a large, indifferent electrode, connected to one pole, is placed somewhere on the body and a metal point electrode is brought in contact with the tissue.

The operation is not very painful because a few short sparks usually destroy a certain amount of sensation, but if the part is very sensitive or when treating nervous patients a local anesthetic by means of ionization with cocaine hydrochloride may be employed.

If the lesion is dry, as in the case of a wart, immediately there follows blanching of the tissue, while if the lesion is open with oozing, blood blackening occurs. Soon after dry crust forms which acts as a natural dressing. In from three days to two or three weeks (the time depending upon the extent of destruction), when the repair is completed, the crust falls, leaving a scarcely noticeable scar, unless the desiccation has been carried too far.

SECTION II

*Reflex Diagnosis**The Why and The How of the High Frequency Currents as a Therapeutic Agent**Some Uses of Light in the Treatment of Disease**The Therapy of Light and the New "R-Ray"**Scientific Medicine**Reflex Diagnosis ***The Interpretation of Symptoms*

MORE than fifty per cent of all the symptoms that a patient complains of are reflex in character. That is to say, one certain organ may be at fault, its own physiological functions may be interfered with or even perverted. That particular organ, however, does not show any symptoms; yet, some other organ may be depending for the proper performance of its own function on the diseased one. As a result, the second or sound organ shows all the symptoms of an interfered-with physiology. During the early months of pregnancy, a patient may suffer from uncontrollable vomiting. The trouble *per se* is not with the stomach, yet there is where the symptoms point to. The vomiting is a reflex symptom. A little fellow is suffering from convulsions, a concretion under the prepuce, pin worms in the rectum or acute indigestion may be the cause. The convulsions are reflex.

Urticaria, eczema, acne, furunculosis, boils even edema when localized, may be of reflex origin.

Nearly all of the neuroses including neurasthenia, hysteria and hypochondriasis, are reflex manifestations. It is therefore of no use to treat the reflex symptoms, it is the cause that must be found and made inoperative if possible.

Spinal Reflexes

The great sympathetic system, by its white and gray rami communicantes, is in direct anatomical connection with the entire cerebro-spinal system. Congestion or anemia of any part of the body is under the direct control of the sympathetic system. Whenever any part of the internal organs is out of balance, it is either in a state of hyperemia or anemia. This condition of an organ can be reflected upon the skin.

One of the first symptoms of an impending appendicitis is a certain tension of the overlying abdominal muscle. Of course, any other pathologic process within that particular area would cause the same muscular rigidity. I am simply trying to show that an internal condition may be reflected to the overlying tissue. A similar condition occurs in the spinal muscles, but, owing to the fact that the spinal muscles rest against a solid structure, it is more difficult of appreciation by the sense of touch.

In a similar manner conditions of the skin may be reflected to internal organs. Burns of the third degree, when more than two-thirds of the skin area is affected, usually cause death, especially in children, by perforation of the duodenum or other portion of the intestine.

* Extract from an article by Dr. A. C. Geyser, published in the Medical Adviser—April, 1917.

Therapeutically we take advantage of these facts. We cause hyperemia or anæmia to reflexly affect our internal structures.

If we avail ourselves of the use of rapidly-interrupted electric current, we are able to bring out upon the spine certain reactions. These reactions are either red spots meaning a hyperemic condition within, or white spots meaning an anemic condition of some internal organ. The red spots are more easily detected because they stand out in bold relief upon an otherwise white background. Not only that, they denote some active process going on inside. The white areas indicate some lesion in a quiescent state.

Instruments and Technic

A suitable faradic coil may be operated from dry cells or by means of the usual commercial current. The vibrator must be capable of being tuned up to high "C", about 5,000 vibrations per second. A galvanic current interrupted the same number of times per second would answer a similar purpose, but such a rate is difficult to attain for the galvanic current while it is very simple for the faradic type.

A coil operated by dry cells would have the advantage of being portable. A bedside examination would be of material value.

One pole is attached to a six by six inch square pad, the other, or examining pole, is the usual hand sponge electrode. When both have been properly moistened, the larger pad electrode is placed over the solar plexus. The patient's back is bared and the hand electrode is passed five or six times up and down the entire length of the spinal column with moderately firm pressure. The current must be just strong enough to feel agreeable to the patient. If now the reflex response has taken place, one or more red spots will be apparent along the spine of the patient. These spots are about the size of a fifty-cent piece, they tend to increase in redness and remain for several minutes. By consulting any book on physiology or diagnosis we will learn the particular organ supplied by the nerve leaving the spinal column at the indicated red spots. These spots are almost pathognomonic. By this method it is possible to discover where an active lesion is located; we do not learn what that lesion is, but simply where it is.

By investigating the particular area or organ indicated and by a process of exclusion we are enabled to arrive at the correct diagnosis.

*The Why and the How of the High Frequency Current as a Therapeutic Agent **

Nothing must "just happen in Nature"; there is always some underlying principle for everything, even in the practise of medicine.

The Underlying Principle of Recovery

WHEN we have arrayed before us all the various therapeutic measures, they are legion. If one single measure could accomplish one-half of what is claimed for it, there would be no more disease, every germ would be annihilated and the millennium would be at hand. So far, there is no system, no pathy, no rule by which disease can be cured.

While each therapeutic measure seems to differ from the other, yet they all have one thing in common: they are all intended to alleviate or cure disease.

If we bear in mind that there is only one way in which disease can be cured, it behooves us to investigate that one way. Before we do that, however, we must first have a clear comprehension of what disease really is. The word almost explains itself. "Dis," meaning a negation, "ease," a certain state of well-being, a state of rest. Dis-ease, the opposite or a state of unrest, a condition of the body marked by inharmonious action of one or more of the various organs due to an abnormal condition or structural change.

As long as a being is perfectly normal, that being is not aware of the fact that he is the possessor of any organs at all. The very moment that an individual

* Extract from a paper by Dr. A. C. Geyser, read at the scientific meeting of the Essex County Medical Society, Oct. 17th, 1911. (Published in the Journal of the Medical Society of New Jersey, 1911.)

becomes aware of the fact that he has a stomach, that moment he has some disease; when he suddenly discovers that he has a liver, that moment he has some dis-ease, not necessarily of the particular organ of which he may complain, but he has a dis-ease. He is not at ease with himself, there is some in-harmonious action of one or more of his organs.

Pathology is that branch of medical science which deals with the various changes that take place under abnormal conditions in the body. The time from 1845 to 1895 are the most memorable years in the history of pathology. Virchow, dissatisfied with the various systems, brought to light his cell doctrine and cellular pathology. According to Virchow, all disease is directly traceable to the individual cells of which the body is composed. Each normal cell springs from a normal parent cell, each cell depends upon its neighboring cell for equilibrium and harmony of action; disturb or change one cell and all the cells in the immediate neighborhood must feel the effect; this effect we term disease.

Frequently, pathology is looked upon as possessing no other function than to furnish a long list of names descriptive of the various morbid states of any particular organ or region. This is much to be deprecated, for the doctor soon gets into the habit of treating the name of the disease process rather than the actual pathological changes which have taken place. In fact, he seems to forget that each patient presents some *definite underlying reason why* he has not recovered from his ailment or *why* he was taken sick at all. Two patients exposed to the same injury seldom suffer exactly the same consequence. In other words, the reaction of living cells to an agent varies in different individuals. As this resistance to disease differs in different individuals, so does the recuperative power differ.

In nature, there is only *one* way in which this recuperative power manifests itself; it may vary in degree, it may vary as to time, but the process is essentially one of *inflammation*. In fact, the word *pathology* might be used to mean the reaction of the individual cells to some injury with an attempt on their part to a recovery or re-establishment of the previously disturbed harmony between the various parts.

Inflammation, then, is the reaction of living cells to an agent desirable or undesirable to the cellular system; this reaction may be either local, general or both, when both it is constitutional in character and known as fever. This reaction of the cells is accomplished by certain manifestations not previously or ordinarily present. It is something that emanates from *within* or from the injured cells assisted by the uninjured ones; it is, therefore, a process and not a state. This process of inflammation is a *succession* of changes which occur as the result of reactions in living tissue, when it is injured or subjected to treatment; provided that the injury is not of such a degree as at once to destroy its structure or vitality. In other words it is a reaction of irritated, stimulated or damaged tissue which still retains its vitality.

This definition is very important, for as we shall see later, when a tissue is incapable of reacting to irritants, either that cell or tissue becomes a foreign body and must be discharged from the economy or it may undergo certain changes and modifications such as fatty degeneration or fibrous accumulations. These changes are for the purpose of making the otherwise foreign substance as innocuous as possible under the circumstances.

The manifestations which accompany this reaction are:

REDNESS—This is clearly due to the dilatation of the blood vessels.

SWELLING—When a part is injured either chemically, mechanically or by the introduction of noxious germs, there is a separation of contiguous cells, into which takes place an exudation of fluids, cells and corpuscles, hence the swelling.

HEAT—Wherever there is increased energy there is increased circulation with the result of increased heat.

PAIN—This is the result of an irritation to the sensory nerves and the pressure exerted by the swelling.

Disturbance of function is the necessary result of loss of equilibrium between the various component parts. All these cardinal points are the result of a chemotaxis. At this time we are obliged to take the sympathetic nervous system into consideration. By some inherent power not yet fully appreciated the fixed as well as the wandering cells are attracted to the injured part. This chemotactic process is evidently of an electrical nature for we have a positive and a

negative chemotaxis; under certain circumstances some cells are attracted while others are repulsed.

In a vascular area the first manifestation is the *dilatation* of the arteries, later the veins. If this dilatation is just of the proper kind and amount, then the repair is at once begun, but if the injury is too severe or the germs too virulent, then there is either delay or no reaction at all. Again, the reaction may take place and later the cells become overwhelmed with the result that there is slowing of the blood stream in the dilated vessels leading to congestion and finally a stasis. During such stasis the process of inflammation is hindered and the further repair is made impossible. Not only is the process of repair interfered with, but, as the wandering cells must either act as scavengers or themselves break down, and ulcer or sloughing surface forms.

There are some diseases incapable of causing a proper or sufficient reaction and the process of inflammation is incomplete. Gonorrhea is an example of the acute variety, while tuberculosis and leprosy represent the chronic ailments. In these cases the toxic elements of the microbes and the antagonistic powers of the cells are nearly balanced. In gonorrhea, the germs are found in a perfectly normal state within the cell body of the leucocytes, the leucocytes do not seem to be able to destroy them; on the contrary, many leucocytes must be discharged from the body after they have become germ-laden. In tuberculosis it frequently happens that proliferation of the germs takes place despite their intra-cellular position. It may be said that the more virulent the microbe the less the tendency for the leucocytes, and for the other fixed cells to take up bacteria, the less virulent the microbe the more extensive the phagocytosis.

Repair of injury or recovery from disease of any kind depends then upon the proper kind of reaction by living cells to the injury produced, the germ present or the toxic element within the system. This reaction, be it large or small, local or general, sufficient or insufficient, is summed up in the one word of *inflammation*.

The Underlying Principle of all Treatment

The very fact that we are about to institute treatment of any kind presupposes a *deviation* of an otherwise normal condition. When a tissue or organ is irritated, either accidentally or by design, there ensues on the part of the living cells a reaction; this reaction on the part of the cells is always an attempt to repair the injury which has resulted from the irritation. In other words, it is Nature's method of recovery and cure of disease.

So far, with all the ingenuity of the human mind, no process, has been discovered that can even favorably compare with a successful natural recovery. The truth of this assertion being self-evident and admitted, it must be apparent that any manner or method of treatment that we wish to institute must be materially influenced by the particular kind of reaction desired or as Nature would have done had she been successful in this instance.

In times gone by, inflammation was looked upon as being in itself harmful. The fever or inflammation was the principal thing against which the doctor turned loose all his energy; when he successfully lowered the temperature of his patient with the various coal tar derivatives, and the patient lived, it was *prima facie* evidence that at least the treatment was right. This view, of course, is no longer tenable. During the last few years, very extensive changes have invaded the domain of therapeutics and are proving themselves advantageous to the patient and at least scientifically correct.

As has been pointed out, all of the old cardinal symptoms of inflammation are not at all essential and some of them are frequently absent under modern treatment. By the Bier's method, we produce either an active or a passive hyperaemia; by the Mikulicz system we develop the resistance period of the individual; by Wright's method the toxins of a specific microbe raise the opsonic index, by the injection of antitoxins we neutralize an already formed toxin.

In all these scientifically correct methods of treatment have we done anything that Nature has not accomplished under suitable circumstances? There have always been recoveries from disease, and more than that, a future immunity has been more or less perfectly established in the individual.

If there is any one lesson to be learned from this, it is that *the more we are able to assist Nature in her effort, not only the better are the results, but as may happen in a failure, the less is the harm to the patient*. We must remember that every disease is curable, but not every patient.

We are forced to the conclusion that inflammation or fever is a normal and natural reaction to an injury, and the right method is not to lessen or arrest this process, but, on the contrary, to stimulate and augment that process in the *right direction*.

If a patient shows any of the designs of an inflammation we may be sure that something abnormal has occurred in the tissues, something that has caused the tissues to react in that particular manner. When a surgeon makes an incision, it is not his purpose, at least not primarily, to reduce the inflammation, but rather to remove that *something* which has *caused* the inflammation. If an operation is contraindicated the physician secures physiological rest of the entire body so that *all* the systemic energy may be utilized to increase that necessary reaction, and that there might be no waste of energy to reduce the inflammation *per se*, but rather to secure for the patient the fullest benefit of that inflammation.

The whole process of reaction of living tissue to an irritant must of necessity resolve itself into one of three conditions: The reaction is either *adequate*, *inadequate* or *excessive*. Whenever the reaction is adequate, there is nothing for the physician to do, for a complete uneventful recovery will take place. The only duty of the physician lies in guiding the patient past dangerous situations and so preventing complications or interferences from taking place. In other words, the case is left, and wisely so, in the hands of Nature.

It may seem almost paradoxical to say that the great majority of cases of severe inflammation are typical examples not of excessive but of inadequate reaction. The very fact that the disturbance is spreading in extent is in itself an indication that the system is for the time unable to counteract the irritant. The irritant may be excessive but the reaction to it is inadequate.

When the reaction is inadequate the indications for treatment are: First, to remove the cause, if possible; second, to promote but not reduce the inflammatory manifestations; third, to aid the general reaction on the part of the whole organism. Here we have the rationale of the Bier's treatment which seeks—and in properly selected cases with great success—so to promote the hyperæmic exudation and inflammatory reaction in general that the first indication for treatment becomes unnecessary. Wright's method of raising the opsonic index is clearly indicated. For ages, it has been known and practised, that when an inflammation, though locally apparently excessive, failed to discharge the irritant from the body, recourse was had to poulticing and the employment of hot compresses. These means were clearly used for the purpose of increasing the reaction and bringing the inflammation to a head.

The surgeon knows very well that frequently a simple laparotomy in local abdominal tuberculosis has given excellent results when everything else was hopeless. This is another example of inadequate reaction which takes place in local as well as in tuberculosis in general, and the simple addition of the extra energy manifested to heal the abdominal incision is enough to change an inadequate reaction, with the result that the patient recovers.

All the measures so far mentioned have one thing in common, namely: to produce one or more of the manifestations of an inflammation. But this inflammation so produced is not a pathological one, but rather a physiological process, a reaction process. Reaction in excess is the exception and not the rule. In acute cases we note that one factor in the inflammatory process may be unduly exalted as compared with others so that the vitality of the tissues may be imperilled; excessive hyperæmia may pass on to stasis and even necrosis result. There may be excessive deposits of fibrin or other exuberant granulation tissue with the development of keloids. Such a condition is usually traceable and indicates an idiosyncrasy on the part of the tissues of the individual whereby a minimal irritation has initiated a persistent overgrowth.

It must be remembered that physiological structure and function depend upon the equilibrium of all tissues. This is maintained by mutual restraint between its competent cells. The destruction of a single integer or group of integers of a tissue or even a single cell, removes a corresponding amount of restraint at the point injured. So the equilibrium is destroyed which permits of the abnormal exhibition of bioplastic energies on the part of the remaining uninjured components. This abnormal bioplastic activity may be viewed as a compensating hyperplasia. This hyperplasia is not, therefore, the direct result of the external irritation. It cannot be, since the action of the irritant is destructive and is confined to the cells that it destroys. It occurs rather indirectly as a function of the

surrounding uninjured cells that have been excited to this increased bioplastic activity. When such a reaction is excessive, there is always hypercompensation. There is more material generated than is really necessary to compensate for the actual loss. In these cases of excessive hyperæmia, as well as referred or sympathetic inflammation at a distance removed from the injury, the local application of cold would clearly seem to be the proper practice. Of course, the local application of cold is the same thing as the distant application of heat. Headache due to some irritant causing congestion may be treated and relieved as well by the application of cold to the head as the application of heat to the feet. Dilatation of the vessels in one part is always balanced by a corresponding contraction in another.

We know that fibroid tubercles and fibroid adhesions have eventually disappeared, without treatment of any kind, showing that under suitable conditions, Nature can accomplish even this unaided. We have here a clear indication for such means or measures as will bring about an increased local circulation, and so promote absorption. In casting about for a drug agent, we naturally strike upon potassium iodide for its absorptive power when administered internally; vesicants, rubifacients, heat, massage, passive motion and counter-irritants and electricity seem to be indicated as external agents.

This is the usual way the text books, among a job lot of other measures, recommend electricity, but, as we shall see, there is a vast difference between the proper and improper use of electricity.

The Physiological Effects of this Current

We have seen that the natural tendency of all disease is toward recovery and cure. We have also seen what requirements are necessary to bring about this result. It is a law in physics that arrested motion results in heat. The carbon filament in the incandescent globe obeys this law. There is no appreciable chemical change; simply a mechanical friction of the various molecules.

Physical Effects of the High-Frequency Current

When this current is passed through water, we see only the usual effect of arrested motion, resulting in heat. There is no chemical decomposition. The water may become heated and changed into steam, but there is no breaking up of the molecules, such as results from the passage of a galvanic current. When the galvanic current is passed through the same water, there ensues at once a chemical decomposition, the hydrogen accumulating upon the negative pole, while the oxygen is seen at the positive pole. Here we have a true electrolysis or decomposition by electricity.

If we take a solution of boiled starch and add to it a small amount of potassium iodide, neither reaction nor precipitation occurs. When this high frequency current is passed through the mixture there is again the same heating process, but no chemical change is apparent. As soon as the galvanic current is passed through this mixture there is at once the usual chemical change or electrolysis. The free iodine liberated at the positive pole at once combines with the starch to form the blue iodide of starch, at the positive pole. It is also true that this arrested motion or friction which causes this heat might produce other effects in the living tissue not observable in dead inert substances as the carbon filament.

We will pass this *high-frequency current* through the living body and the lamp at the same time; at once the filament takes on incandescence, yet there is no sensation at the point of contact with the body. It must be apparent that the same current that causes the glow in the lamp does actually pass through the body; and at least the effect of arrested motion must have some effect upon that body. We will pass this same current through a raw potato, making simply metallic contact with either end of the potato. The spark gap is opened and the milliampere meter shows a reading of one thousand five hundred milliamperes. The effect upon the potato is again as in the lamp, one of arrested motion, resulting in heat. But here we have a different substance, a compound body and the effect is also equally compound. The heat here developed causes chemical changes. The vitality of the cells has been completely destroyed. This potato, under suitable circumstances prior to the passage of this current would have shown signs of life and reproduced its own kind, while now, after the passage of the current, the potato is dead and almost cooked. It has changed its chemical constituents entirely.

Another effect will be seen upon cutting this potato in half. Exactly through the path of the current, the greatest change has taken place, while at the periphery the change is imperceptible. Next we will pass the current through a piece of raw liver, making the same metallic contact as before. The liver, being still more complex in its cellular construction, nevertheless is bound to obey the same law of physics, that of arrested motion resulting in heat. In addition all the changes seen in the potato are now visible in the liver.

In this instance we made use of three thermometers placed in direct line of travel with the current. Upon inspection we find that the center thermometer or the one farthest removed from the metallic contact registers the higher degree of temperature. This is of direct clinical importance. Upon cutting this piece of liver we find the same heating and cooking process having taken place as in the potato. With the naked eye, we are also able to note not only the tract of the current, but also the additional effect of the greatest change having taken place in the centre of the liver and not at the points of metallic contact. In the potato experiment the skin or covering was removed the same as in the liver and we had a moist contact for the electrodes.

In this test we will make use of a raw egg without, however, first breaking the shell, so that the current is obliged to find its way through the unbroken shell. After a few minutes, if the current has not been too intense, we break the shell and find that the centre, or the yolk of the egg, is cooked harder than the white. We will notice that this is just the reverse from what would have happened if the egg had been subjected to the boiling water process. Yet another and perhaps even more conclusive test is the following one: Here we have a U-shaped tube filled with egg-albumen. A piece of metal is passed into the upper ends of the tube. First the galvanic current is passed through this mixture without any appreciable change taking place. To the same contact points now we attach the high-frequency current. In less than three minutes we see that the bottom or centre of the albumen is coagulated and has become solid and absolutely opaque. By feeling the tube with the finger we find the centre so that the contact is uncomfortable, while at the ends the tube and contents are cool. Something new is beginning to dawn upon us, namely, the fact that the centre of the egg is affected considerably more than the parts in contact with the electrodes; in other words, we are beginning to realize that this heating effect is from *within outward*, and not from *without inward*.

So far we have been making these tests upon substances that were devoid of a circulating blood stream. If, therefore, these various phenomena are to be of any value to us, all these same effects must be produced upon the living tissue and in no way negated by the circulation, as is the case when heat is applied through some external agency. For this purpose the proverbial Guinea pig answers our requirements. The temperature per rectum of the disturbed animal will register about 100 degrees F.

Two metallic or sponge-covered electrodes are placed upon either flank of the animal and the current turned on. As there is no sensation beyond a slight feeling of warmth, we need take no especial precaution with either the animal or the current. In the short space of three minutes the rectal thermometer will show a reading of 105 degrees. This increased temperature may remain for one to three hours without any apparent ill effects upon the animal. Here, then, we have the circulating blood in no way interfering with the heating effect. On the contrary, we produce all the essentials of a natural reparative process—heat, increased blood supply and increased oxydation.

The Effects of the High-Frequency Current Upon the Patient

When the two poles of this current are applied to any part of the body, there is not, or should not be, the slightest sensation. After a few minutes the part treated becomes sensibly warmed. The patient will tell you that each pulse beat can be perceptibly felt within that region. Upon inspection the parts appear hyperæmic, feel hot to the touch and are covered with a profuse perspiration. We have produced some of the cardinal symptoms of inflammation—heat, redness and an increased blood supply. We have within the region treated all the elements necessary for a natural repair. This effect as we have seen did not proceed from without inward, but, on the contrary, from within outward.

From time immemorial, heat in some form or other has been used to alleviate pain. This heat was always some external agent and the greatest heat was al-

ways upon the outside. It is easy to understand how difficult it must be, or even how impossible it is, to heat any deep lying structure at all by the external application of heat. The blood stream has a constant tendency to equalize the temperature. The heat so applied externally always had to be greater upon the outside than it could ever be upon the inside of the body. Yet would you be willing to say that such external application of heat never caused any relief?

How much more should you expect from an agent that produces its greatest effect upon the inside with hardly any effect at all upon the outside? Furthermore, the heat so produced upon the inside lasts for several hours; it is not dissipated. The explanation is this: As has been previously stated, closely associated with the process of inflammation is the one of chemotaxis, and this chemotaxis is an electrical phenomenon. Inflammation without this chemotaxis is futile and inadequate. Clinical observation has proven that the opsonic index is always higher after a general high-frequency treatment.

The reaction then that is produced in the tissues by the application of the high-frequency current is a physiological inflammation plus a strong or positive chemotaxis. Now having the agent, understanding its physical properties, appreciating the physiological reaction of living cells, it seems easy to deduce the therapeutic indications.

. . .

This *high-frequency current* is the only agent that we know of to-day that is capable of causing a natural adequate reaction in any part of the body desired. There is no organ so hidden or so deeply seated, that it cannot be reached by the heat of this current and, of course, without practically any effect upon the skin, excepting that of warmth, redness and perspiration.

Neither will it be necessary, after extolling the various virtues of this current, to call your attention to the fact that this agent is not a cure-all nor a panacea for all the ills of mankind, nor do I wish to be understood as advocating this agent to the neglect of any other measure.

If there is one thing that I am strenuously opposed to, it is the one-method treatment. During the use of the high frequency current diet and hygiene, even other therapeutic measures as tonics and eliminants must not be neglected. I am equally opposed to useless drugging or meddling. All of our therapeutic measures must be in harmony with the pathology of the disease and the physiology of the patient.

But I do wish to emphasize and impress you with the *underlying principle of why and how* this current acts as a therapeutic measure. For, after all, it is the *reaction of living cells to an agent that must be our guide in the selection of that agent.*

Some Uses of Light in the Treatment of Disease *

Synopsis: The value of light as an efficient remedy when properly employed in the treatment of many painful and diseased conditions is discussed in the following article. A brief review of the art of applying the therapeutic effect of light is also included.

TO many, the subject of phototherapy is invested with so much mystery, and its fundamental principles are so frequently imperfectly understood, that it is not surprising that progress in this field has been so slow. Even now comparatively few are making systematic use of this important therapeutic agent. It would consume much more time than is at my disposal to present more than an outline of this subject, and I will therefore confine myself chiefly to its practical therapeutic aspect, as based largely upon my own observations.

From time immemorial, the beneficial influence of sunlight upon animal and vegetable life has been recognized, but it is only at the present time that we are appreciating its full value in the treatment of disease.

The excellent and even wonderful results of heliotherapy in the treatment of bone tuberculosis, to which attention has been called within a recent period, will serve as an illustration.

* A paper by Dr. E. C. Titus, read at the eighth annual convention of the Illuminating Engineering Society, Cleveland, O.

For obvious reasons, however, sunlight is not always available, and it has therefore been found advantageous to resort to other sources of light. Thanks to the progress made in electricity, we now have at our disposal various means of obtaining light closely approaching that of the sun in its remedial action, and to these means, chiefly, my paper will be devoted.

Phototherapy may be considered under two heads, its thermic and actinic effects, although both of these are represented in varying degrees in all light, irrespective of its source.

It must be remembered that the thermic effects of light are due to the impingement of the rays upon the translucent cutaneous tissues. The arrest of the light rays by the skin and subcutaneous structures produces radiant heat which has a higher penetrating power than convection heat as generated by a hot-water bag or poultice, for instance. It has been found that the thermic effects of light extend to a depth of 2 inches or more, while convection heat is principally exerted upon the surface. In comparing the therapeutic action of both it will be seen that the changes produced in the tissues by the former are much more pronounced. Thus if the body be exposed to an intense light, as in an electric light cabinet bath, the resulting hyperemia and elimination of waste products by the skin and kidneys (cellular nutrition) are much more pronounced than in a Turkish or Russian bath. The marked augmentation of the oxidation processes in the tissues is shown by the greater amount of CO_2 thrown off by the lungs and by the increase of solids in the urine. It is also claimed that the natural defenses of the body (phagocytosis) are greatly promoted.

The actinic or chemical rays play an important part in phototherapy only when the light is concentrated upon a localized area, as in the use of the arc lamp. Under these circumstances the actinic rays appear to enhance as well as modify the action of the thermic and luminous rays. Thus the ultra-violet radiations, which are actinic, have been shown to exert an anti-bacterial action as well as to promote local phagocytosis.

I am not unmindful of the fact that much of our knowledge is still in the theoretical stage, and for that reason have refrained from entering into the many details. I will, therefore, proceed now to the clinical aspects of this subject, dividing it into the general and local applications of phototherapy.

The general application of phototherapy consists practically in the use of the electric light bath, and since much of the benefit to be derived from this agent will depend upon the apparatus employed, I will first give a description of what has proven to me the most satisfactory type of cabinet.

An electric light cabinet should be constructed according to the following plan. The cabinet should be octagonal in shape, 4 ft. square by 5 ft. high; the lining should be of white blotter and not mirror surface; the source of light should come from 100 40-watt tungsten lamps, conveniently arranged, so that they will be under control from within by properly placed switches, one-half or full number of the lights to be employed, as desired. The cabinet should be open at the top, not entirely, but partly so and it should have an air vent 3 inches in diameter in the center of the floor, over which is placed a low stool 18 inches high, upon which the subject is seated. (It has been found that a ventilated room is much more quickly and evenly heated artificially than one that is closed or sealed.) The further advantages of this construction are that a large volume of light with a minimum amount of heat is produced in the cabinet, that the emanations of noxious gases and odors from the human body are quickly carried off, that the degree of cutaneous hyperemia and diaphoresis is much more intense, and that the usual depression and other unpleasant symptoms are entirely obviated, as compared with the older form of closed cabinet.

Among the conditions in which the electric light bath has proved to be most serviceable are arteriosclerosis (hardening of the arteries), gouty and rheumatic conditions, Bright's disease, diabetes, obesity and acute catarrhal affections of the respiratory tract.

In the majority of cases of arteriosclerosis in the earlier stages I have advised the regular use of these baths with beneficial results, and I firmly believe that they have warded off more serious organic changes which otherwise frequently ensue.

The effects of the baths are:

1. To induce intense hyperemia or reddening of the skin and thus reduce the congestion of the deeper organs, which is frequently present.

2. To increase elimination by way of the lungs and skin. It has been found that during and following the bath the elimination of CO_2 is practically doubled, while the profuse perspiration produced carries away much toxic or poisonous material and in that way relieves the overtaxed kidneys. As it is generally accepted that toxemia plays an important part in the causation of hardening of the arteries, the benefit to be derived from this method is readily apparent.

Rheumatic and Gouty Affections.—In late years it has been frequently pointed out that many conditions commonly termed rheumatic differ essentially from the acute type of the disease which is very probably of bacterial origin. On the other hand, there is abundant reason to believe that these chronic forms which have been grouped under the names of rheumatoid arthritis, rheumatic gout, osteoarthritis deformans, are the result of auto-intoxication and disturbances of metabolism. From what has been said above, it will be readily understood that the marked effect of the electric light bath in increasing elimination will exert a beneficial influence upon the toxemia in these cases and therefore prove of material aid to other treatment. The distressing pains and stiffness in the joints are also greatly relieved as patients have frequently assured me. In chronic gout, which is more frequent in this country than is generally thought, the action of light baths is to augment the cutaneous or peripheral circulation and in that way favor the absorption of uratic or chalky deposits.

It may be asked why a Turkish or Russian bath will not do equally well in the conditions mentioned. My own experience has shown that the effect of the light bath is much more pronounced and prolonged.

Bright's Disease.—One of the chief aims in the treatment of Bright's disease is to lessen the work of the kidneys. The light bath will be found a better auxiliary measure for accomplishing this purpose than the usual hot pack or steam bath. As previously pointed out, notwithstanding the profuse sweating induced, the patient experiences no depression because of the stimulating effect of the light energy upon the peripheral nerves.

Diabetes.—The light baths are not adapted to every case of this disease, but particularly to patients who present a dry skin with various cutaneous eruptions, especially of an eczematous character. The best results are obtained where diabetes is attended with high blood pressure.

Obesity.—The heat penetration in an electric light bath, which as already mentioned extends to a depth of over 2 inches, stimulates the oxidation processes in the fatty tissues and promotes their disintegration in cases of obesity. It will thus prove an excellent auxiliary to the customary treatment.

Acute Catarrhal Affections of the Respiratory Tract.—The writer has frequently had an opportunity to witness the beneficial effects of an electric light bath at the beginning of a cold in aborting it or greatly ameliorating its course. From personal experiences, there can be no question of its superiority over the customary hot bath and diaphoretic (perspiration inducing) remedies.

Local Application of Light

In the local applications of light the following means are available:

1. The arc light, which is best employed by means of an ordinary marine searchlight, with its glass front window removed. The one I employ consumes 25 to 35 amperes of direct current at 40 volts, and projects the light in parallel rays by means of a 12-inch parabolic reflector, and has a light value of about 5,000 candle-power.

2. The high power incandescent lamp with a carbon or tungsten filament of 500 candle-power and provided with a dome reflector. The carbon filament uses 12 amperes at 110 volts, while the tungsten lamp consumes only 3 amperes at 110 volts. The former gives off more thermic rays, while the latter produces a greater amount of white light with a minimum amount of heat.

Without entering into detail regarding the physiological action of light when applied locally, it may be of interest to call attention to some of its main features.

As already mentioned in discussing the general applications of light, it constitutes a means of generating heat within the tissues down to a depth of 2 inches or more, while convective heat is far less penetrating. Moreover, besides the conversion of light rays into heat, we have to deal with the chemical actinic rays which also play a not unimportant part in phototherapy.

The sum total of these combined effects is as follows. There is an increased local activity, as manifested by a pronounced hyperemia and an augmented tissue oxidation and elimination. The effects of radiant energy, however, are not confined to the site of application, but are so diffused that remote effects are produced in distant organs and nerve centers as a result of peripheral or cutaneous stimulation. It is easy to understand that the increased circulation, oxidation and elimination in the affected part will relieve congestion and promote absorption of exudates and deposits and the excretion of toxic materials. It has likewise been shown by physiological investigators that the heat production in the tissues increases phagocytosis and thus enhances the vital resistance.

The rapid relief of pain and local spasm experienced from light therapy is due in a great measure to the reduction of congestion and to tissue relaxation. In this connection it may be emphasized that these decided effects are brought about without the least risk to the patient, a statement which is not applicable unreservedly to other methods of treatment.

I shall now briefly discuss those conditions in which the local application of phototherapy in my experience has yielded the most satisfactory results. The employment of the parallel rays from a high power marine searchlight as described above, applied for 30 minutes to the spine at a distance of 10 feet, is one of the most effectual and lasting means of relieving many forms of spinal congestion.

In the acute stages of bronchitis or in pulmonary congestion from almost any cause, light applications to the chest afford a more prompt relief of chest pain and respiratory distress than any other measure with which I am familiar. In cases of chronic bronchitis marked benefit is obtained by prolonged daily applications of light to the front and back of the chest, continued until marked redness and tanning of the skin is produced.

To promote more speedy absorption in pleurisy I know of no better means than the daily use of phototherapy. In lobar and bronchial pneumonia its beneficial influence is manifested by marked relief of pain and dyspnea (shortness of breath) and an improvement in the general comfort of the patient; and in cases where resolution was delayed, it seemed to hasten this process.

I have frequently had occasion to resort to this treatment, using either the arc or 500 candle-power tungsten lamp, in cases of both acute and sub-acute inflammation of the gallbladder, congestion of the liver and other abdominal viscera from chronic malaria, alcoholism and persistent intestinal auto-intoxication. It is no exaggeration to say that my results have been far better than when sole reliance was placed upon customary medicinal treatment.

In the treatment of muscular rheumatism, neuritis and even the intense discomfort associated with herpes zoster (shingles), more rapid and lasting relief, due to diminished congestion and nerve sensibility, will be obtained by this method than by recourse to the various analgesics and with no risk of undesirable after-effects.

The pain in acute middle ear catarrh (common earache), the frontal or orbital headache accompanying acute colds, and especially involvement of the frontal sinus and ethmoid cells is promptly alleviated by a thorough application at frequent intervals of light from a 50 candle-power carbon or tungsten lamp in a suitable reflector. To this I can testify not only from my own experience, but I could add the testimony of many physicians familiar with the use of this potent therapeutic agent. In chronic ear trouble and disease of the frontal sinus and antrum, it has proved a very valuable auxiliary by relieving the congestion and clearing up the discharge.

It has been my privilege to witness the success of this treatment in several cases of catarrhal appendicitis, and it has seemed to me that the pain and other symptoms were more quickly ameliorated and the necessity of surgical intervention more often avoided than had been my previous experience.

In various types of septic conditions, such as phlebitis, so-called milk-leg, following child-birth, or intrapelvic operations, the use of light in the manner indicated or by means of the multiple light dome, as employed in the Women's Hospital in New York, has proved a well-nigh indispensable agent in gynecological practice.

It will be found equally useful in the treatment of infected wounds of the extremities, cellulitis, furuncles, varicose ulcers, and localized infective processes in general.

From experience, up to date there seems to be a brilliant future for this measure in hastening repair in cases of delayed union of fractures.

In an article published some time ago, I reported observations which showed that it might be possible to prevent the occasional deleterious effects of the X-ray by following its application with the rays from a marine searchlight. It is very gratifying to me to state that subsequent experience has seemed to confirm these results.

If, in this rather fragmentary sketch, I have been sufficiently fortunate to impress upon you the value of phototherapy as a safe and efficient auxiliary in the treatment of many conditions, the object of this paper will be fully realized.

*The Therapy of Light and the New "R-Ray" **

THE therapeutic use of light has been known for ages; in fact, it belongs to a period so remote, that we are unable to determine even approximately the time of its introduction as a healing agent.

In the far East the earliest writings mention the use of light in the cure of disease, and in the comparatively more recent records of Central-American aborigines, we find accounts of miraculous cures performed by the Sun God. Even at the time of our early pioneers on this continent there are authentic reports of a custom practised by many Indian tribes, who treated wounds and pulmonary afflictions, rheumatism, neuralgia, etc., by exposing the naked skin to the mid-day sun, allowing the rays to fall directly on the part afflicted. This custom was in vogue ages before the Spanish Conquest, and was common among the aborigines of America, from Yucatan to the Arctic Sea.

We have, therefore, historic proof that light rays have been used from time immemorial in the treatment of disease, and, while modern science and modern methods have attained the same ends, they have not changed the principles known to primitive man—but have merely developed the art.

As light rays are the oldest and most universally accepted therapeutic agent, we naturally ask—how are they translated into terms of therapy by the human body? To which the answer is, through the medium of *vibration and penetrative force of quantity*.

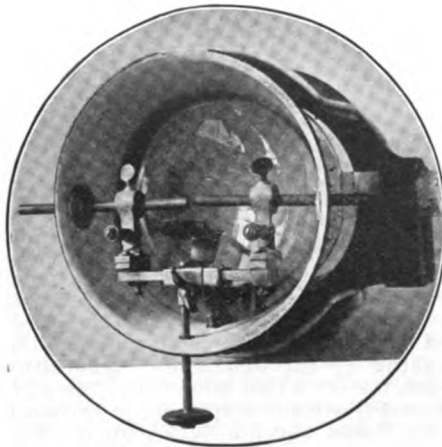


Fig. 102—Appearance of Special Electric Arc Devised for Producing the "R-Ray" Radiations, Which Have Proven Extremely Satisfactory in Light Therapy Treatment for Certain Diseases and Ailments.

* H. Rosenthal, in *The Electrical Experimenter*, May 1917.

Light and electrical radiations are both waves that are projected through space at the same velocity. They are identical in nature, though one wave length or radiation may differ from another, the same as one sound wave may vary in length from another, as found in the various tones or vibrations of music. Yet all wave lengths, whether light or sound, produce their own corresponding vibrations, and we therefore recognize all such vibrations in terms of light and sound.

In further proof of this existing vibratory theory, we have color, which in reality exists only in the mind, for color value is dependent solely upon the number of vibrations impinging upon the retina of the human eye. As, for instance, when the retina is stimulated by a vibratory force that approximates 400 trillions per second, the impression produced upon the brain is that of the color red; 750 trillion vibrations per second is interpreted by the brain as the color violet. And so on through the scale of our visible spectrum. Yet, were the human retina sufficiently sensitive to receive and distinguish the many intermediate vibrations, it would perceive, through the brain countless millions of tints and numerous values that lie between these two extremes.

When these countless millions of tints are all combined we see only *white*. And though we perceive and interpret white light as being white, still we know that it is not white, but the combined primary colors and their countless intermediate tints. This fact is easily proved by simply passing a beam of white light through a prism, which will show the primary colors making up the white beam.

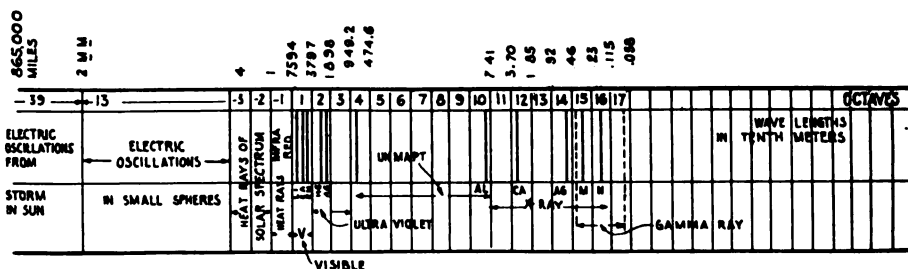


Fig. 103—Chart Showing the Position Occupied by the New "R-Ray" in the Spectrum, Including the Relative Position of the X-Ray Vibrations and Ultra-Violet Rays.

4,503,599,627,370,496.....	= Ultra violet photog. in vacuo
789,000,000,000,000.....	= Violet end of visible spectrum
562,949,953,421,312.....	= Green light
451,000,000,000,000.....	= Red end of spectrum
281,474,976,710,656.....	= Infra-red
70,368,744,177,664.....	= Heat rays of solar spectrum
47,000,000,000.....	= Electric oscillations in small spheres
Once in 4.7 seconds.....	= Electric oscillations from storm in sun

Light vibration without penetration, force or quantity is in itself therapeutically negligible. To have force, it should be direct, and to have penetration, the source and quantity should furnish vibrations of practically uninterrupted intensity.

One source of light which fulfills the above conditions is our own *sunlight*, which penetrates every portion of the human body and exerts a most powerful influence on its economy by oxygenating the blood, generating hemoglobin and producing red corpuscles. And when we become *Sun-Dodgers* we cannot expect any other physical condition than that which takes place in plants under like circumstances, and which entails on human beings the necessity of resorting to other means for making up the deficiency—generally drugs.

Summing up, therefore, the laws that govern the therapy of light, we find it has the same relation to chemical actions which are governed by the chemic response set up in the substance or tissue, and not by the inherent quality of the ray; while all physical conditions are secured in direct ratio to the penetrative power, quantity and vibrating quality of the light employed.

All light waves possess two main characteristics that differentiate the effect produced, namely: first, the *number* of vibrations in a given interval of time, and second, the *length* of each oscillation, or wave, in a given interval; so that, from a therapeutic standpoint, it is always highly important to have at our command as great a number of these vibrations as possible; i. e., of the oscillations. It has

been averred by the medical profession that each and every corpuscle and cellular structure in the human body is composed of an infinite number of delicate receivers, each of which respond only when the right *tune* or *vibration* strikes them. Thus when given major, minor and chromatic scales to operate with, the skilled therapist can compel the vibrations of any cellular structure to respond to those which are produced artificially; and call into action complete therapeutic results, just as in music we call into play the various graduations of tone and produce perfect harmony.

The period of vibration or oscillations which make up light waves and which the human eye will respond to, are those above the infra-red rays or heat rays and those below the ultra-violet or invisible light rays. The difference between the two is that the vibration of the infra-red is very small and the wave length very long, while those of the ultra-violet region have a tremendous period of vibration and a very short wave length.

The therapeutical work that has been conducted points to the fact that the *ultra-violet* rays are most advantageous and consequently of greatest use in light therapy.

We know that light rays from such sources as the Finsen, Minin, Ultra-violet and X-ray are each capable of exciting a normal, subnormal or abnormal human receiver.

However, our scientists, not being satisfied with the belief of the existence of another source of vibration beyond the ultra-violet region, took another step in this direction which proved to be successful, inasmuch as they have found a

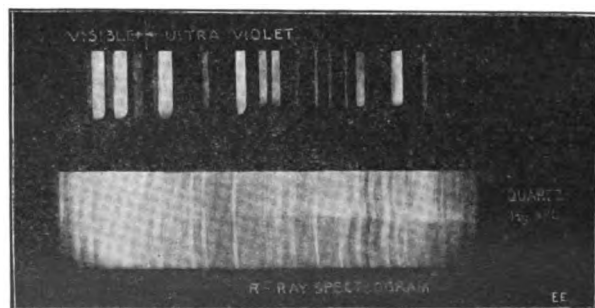


Fig. 104—Spectrogram of the New "R-Ray," Showing Clearly Its Great Range in the Field of Light Therapy, Extending as it Does Beyond the Visible Spectrum.

region between the extremity of the ultra-violet and the beginning of the X-rays. The region is still unexplored, but there is little doubt that the greatest therapeutic secrets lie hidden there.

It is believed that we are only beginning to learn of the real benefits to be gained by the scientific application of light rays by skilled therapists.

The author, who has been engaged in this, as well as the electrical field of research for many years, discovered a new ray which he christened the *R-ray*. The production of this new source of radiation is somewhat similar to the Ultra-violet ray, inasmuch as an arc is used; but two different arc electrodes are employed in this work. The arc is produced between an electrode composed of quartz and mercury with a second electrode of ordinary arc carbon. Fig. 102 shows one of the complete arc lamps used in these experiments.

Viewed as a spectrogram the R-ray occupies one side of the Ultra-violet region and grades uniformly from the first octave to out and beyond the visible portion. Also here we find radiations that cause air and matter to have such affinity that they are instantly absorbed, and investigation of their characteristics can only be conducted in a vacuum.

As resultant deductions of therapeutic interest in considering the properties of the R-ray, we find the following:

(1) They are readily controllable, and give penetrative therapeutic light of uninterrupted intensity.

(2) They are rich in Ultra-violet rays of shorter wave lengths than the emissions from any other known arc.

(3) They differ materially from X-rays, in that they may be deflected and focussed on any given area, so as to combine their inherent heat-ray value with their visible and invisible light radiations.

(4) They are more readily absorbed by matter than any present known arc ray, and as such secure vibratory reactions in deep-seated cellular organisms.

In order to show the position of the unmapped region wherein the R-ray lies, and as compared with the vibrations of other sources of radiation, the chart, Fig. 103, was made. It will be found very interesting to those who are pursuing the study of different sources of radiations.

The chart indicates the wave lengths of radiations ranging from the visible part of the spectrum to X-rays and the Gamma rays of radium.

To fully understand this chart, the following notation is used: the numbers across the top give their respective wave lengths in Angstrom units (one Angstrom unit is equal to one tenth of a meter and this unit is abbreviated as A.U.). Thus the wave lengths are given in *tenths of a meter*, using here the language of the scientist. The Angstrom unit is equivalent *actually* to 10^{-10} meter, one meter being equal to 39.37 inches. The numbers below represent the number of octaves which these rays range over.

The region of about six octaves, beginning at 4 and ending at 10, represents the unmapped portion. This separates the extreme ultra-violet from the commencement of the very soft X-rays. The most easily absorbed X-rays, whose wave length has been determined, are the characteristic rays of burning aluminum with a wave length of 8.4 A.U. Passing up through several octaves of X-rays, the limit indicated by the line "N" is reached; these represent the hardest, i. e., the most penetrating X-rays, which have so far been produced. The line "M" represents the *medium* penetrating ray. It will be noticed that some of the gamma rays as produced by the disintegration of the radium atom, are of longer wave lengths than some of the shorter X-rays.

The region ranging between octaves 4 and 10 are vibrations which are easily absorbed by matter. They vary in wave length from approximately 900 to 9 A.U. The region between wave lengths 3,800 to 1,900 is the portion of radiation which is of therapeutic interest.

Scientific Medicine *

ANOTHER scientific field of medicine includes the use of all physical measures. The employment of physical measures in therapeutics is not new but advanced. The physical effects of physical agents are definite and produce definite physiological effects upon the organism, which have been in large measure demonstrated as to their character of action and indications in medicine. Nothing can be more definite and reliable than these measures when used with instruments of precision and scientific regulation of dosage than the action of the electric modalities, the X-ray, and radiant energy. So definite is the demonstrated effect, that these natural sources of energy may be relied upon to produce definite action upon numerous affections which respond favorably to their influence.

The effects of stimulation or activation as by the static wave and high-frequency currents and other modalities by arousing the deep spinal centers, as well as awaking active physical functional metabolism are, in the experience of those familiar with them, so fully demonstrated that their physical effects upon the physiological processes of the body are definitely determined.

The effects of hyperemia as induced by radiant energy from luminous sources and by the high-frequency current and superficially by the stimulating influence of the vacuum tube applications are absolutely demonstrable effects, inducing as they do an increase in the processes of metabolism and phagocytosis.

The applications for spinal stimulation employing various modalities for either stimulating or inhibiting the nerve centers at the discretion of the operator

* Extract from the editorial published in *The American Journal of Electro-therapeutics and Radiology*, September, 1916 (Vol. XXXIV, No. 9).

is productive of positive effects, affecting the end nerves and functions they control at the will of the operator. These effects are definite, profound and positive and in every sense scientific.

So also is the employment of dry heat in the treatment of local septic infection effecting to destroy the germs present in local infection and promptly restore the part. The result is absolutely scientific in point of laboratory experience effecting certain relief in all cases affecting the limbs, but not so certain in head and trunk. This and other demonstrations of positive effects belong to the rôle of scientific medicine, because the results of treatment are so certain that it can be assumed in respective conditions that certain effects will be produced in definite ways, and with uniform results as demonstrated in the laboratory of the physical therapist.

When the extent and scope of indication of these methods is generally recognized, it will be found that they fill the most important and largest place in scientific medicine.

Laboratory demonstrations are not more positive nor results more definite as obtained in any other department of medicine and the scope covered by their application is larger than in all other fields of therapeutics combined.

These measures call upon the natural sources of energy and are most effective in their influences upon metabolism, the destruction of germ life in the tissues, and treatment of inflammation and malignancy, and the induction of the general activity of physical functions in the body. The treatment of inflammation by these measures, where infiltration is present and no infection is so profoundly successful that it is possible to definitely determine the prognosis when the diagnosis and localization of the lesion is determined.

Scientific medicine finds, therefore, its most effective and broadest field in physical therapeutics. It does not, however, detract in the minds of its scientific exponents from the other great laboratory advances, but fills a larger place, working in harmony with all that is scientific in medicine and surgery.

SECTION III

Glossary of Electrical Terms
Brief Outline of Therapeutic Indications

—♦—
Glossary of Electrical Terms

Actinic Rays.—Rays having the property to induce chemical action. Blue, indigo, violet and ultra-violet rays of the spectrum.

Alternating Current.—A current in which the rise and fall of voltage in a positive direction is immediately, without break, followed by a corresponding rise and fall in a negative direction.

Alternation.—A change of direction or one half of a cycle.

Ammeter.—A galvanometer which measures the strength of current in amperes.

Ampere.—The practical unit of current flow. A flow of electricity at a rate which transmits one coulomb per second. The current under a pressure of one volt which passes through a circuit offering a resistance of one ohm.

Anelectrotonus.—The decreased nervous activity produced near the anode (positive electrode).

Anions.—The electro-negative substances (negatively charged elements) which are repelled by the cathode (negative pole) and attracted toward the anode (positive).

Anode.—The positive pole of an electric battery. The electrode connected to the positive terminal.

Battery.—Two or more cells properly connected.

Becquerel Radiation.—Invisible radiation, discovered by Becquerel, given out by some salts, especially salts of uranium. This radiation has the power to permeate many bodies opaque to the ordinary light, and affect a photographic plate.

Bergonié's Cell.—A cell consisting of a zinc plate immersed in a 3 to 5 per cent. solution of ammonium chloride with manganese dioxide as a depolarizer, having the electro-motive force of 1.45 volts and the internal resistance (with a 4 per cent. solution) of 1 ohm.

Bicromate Voltaic Cell.—A cell consisting of a plate of zinc and a plate of carbon immersed in aqueous solution of bicromate of potash and sulphuric acid.

Binding Post.—A metal screw fastened to a machine for securing electric connection.

Bipolar.—Employing two poles.

Board of Trade Unit.—One thousand watts of electrical energy consumed per hour. One "kilo-watt."

Candle Power.—The intensity of light given out by a luminous body calculated by standard candles.

Cathalelectrotonus.—The increased nervous activity produced near the cathode (negative electrode).

Cathions.—The electropositive substances (positively charged elements) which are repelled by the anode (positive) and attracted towards the cathode (negative).

Cathode.—The negative pole of an electric battery. The electrode connected to the negative terminal.

Cathode Rays.—Rays emitted by the cathode of an X-ray tube.

Cathodoagram.—A radiograph.

Cell.—(Primary)—A vessel holding the elements and the exciting fluid necessary to produce electricity. (See Bergonié's cell; Bicromate Voltaic cell; Chaperon Cell; Chloride of silver cell; Junius cell; Laclanché cell.)

Chaperon Cell.—A cell consisting of zinc plates immersed in a 30 or 40 per cent. solution of caustic potash, with copper peroxide as a depolarizer, having the electro-motive-force of 0.8 to 0.9 volts.

Chemical Rays.—See *Actinic rays*.

Chloride of Silver Cell.—A cell consisting of zinc and chloride of silver immersed in a weak solution of ammonium chloride.

Circuit.—The path through which electricity flows.

Circuit, Closed (Closed Circuit).—A circuit completed.

Circuit, Open (Open Circuit).—A circuit which is broken.

Commutator.—A device by means of which it is possible to reverse the polarity, or change the direction of current from one portion of a circuit in another.

Conductor.—Any material allowing the electric current to pass.

Continuous Current.—An electric current flowing in the same direction.

Coulomb.—The practical unit of electric quantity. A quantity of electricity passing in one second through a circuit carrying one ampere; or a quantity of electricity which a condenser of one Farad capacity contains when subjected to the pressure of one volt.

Cycle.—One positive and one negative alternation.

Depolarizer.—Substances preventing polarization in a cell by fixing the hydrogen.

Diathermy.—The production of heat in the internal tissue of the body by means of high-frequency currents.

Dielectric.—Any substance through which electrostatic induction is allowed to occur.

Dimagnetics.—Substances repelled by the magnets (e. g., bismuth, zinc, antimony, phosphorous, copper, etc.).

Dynamo.—A machine generating electricity by converting the mechanical energy into electrical.

Dyne.—The practical unit of force of the centimeter-gramme-second (C. G. S.) system. The force capable of moving a body weighing one gramme for a distance of one centimeter in one second of time.

Electrocardiograph.—An instrument which records graphically the electrical changes of the heart muscle during its activity.

Electrocardiogram.—A permanent record of the electrical changes of the heart muscle during its activity, produced by the electrocardiograph.

Electrode, Active.—Electrode brought near, or in contact with the part treated.

Electrode, Indifferent.—Electrode (larger than the active) necessary only for the production of a circuit in electrotherapeutic application, which may be placed anywhere on the body.

Electro-Motive-Force (E. M. F.).—Voltage.

Electrolysis.—A separation of a compound substance into its elements, or ions, by the action of an electric current.

Electro-Magnet.—A bar of soft iron, surrounded by a coil of insulated copper wire, in which the electro-magnetism is induced by a flow of current through the wire.

Electrophorous.—An instrument for generating static electricity by induction.

Electroscope.—“An apparatus indicating the pressure of an electric charge, and for determining its character, as to the positive or negative state of the charge, without measuring its amount of value.” (W. L. Weber.)

Erg.—A practical unit of work in the centimeter-gramme-second (C. G. S.) system. The energy expended in moving a body through a distance of one centimeter or against a resistance of one dyne in one second.

Farad.—The practical unit of electric capacity. The capacity of a conductor to hold one coulomb of electricity at one volt pressure.

Filament.—A fine thread. The wire inside an incandescent lamp, which gives light.

Fluoroscope.—A screen containing barium-platinum-cyanide, which fluoresces when exposed to the X-rays.

Frequency of Alternation.—The number of complete cycles occurring in one second of time.

Fuse.—A piece of lead, tin, or copper wire, which, when the electric current exceeds a certain strength, melts and breaks the circuit and thereby prevents damage to the lamps, motor, or other electrical apparatus.

Galvanic Current.—A direct, continuous current obtained from primary cells or from a direct current generator.

Galvanometer.—An instrument for measuring the strength of an electric current by the repulsion of an electric needle.

Generator.—A dynamo.

High-Frequency Currents.—The alternating or oscillating currents in which the frequency rises up from ten thousands to several millions of alternations per second.

Induction Coil.—A coil consisting of a soft iron core, a primary and a secondary winding of insulated copper wire, inducing a current of very high voltage and low amperage in the secondary.

Interrupter, Automatic.—An automatic arrangement for making and breaking the circuit.

Interrupter, Wehnelt (Electrolytic).—An electrolytic interrupter consists of a platinum point (connected to the positive lead) and a lead electrode immersed in a vessel filled with a 10 per cent. solution of sulphuric acid (H_2SO_4). "When the current passes, the water is decomposed and this is accomplished by an evolution of heat, which sets up the phenomenon known as *caefaction*. The bubbles of oxygen collected round the heated platinum point form a non-conducting sheath which interrupts the circuit. The moment the current is arrested the bubbles cease to form, contact is made between the liquid and the wire, and the current passes once more." (Guilleminot.)

Insulator.—Any material which offers very great resistance to (arrests) the passage of electricity.

Ion.—A substance resulting from the decomposition of a body by electrolysis.

Ionic Medication.—The process of introducing medicines through the unbroken skin into the tissue of the body, with a view of securing a local effect.

Ionization.—The property possessed by an electric current, by which it transports the ions of a compound substance to the positive and to the negative pole.

Joule.—The practical centimeter-gramme-second (C. G. S.) unit of electrical work, equal to 10^7 ergs. It is the work necessary to raise the potential of one coulomb of electricity one volt. Ten million ergs.

Joule's Law.—The heating power of a current is proportioned to the product of the square of its strength and the resistance of the circuit through which it passes.

Junius Cell.—A cell consisting of a zinc plate immersed in a solution of caustic soda, with manganese dioxide as depolarizer, having the electro-motive-force of 1.6 volts and an internal resistance of 0.25 ohm.

Kilo-Watt.—(K. W.)—One thousand watts.

Laclanchè Cell.—A cell consisting of a rod of zinc and a plate of carbon immersed in a saturated solution of ammonium chloride with manganese dioxide as a depolarizer.

Leyden Jar.—A condenser consisting of a glass jar coated in its lower half, inside and outside, with tin-foil.

Megerg.—One million ergs.

Megohm.—One million ohms.

Metronome.—A mechanical (clockwork) device for interrupting an electric current.

Micro-Ampere.—The millionth of an ampere.

Microhm.—The millionth of an ohm.

Micro-Volt.—The millionth of a volt.

Milliampere.—The one-thousandth of an ampere.

Motor (Electric).—A machine, operated by an electric current, imparting motion.

Ohm.—The practical unit of resistance. It represents the resistance offered by a copper wire two hundred and fifty feet long and one twentieth of an inch in diameter. A resistance which would allow a current of one ampere at a pressure of one volt.

Ohm's Law.—The difference in voltage between any two points in an electrical circuit is strictly proportional to the current, all other conditions remaining constant.

Oscillation.—A vibration back and forth.

Oscilloscope.—A glass tube about eight inches long, exhausted to a certain specified degree of vacuum, having two electrodes of aluminum wire, by means of which an inverse current can be detected.

Period.—The time required to complete a cycle.

Photo-Chemistry.—The science treating of the chemical action of light.

Photo-Electricity.—A variation of electric potential resulting from light action.

Polarity Indicator.—An instrument indicating the direction (polarity) of a current.

Polarization.—An accumulation of hydrogen on the negative element in a primary cell tending to decrease its efficiency by neutralizing the current flow.

Pole Changer.—A commutator which reverses the direction of a current.

Porous Cell.—A clay or unglazed earthenware jar used in primary cells to keep two liquids separate and at the same time permit electrolysis and electrolytic induction.

Primary Current.—Current which passes through the primary circuit.

Radio-active Substances.—Substances giving out Becquerel radiation (e. g., uranium, radium, mesothorium, etc.).

Radiograph.—A picture produced by means of X-rays.

Rectifier, Electrolytic.—Electrolytic rectifier consists of iron cells (filled with ammonium phosphate or sodium bicarbonate solution) and aluminum rods connected in series. When an alternating current passes through these cells, it is changed into a direct current, because the current flows only from the iron to the aluminum; the reverse alternation being suppressed.

Reluctance.—Magnetic resistance. (This is analogous to the resistance of a conductor of electricity.)

Rheotome.—See *Metronome*.

Rheostat.—An instrument of adjustable resistance, by means of which it is possible to control the current strength.

Rotary Converter.—A motor and dynamo combined by means of which it is possible to transform the alternating current into direct or vice versa.

Ruhmkorff Coil.—An induction coil with interrupter.

Shunt.—A connection in parallel with a portion of the circuit.

Sinusoidal Current.—An alternating current in which the rise and fall in voltage in the positive and negative directions is gradual and represents a sine curve, or a horizontal letter S.

Skyagraph.—A radiograph.

Spark-Gap.—A space across which the spark jumps when there is a difference of potential between two opposing conductors.

Spectrograph.—A radiograph.

Static Electricity.—Electricity generated by friction.

Step-Down Transformer.—A transformer which transforms a current of low amperage and a high voltage into a current of high amperage and a low voltage.

Step-Up Transformer.—A transformer which transforms a current of high amperage and a low voltage into a current of low amperage and a high voltage.

Switch.—An appliance for opening and closing an electric circuit.

Tension.—Voltage; Pressure; E. M. F.

Tesla Coil.—An oil insulated induction coil which raises the voltage and decreases the amperage in the secondary winding.

Thermal Absorption.—The absorption of heat while it passes through the body.

Thermal Current.—A current produced by the flow of heat through a conductor.

Thermal Resistance.—The resistance offered by a body to the passage of heat through it.

Thermic Rays.—(Heat Rays)—The red and the infra-red rays of the spectrum.

Thermopenetration.—See *Diathermy*.

Thermophore.—Electric heating pad composed of insulated flexible resistance wire imbedded in a chemically pure asbestos, or other non-inflammable material.

Transformer.—An induction coil.

Undulatory Current.—Current flowing in one direction, whose voltage increases and decreases (represents a sine curve, without changing polarity).

Vacuum Tube.—Sealed glass tubes from which the gases have been partially removed.

Volt.—The practical unit of the pressure which overcomes the resistance of the electrical circuit, and thereby maintains the current flow. A pressure which maintains a current of one ampere through a resistance of one ohm.

Watt.—The practical unit of work or power. It represents one seven hundred and forty-sixth part (1/746) of a horse power, and is obtained by multiplying the voltage by the amperage.

Brief Outline of Therapeutic Indications

(*Practical Electrotherapeutics*)

IN order to avoid unnecessary repetitions, some practical points in applying electricity to the various parts of the body are given herewith, and *unless otherwise mentioned* under the respective condition, the operator should guide himself by the following technique:

Electrodes

In applying various electrical currents and modalities to the various parts of the body, especially to the eye, ear, nose, throat, vagina, uterus, urethra, rectum, etc., in order to avoid unnecessary pain or shock to the patient, the electrode should always be placed in position (inserted) before the current is turned on, and the current turned off before the electrode is removed.

When lubrication is necessary for the introduction of electrodes to the body cavities (such as urethra, rectum, vagina, etc.), for the sake of better conductivity, vegetable lubricant is preferred to the mineral lubricant.

When in contact with the mucous surfaces, unless otherwise indicated, the electrode should be frequently moved so as to prevent sticking.

Current Strength

Current should be gradually increased and decreased. In employing physiological diathermy, patient's (comfortable) toleration is the best guide as to strength.

Eye Technique

In the treatment of the eyes, the greatest gentleness and care must be exercised, so as to avoid irreparable injury which may result. A study of the blood pressure should be made in every case. If both eyes are affected a double eye electrode may be employed, while if only one eye is treated a single electrode is used. These should be kept in light but firm contact with the closed eyelids.

When the galvanic current is indicated, the negative (on account of its stimulating, liquefying and other effects) is usually the active electrode. (Current strength from 2-7 m. a.; 5-10 min., daily or every other day; indifferent electrode on the nucha). In applying high-frequency current by means of vacuum tube, mild current of very high frequency should be employed from 3-10 minutes.

Mechanical Vibration relieving muscular tension, assisting elimination and absorption, and stimulating the functions of the various structures of the eye is indicated in twitching of the lids, blepharospasm and glaucoma; but contra-indicated in acute inflammations (e. g., conjunctivitis, iritis, keratitis, scleritis, etc.). It should be applied (30-60 seconds) gently, without pressure over the eyeball or over the base of the operator's fingers (finger tips being placed over the closed eyelid).

See Therapeutic Indications under: Amblyopia, Asthenopia, Blepharitis, Cataract, Chalazion, Choroiditis, Conjunctivitis, Corneal Opacity and Ulceration, Diplopia, Entropion, Glaucoma, Iritis, Keratitis, Optic Atrophy and Neuritis, Pterygium, Retinal Atrophy, Retinitis (luetica) Scleritis and Trachoma.

Ear Technique

In treating the middle ear with the high-frequency currents by means of insulated vacuum tubes, in addition to the heat effects (relief of congestion, inflammation and pain) peculiar mechanical and high tension inductive effects on the deeper tissue are produced. Treatments should be continued until the heat effect becomes slightly unbearable but in no case should exceed 6 to 7 minutes. Pneumatic Vibration (suction and pressure) and Hot Air insufflation are valuable adjuncts to the high-frequency currents.

See Therapeutic Indications under: Deafness (Catarrhal and Nervous), Ear-ache, Otitis Media (Chronic Suppurative) and Tinnitus Aurium.

Vaginal and Intra-Uterine Technique

Place the patient in Sims's position so as to reposit the displaced organs and keep them in position during the treatment. If there is no displaced organs the patient may be placed in the dorsal position. In entering the vagina or the uterus strict antiseptic precautions must be observed. Have the patient take an antiseptic vaginal douche before coming for treatment. Sterilize the electrodes thoroughly especially when they are to be used for faradic or negative galvanic applications. (Positive galvanic is germicidal.).

Intra-uterine applications require the use of speculum. For vaginal applications speculum is not necessary. In administering intra-uterine treatments, before introducing the electrode into the cervix clean the vagina and cervix.

See Therapeutic Indications under: Adhesions (Pelvic), Amonorrhea, Cervicitis, Cervix Lacerations, Dysmenorrhea, Endocervicitis, Endometritis, Infantile Uterus, Leukorrhea, Menorrhagia and Metrorrhagia, Metritis, Ovarian Neuralgia and Neuritis, Pelvic Cellulitis and Peritonitis, Pyosalpinx, Salpingitis (Chronic), Uterine Cancer, Fibroids, Prolapsus and Sub-involution, Vaginismus, and Vaginitis.

Urethral Technique

Patient is placed upon his back on the operating table, with the legs ordinarily straight or drawn up (slightly separated). The sterilized metal electrode or an insulated glass tube is lubricated and introduced (without force). In employing glass tubes, great care should be exercised on account of the possibility of breaking the tube while in the urethra; therefore if the canal is too small to admit easily the tube, the urethra should be previously dilated with a steel sound. The posterior urethra may be treated through the rectum.

See Therapeutic Indications under: Gleet, Gonorrhea, Urethral Stricture and Urethritis.

Rectal and Prostatic Technique

Patient is placed on one side, with the knees well drawn up. The current is administered by means of insulated rectal or prostatic electrodes per rectum.

See Therapeutic Indications under: Anal Fissure, Hemorrhoids, Rectal prolapsus, Stricture and Ulcer, Prostate (Ulcerated), Prostatic Hypertrophy and Prostatitis (Chronic).

Therapeutic Indications

Treatments hereafter outlined have been founded on personal observations of a great many practitioners, authorities on the subject, both in this country and in Europe, who unanimously report favorable results from its application.

Books, periodicals and papers which have been read before various medical societies, etc., have been used for reference, but to enumerate all the pages from which facts have been gleaned for corroborative testimony concerning the method of treatment is impossible. The order in which various electrical currents and modalities are mentioned under the respective conditions does not necessarily indicate the order of the therapeutic efficiency or the results obtained by these methods.

During the past five years, having administered over 24,000 electrical treatments to about 3000 different patients, the author has endeavored to mention (in numerous conditions), the various modalities in the order in which he has found them to be more efficient or their application more practicable in the largest percentage of cases.

The practitioner who realizes that there are no two cases alike and that while some patients respond under certain modality, others suffering apparently from the same affection, respond better under some other form of treatment, will consider each individual case and will endeavor, whenever possible, to select the treatment which will remove the primary cause of disease (through the stimulation, inhibition or elimination, as the case may be) rather than the various symptoms. By combining such treatment with dietetic and hygienic measures, which are the essential adjuncts of all the branches of the healing art, he will obtain gratifying results.

Although one may possess the apparatus for the administration of all the various currents and modalities it is not advisable to employ all the various treatments, indicated under a respective condition, at the same time. The practitioner should select one or two modalities at a time, and if after a reasonable length of time, the case does not respond to such a treatment, he should select the other.

NOTICE

Although this work is devoted merely to the principles of Electro-Medicine, Electro-Surgery and Radiology, in order to make it more valuable and interesting, the writer has at the last moment decided to include this "Brief Outline of Therapeutic Indications" from which the practitioner will be able to see at a glance what currents and modalities are indicated in each condition. Due to the lack of space, it was, however, impossible to describe the various treatments in detail (as that would require an additional volume). For the convenience of the prac-

tioners, the author is, however, willing to elaborate, upon request, special detailed description for the treatment of each individual case from the physiological rather than the symptomatic standpoint. In requesting such description, it is, however, necessary to enclose the amount of \$2.00 for each individual case, so as to cover various incidental expenses. Address your communications to the author: Dr. A. MATIJACA, Electropath and Roentgenologist, 413 Cass Street, Joliet, Ill., U. S. A.

Explanatory

When the *Rapid Sinusoidal Current* (or *Vibration*) is indicated mentioning only a certain spinal center (e. g., *Rapid Sinusoidal* to the VII C. or I to III L.), it indicates that the application is employed with a view of eliciting vertebral reflexes. This is accomplished by means of a Sinusoidal current, by placing the active interrupting disc electrode at the spinal center (mentioned) and the indifferent electrode at the sacrum; or by means of a short application of the interrupted vibration.

Vacuum Tube Application and Effleuve

Vacuum tube application indicates that the tube should be in contact with the part treated; while *Effleuve* indicates the use of the vacuum tube (or a metal electrode with number of points) at a certain distance, so as to allow a shower of sparks upon the part.

Active and Indifferent Electrodes

In the application of Galvanic, Faradic, Sinusoidal, and some forms of Static and High Frequency currents in which it is necessary to employ two electrodes when only one is mentioned, it refers to the active which is placed on the part treated (or as mentioned); the other is the indifferent electrode and unless otherwise mentioned may be placed anywhere in contact with the patient.

ABSCISS.—*Chemical Rays* relieve pain and destroy the pus-forming germs.

ACNE VULGARIS.—*Vacuum tube application; Effleuve; Fulguration* (when pustules are present); *X-rays* (medium tube at a distance of 16 inches; once a week); *Arc Light; Radiant Light and Heat; Radium* (for indurated nodules).

ACNE ROSACEA.—*Effleuve; Fulguration* (the object is to destroy the enlarged veins; don't repeat until the effect of the first treatment has subsided).

ADENITIS, CHRONIC SUPPURATIVE (Tubercular).—*Vacuum tube applications; Effleuve; X-rays* (hard filtered rays; about 1.5 m. a.; 15 minutes, every other day; tube 15 inches from the surface); *Arc Light; Diathermy* (to a point of tolerance, 20 to 30 minutes daily for 4 to 6 weeks, then less often until glands disappear); *Iodine Ionization*.

ADHESIONS, PELVIC.—*Morton Wave current; Negative Galvanization* (with covered copper ball, vaginal electrode); *Secondary Faradic; Thiosinamin Ionization* (from the positive).

ALBUMINURIA.—*Auto-condensation* (375 to 700 m. a. for 20 minutes) followed by *Effleuve* over the spine, liver and renal areas.

ALOPECIA (Loss of Hair).—*Ultra-Violet Rays; Effleuve; Static Negative Head Breeze; Vibration*.

ALOPECIA AREATA.—*X-rays* (medium or high tube; once every two weeks; remember that small doses of X-rays stimulate the growth, while the large doses act as a depilatory); *Effleuve; Ultra-Violet Rays; Arc Light; Zinc Ionization*.

AMBLYOPIA.—*Galvanic Sinusoidal*.

AMENORRHEA.—*Negative Galvanism* (vaginal); 30 to 40 m. a., 10 minutes every other day; *Auto-condensation* (400 to 600 m. a., 10 to 15 minutes); *Effleuve; Vibration* over the lower lumbar vertebrae; *Light Bath*. See also *Infantile Uterus*.

ANÆSTHESIA (a condition due to peripheral cause).—*Faradization; Effleuve*.

ANÆSTHESIA, PRODUCTION OF—*Ionization* with Cocaine Hydrochloride; *Leduc Current* (a highly interrupted galvanic current).

ANAL FISSURE.—*Vacuum tube application* 3 to 7 minutes daily (tube should be well lubricated with vaseline and passed well up into the rectum so as to be in contact with the whole breadth of the sphincter); *Metallic Cataphoresis* with copper, active electrode, connected to the positive pole (5 m. a. for 5 minutes).

ANEURISM.—*Auto-condensation* (400 to 800 m. a., 10 to 20 minutes; 3 to 6 times per week); (*Vacuum tube applications are contra-indicated*); *Positive Electrolysis* (20 to 30 m. a., at most per needle; 30 minutes at first seance, increasing at following); *Vibration* of the VII C. interspace for 5 minutes or less; *Rapid Sinusoidal* over VII C.

- ANGINA PECTORIS.**—*Auto-condensation*, (if hypertension exists); *Bachalet Wave*; *Light Bath* of short duration; *Radium Emanation*; *Rapid Sinusoidal* over VII C. (in Angina Pectoris with dilatation) or over III to IV D. (in Cardio-tonic Angina Pectoris).
- ANGIOMA.**—*High Frequency Desiccation*; *Radium*; *X-rays*; *Electrolysis*.
- ANKYLOSIS.**—*Diathermy* creates sufficient heat within the tissues and causes Nature to absorb the necessary fibrous deposit; *Negative Galvanism*.
- ANOSMIA.**—Good results are obtained with the intra-nasal application of *Galvanism* and with the *Vibration* of the mucous membrane.
- ANURIA.**—*Galvano-Faradization* to the spine (weak current 5 to 10 minutes daily).
- APHONIA (Loss of Voice).**—*Galvanism* (positive at the nucha; negative over the larynx; 15 m. a. for 10 minutes; follow by placing the electrode on the sides of the neck. Both electrodes should be saturated with Sodium Bicarbonate Solution.); *Slow Sinusoidal* so as to produce strong but painless contractions; *Vibration* with medium pressure over the neck, throat, liver and stomach.
- APHONIA, HYSTERICAL.**—*Effleuve* or *Faradization* over the laryngeal region.
- APPENDICITIS.**—In early cases, the disease may be aborted entirely by the *Radiant Light* treatment. See also *Pseudo-Appendicitis*.
- ARRHYTHMIA.**—*Rapid Sinusoidal*; or *Vibration* over VII C.
- ARTERIOSCLEROSIS.**—*Auto-condensation* (300 to 800 m. a., 10 to 20 minutes daily) is practically a specific. (*Effleuve* to the spine and solar plexus is distinctly contra-indicated.) *Bachalet Wave*; *Light Bath*; *Radium Emanation*; *Sinusoidal Bath*.
- ARTHRITIS, ACUTE.**—*Positive Galvanism*; *Lithium* or *Salicylic Ionization*; *Diathermy*. Treatments should not be administered during febrile period.
- ARTHRITIS, GONORRHEAL and RHEUMATOID.**—*Diathermy*; *Auto-condensation*; *Morton Wave*; *Vibration*; *Hot Air*; *Light Bath*; *Radium Emanation*; *Positive Galvanism* (in rheumatoid arthritis); *Lithium Iodine* or *Salicylic Ionization*.
- ASCITES.**—*Auto-condensation*; *Morton Wave*; *Negative Head Breeze*; *Light Bath*; *Vibration*.
- ASPHYXIA.**—*Faradization*.
- ASTHENOPIA.**—Strong *Effleuve* up and down the spine for 3 minutes, over the back of the head and neck for 3 minutes, daily; *Ozone Inhalation*; *Vibration* or *Rapid Sinusoidal* over II and III D.
- ASTHMA, BRONCHIAL.**—*Diathermy* (1500 m. a., 30 minutes, daily; same size electrodes covering the anterior and posterior upper part of the chest); *Effleuve* along the spine, over the chest and over throat glands; *Ozone Inhalation*; *Rapid Sinusoidal* over the spines of the IV and V C. stimulates the lung reflex of contraction, apply strong current from 15 to 45 minutes, daily; *Morton Wave*; *Spinal Vibration*; *Radiant Light and Heat*.
- ASTHMA, CARDIAC.**—*Rapid Sinusoidal* over the VII C.
- ATELECTASIS.**—*Rapid Sinusoidal* over III to VIII D.
- ATHEROMA.**—*Diathermy*.
- AUTO-INTOXICATION.**—*Auto-condensation*; *Light Bath*; *Slow Sinusoidal* (15 cycles per minute, 40 to 60 volts; 10 to 15 minutes, every other day. Same size electrodes, one over abdomen and the other over the IV to XII D. or in the form of a bath); *Rapid Sinusoidal* over I to III L.
- BASEDOW'S DISEASE.**—See *Goitre*, *Exophthalmic*.
- BLADDER CALCULI.**—*Electro-coagulation*.
- BLASTOMYCOSIS.**—*X-rays*.
- BLEPHARITIS MARGINALIS.**—*Vacuum Tube* applications to the lids for 5 to 15 minutes, daily; *Galvano-Cautery* (in ulcerative blepharitis); *Radiant Light* from an incandescent lamp of 500 candle power placed closely over the eyes for few seconds, and repeated several times at each treatment; *X-ray* (hard tube) is the best treatment in severe cases.
- BRIGHT'S DISEASE, CHRONIC.**—*Auto-condensation*; *Vacuum Tube* application over the kidney regions; *Diathermy*; *Negative Head Breeze* (15 minutes) followed by the *Positive Charging* (15 minutes); *Morton Wave* to the spine may be alternately substituted for the head breeze; *Bachalet Wave*; *Light Bath* or strong applications of radiant light and heat over the lumbar region; *Radium Emanation*; *Vibration* over the kidneys with the slow, heavy, penetrating stroke; *Rapid Sinusoidal* over the X-D. increases the functional activity of the kidneys; increases red blood corpuscles and reduces hypertension. In Interstitial form, apply over the VI and VII D.; in Parenchymatous, over the XII D.

BROMIDROSIS.—*X-rays* (short exposures).

BRONCHITIS.—*Auto-condensation* (400 to 800 m. a., 10 minutes); *Effleuve* to the chest and back, causing a reddening; *Ozone Inhalation*; *Radiant Light and Heat*; *Vibration* removes congestion and makes easier the expectoration. Apply on each side of the neck, and front and back of the chest. Also on each side of the spine from middle dorsal to lumbar vertebrae, with heavy pressure.

BRONCHOCELE.—See *Goitre, Simple*.

BUBOS, VENEREAL.—*X-rays* (one sixth of the aluminum filter ordinarily used for deep radiotherapy or only one half mm. and one half the focal distance).

CARBUNCLES.—*X-rays* (as in *Acne*); *Effleuve* diminishes pain and reduces surrounding inflammation; *Metallic Cataphoresis* with a zinc needle connected to the positive terminal.

CARCINOMA.—*X-rays* (medium tube; 8 to 10 inches from the surface; 5 to 10 minutes, once a week; "Cross-Fire" method); *Desiccation*; Post-operative *Fulguration*; *Radium*; *Chemical Rays*; *Electrolysis* with zinc needles (connected with the positive terminal) thrust into the edges of the growth. In-different electrode in the center of the large growth (or elsewhere in the case of a small growth).

CATALEPSY.—*Faradization*; *Sinusoidal* to the left nipple; *Effleuve*.

CATARACT.—*Negative Galvanism* (5 to 15 m. a., 10 to 15 minutes, daily) to the eyelids; indifferent positive to the nucha; *Radiant Light*; *Vacuum tube application* over the closed eyelids.

CEREBRAL ANAEMIA.—*Negative Head Breeze*; *Spinal Vibration* or centripetal friction.

CEREBRAL ASTHENIA.—If hypertension exists: *Auto-condensation* (400 to 800 m. a., 10 to 15 minutes, daily) followed by a *Vacuum tube application* to the forehead over the eyes and to the back of the head and neck for 10 to 15 minutes; if hypotension exists: *Static Positive Charge*; *Effleuve* over the spine and solar plexus; *Vibration* along the spine.

CEREBRAL HYPERAEMIA.—*Positive Head Breeze*; *Vibration* (interrupted) between the II and III D. on each side for two periods of 5 minutes each.

CERVICITIS.—*Metallic Cataphoresis* by means of the copper intra-uterine electrode (introduced through a glass or rubber speculum) up to the internal os., gives more permanent results than curettement; (8 to 12 m. a., 7 to 10 minutes; indifferent electrode on the abdomen.) Do not move the electrode, but allow it to stick to the mucous. When the mucous plug has adhered to the electrode, by a little traction withdraw same. (There may be some bleeding but this is of no consequence.) *Copper Ionization*; *Insulated vaginal Vacuum tube applications*, 5 to 7 minutes, daily or every other day; *Vibration* (if the cervix is considerably enlarged) applied directly to the cervix.

CERVIX, LACERATIONS OF—*Thiosinamin* (*Allyl-sulphocarbamide*) *Ionization* by means of a covered non-oxidizable (platinum) electrode connected to the positive terminal and applied to the cicatrix (10 to 15 m. a., 10 minutes).

CHALAZION.—*Negative Electrolysis* (3 to 5 m. a., 10 minutes); if the thickening remains after the removal of chalazion, grasp the part with the forceps and apply to it *Negative Galvanism* (sponge, with 2 m. a. for 2 or 3 minutes).

CHANCROID.—*Fulguration*. One treatment of $\frac{1}{2}$ to 1 minute is usually sufficient and has proven more effective than chemical cauterization.

CHILBLAINS.—*Vacuum tube application* or *Effleuve* (with a high exhausted electrode), daily; *Rapid Sinusoidal* or *Vibration* over the VII C.; *Positive Galvanic Bath* (local).

CHLOASMA.—*Negative Galvanism* to pigmentations.

CHLOROSIS.—See *Anaemia*.

CHOLECYSTITIS (Inflammation of the gall-bladder).—*Diathermy*; *Rapid Sinusoidal* or *Vibration* from IV to VI D.

CHOLELITHIASIS (Gall-stones).—*Diathermy*; *Radiant Light and Heat*; *Rapid Sinusoidal* over IX D.

CHOREA (St. Vitus Dance).—*Effleuve sparks* over the spine, abdomen and extremities (15 minutes, daily or every other day); *Auto-condensation* (400 to 600 m. a., 10 to 15 minutes); *Morton Wave*; *Static Charge*; Sparks drawn from the spine and affected side; *Vibration* between the II and III D.; *Bachal-let Wave*; *Light Bath*; *Faradic Bath*; *Ozone Inhalation*.

CHOROIDITIS.—*Negative Galvanic* over the eyes (positive to the nucha; 5 to 15 m. a., 5 to 10 minutes daily); *Rapid Sinusoidal* (10 minutes, daily); *Radiant Light* to the eyes (5 minutes, daily); *X-rays* (50 to 100 flashes per minute).

CICATRICAL TISSUE.—*Negative Galvanism*; *Thiosinamin Ionization*.

COLITIS.—*Diathermy* with large tinfoil electrodes over the abdomen and back (2000 m. a., 30 minutes, daily for two weeks, then every other day until cured); *Effleuve* over the bowel area; *Auto-condensation* (400 m. a., 10 to 15 minutes); *Zinc Ionization*.

CONDYLOMATA.—*Fulguration* until the growth is distinctly reddened. (Do not repeat until all irritation has disappeared); *Negative Electrolysis*; *Magnesium Ionization*; *Desiccation*.

CONJUNCTIVITIS (Acute Catarrhal).—*Radiant Light* gives better results than any drug treatment known (10 to 20 minutes, daily); *Zinc Ionization* gives better results than light when the disease is due to the *Morax Axenfeld* infection.

CONJUNCTIVITIS (Chronic Palpebral).—*X-rays* (low tube 5 to 10 inches from the eyes); 5 to 10 minutes, three times a week; *Effleuve*; in *Chronic Hyperplastic Conjunctivitis*: *Metallic Cataphoresis* with copper electrode (3 m. a., 5 minutes, daily; under cocaine anæsthesia).

CONSTIPATION.—*Slow Sinusoidal* (15 cycles per minute, 40 to 60 volts; 10 to 15 minutes, every other day; same size electrodes: one over the abdomen, the other over the IV to XII D. or II L. or in the form of a bath); in atonic constipation: *Rapid Sinusoidal* over the I to III L.; in spastic constipation over XI D.; *Galvanism* (15 to 20 m. a., interrupted 100 times per minute, 10 minutes, daily) with two small sponge electrodes held about three inches apart and passed over the abdominal wall in the direction of the colon; also positive stable over the liver; negative labile following the colon; *Galvano-Faradization* with a large positive over the region of the coeliac plexus and the negative over the IV to XII D. (10 to 15 minutes); (occasionally interrupted); Rectal and abdominal *Vacuum Tube* applications (low frequency; 10 minutes, daily); *Auto-condensation* (600 m. a., 10 minutes) with metal plate over the abdomen; *Static Induced*; *Morton Wave* or *Static Sparks* (20 minutes, daily); *Slow Vibration*, with heavy pressure on and between the lumbar vertebrae especially over the IV L.), also on and around the abdomen, following colon (5 to 10 minutes).

CORNEAL OPACITY or CORNEAL ULCERATION.—*Vacuum tube application* to the closed eyelids; *Chlorine Ionization* (in Opacity); *Zinc Ionization* (in Ulceration).

CORYZA.—*Vacuum Tube Application* (nasal and external); *Ozone Inhalation*; *Hot Air* (nasal insufflation); *Rapid Sinusoidal* over VII C.; *Vibration* (slow stroke over the posterior nerve roots in the intravertebral spaces between VII C. and I D., 2 minutes, also on each side of the neck and back of the head and between the eyes and cheeks [rapid stroke] 10 to 15 minutes).

CRAMP, PROFESSIONAL.—See *Occupational Neuroses*.

CYSTITIS.—*Vacuum Tube application* over the bladder region; also rectal application; *Radiant Light and Heat*, 10 to 15 minutes; in chronic cases 15 to 30 minutes, every other day; *Bachalet Wave*.

DEAFNESS, CATARRHAL.—*Vacuum Tube application* (with the ear electrode), increasing the strength until the patient can tolerate with comfort; *Hot Air* insufflation; *Pneumatic Vibration* (suction and pressure); *Mechanical Vibration* (with a soft rubber applicator) over and just under and around the ear with the mouth open. (Place cotton in the opposite ear to the one under treatment.) Daily treatments with *Vacuum tube*, hot air and vibration is considered almost a specific as remarkable results are obtained in ninety per cent. of cases treated.

DEAFNESS, NERVOUS.—*Rapid Sinusoidal* over VII C. Also see *Catarrhal Deafness*.

DELIRIUM TREMENS.—*Bachalet Wave*.

DIABETES (Mellitus).—*Auto-condensation* (400 to 800 m. a., 10 to 20 minutes, daily until the sugar begins to decrease; then every other day) is the best single remedy that we have for this condition; *Effleuve*, *Vibration*, *Morton Wave* or *Slow Sinusoidal* (12 to 120 cycles per minute) over the epigastrium and back (or *Sinusoidal Bath*); *Rapid Sinusoidal* over the VII C.; *Light Bath*; *Radium Emanation*.

- DIARRHEA, NERVOUS.**—*Rapid Sinusoidal* over XI D.
- DIPLOPIA.**—*Vibration* between the II, III and IV D. for about 3 minutes.
- DROPSY, RENAL.**—See *Ascites*.
- DUODENAL ULCER.**—Pain may be relieved by *Rapid Sinusoidal* over the X D. vertebra.
- DYSMENORRHEA, CONGESTIVE.**—*Morton Wave*; *Bachalet Wave*; *Vaginal Vacuum tube application* (15 minutes). See also *Metritis*.
- DYSMENORRHEA, MEMBRANOUS.**—*Negative Electrolysis* destroys (decomposes) the diseased endometrium and stimulates a healthier growth. (Insert a negative metal sound into the cervix so that the metal part will come in contact with the internal os; large indifferent, positive upon the lower abdomen, 20 to 40 m. a. from 5 to 10 minutes. Treat every four or five days, and decrease the current strength as the condition improves.)
- DYSMENORRHEA, NEURALGIC.**—*Positive Galvanism* by means of covered copper ball, vaginal electrode; *Vaginal Vacuum Tube application*.
- DYSMENORRHEA, OBSTRUCTIVE.**—See *Infantile Uterus*.
- DYSPEPSIA.**—*Slow Sinusoidal* (one electrode on the back at the level of the VIII D.; active labile over the epigastric region); *Effeuve* over the stomach and solar plexus, 10 to 15 minutes, daily; *Auto-condensation* (400 to 600 m. a., 15 minutes, daily) with a broad metallic electrode over the stomach; *Bachalet Wave*; *Static Positive Charge*; *Radiant Light and Heat*. Treat one or two hours after the patient has taken his meal.
- DYSPNOEA.**—*Vibration* or *Rapid Sinusoidal* over VII C.
- EARACHE.**—*Vacuum Tube application* (with the ear electrode); *Morton Wave* by means of a double ear electrode with wet cotton twisted upon the distal ends and inserted as far as possible into the ears (without force). Spark gap about $\frac{1}{4}$ of an inch apart or less.
- ECZEMA.**—*X-rays* (medium tube; 8 to 10 inches from the surface; 4 to 6 seconds, once a week); *Finsen Light*; *Arc Light*; *Vacuum Tube application*; *Effeuve* (if itching); *Auto-condensation*; *Ozone Spraying*; *Hot Air* (after the application, cover the affected region with olive oil); *Radiant Light and Heat* (short, sharp treatments of 1 to 2 minutes, continued at 2 minute intervals for 15 to 30 minutes); *Static Spray*; *Sinusoidal Bath* at a temperature of 98 to 100 degrees F.; *Zinc Ionization* (in pustular form).
- EMPHYSEMA.**—*Light Baths*; *Hot Air*; *Rapid Sinusoidal* III and IV D.; *Arc Light*. Raise the blood pressure.
- ENDOCERVICITIS.**—See treatment for *Endometritis*.
- ENDOMETRITIS.**—*Positive Galvanization* with a copper sound (having a hard rubber insulated tip) to the fundus. (20 to 50 m. a., according to the toleration of the patient, for 5 to 10 minutes.) In order to prevent sticking, the copper sound should be amalgamated before each treatment. This is accomplished by plunging the sound into 10 per cent. sulphuric acid solution and then into a bottle containing metallic mercury, and rubbing it briskly with absorbent cotton. In administering this treatment, the patient should be informed that the first few applications often cause a bloody discharge from the uterus, which is beneficial, as it relieves the engorged blood vessels. After gradually turning off the galvanic current, without withdrawing the sound turn on the *Secondary Faradic* or *Rapid Sinusoidal Current* (rhythmically interrupted about 60 times per minute), and regulate the current strength so as to produce painless muscular contractions. (This will contract relaxed uterine muscles and stimulate the absorbents to take up the products of decomposition.) Allow this current to flow from 3 to 5 minutes, increasing the duration two minutes at every succeeding treatment, until it is given for 10 minutes. Insulated vaginal *Vacuum Tube applications* (5 to 7 minutes.) Treat only twice per week.
- Rapid Sinusoidal* over XI D.
- ENTERALGIA.**—*Slow Sinusoidal* (15 cycles; 40 to 60 volts; 10 to 15 minutes, every other day for 2 to 4 months) with same size electrodes, one over the abdomen, the other over the IV to XII D.; *Rapid Sinusoidal* III to VIII D.
- ENTROPION.**—Electrolysis by means of negative needle introduced beneath the integument parallel to the lid border, and three mm. above the edge (5 to 8 m. a., 6 to 8 minutes.) If not successful, repeat the process two weeks after. Deep puncture with *Galvano-Cautery* tip.

- ENURESIS.**—*Rapid Sinusoidal* or *Vibration* (rapid stroke) over the V L.; *Secondary Faradic* (rapidly interrupted) with a short active per rectum and an indifferent sponge over the pubis.
- EPIDIDYMITIS.**—*Vacuum tube application* over the scrotum (daily); *X-rays* may be used in connection with the vacuum tube, but the healthy part must be protected during the treatment.
- EPILEPSY.**—Some cases have been cured and scores of others relieved to a greater or less degree by *Vacuum tube applications* over the brain and *Effleuve* over the spine (5 to 10 minutes, daily); *Bachalet Wave*; *Slow Sinusoidal*.
- EPISTAXIS.**—*Rapid Sinusoidal* or *Vibration* over the VII C.
- EPITHELIOMA.**—*X-rays* (very low tube; 8 to 10 inches from the surface; 3 to 4 minutes, once every five days). When the reaction appears, cease the X-ray and use *Vacuum tube* until a scab is formed; *Radium*; Vigorous applications of the *Radiant Light*; *Zinc Ionization*.
- FAUCHARD'S DISEASE.**—See *Pyorrhea Alveolaris*.
- FAVUS.**—*Effleuve* from a metal or carbon electrode (5 to 10 minutes, daily); *X-rays*. See also treatment for *Ringworm*.
- FIBROMA.**—*X-rays*; *Radium*; *Diathermy*. See also *Uterine Fibroids*.
- FISTULA.**—*Metallic Cataphoresis* with a pointed copper (or zinc) probe introduced (under a local anæsthesia) to the full depth of the tract (5 to 15 m. a., according to the size of the electrode, until a film of green oxide is thoroughly deposited in the tissue surrounding the electrode; *Desiccation*; *Effleuve*; *Zinc* or *Copper Ionization*.
- FLATULENCE.**—*Abdominal Vibration*; *Spinal Vibration* on the left side of the spine from VI to VIII D.
- GALACTORRHEA.**—*Positive Galvanization* of the mammary glands (avoiding the nipples).
- GALL-STONES.**—See *Cholelithiasis*.
- GASTRALGIA** (Pain in the stomach).—*Radiant Light* and *Heat* over the epigastric region relieves the congested nerve centers; *Galvano-Faradization*. See also *Gastritis* and *Constipation*.
- GASTRECTASIS** (Dilatation of the Stomach).—*Slow Sinusoidal* (15 to 60 cycles per minute; 40 to 60 volts; 10 to 15 minutes, every other day), one electrode over the abdomen, other over the IV to XII D., followed by *Vibration* or *Rapid Sinusoidal* I to III L.
- GASTROPTOSIS.**—*Slow Sinusoidal* (as in Gastrectasis); one electrode (3 x 6 inches) over the left side of the spine from III to VII D., other electrode below the stomach.
- GLANDS, ENLARGED.**—*Vacuum tube applications*; *Radiant Light* if applied while in the incipient state, the swelling will be reduced and the germs destroyed.
- GLANDS, SUPPURATIVE.**—See *Adenitis*.
- GLAUCOMA.**—*Vacuum Tube application* (preferably from *Morton Wave* current) 8 to 15 minutes; *Radiant Light*; *X-rays* (50 to 100 flashes per minute); *Galvanization* (4 to 6 m. a., 10 to 15 minutes, negative to the eyelids; positive to the back of the neck, daily; *Auto-condensation*; Gentle *Vibration* over the closed eyelids (about 30 seconds).
- GLEET.**—*Vacuum Tube application* with the insulated urethral electrode (7 minutes.) The higher the vacuum of the electrode, the better the results. If urethral tube cannot be used, rectal application will give relief. It should be explained to the patient that the discharge usually increases during the first few treatments, then gradually diminishes. *Diathermy* with the steel sound in urethra and a large metal electrode over the abdomen. Increase the current up to the comfortable toleration within the organ. (30 minutes, every day for a week, then every other day for two weeks.) See also *Urethritis*.
- GLYCOSURIA.**—See *Diabetes Mellitus*.
- GOITRE, SIMPLE.**—*Negative Galvanization* (15 to 40 m. a., 20 to 45 minutes, every other day); *Iodine Ionization*; *Effleuve* over the sides of the neck as well as over the goitre itself; *Auto-condensation*; *Vibration* (slow) between VII C. and I D.; *Morton Wave*.
- GOITRE, EXOPHTHALMIC.**—*X-rays* (low tube; 16 inches from the surface; 3 to 4 minutes, 2 or 3 treatments a week.) Alternate treatments with *Effleuve* over the gland and over the Spine until intense hyperemia is produced. *Static*

Positive Charge (15 minutes); **Galvanization** (negative active as in Simple Goitre is contra-indicated) with the positive active, over the gland will decrease the pulse beat (15 to 20 m. a., 5 to 10 minutes); **Thiosinamin Ionization** (from the positive) will reduce the enlargement; **Diathermy** (one electrode over the thyroid gland, other over the cervical and upper dorsal region; 30 minutes, daily for six or eight weeks) reduces the enlargement and improves the general nervous manifestations; **Radiant Light and Heat** over the entire abdominal region (15 to 25 minutes); **Rapid Sinusoidal** over the VII C.

GONORRHEA.—See *Gleet*.

GOUT.—**Vacuum Tube application; Auto-condensation** (300 to 800 m. a., 5 to 15 minutes); **Diathermy; Hot Air; Radiant Light and Heat; Morton Wave; Sinusoidal Bath; Ionization** by means of Schnee Bath (Lithium Chloride Solution in arm cells, connected to the positive; Potassium Iodide Solution in feet cells connected to the negative); **Radium Emanation; Gentle Vibration**; begin with short treatments and gradually increase. (Don't treat during an acute attack).

GRAVE'S DISEASE.—See *Goitre, Exophthalmic*.

GRIPPE.—See *Influenza*.

HAIR, FALLING OF.—See *Alopecia*.

HAIR, SUPERFLUOUS.—See *Hypertrichosis*.

HAY FEVER.—**Ozone Inhalation; Vacuum Tube** over the nose and the spine; **Auto-condensation; Vibration**.

HEADACHES.—Treat the primary exciting cause. **Frontal or Congestive: Vacuum Tube** over the seat of pain (5 to 10 minutes); **Auto-condensation** 400 to 600 m. a., 10 to 15 minutes; **Positive Head Breeze; Vibration** (inhibitive) toward the center of forehead, across the temples and from above downward in the occipital region, the neck and from I. C. to I. D. **Nervous Headaches: Vacuum Tube** over the affected area and cervical vertebrae; **Bachalet Wave; Vibration** (as for Congestive). **Headaches due to Anaemia: Negative Head Breeze; Bachalet Wave**.

HEMOPTYSIS.—**Rapid Sinusoidal** over the VII C.

HEMORRHOIDS.—**Positive Galvanization** with a short, copper, rectal electrode (10 to 15 m. a., 10 minutes, every other day); **Rectal Vacuum Tube application; Auto-condensation; Zinc Ionization; Electro-coagulation; Radiant Light and Heat**.

HEPATIC CONGESTION.—**Static Induced; Morton Wave; Rapid Sinusoidal I to III L**.

HEPATIC FEVER.—(If associated with Gall-Stones) **Rapid Sinusoidal IV to VI D**.

HERPES ZOSTER (Shingles).—**Effleuve; Vibration; Ozone Inhalation; Galvanization** (large positive electrode on the spine over the roots of the affected nerves; negative on the affected region, but not over the eruption; 5 to 20 m. a., 10 to 15 minutes, every other day.).

HICCUGH.—**Secondary Faradic (Oesophageal); Galvanization** (one electrode on the neck, other on the epigastric region; 10 to 15 m. a., 10 to 15 minutes); **Bachalet Wave**.

HIVES.—See *Urticaria*.

HODGKIN'S DISEASE.—See *Pseudoleukemia*.

HYPERHYDROSIS.—**X-rays**.

HYPERTENSION (High Blood Pressure).—Treat the primary exciting cause. **Auto-condensation; Bachalet Wave; Morton Wave; Light Bath; Vibration** or **Rapid Sinusoidal** to the II, III, and IV D. (5 minutes, daily) or if due to cardiac weakness to the VII C.

HYPERTRYCHOSIS (Removal of Superfluous Hair).—**X-rays** (large doses); **Electrolysis** with a needle connected to the negative.

HYPOCHONDRIASIS.—**Faradic Bath; Static Positive Charge**.

HYPOTENSION (Low Blood Pressure).—**Effleuve** to the spine and solar plexus; **Static Positive Charge; Vibration** or **Rapid Sinusoidal** over the VI and VII D. Treat the primary cause.

HYSTERIA.—If blood pressure is normal or high: **Auto-condensation** and **Bachalet Wave**; if blood pressure is sub-normal: **Static Positive Charge; Sinusoidalization; Ozone Inhalation**.

IMPOTENCE.—**Mild Effleuve** over the generative organs, perineum, inguinal and bladder regions, and the lower half of the spine; also per rectum; **Pneumatic**

and *Mechanical Vibration*; *Galvano-Faradization* (10 to 15 m. a.), positive to the nucha; negative to the coccyx for 5 minutes, then positive to perineum, negative to lumbar region for another 5 minutes; *Faradization* (mild urethral from 1 to 3 minutes, also external).

INDIGESTION.—*Effleuve* over the stomach; *Auto-condensation*; *Vibration* over the abdomen and over the spine from the IV C. to VI D. vertebrae; *Slow Sinusoidal*.

INFANTILE UTERUS.—*Negative Galvanization* (5 m. a., for 5 minutes) with an olive shaped tip introduced into the cervix, followed by *Secondary Faradization* (5 to 10 minutes).

INFLUENZA.—*Effleuve* over the spine, solar plexus, sides of the nose, etc.; *Auto-condensation*; *Ozone Inhalation*; *Radiant Light and Heat* over the chest, throat and nose (10 to 12 minutes, daily).

INFECTION, LOCAL.—*Diathermy*; *Radiant Light and Heat*; *Hot Air* (especially in local septic infection); *Static Induced Current*.

INSOMNIA.—Remove the primary cause. *Auto-condensation*; *Vibration* (centrifugal toward the extremities; to the neck, liver, stomach, kidneys, etc); *Bachalet Wave*; *Static, Positive Charge*; *Positive Head Breeze*; *Morton Wave*; *Vacuum tube* over the back of the head and neck for about 5 minutes, following over the eyebrows for 3 to 4 minutes; *Ozone Inhalation*; (Treat preferably in the latter part of the day).

INTESTINAL ATONY.—*Slow Sinusoidal* (15 cycles per minute, 40 to 60 volts; 10 to 15 minutes, every other day) with the same size electrode over the abdomen and over the spine from IV to XII D. vertebrae.

INTESTINAL OR SPLANCHNIC NEURASTHENIA.—*Sinusoidal* (slow or rapid) with both electrodes (of the same size) in the intra-scapular region of VIII D.; or a small electrode in the intra-scapular region and a large pad on the abdomen (10 to 20 minutes, daily); *Rapid Sinusoidal* III to VIII D. and I to III L.

IRITIS.—*Negative Galvanism* to the closed eyelids; positive to the nucha or the mastoid process (1 to 4 m. a., 10 to 25 minutes, every other day); *Blue Light* (15 minutes); *Vacuum Tube applications*; *Radiant Light* (from a 500 c.p. lamp).

ITCH, BARBER'S.—See *Sycosis*.

JAUNDICE, CATARRHAL.—*Rapid Sinusoidal* IV to VI D.

JOINTS, ANKYLOSIS OF.—*Diathermy*; *Chlorine Ionization*.

JOINTS, HYPERTROPHY OF.—*Chlorine Ionization*.

JOINTS, INFLAMMATION OF.—*Vacuum Tube applications*; *Morton Wave*; *Auto-condensation*; *X-rays*.

JOINTS, STIFF.—*Radiant Light and Heat*; *Galvano-Faradization*; *Diathermy*; *Chlorine Ionization* (if resulting from fibrous ankylosis).

JOINTS, TUBERCULOSIS OF.—*Radiant Light and Heat* (30 to 40 minutes), to the diseased area, down the thigh and the knee, and up the spine if there is any tenderness. (Perform movements during the application.) *Diathermy* (1 to 2 hours per day); *Galvanization* through the joint, if electro-chemic action is desired (50 to 100 m. a. for 10 to 15 minutes); *Effleuve* (in sub-acute and chronic cases).

KELOID.—*Electrolysis* with the negative needle; *Ultra-Violet rays*; *X-rays*; *Static Sparks*; *Radium*.

KERATITIS, PURULENT.—*Zinc Ionization*.

LACHRYMAL CANAL, STRICTURE OF.—*Negative Electrolysis* with a copper sound No. 1 or 2. (3 to 5 m. a., 2 to 4 minutes; every eight days until relieved.)

LARYNGITIS.—*Vacuum Tube application*; *Blue Light*; *Ozone Inhalation*; *Radium Emanation*.

LEUKAEMIA (Spleenic).—*X-rays* is the best remedy we possess; (*Effleuve* is distinctly contra-indicated.) *Auto-condensation*; *Rapid Sinusoidal* I to III L.

LEUKODERMA.—*Radiant Light*; *General Galvanization* (positive to the nucha; negative to the affected spots; 2 to 5 m. a. Stop the application before excessive reaction is induced).

LEUKORRHEA.—*Vaginal Vacuum Tube application* (3 to 10 minutes, daily); *Auto-condensation* (when general conditions indicate its application).

LICHEN.—*Vacuum Tube application*; *Radiant Light*; *X-rays* (as in Eczema).

LITHIASIS.—*Auto-conduction* or *Auto-condensation*; *Galvanization*.

LIVER, CONGESTION OF.—See *Hepatic Congestion*.

LOCOMOTOR ATAXIA.—See *Tabes Dorsalis*.

LUMBAGO.—*Effleuve*; *Auto-condensation*; *Vibration* (with heavy pressure over the lower dorsal and lumbar regions); *Radiant Light and Heat*; *Diathermy*; *Hot Air*; *Morton Wave*; *Slow Sinusoidal* (one pad on the cervical region, another on the sacrum; 15 to 20 minutes, daily); *Sinusoidal Bath* at a temperature of 97 degrees F. (one electrode on the lumbar region and several electrodes, connected together, hung around the sides of the tub); *Galvanism* (large active positive to the painful region; larger indifferent to the abdomen; 60 to 100 m. a., 20 to 30 minutes, daily); *Salicylic* or *Iodine Ionization*.

LUPUS VULGARIS AND ERYTHEMATOSUS.—*Ultra-Violet Rays*; (*Finsen Treatment*); *X-rays* (medium tube; low frequency and low voltage; 1 to 3 minutes, two or three times per week); avoid any reaction greater than superficial erythema; *Desiccation*; *Radium*; *Effleuve* (from a metal electrode); *Fulguration* (for nodules); *Zinc Ionization* (in Erythematosis).

LYMPHADENOMA.—See *Pseudoleukaemia*.

MELANCHOLIA.—*Light Bath*; *Morton Wave*; *Vibration* over the spine, liver, spleen and stomach.

MENOPAUSE.—*Auto-condensation* (300 to 800 m. a., 10 to 20 minutes, every other day) and *Vacuum Tube application* over the spine, abdomen, back of the head and neck (15 to 20 minutes) will alleviate the various nervous symptoms.

MENORRHAGIA AND METRORRHAGIA.—*Positive Galvanization* with a copper intra-uterine electrode; *Vaginal Vacuum Tube applications*; *X-rays*; *Rapid Sinusoidal I to III L.*

MERALGIA PARASTHETICA.—*Auto-condensation* followed by *Effleuve* over the affected area; *Positive Galvanization* (8 to 20 m. a., daily; positive to the painful area or beneath the anterior-superior iliac spine of the affected side; indifferent negative to the lower spine); *Faradization*.

METRITIS.—In early stages *Positive Galvanization* (30 to 50 m. a., 10 minutes) with a copper ball electrode, followed with *Secondary Faradic* (interrupted 30 to 60 times per minute) for 5 to 10 minutes; in later stages employ the *Negative Galvanization* instead of *Positive*.

MOLES.—*Desiccation*; *Fulguration*; *Negative Electrolysis*.

MUSCULAR ATROPHY.—*Slow Sinusoidal*; *Galvano-Faradization*; *Static Induced*. (For Progressive Muscular Atrophy see *Poliomyelitis, Chronic*.)

MYOCARDITIS.—*Auto-condensation* removes the load from the heart and has a distinctly tonic action upon the heart muscle; *Radium Emanation*.

MYOMA (Muscular Tumor).—*X-rays*; *Electro-coagulation*.

MYXOEDEMA.—*Morton Wave* with a metal electrode over the gland; also over the abdomen with a flat metal electrode about 6 x 8 inches; (Spark-gap 1 to 3 inches; produce slow rhythmical contractions; duration of treatment, 20 minutes); *Vibration* over the spine, abdomen, liver, spleen, thyroid gland; *Light Bath* (twice per week).

NASAL CATARRH.—*Ozone Inhalation*; *Hot Air*; *Radiant Light and Heat*; *Vacuum Tube* (intra-nasal and external applications); *Vibration* (intra-nasal and external to the root and to each side of the neck; also over the VII C.).

NECROSIS OF THE BONE.—*Electro-coagulation*.

NEPHRITIS, CHRONIC (Interstitial and Parenchymatous).—See *Bright's Disease, Chronic*.

NEURALGIAS.—*Effleuve*; *Auto-condensation*; *Diathermy*; *Hot Air*; *Bachalet Wave*; *Rapid Sinusoidal* or *Secondary Faradic*; *Morton Wave*; *Vibration*; *Radiant Light and Heat* (short but strong applications); *Blue Light*; *Salicylic* or *Quinine Ionization*.

NEURASTHENIA.—If hypertension exists: *Auto-condensation*; *Bachalet Wave*; *Light Bath*. If hypotension exists: *Effleuve* over the spine and solar plexus; *Negative Head Breeze*; *Rapid Sinusoidal* over VI and VII D.; *Arc Light* (all along the spine) or the spinal application of *Radiant Light and Heat*; *Ozone Inhalation*; *Vibration*.

NEURITIS.—*Auto-condensation* and *Bachalet Wave* (if blood pressure is not sub-normal); *Diathermy*; *Hot Air*; *Positive Galvanism*; *Morton Wave*; *Gentle Vibration* over the spinal region corresponding to the origin and exit of the affected nerves; *Radiant Light and Heat* (especially *Blue Light*); *Salicylic*, *Quinine*, *Aconite* or *Menthol Ionization*. (Explain to the patient that first few treatments may aggravate the pain.)

- NEURITIS, BRACHIAL.**—*Morton Wave* with a shoulder electrode (20 minutes).
See also treatments indicated under *Neuritis*.
- NEURITIS, TRIFACIAL.**—See *Neuritis*.
- NEVUS VASVULOSIS.**—*Fulguration*; *Electro-coagulation*; *Positive Electrolysis* (with a gold or platinum needle; 3 to 4 m. a.); *X-rays* (low tube; 6 to 8 inches from the surface; 5 to 10 minutes, every other day, until slight dermatitis appears); *Radium*; *Ultra-Violet rays*.
- OBESITY.**—*Slow Sinusoidal* (general application or bath); *Static Induced*; *Auto-condensation* (400 to 800 m. a., 15 minutes, daily); *Light Bath* (eliminative); *Effleuve* and heavy *Vibration* over the abdomen, ribs and lumbar vertebrae.
- OCCUPATION NEUROSES.**—*Vacuum Tube application* from finger tips to and including the shoulder area and brachial plexus; *Effleuve* over the spinal centers; *Diathermy*; *Auto-condensation*; *Hot Air*; *Vibration*; *Sinusoidal Local Bath* (hand in water; indifferent electrode on the shoulder of the affected side); *Galvanism* (positive over the affected muscles; negative on the neck; 15 minutes, every other day).
- OPHTHALMIA, GONORRHEAL.**—*Radiant Light*; *Zinc Ionization*.
- OPIUM POISONING.**—*Faradization*.
- OPTIC ATROPHY.**—*Rapid Sinusoidal* (2800 cycles per minute; 30 to 35 volts; 10 to 20 minutes daily) with a double eye sponge electrode and a pad to the nucha; *Negative Galvanism* to the closed eyelids; indifferent to the nucha (5 to 8 m. a., 3 to 5 minutes, every other day; rhythmically interrupted at the end of each treatment); *Faradization*; *Galvano-Faradization*; *Vacuum Tube application*.
- OPTIC NEURITIS.**—See *Optic Atrophy*.
- ORCHITIS.**—See treatment for *Epididymitis*.
- OTITIS MEDIA, ACUTE NON-SUPPURATIVE.**—See *Earache*.
- OTITIS MEDIA, CHRONIC SUPPURATIVE.**—*Vacuum Tube application*; *X-rays*; *Ozone Spraying* through a eustachian catheter into the middle ear for about 4 minutes at a time, every other day.
- OVARIAN NEURALGIA (Ovaralgia).**—*Static Induced*; *Slow Sinusoidal* (one electrode on the X D.; other over the ovary; 20 minutes, daily); *Secondary Faradic*; *Radiant Light and Heat*; *Vibration* on each side of the spine from middle dorsal region to the coccyx.
- OVARIAN NEURITIS (Ovaritis), CHRONIC.**—*Positive Galvanic* with a copper ball vaginal electrode against the diseased ovary (50 m. a.; 10 min., every other day).
- OZENA.**—*Ozone Inhalation*; *Copper* or *Zinc Ionization*; *Nasal Vacuum Tube application*; *Positive Galvanism* (4 to 7 m. a., 10 to 15 minutes); *Metallic Cathaphoresis* with a copper nasal electrode (10 to 20 m. a., 5 to 20 minutes).
- PALPITATION OF THE HEART.**—Find the cause and remove it. *Vibration* or *Rapid Sinusoidal* between VII C. and I D.
- PANCREATITIS.**—*Diathermy*.
- PAPILLOMA.**—*Electro-coagulation*; *Magnesium Ionization*; *Negative Electrolysis*.
- PARALYSIS AGITANS.**—*Auto-condensation*; *Bachalet Wave* or *Light Bath* (if hypertension exists); *Effleuve* over the spine and solar plexus (if hypotension); *Rapid Sinusoidal* or *Faradic*, *Bi-polar* or *Schnee Bath* at a temperature of 98 degrees F., beginning with 5 minutes and increasing to 15 minutes; daily for 4 to 5 weeks; (*Cerebro-spinal*) *Galvanization* from head to epigastrium (5 to 15 m. a., for 5 minutes); follow this with stable pad on epigastrium and labile up and down the spine (from nucha to the coccyx; 30 to 40 m. a., 5 to 10 minutes); *Morton Wave*; *Static Sparks* (to the spine); *Radiant Light and Heat* (from nucha to the coccyx); *Radium Emanation*.
- PARALYSIS, DELTOID.**—*Galvano-Faradization* (positive to the nucha; negative labile to the affected muscle); *Effleuve*; *Sinusoidal*.
- PARALYSIS, DIPHTHERIC.**—*Negative Galvanization*; *Effleuve*.
- PARALYSIS, FACIAL (Bell's Paralysis).**—*Secondary Faradic* (if R. D. has not taken place); *Galvanic* (if R. D. has taken place); if there is pain: active positive, labile over the painful area. If there is no pain: active, negative, labile over the affected area. (10 to 15 m. a., 5 minutes daily). Follow galvanization with *Effleuve* for 5 minutes. *Sinusoidal* and *Galvano-Faradic* currents may be also employed.
- PARALYSIS, INFANTILE.**—See *Poliomyelitis, Acute Anterior*.
- PARALYSIS, LEAD.**—See treatment for *Facial Paralysis*; also *Light Baths* (eliminative; twice per week).

PARALYSIS, MUSCULO-SPIRAL.—*Galvano-Faradization* (active negative, labile over the affected muscles; indifferent positive, stabile on the sternum or to the nucha); *Effleuve*.

PARAPLEGIA (Spastic)—(Lateral Sclerosis).—Slowly interrupted *Sinusoidal* or *Faradic* to the legs and feet; *Radiant Light and Heat*; *Rapid Sinusoidal* from IX to XII D.; *X-rays* (when caused by pressure of a tubercular process in the spinal cord); *Static Sparks* (over the spine and nerve roots); *Galvanic Bath* (Patient in a sitting position; positive on the spine between the shoulders; negative in water; 10 to 15 m. a., 10 to 20 minutes); *Galvanization* (descending spinal; 20 to 25 m. a., 10 to 15 minutes).

PARKINSON'S DISEASE.—See *Paralysis Agitans*.

PELVIC CELLULITIS AND PELVIC PERITONITIS.—*Positive Galvanization* (25 to 50 m. a., 10 minutes) with the copper vaginal electrode, followed with *Secondary Faradic* (interrupted 30 to 60 times per minute; 5 to 10 minutes). If in a stage of induration and adhesions, apply *negative Galvanization* in place of positive.

PERITONITIS (Acute).—Strong application of *Radiant Light and Heat* over the abdominal region will promptly reduce the inflammation.

PERTUSSIS.—*Ozone Inhalation*; *Effleuve* to the chest and back; *Rapid Sinusoidal* to the VII C.

PHARYNGITIS.—See Treatment for *Laryngitis*.

PHLEBITIS.—*Negative Galvanism* (8 to 20 m. a., labile along the course of the vein) followed by *Sinusoidal*; *Vacuum Tube*; *Radiant Light and Heat*.

PHTHISIS PULMONALIS (Pulmonary Tuberculosis).—*Diathermy* (in the first stage); 500 to 1000 m. a. through the affected area; one hour daily; *Static Brush Discharge* to the cervical region (10 minutes, every other day); *Ozone Inhalation*; *X-rays* (high tube, 16 to 18 inches from the chest; 3 minutes; twice per week; should any dermatitis appear, discontinue the treatment until it has entirely disappeared); *Radiant Light and Heat*; *Arc Light*; *Rapid Sinusoidal* to X D. or *Vibration* to the IV and V C.

PILES.—See *Hemorrhoids*.

PITYRIASIS.—*Radiant Light and Heat*; *Vacuum Tube*.

PLEURISY (Acute).—*Diathermy*; *Static Brush Discharge* over the painful area; *Effleuve*; *Ozone Inhalation*; *Radiant Light and Heat*; *Rapid Sinusoidal* (one electrode over the VIII D.; other over the seat of pain (stabile); 10 minutes, daily); *Vibration* on each side of the spine from the III C. to the IV D. (10 minutes, daily).

PLEURITIC ADHESIONS.—*Diathermy* (1500 to 2000 m. a., 30 minutes, daily for two or three months).

PNEUMONIA.—*Diathermy* is almost a specific in the early stages (700 to 1200 m. a., 15 to 20 minutes, several times daily); *Ozone Inhalation*; *Effleuve* to the back and chest until flesh becomes red.

POLIOMYELITIS, ACUTE ANTERIOR.—There is no organic disease along the entire range of nervous diseases to which electricity is of such universal benefit as poliomyelitis.—"The children who have been electrically treated furnished a contingent of cases, either cured or improved, in a proportion far larger than those who have been left untreated." (Guilleminot)—*Effleuve* over the spine and over all the paralyzed muscles; *Auto-condensation*; *Rapid Sinusoidal* foot bath (indifferent electrode over the lumbar region; interrupted current; *Rapid Sinusoidal* from IX to XII D.; *Slow Sinusoidal* to the motor points of the affected muscles; *Interrupted Galvanization* of all the muscles that fail to contract under the *Sinusoidal* bath; *Radiant Light and Heat*; *Vibration*; *Faradization*; *Static Induced*; *Morton Wave*; *X-rays*.

POLIOMYELITIS, CHRONIC ANTERIOR.—*Radiant Light and Heat* to the spine followed by the *Negative Galvanism* to the spine (8 to 15 m. a., 10 to 20 minutes, daily); *Effleuve*; *Galvano-Faradization*.

POLYARTHRITIS DEFORMANS.—See *Arthritis*.

POLYPUS.—*Electro-coagulation*; *Electrolysis*.

POTT'S DISEASE.—See *Spondylitis*.

PROSTATE, ULCERATED.—*Zinc Ionization* (15 to 20 m. a., 20 minutes).

PROSTATIC HYPERTROPHY (Enlarged Prostate).—*Static Induced*; *Morton Wave* with a metallic electrode attached to the positive terminal; negative grounded (250 interruptions per minute); *Negative Galvanism* with the metal urethral electrode (indifferent positive rectal prostatic electrode per

- rectum, or a pad on the perineum; 10 m. a., 5 minutes; especially indicated in fibroid type in patients of over 60 years of age); Rectal Vacuum Tube applied against the prostate, 10 minutes, every other day; *Sinusoidal* (strong current; active per rectum; indifferent on the abdomen); Rectal *Vibration*.
- PROSTATITIS, CHRONIC.**—Good results are obtained before the enlargement has taken place, by means of *Diathermy*; metal electrode 6 x 6 inches over the abdomen and another electrode 6 x 8 inches over the lower spine, connected to one binding post of the apparatus; and the usual metal rectal electrode connected to the other post. Turn on the current to a point of comfortable heat tolerance in the rectum for 20 to 40 minutes, daily or every other day for four to six months. Empty the bowel with the rectal douche before treatment. (Geyser.) —*Morton Wave* with rectal metal electrode (20 minutes); Rectal *Vibration* (in non-infected).
- PRURITUS.**—*X-rays* (low tube; 4 inches from the surface; 8 minutes; two or three exposures per week); *Hot Air*; *Effleuve*; *Positive Galvanism*; *Radium*.
- PSEUDO-APPENDICITIS.**—*Rapid Sinusoidal* over the VI and VII D.
- PSEUDO-LEUKAEMIA.**—*X-rays* cause prompt reduction of glands. (*Effleuve* is distinctly contra-indicated.)
- PSORIASIS.**—*X-rays* and *Effleuve* hold the first place among curative agents. (Treat as described under Eczema.) *Auto-condensation*; *Hot Air*; *Arc Light*; *Radiant Light and Heat*; *Static Breeze*.
- PTERIGIUM.**—*Vacuum Tube* (connected to the positive terminal of the Morton Wave); *Electrolysis* (with the needle connected to the negative terminal; positive on the temple; 3 to 4 m. a.; 30 seconds to 2 minutes).
- PYLORUS, CONTRACTION OF.**—*Rapid Sinusoidal* over the V D., will dilate the pylorus; *Radiant Light and Heat*; *Effleuve*.
- PYORRHEA ALVEOLARIS.**—*Zinc Ionization* (with a zinc, copper, or platinum electrode; 2 to 4 m. a., 10 to 15 minutes) followed by *Vibration* of the gums; *Effleuve*; *X-rays*; *Ozone Spraying*.
- PYOSALPINX.**—See *Salpingitis*.
- RACHITIS.**—*Rapid Sinusoidal Bath* of 20 minutes' duration, two or three times per week, and *Radiant Light and Heat*, arrest the disease and diminish the osseous deformities.
- RECTAL PROLAPSUS.**—Insulated Rectal Vacuum Tube applications; 5 minutes, every other day. (For infants and children insulated urethral tube may be employed.) *Galvanism* (negative over the anus; positive over the loins; 15 to 25 m. a.; 5 to 10 minutes, every other day).
- RECTAL STRICTURE.**—Insulated Rectal Vacuum Tube applications; *Negative Electrolysis*.
- RECTAL ULCERS.**—*Negative Galvanism* with a metal electrode having an oval tip to the ulcer; (indifferent positive under the sacrum; 7 m. a., 5 minutes, every four days); Insulated Rectal Vacuum Tube application.
- REGURGITATION, NERVOUS.**—*Faradization* or *Galvano-Faradization* (positive to the abdomen, negative to the gastric mucosa through the stomach tube).
- RETINAL ATROPHY.**—See *Optic Atrophy*.
- RETINITIS, LEUTIC.**—*Negative Galvanism* over the eyes; positive to the nucha (5 to 15 m. a.; 5 to 10 minutes, daily).
- REYNAUD'S DISEASE.**—*Galvanization* (negative active arm bath; positive to the nucha, 10 to 20 m. a., 10 minutes); *Sinusoidal*; *Effleuve*; *Auto-condensation*.
- RHEUMATISM, ACUTE ARTICULAR.**—*Radiant Light and Heat* (Blue light being preferred); *Radium Emanation*.
- RHEUMATISM, CHRONIC ARTICULAR.**—*Auto-condensation* (300 to 800 m. a., 10 minutes, daily); *Diathermy*; *Bachalet Wave*; *Effleuve* over the affected areas 15 to 20 minutes; *Hot Air*; *Static Negative Charge*; *Rapid Sinusoidal Bath*; *Light Bath*; *Local Radiant Light and Heat*; *Vibration* to the painful area (10 to 15 minutes, daily); also from the III C. to the coccyx on each side of the spine; abdominal from the liver to the stomach, etc.; *Lithium* or *Salicylic Ionization*; *Radium Emanation*.
- RHEUMATISM, GONORRHEAL.**—See *Rheumatism, Chronic Articular* (especially *Hot Air*). In obstinate cases *X-rays* may be employed.
- RHEUMATISM, MUSCULAR.**—See *Lumbago* and *Torticollis*.
- RHINITIS, ATROPHIC.**—See *Ozena*.
- RHINITIS, INTUMESCENT.**—*Galvano-Cautery* under cocaine anaesthesia. (One cauterization is usually sufficient; although it may be repeated, if necessary).

- RIGG'S DISEASE.**—See *Pyorrhea Alveolaris*.
- RINGWORM (Tinea).**—*X-rays* supplemented by *Effleuve* is the best treatment; *Copper Ionization* until a marked redness appears.
- RODENT ULCER.**—*X-rays*; *Radium*; *Fulguration*; *Effleuve*; *Copper* or *Zinc Ionization*. See also *Ulcer, Chronic*.
- SALPINGITIS, CHRONIC.**—*Positive Galvanism* with covered copper vaginal electrode or *Copper Ionization*.
- SARCOMA.**—See treatment for *Carcinoma* and *Epithelioma*.
- SCIATICA.**—*Diathermy*; *Auto-condensation* (200 to 400 m. a., 10 to 15 minutes); *Effleuve* along the course of the nerve, lower part of the spine and over painful areas; *Static Induced* (in *Sciatic Neuralgia*); *Morton Wave* with a flat metal electrode over the sacro-sciatic notch; 20 minutes (in *Sciatic Neuritis*); *Static Sparks* or *Spray* (as strong as the patient can bear) over the region of the sciatic nerve. If it relieves pain, repeat once or twice daily. *Vibration* with medium pressure to the nerve trunk; inhibitory vibration to the sacro-sciatic notch; prolonged vibration over the exit and origin of the affected nerve, etc. In double sciatica vibration over the VI to XII D. and V L. nerves; also over the liver and spleen; *Radiant Light and Heat* (local or *Light Bath*); *Slow Sinusoidal*; *Galvanism* (20 to 60 m. a., 30 minutes; large negative against the iliac fossa; smaller positive along the course of the nerve); *Salicylic Ionization* repeated once every week generally relieves the condition after about six treatments, unless there is a definite aggravating cause, such as pressure from the bowel, tumors, etc.; *Radium Emanation*.
- SCLERITIS, RHEUMATIC.**—*Chlorine Ionization* (3 to 5 m. a., 15 minutes, twice weekly); *X-rays* (low tube; six inches from the eye; 5 minutes, every other day); *Effleuve*; *Radiant Light*.
- SCLERODERMA.**—*Galvanization* of the spine and the sympathetic ganglion in the neck, followed by the negative, labile, over the affected regions; *Negative Electrolysis* of the sclerosed patches; *Effleuve*; *X-rays*; *Sinusoidal Bath*.
- SCROFULA.**—*Vacuum Tube application*; *Radiant Light and Heat*.
- SINUSITIS.**—*Zinc Ionization*; *Ozone Inhalation*.
- SPASMS.**—Treatment depends upon the cause. Try *Sinusoidal*, *Galvanic* or *High Frequency* currents.
- SPASMS, LOCALIZED ARTERIAL.**—*Auto-condensation* (large doses); *Effleuve* (preferably from a resonator having large Leyden jars, energized by a static machine) over the lower cervical and upper dorsal region until a thorough redness of the skin appears.
- SPERMATORRHEA (Seminal Emissions).**—*Effleuve* over the lower part of the spine, followed by the rectal application to the seminal vesicles; *Galvanization* (positive on the perineum; negative on the loins; 5 to 10 m. a., 5 minutes, every other day); *Faradization* (rhythmically interrupted 30 times per minute; one electrode on the perineum, other on lumbar region).
- SPLEEN, ENLARGEMENT OF**—*Vibration* or *Rapid Sinusoidal* over the I to III L will contract the spleen; *Radiant Light and Heat* will withdraw large quantity of blood from the organ.
- SPLEEN, INFECTION OF**—Combination of *Diathermy* and *X-rays* at the same seance or alternating.
- SPONDYLITIS.**—*Radiant Light and Heat* followed by *Negative Galvanism* (10 to 15 m. a.; 10 to 20 minutes); *Effleuve*.
- SPRAINS.**—*Diathermy* (both electrodes on the same side, separated four or five inches); *Morton Wave*; *Vibration*; *Radiant Light and Heat*; *Salicylic Ionization*; *Galvano-Faradization*.
- STENOCARDIA.**—See *Angina Pectoris*.
- STOMACH, ATONIC DILATATION.**—See *Gastrectasis*.
- ST. VITUS DANCE.**—See *Chorea*.
- SYCOSIS.**—*X-rays* (medium tube; 10 to 12 inches from the surface; 3 to 5 minutes, every third or fourth day. *X-rays* are contra-indicated when there are purulent pockets with deep infiltrations); *Effleuve* over the surface and about the edges, according to the tolerance of the patient; *Mild Fulguration*.
- SYNOVITIS.**—*Vacuum Tube application*; *Morton Wave*; *Diathermy*; *Auto-condensation*; *Lithium Ionization* (20 to 40 m. a., 20 minutes, twice per week); *Negative Galvanism*.
- TABES DORSALIS.**—Cure should not be looked for by any therapeutic agent but electricity if used in the initial and ataxic stage will check or at least modify

- the course of disease. *Effleuve* to the spine, buttocks, abdomen and back of legs; *Auto-condensation*; *Vibration* or *Rapid Sinusoidal* to the X D.; *Diathermy* with electrodes on either side of the spinal column corresponding to the seat of pain is practically a specific for the relief of lancinating pains; *Morton Wave* with a long, narrow electrode over the spine (20 minutes); *Radiant Light and Heat* over the seat of pain and the entire length of the spine until an intense hyperemia is produced; *Galvanism* (positive to the painful areas; negative to the abdomen; 20 to 30 minutes); *Sinusoidal Bath*; *Faradization* or *Galvano-Faradization* (6 to 20 m.a., 10 to 30 minutes; one electrode to the cervical region; other a foot bath; reverse the polarity every few minutes; start with short treatments and a weak current and increase at every subsequent treatment). Treat daily or every other day.
- THROAT, SORE (Angina).**—*Effleuve* over the throat; *Vibration* over the throat and the cervical region.
- TIC DOULOUREUX.**—See *Neuritis, Trifacial*.
- TINNITUS AURIUM (Ringing in the Ears).**—*Slow Sinusoidal* (one pole to the external auditory canal; other on the tongue); *Vacuum Tube* with the ear electrode; *Hot Air*; *Static Induced*; *Pneumatic Vibration*; *Mechanical Vibration* around the ears and over the forehead; *Ozone Spraying* (through an eustachian catheter into the middle ear for about 4 minutes daily); *Auto-condensation* (300 m.a., 10 minutes, every other day).
- TONSILITIS.**—*Effleuve* over the throat and internally over the tonsils; *Fulguration*.
- TORTICOLLIS (Acute and Sub-acute).**—*Effleuve* along the sternomastoid muscle; 15 to 20 minutes, daily; *Radiant Light and Heat*; *Interrupted Vibration* on each side of the spine in the interspaces from the occiput to the II D.; *Auto-condensation*; *Galvanization* with the active positive on the trapezius or the sternomastoid; (15 to 20 m.a.); *Faradization* or *Galvano-Faradization*; *Morton Wave*.
- TRACHOMA.**—*Metallic Cataphoresis* with a copper electrode (indifferent to the nucha; 2 to 4 m.a.; 1 to 3 minutes); *Fulguration*; *Vacuum Tube application* over the closed eyelids (10 minutes, daily for 2 to 3 weeks); *X-rays* (50 to 100 flashes per minute).
- TUBERCULOSIS OF THE BONE.**—*X-rays*.
- TUBERCULOSIS OF THE GLANDS.**—See *Adenitis*.
- TUBERCULOSIS OF THE LUNGS.**—See *Phthisis Pulmonalis*.
- ULCERS, CHRONIC.**—Sharp *Effleuve* will convert the chronic into an acute condition; *Diathermy*; *Mild Fulguration* (under a cocaine anaesthesia); *Hot Air*; *Ozone Spraying*; *Arc Light*; *Radiant Light and Heat*.
- ULCERS, VARICOSE.**—*Morton Wave* with a "block-tin" electrode, connected to the positive, over the ulcer; *Effleuve* (10 to 15 minutes, every other day); *Ozone Spraying*; *Sinusoidal Bath*; *Zinc Ionization*.
- URAEMIA.**—*Light Bath*.
- URETHRAL STRICTURE.**—*Negative Electrolysis* with olive point electrode introduced up to the obstruction; indifferent electrode on the abdomen or the lumbar region; 2 to 5 m.a. In *Spasmodic Stricture*: *Insulated Urethral Vacuum Tube* (mild current; 5 minutes, every three or four days).
- URETHRITIS, CHRONIC (Glandular).**—*Negative Electrolysis* of the crypt of Morgagni, with a blunt pointed electrode and the glands of Littre with a sharp electrode; *Zinc Ionization* or *Metallic Cataphoresis* with zinc or copper olive point electrode (2 to 5 m.a., for 5 minutes). See also *Gleet*.
- URTICARIA (Chronic).**—*High Frequency* or *Static Effleuve* (5 to 10 minutes); *Sinusoidal Bath*.
- UTERINE CANCER.**—*X-rays* and *Radium* ("Cross-Fire" Method). See also *Carcinoma*.
- UTERINE FIBROIDS.**—*Positive Galvanism* with vaginal ball electrode; negative to the abdomen; 50 to 100 m.a.; 10 to 15 minutes, every other day. Contra-indicated if the patient is affected with nephritis, inflammation of the appendages, cancer, etc. *X-rays*; *Radium* (intra-uterine).
- UTERINE PROLAPSUS (Falling of the Uterus).**—*Slow Sinusoidal*; Rhythmically interrupted *Galvanic* (15 to 20 m.a.), or *Faradic* currents; *Interrupted Vibration* over the post-sacral nerves.

- UTERINE SUBINVOLUTION.**—*Morton Wave; Extra-uterine Faradization or Positive Galvanization; Rapid Sinusoidal* from I to III L.
- VAGINISMUS.**—*Vaginal Vacuum Tube applications; Positive Galvanization; Faradization* with a bi-polar vaginal electrode, or one electrode per vagina; other to the abdomen (15 to 30 minutes); *Vibration* (vaginal or rectal 5 to 8 minutes).
- VAGINITIS (Sub-acute).**—*Vaginal Vacuum Tube applications* 5 minutes, daily; *Positive Galvanism* with an amalgamated copper vaginal, ball electrode.
- VAGUS HYPOTONIA (Low Vagus Tone).**—The tone of the vagus may be permanently increased by *Rapid Sinusoidal* to the VII C. by means of a double interrupting electrode; 10 to 15 minutes. (Do not over-stimulate).
- VARICOCELE.**—*Ionization with hamemalis, thuja, iodine, or adrenalin solution.*
- VERRUCA.**—*See Condylomata.*
- VERTEBRAL CRIES.**—*Radiant Light and Heat* over the spine for 15 to 30 minutes, increasing the heat as much as the patient can bear.
- VERTIGO.**—*Vibration* on head and back of the left ear.
- VISCEROPTOSIS.**—*Morton Wave; Slow Sinusoidal.* (*See Gastropstosis.*)
- VITILIGO.**—*See Leukoderma.*
- VOMITING, NERVOUS.**—*Vibration* (deep, interrupted) in the interspaces over the transverse process of the III and IV D. nerves and throughout the splanchnic region; *Galvanization* with the large negative electrode on the epigastric region and two small positives on each side of the VII C. (10 to 15 m. a.; 10 to 30 minutes).
- VOMITING OF PREGNANCY.**—*See Nervous Vomiting.*
- WARTS.**—*See Condylomata.*
- WHOOPING COUGH.**—*See Pertussis.*
- WOUNDS.**—*Vacuum Tube*, 5 to 6 minutes, every other day; *Radiant Light and Heat; Metallic Cataphoresis* with a pure copper electrode (5 to 10 m. a., until a film of green oxid of copper is thoroughly deposited in the tissue surrounding the electrode).

SECTION IV

*Practical Radiography **

IN ORDER to obtain good results, radiographers must consider the following:

- a) Penetration of the rays
- b) Amount of current passing through the tube
- c) Time of exposure
- d) Distance from the target to the plate
- e) Size of the subject.

The M. A. S. (milliampere-seconds) given in the following table, are based on the exposures required for an average 160 lb. adult; a specified distance from the target to the plate and a tube of proper penetration.

If the subject is large and muscular, the M. A. S. must be increased—or decreased in the case of a child. If the distance from the target to the plate is greater than the distance given in the table, the M. A. S. must be increased one-tenth (1/10) for each additional inch, or, if shorter, it (the M. A. S.) should be decreased in proportion.

From the study on Penetration (Chapter XIV; pages 105 and 106), we have learned that the higher the vacuum of the tube and the higher the voltage produced by the apparatus, the greater the penetration; and the greater the “Equivalent-Spark-Length” (“Back-Up-Spark”), the higher the vacuum of a tube (more penetrative the rays). If it is impossible to use a tube of proper penetration (or a specified equivalent-spark-length), the exposure must be considerably lengthened when a softer tube (shorter spark-length) than the right one is employed, and somewhat shortened for a harder one (greater spark-length).

Determining the “Equivalent-Spark-Length”

(The Technique on page 106 applies only when tubes are used with a static machine.)

In measuring the “Equivalent-Spark-Length”, the terminals of the apparatus should be set at the distance required for the part which is to be radiographed. The rheostat should be moved to the point at which the desired milliamperage is usually obtained; the switch is quickly closed and opened. If the spark jumps across the gap, the current is reduced by means of a rheostat and is tried again. If the tube takes the current, and the milliampere-meter shows that there is not enough current passing, the tube is slightly reduced; the rheostat is moved one point up and tried again. If the spark jumps over the second time, the tube is again reduced slightly, until it is found that the tube takes the current, allowing a bluish haze to pass between the terminals (almost ready to spark). The current is switched on for about 1/3 second and the milliampere-meter is read; then the rheostat is moved to one point lower and the milliampere-meter is read again (using a low scale if it has two). After this, the rheostat is moved to the point where it was when testing at the heavier current, and the apparatus is ready for exposure.

It is not necessary to make such tests for every exposure. Next time when it is desired to radiograph same part of the body, the tube is reduced until it takes same test milliamperage (using low scale of the meter) on the low point of the rheostat.

The time of exposure in seconds can be obtained by dividing the M. A. S. in the exposure table with the milliamperage shown by the milliamperemeter.

If the milliamperemeter has a double scale, the high scale should be switched on before exposing.

* In compiling this information, free reference has been made to the Paragon X-ray Pointers and Exposure Table.

In order not to allow the rays to exceed the desired penetration, the terminals should be left at the original tested distance.

When the subject and the plate are in place, the rheostat is moved to the high point (as in the first test) and the exposure is made.

Intensifying Screen

The intensifying, or accelerating screen, which consists of a sheet of cardboard coated with some fluorescent substance (e. g., tungstate of calcium) is used when very fast exposures are desired, e. g., in abdominal and chest exposures (stomach, intestines, heart, etc.). This screen is usually mounted in a holder (cassette) with aluminum or other front (which is transparent to the X-rays but opaque to daylight) in such a way that when the film of the plate is placed in close contact with the screen, the light will pass through the glass of the plate and through the film before reaching the screen itself.

When the exposure is made, the ray reaches the screen and causes it to fluoresce (give off bluish visible rays). This fluorescence causes an intense chemical effect on the silver contained in the emulsion of the plate, and thereby greatly increases the effect of the X-rays. On this account, when such a screen is used, the time of exposure is greatly reduced. As some screens fluoresce for some time after the exposure, it is advisable to remove the plate from the holder as soon as possible, and for the same reason (unless absolutely necessary) not to place another plate in the holder immediately after.

When employing a screen, in order to get the best results, it is advisable to use special screen (X-ray) plates, a soft tube and longer development.

Stomach and Intestinal Exposures

In radiography of the stomach and intestines, in order to produce a shadow on the plate, it is necessary to fill the part with a substance opaque to the X-rays. This is accomplished by administering to the patient a test meal containing a sufficient quantity of bismuth or barium. (2 ounces of bismuth sub-carbonate or bismuth oxychloride or 5 ounces of barium sulphate stirred into 12 ounces of buttermilk.)

Radiography of the stomach may be taken immediately after the patient has taken a test meal.

When it is desired to expose the intestinal tract, a series of radiographs should be made. In this connection, it should be remembered that it usually takes six hours until the stomach empties the bismuth into the duodenum, and about 24 hours until the bismuth passes through the entire canal (except in very rare cases, especially in patients suffering from chronic constipation, when it may take 72 hours).

Large size X-ray plates (11 x 14 or 14 x 17 inches) should be used. A penny or a dime placed on the navel will enable the operator to locate the stomach on the plate and determine if it is in normal position.

An intensifying screen and a soft (low) tube with almost full power of the apparatus should be employed. (If a hard [high] tube is used, reduce the exposure.) Develop the plate for a long time.

Exposure for Coils

Up to the present time, there is no satisfactory apparatus to estimate correctly the current (milliamperage) delivered by the coil to the tube. It is therefore impossible to give hard and fast rules of operation, and the time of exposure which will apply to all makes of X-ray coils. If the practitioner guides himself by the exposure table supplied with his apparatus, uses the lowest frequency and adjusts the interrupter for heavy currents, he will obtain satisfactory results.

Exposure Table for Interrupterless Transformers

(Without the use of intensifying screen)

	Distance from target to plate in inches	Equivalent Spark-Length in inches	ORDINARY TUBE		COOLIDGE TUBE	
			M.A.S.	Exposure time in seconds, when the Transformer is adjusted for 35 m.a.		M.A.S.
Hand	18	5½	18	½	.3	10
Wrist (Lateral)	18	5½	27	¾	.5	18
Elbow	18	5½	35	1	.75	27
Ankle (Lateral)	18	5½	44	1¼	1.00	35
Ankle (Ant. Post.)	18	5½	62	1¾	1.5	50
Knee (Lateral)	18	5½	62	1¾	1.5	50
Knee (Ant. Post.)	18	5½	70	2	1.6	55
Shoulder	18	5½	105	3	2.3	80
Kidney (Medium)	18	5½	175	5	5.	175
Ureter	18	5½	175	5	5.	175
Lumbar Spine	18	5½	175	5	5.	175
Dorsal Spine	18	5½	235	6½	6.5	235
Gall Stones	18	5½	52—105	1½-3	1¼-3	40-90
Stomach (130 lb. Patient)	22	6½	40	1¼	1.	30
Stomach (160 lb. Patient)	22	6½	65	1¾	1.5	50
Stomach (190 lb. Patient)	22	6½	90	2.5	2.	70
Chest (Medium Size)	24	6; C 5½	60	1¾	1¾	60
Head (Lateral; Large)	Compression	7; C 6½	40	1¼	1¼	40
Head (Ant. Post.; Large)		7; C 6½	140	4	4.	140
Head (Ant. Post.; Small)		7; C 5½	120	3½	1¼	40
Hip	20	6½; C 6	80	2.3	2.5	90
Pelvis	25	6½; C 6	120	3½	4½	150

Remarks: With Edwards T. E. intensifying screen and screen plates only 1/8 of exposure time or M.A.S. should be employed; with Rotax or other slower screens 1/5 of exposure. When ordinary plates are used with the screens, reduce the exposure only one fourth (25 per cent.).

When the transformer is adjusted for other milliamperage, divide M.A.S. with the m.a. and the exposure time in seconds will be obtained.

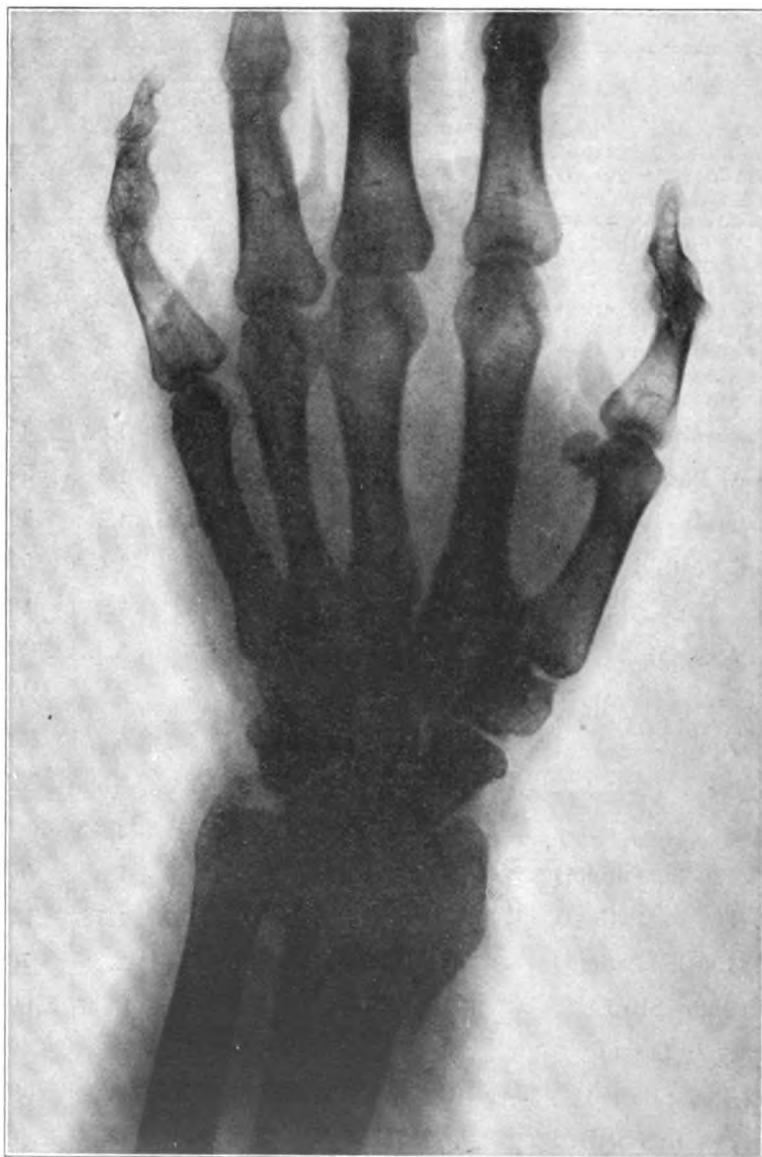


Plate IX

Impacted fracture of right radius without deformity, five days' duration.

There was a little palsy of the hand, which accounts for blur on fingers.

Courtesy of McIntosh Battery and Optical Co.

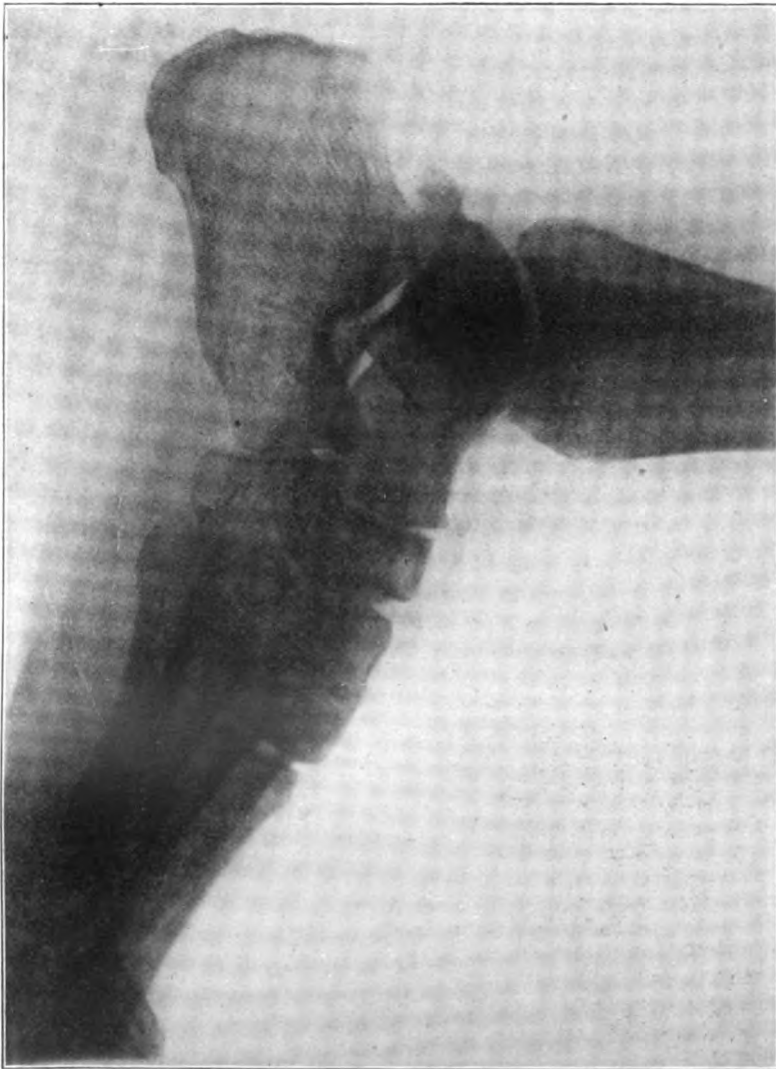


Plate X
Exostosis Os Calcis.

Courtesy of McIntosh Battery and Optical Co.

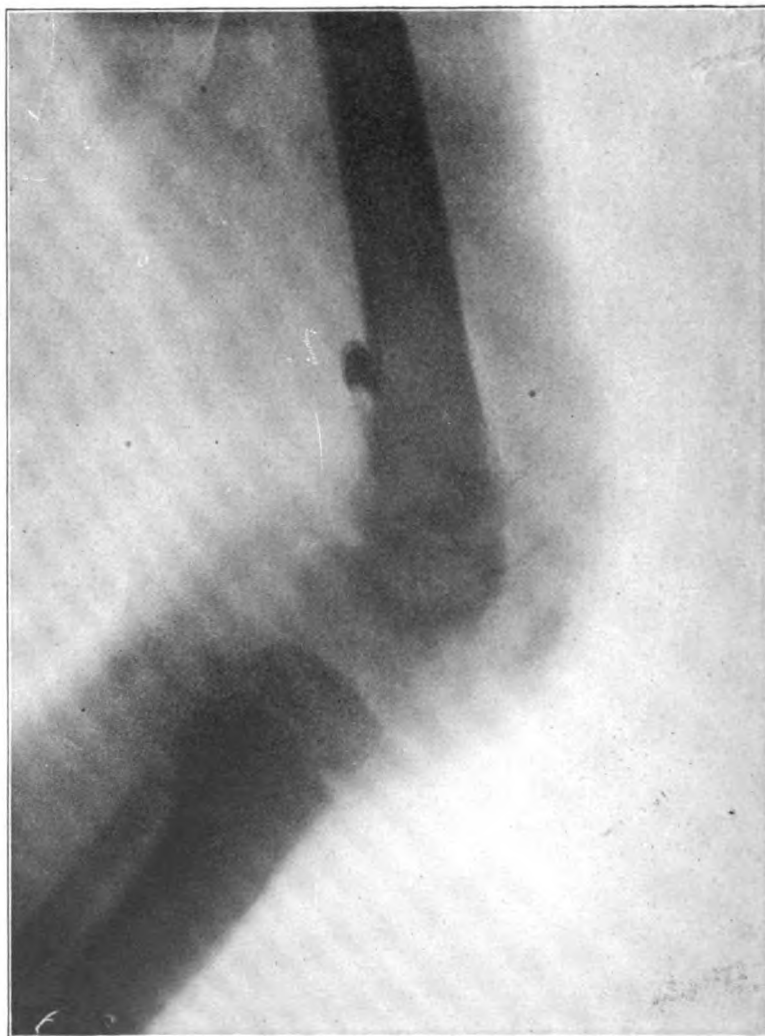


Plate XI

Gunshot wound of thigh (.22 rifle ball).

Bullet on under side of femur, having passed through the center of the bone and lodged in periosteum.

Courtesy of McIntosh Battery and Optical Co.

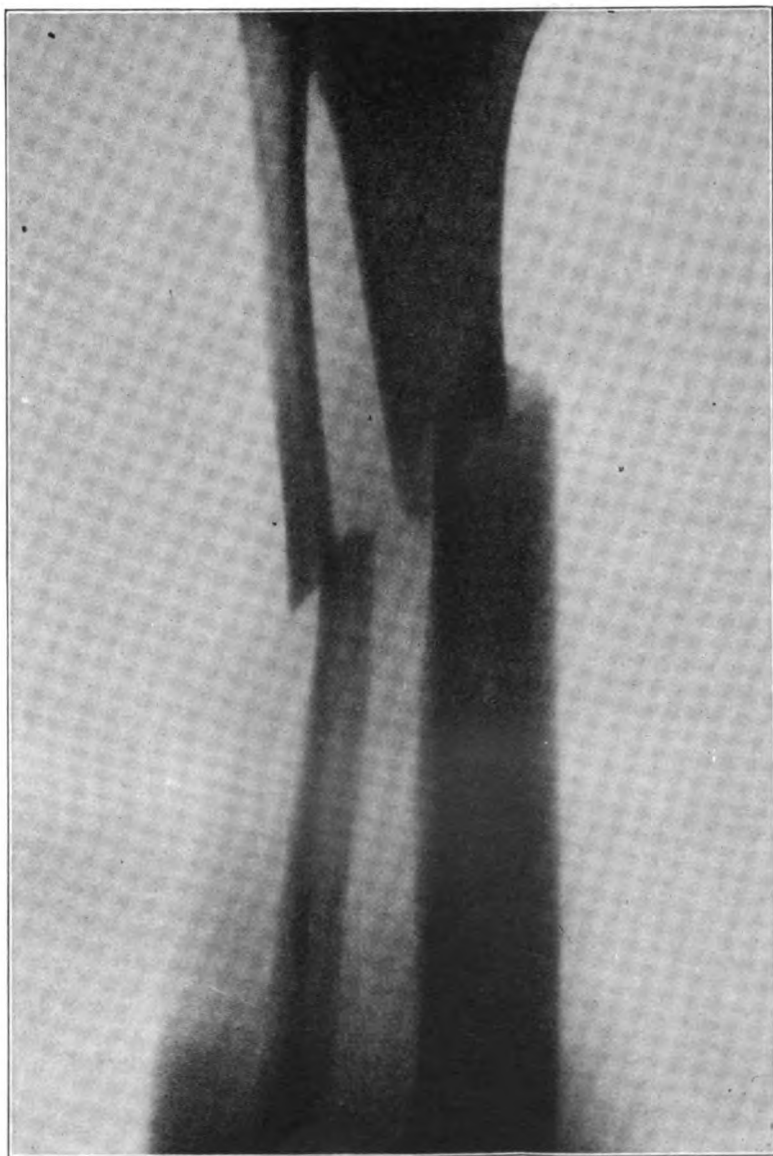


Plate XII

Fractured forearm, both bones, before setting.

Courtesy of McIntosh Battery and Optical Co.

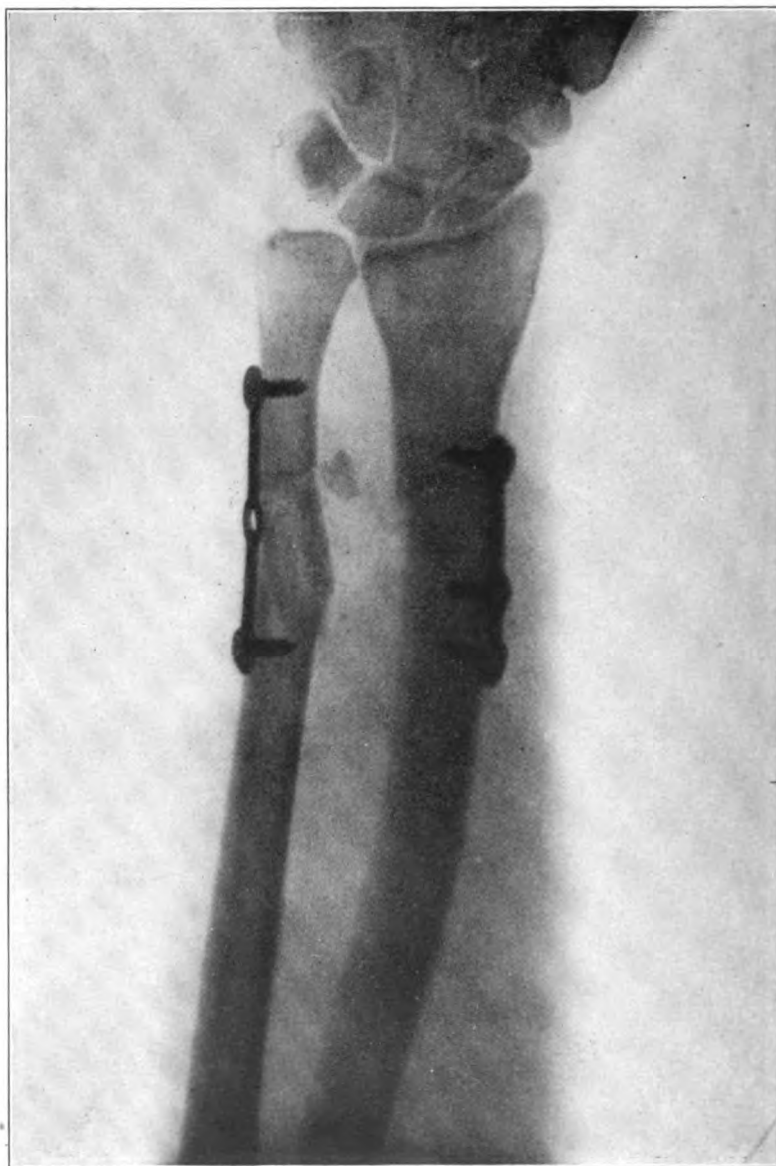


Plate XIII

Fractured forearm after the Lane bone plates had been put on.

Courtesy of McIntosh Battery and Optical Co.



Plate XIV

Child one year old swallowed a button.

Courtesy of McIntosh Battery and Optical Co.

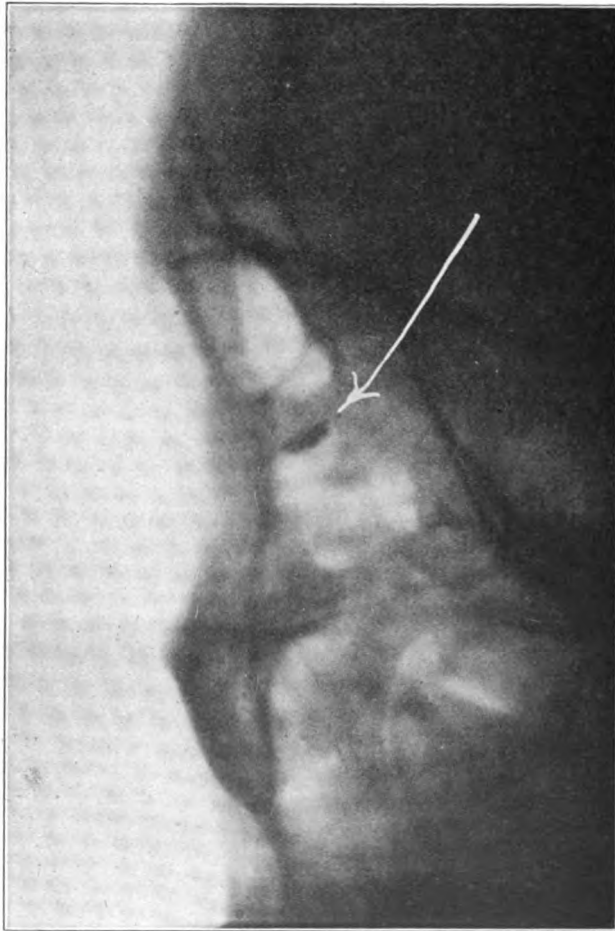


Plate XV

Nail head in eye.

Courtesy of McIntosh Battery and Optical Co.



Plate XVI

Impacted fracture of upper end of tibia and fibula.

Picture taken at a time when the swelling was very marked.

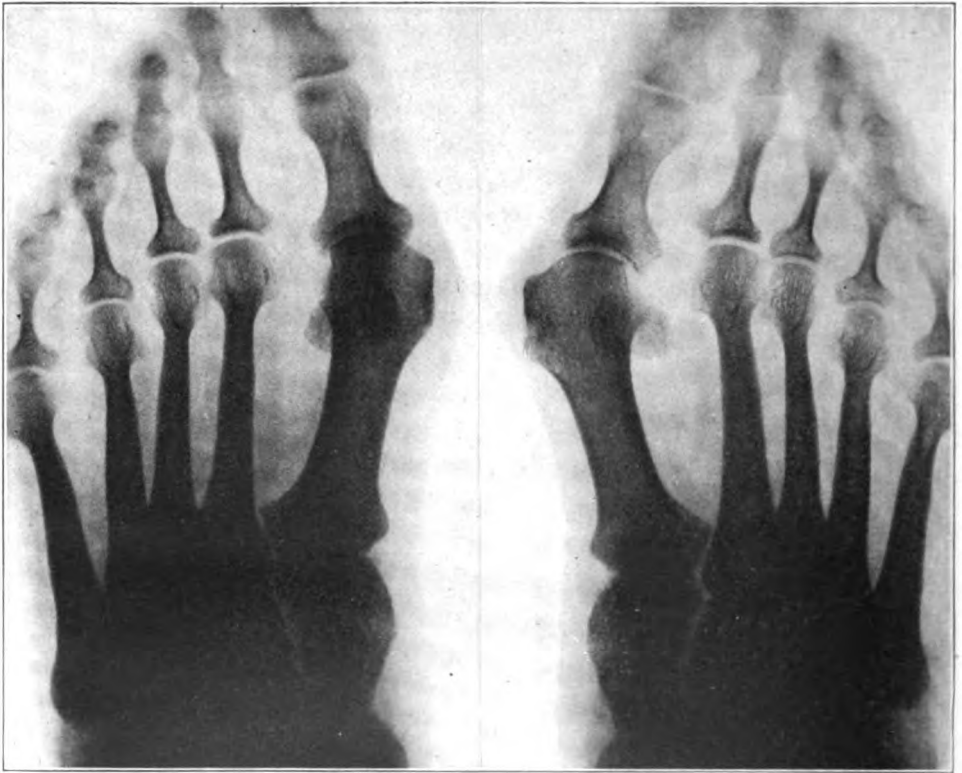


Plate XVII

Hallux Valgus, right and left.

Courtesy of McIntosh Battery and Optical Co.

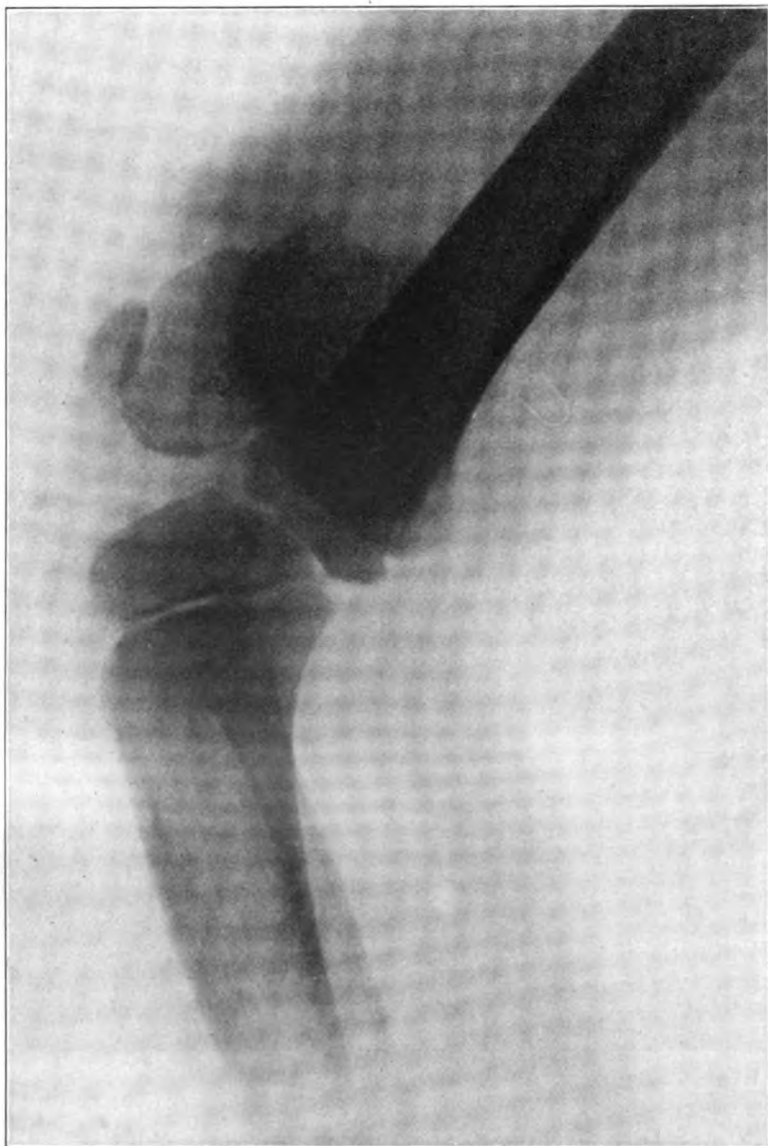


Plate XVIII

Dislocation lower epiphysis of femur.

Courtesy of McIntosh Battery and Optical Co.



Plate XIX

Osteomyelitis of humerus, boy five years old.

Upper half of bone involved. Spicula of bone showing at the upper part of humerus.

Courtesy of McIntosh Battery and Optical Co.

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The Philosophy of Fasting

A MESSAGE TO SUFFERERS AND SINNERS

By EDWARD EARLE PURINTON



HIS work is the product of an enthusiast along the lines of being. He is an explorer afloat on the ocean of existence, with a ready pen to record what he sees, what he feels, what he desires, what he hopes for. His mystic sympathies give birth to an iridescent philosophy that is ballasted by a sincere effort to shed from his soul-binding flesh its pains and impurities, that he may the more readily mount the eternal palace stairs of health and truth and beauty. He has discovered a Fountain of Youth where the ailing body may wash away its pains, troubles, weakness, blindness and rise like a god refreshed and ablaze with joy and ambition. He describes this fountain in these words:

"Fasting, *rightly conducted and completed*, is nearest a panacea for all mortal ills of any drugless remedy I know, whether physiological, metaphysical, or inspirational. Fasting, resting, airing, bathing, breathing, exercising and hoping—these seven simple measures, if sanely proportioned and administered, will cure any case of acute disease. And almost any case of chronic.

Mr. Purinton ought to know what he is talking about for he has actually experienced a fast of thirty days duration, and his book is a log-book as it were of his sensations. He says he "found God through this fast." His object was not merely to eliminate poisons from his body through fasting but to fast for health, enjoyment, freedom, power, beauty, faith, courage, poise, virtue, spirituality, instinct, inspiration, and love.

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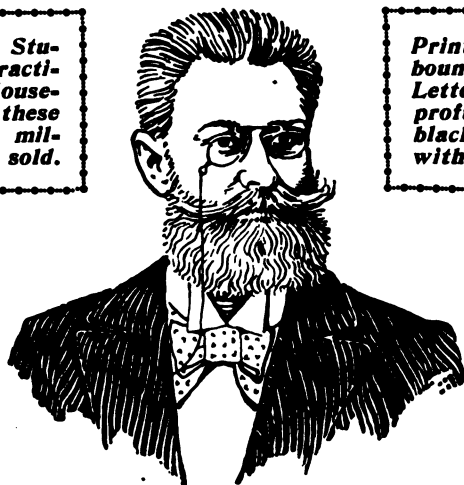
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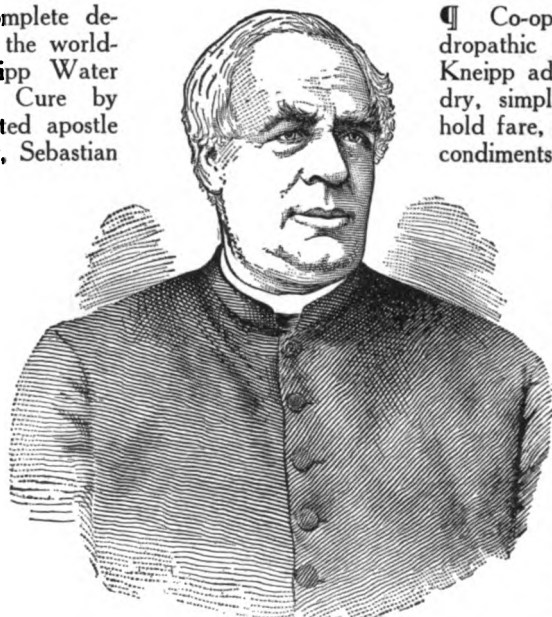
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THIS magazine, which is the professional organ of the American Naturopathic Association, first appeared in 1896 as *The Kneipp Water Cure Monthly*; then in 1902 it became known as *The Naturopath and Herald of Health*; and finally, in January, 1916, it became *The Herald of Health and Naturopath*. As the name indicates, this publication is the exponent of every phase of drugless healing. It is many years older than the Naturopathic Society, the name by which the American Naturopathic Association was first known, and which was founded December 2nd, 1902, in the city of New York.

The Herald of Health and Naturopath is the only journal published in the United States that espouses the healing of disease by the simple and natural methods, as opposed to the vile nostrums and superstitions of Allopathy, otherwise known as official medicine.

The Natural System of Healing alone has the courage to assert that Nature cures, that the only healing force is the *vis naturae medicatrix*, and not the potions, pills and powders of the empirics. It had its inception in Germany. Priessnitz of Gräfenberg, Kuhne of Leipzig, Schroth of Lindewiese, Bilz of Dresden, and Kneipp of Woerishofen, established sanatoria, and proved to a world sick unto death with swallowing paralyzing palliatives, of annihilating fermenting substances with chemicals, of suppressing fevers with poison, of relieving constipation with purgatives, causing the muscular system of the intestines to lose tone and elasticity, all practices antagonizing nature in her benign efforts to get rid of the offending *materies morbi* that is the cause of the specific disease, that the benign forces of sunshine, air, light, exercise, simple foods, earth cure, water cure, mental science, etc., are a thousand times more curative of the ills of mankind than the poisons of the allopaths.

The epoch-making work done by these great pioneers in Natural Healing is fully described in the pages of our magazine. The twentieth century will be known as the Century of Naturopathy. The long slavery of mankind to the bag of bones and feathers of the primitive medicine man, the Witches Brodth of the Middle Ages, the vacuous "megrimms" and "vapors" of *le docteur à la mode*, the bleeding craze of our immediate forefathers, the drugging craze, and the present craze for serums, inoculations, and vaccines, has been broken at last, and many allopaths are now turning naturopaths, thus fleeing from the wrath to come.

The specialties in Natural Healing, no matter by whom introduced, receive most elaborate exposition. These include the German Water Cure; the Nature Cure or Naturopathy, which includes Diet, Hydrotherapy, Thermotherapy, Phototherapy, Heliotherapy, Chromotherapy, Electrotherapy, Psychotherapy or Mental Healing, including suggestive therapeutics, Mechanotherapy, or Massage, and Physical Culture, Osteopathy, Ophthalmology, Chiropractic and Spondylotherapy.

All these various drugless methods, and others not specifically mentioned, are parts of an immense whole that forms a body of medical principles and practice that are the very antithesis of allopathic medicine, which is but a system of ignoring the cause of disease, thus leaving it intact to break forth again. The system is an attempt to enable man to violate the laws of nature, and yet secure immunity from punishment for so doing by the vicarious virtues of drugs, serums and vaccines. This false system of finding "cures" for disease, by treating the effect, even if successful, would only result in our seeing a new series of ailments springing from the unextirpated roots thereof, each requiring a new artificial "remedy," produced in most cases with the infinite suffering of animals in the shambles of the medical laboratory.

The Natural Method of Healing, on the contrary, seeks to change the very habits of the individual by urging a return to nature in eating, drinking, breathing, bathing, working, resting, dressing, thinking, by making use of elementary remedies of nature, by correct physiological principles.

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These apostles of Natural Healing and their disciples are doing a wonderful work in the prevention and cure of disease, having reduced the death rate of over fifty per cent. under the old and false drug treatment to less than five per cent. by the drugless method.

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THE MEDICAL QUESTION

The Truth About Official Medicine and Why We Must Have Medical Freedom

Medical Laws vs. Human Rights and Constitution. The Great Need of the Hour. What Constitutes the True Science and Art of Healing

By A. A. ERZ, N. D., D. C.

HERE is a book that cheers one like a draught of ozone after having breathed the mephitic vapors of the philosophy of official medicine, that exploits the immorality of vivisection, and swears by the unscientific and useless products of the torture trough.

It consists of 600 pages, written by the trenchant pen of one who is master of his subject. It embodies the revolt of the latest and most efficient school of medical healing against the tyranny and ignorance of the drug doctors, who, while attacking symptoms, fail to understand the need of the higher practice of treating the causes of disease instead. The charlatanism and inefficiency of official medicine has reason to be envious of the successes of the natural school whose philosophic practices are here fully manifested.

Dr. Erz makes very clear his position in the art of healing. He is an enthusiastic Naturopath. He believes that when a man becomes ill, he should employ the natural forces of hydropathy, diet, exercise, sunshine, electricity, mechano-therapy, massage, and all the healing agencies that have proven their worth as prophylactics, and their ability to arouse the inherent restorative power for health that resides in every organism. His information is illuminating in the highest degree.



In support of his statements, he quotes the opinions of the greatest exponents of official medicine who confess that allopathic medicine has produced more misery and premature death than famine, pestilence and war combined. As Billroth says, "Our progress is over mountains of corpses."

He proves that the American Medical Association, and the various State and County Associations affiliated therewith, form one vast engine of oppression, armed with legal power to harass, crush, and if possible destroy, the true saviors of mankind, the exponents of natural healing, whose activities naturally discredit official medicine. By legally securing a monopoly of practising medicine, **THEY ARE ABLE TO MAKE IT MORE OF A CRIME TO CURE A PERSON THAN TO KILL HIM.**

He shows how easy it is to understand why the unthinking legislator favors official medicine to the exclusion of the natural school of therapy. The psychological pressure of an institution, no matter how despotic its use of power may be, or how false and deadly its products are, that has its roots deeply rooted in history, is vastly greater on the unenlightened mind, than a true and noble institution that was born but yesterday—where man does not know conservatism rules.

Dr. Erz fully proves that the so-called remedies of medical research are violations of every law of nature, of health, of life, and a disregard of every principle of physiology, biology and therapeutics.

The people were never consulted about these laws, and never asked for them

They are the product of medical feudalism, which means intolerance, injustice and brutality, instead of charity, justice and dignity. The people should rise in their might and stay the infamous activities of these medical malefactors.

It is a startling indictment of humanity that its saviors are never recognized until the advance guard, and many of the main army, are killed, or trodden underfoot, and official medicine in America, the glorious Land of Freedom, is busy at this moment, as it has been for many years past, in hunting down the drugless practitioner, whose only fault is the fact that he cures patients by natural methods, where the vendors of rotten pus have signally failed. He is arrested, and heavily fined, or thrown into jail for the offense of practising medicine without a pus-vendor's license.

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