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**Electro-
Therapeutical
Practice.**

NEISWANGER



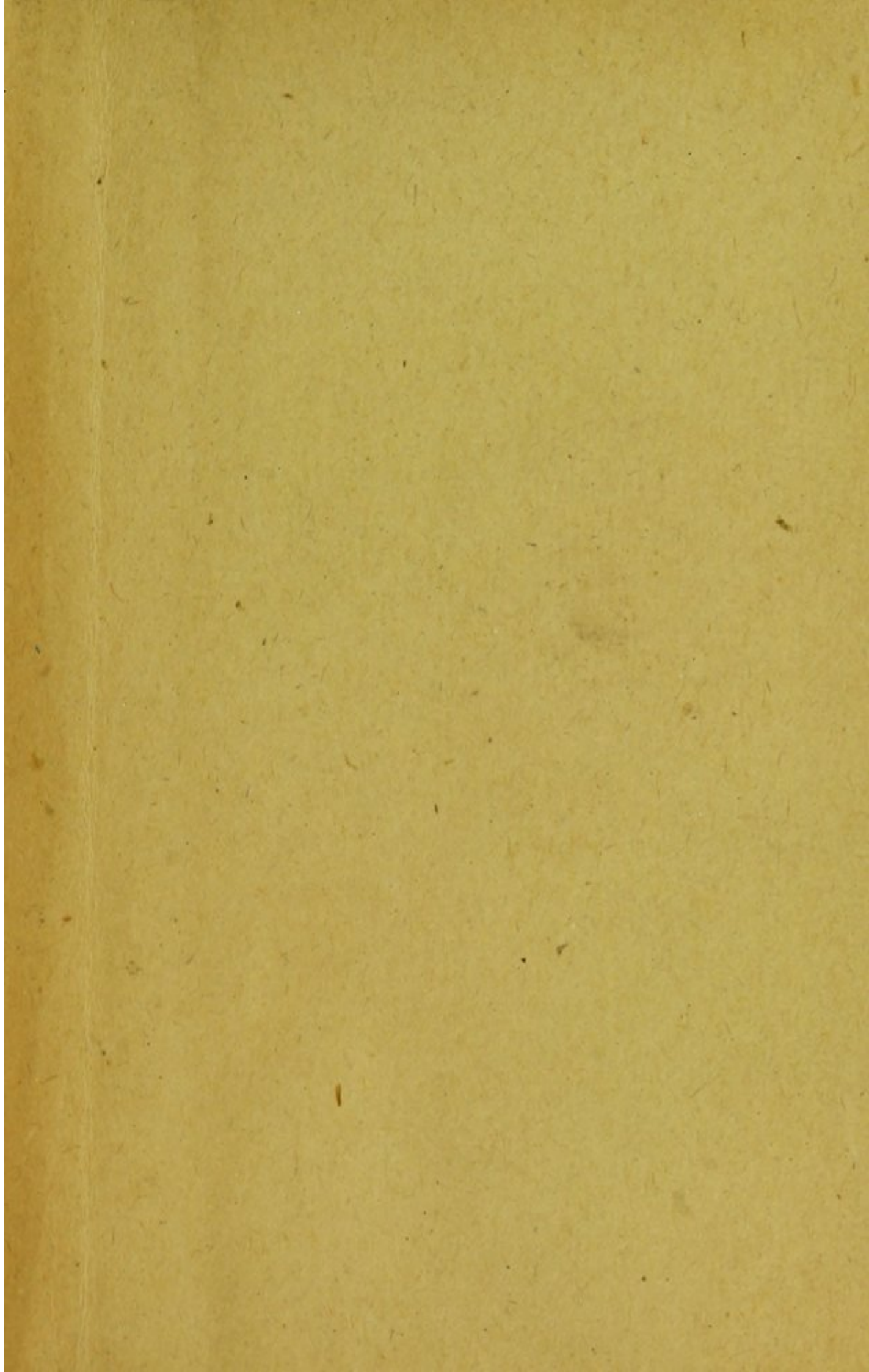
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ELECTRO- THERAPEUTICAL PRACTICE.

A READY REFERENCE GUIDE FOR PHYSICIANS IN THE
USE OF ELECTRICITY.

SEVENTH EDITION.

REVISED, REWRITTEN AND GREATLY ENLARGED.

BY

CHAS. S. NEISWANGER, Ph. G., M. D.

Author of "Suggestions in Electro-Therapeutics;" Prof. of Electro-Therapeutics
Post-Graduate Medical School of Chicago; Prof. of Electro-Therapeutics,
Illinois Medical College; President Illinois
School of Electro-Therapeutics;
Member A. M. A.

E. H. COLGROVE & CO.

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PREFACE

The following is a list of the names of the authors of the various papers contained in this volume. The names are arranged in alphabetical order of the surnames. The names of the authors of the papers which are not included in the list are given in the margin of the text. The names of the authors of the papers which are not included in the list are given in the margin of the text.

Faint, illegible text centered on the page, possibly bleed-through from the reverse side.

PREFACE.

In presenting this little volume as an aid to the more rational use of electricity in the medical profession the author is not unmindful of the fact that much literature of a contradictory and confusing nature has been written and published.

In the present work, however, all superfluous verbiage has been discarded; no theories are advanced, no pathology given, and there is no war waged on the various writers and teachers of electro-therapy because of different views and theories held by them, but the aim of the writer has simply been to teach *plain facts* and *simple rules* for the guidance of the great mass of practitioners who, it is supposed, have learned theory and pathology from their text-books, but desire to use electricity in their practice principally as an adjunct to other therapeutic agents; it is not intended to convey the idea that electricity is a specific for the various pathological conditions mentioned in this work.

PREFACE TO THE FIFTH EDITION.

“Life is too short for us to wade through enormous quantities of superfluous matter in order to get a small fund of information. For this reason the writer who can condense the crystallized expression of a good subject in the most complete way is the one most appreciated.”

In revising this work it is not the desire of the author to materially depart from the original intention of making it a condensed guide, but the additional chapters were considered necessary for the better understanding of the abbreviated matter contained in the original text. Ever since the first appearance of the book, nearly three years ago, the author has received numerous requests for such rudimentary physics as would enable physicians to get a better start in the study of electro-therapy, and that is his excuse for the elementary character of the additional matter contained in the present edition.

The rapid advance made in this branch of medicine has necessitated many changes in the technique of the other editions, and the physician is assured that although many of the operations herein given may, by observation on his part, be improved upon, he has the most recent ideas of leading electro-therapeutists.

PREFACE TO SEVENTH EDITION

A revision of this work is again made necessary by the rapid strides in electro-therapy during the past five years.

Most of this advance has been made in the field of the Roentgen X-ray, both radio-therapy and radiography, which, being only a bare possibility when the fifth edition was written, has taken such a high place in the roster of therapeutic agents, as to make it the wonder of the twentieth century.

The enthusiasm begotten by this wonderful unknown agent, is very likely to do harm by causing it to be overused. The author has, therefore, deemed it advisable to deal with this part of the subject in a conservative manner, believing, however, that the ultra possibilities claimed for it are not impossible of realization.

The author takes this opportunity to thank the many thousand physicians who have given him their support and words of encouragement in his endeavor to promulgate a more rational use of electricity in medicine.

11 Washington St., Chicago

PREFACE TO THE SEVENTH EDITION

BY

W. H. WELLS, M.D.

NEW YORK

1938

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WORK OF A COMMITTEE OF THE AMERICAN ELECTRO-THERAPEUTIC

ASSOCIATION, INCORPORATED, AND THE AMERICAN SOCIETY OF

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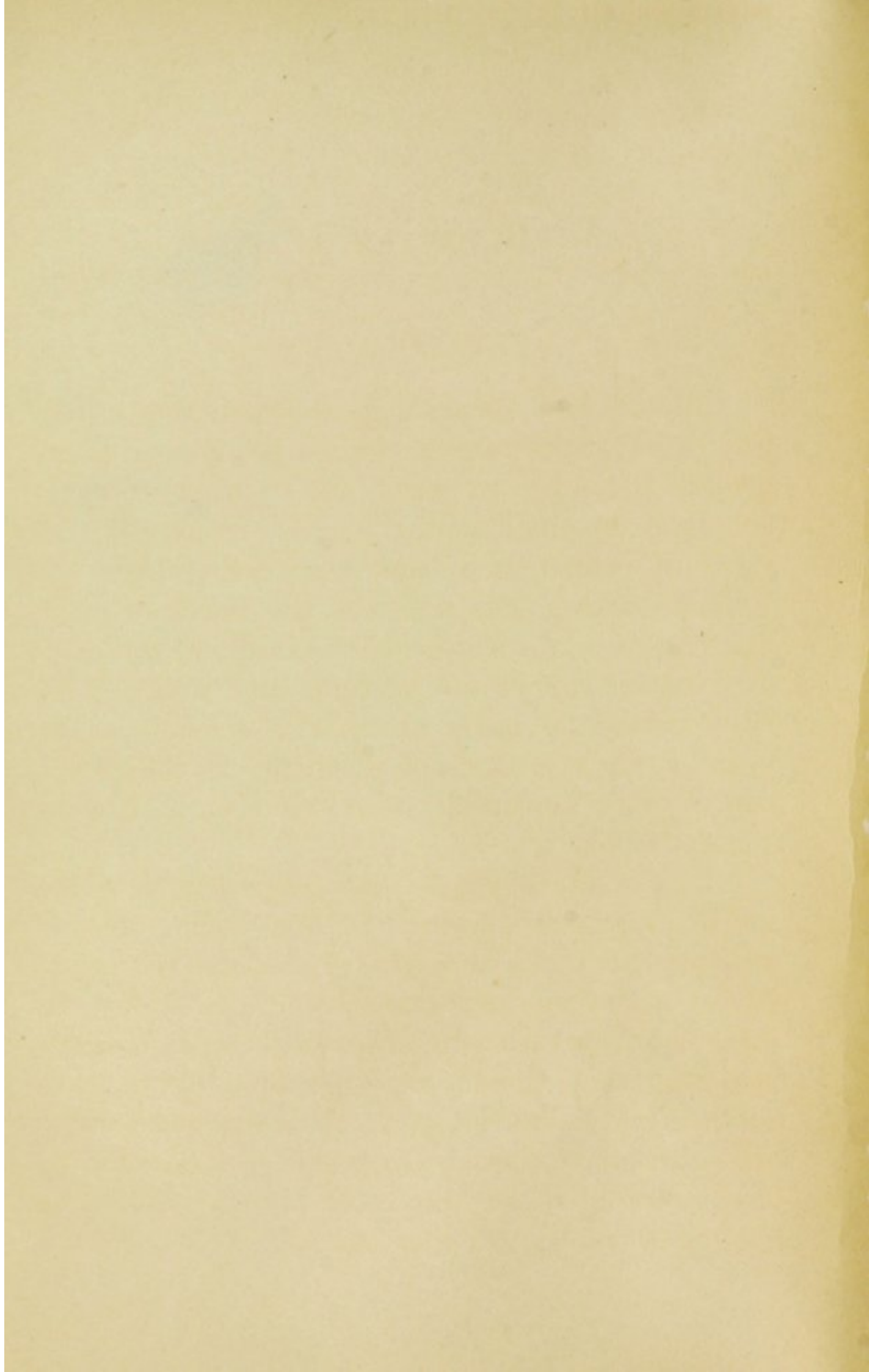
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...is to observe...
...in which nature speaks to us...
...study and work for...
...conclusions, the result of which...
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CHAPTER I.

ELECTRICITY.

Electricity is a natural phenomenon, and the only way to accomplish results either physical or therapeutical is to observe closely and try to interpret the language in which nature speaks to us. It took years of patient study and work for Galvani and Volta to arrive at conclusions, the result of which has been a permanent benefit to mankind and made their names famous for all time; and although we have apparently made much advancement in late years in the application of electricity for the alleviation of many human ills, it yet remains, as it were, a sealed book.

The apathy of physicians in regard to electricity for therapeutical purposes is not being able to measure the results at a glance; they are too apt to expect something phenomenal which, in reality, has never been the case with any great therapeutic agent, and why they should expect it from electricity is another unexplained mystery. Brown-Sequard, Koch and others have furnished splendid examples for the observation of those who would benefit mankind by one great stride in the therapeutical world.

Physicians as well as the laity have been accustomed to surround everything pertaining to electricity with a mysteriousness and awe that have almost precluded its rational study from a standpoint of materiality, and it is a noticeable fact that just as soon as it loses its air of mystery and assumes the shape of something that can be handled, controlled and utilized, great progress is made in its study.

Let us compare electricity with some of the other forces with which we think we are familiar and see how closely they are related. The latest and most plausible theory regarding electricity is, that it is a mode of motion or other manifestation of a very exceptionable form of matter called *the ether*. Referring to some of the properties of this ether, Duff says:

(1) It permeates all bodies and pervades all known space, even to the most distant star.

(2) It is affected by the matter of bodies in which it is. It appears to be concentrated in it to an extent depending on the density of the matter. Ether thus bound differs from free ether in that it transmits short waves more slowly than long ones.

(3) It is continuous, not granular.

(4) Its density is to that of water as is unity to unity followed by twenty naughts (10^{20}), while its rigidity is one-billionth that of steel.

This ether then is electricity in a latent or passive state, but in order to convert it into energy it is necessary to destroy its equilibrium, and kinetic

The first part of the book is devoted to a general history of the United States from its discovery to the present time. It is written in a simple and plain style, and is intended for the use of schools and families.

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Physicists as well as the public have been surprised to find that the hydrogen spectrum of the sun is not a simple spectrum but a complex one. It is a complex spectrum because it is a spectrum of a gas which is not at rest but is moving with a velocity of about 200 miles per second. This velocity is due to the fact that the sun is rotating and the hydrogen is moving with it. The result is that the spectrum is shifted towards the red end of the spectrum. This is known as the Doppler effect. The Doppler effect is a well known phenomenon in physics. It is the change in frequency of a wave as it moves towards or away from an observer. In the case of the sun, the hydrogen is moving away from us, so the spectrum is shifted towards the red end.

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energy is generated when it seeks to restore that lost equilibrium, much the same as water when raised above its level can be made to do work by the pressure it exerts, e. g., a mill race.

If we take a rubber tube open at both ends and immerse it in a lake the tube will be filled with water but we can do no work with it, although the tube is what we might call a *conductor*, because the water does not flow; but put a force pump at one end of the tube and cause a flow and the work that can be done will be in proportion to the pressure exerted by the pump.

A copper wire is strung up along the street on poles and although the wire is immersed, as it were, in electricity (ether) and is a good conductor of the same, we have no current or flow because the *electric level is not disturbed*; but put a force pump (dynamo) at one end of the line and we can do work in proportion to the *pressure* exerted by the dynamo, such as operating motors, electric lighting, etc.

A battery then is merely a machine or instrument for keeping up a difference in electric level and thereby causing a current of electricity to flow.

Light is only a transverse vibration of this same ether, the wave lengths being infinitesimally shorter than the other forces, the vibrations of red light being about 400,000,000 per second. Heat and sound are apparent to us by the aid of the same medium, the waves being longer.

We know the laws that govern electricity just as well as we know the laws regulating light, heat, sound and gravitation, and when we observe that they are elucidated by a mathematical process, much of the mystery surrounding them is dissipated and we look upon them as cold facts capable of being demonstrated; but when we come to consider the fact that all animal and vegetable life is not only due to but dependent upon the electrical conditions that surround and are within them, is it not reasonable to suppose that we should be able to restore the equilibrium of the body (health) by supplying electricity from some outside source?

Althaus gives excellent reasons for believing that the work of the brain cell is of an electrical nature and compares the axons to conductors and their myeline sheaths as insulators, so that there is isolated conduction along the whole of fully matured nerve fibers, up to the point where they reach the peripheral or central terminations of the sensory organs or the muscles, where the myeline sheath disappears and the axons become naked, allowing of the free transmission of the current. Thus the axons of the neuron resemble the conducting cords of a battery.

In health the nerves are all in a state of vibration, due, in all probability, to the currents of electricity which traverse the body in every direction, and when a nerve loses its vibratory action its function is destroyed and degeneration commences.

All the nerves respond to stimuli in a similar manner. For instance, the nerve fibers of the optic nerve, which carry the impulses from the eye to the brain, are stimulated by light. The impulses travel along the nerve fibers and are transmitted to the brain.

The speed of the nerve impulses varies with the type of nerve. In the case of the optic nerve, the impulses travel at a speed of about 100 meters per second. In the case of the nerves of the brain, the impulses travel at a speed of about 100 meters per second. It is important to note that the speed of the nerve impulses is not affected by the length of the nerve.

All the nerves respond to different vibrations; for instance, the sun causes a very rapid vibration of the ether and the optic nerve is so constructed that it responds to these vibrations or wave lengths and *we see*.

The sound of the voice disturbs this same ether, only the waves are longer, and the auditory nerve is so constructed that it responds to these wave lengths and *you hear*. If it happened that the optic and auditory nerves both responded to the same vibration, then you could *see the sound* and would not need ears.

CHAPTER II.

VOLTS—AMPERES—OHMS.

The *volt*, *ampere* and *ohm* are the first three measurements in electricity, and it is necessary for the physician to have a proper conception of them before he can hope to apply it rationally for therapeutic purposes.

Voltage is pressure or push power, and is not electricity but the force which impels it. Voltage is therefore produced by a difference in electric level and is due to the difference of potential of the two metals we use as elements in the cell.

If we take two dissimilar metals and plunge them into an exciting fluid they are acted upon differently by the fluid, and the greater this difference of action the greater the difference in electric level; the greater the difference in electric level the greater the voltage or push power.

Suppose we immerse a piece of zinc and a piece of iron in an acid or other exciting fluid, the zinc and iron will be attacked by the fluid in nearly the same proportion, and the difference of potential between the two metals will be so small that the resultant voltage or push power will be very little; but sup-

possess the two metals to be zinc and carbon—the zinc is acted upon readily while the carbon is unaffected by the fluid, consequently these two metals give us the greatest difference of potential and a high voltage or push power is obtained by their use than by any other metals.

The volt then is the unit of electro-motive force (E. M. F.) and is about equal to the push power or pressure exerted by one Daniell's cell, which although not a technical definition according to the present electrical standards, will serve the purpose of this work and is approximately correct.

Amperage is the rate of flow and is not to be confounded with voltage, for although each is a component part of electrical energy they serve a entirely different purpose. Voltage is that which tends to move current over a conductor, while amperage is electricity and is that which is moved.

The water that pours over the falls of Niagara we might compare to the *amperage* or quantity while the distance it falls we would call *voltage*.

The water in the river represents *amperage* the swiftness with which it flows (caused by difference of level) the *voltage*. We may have a very large river flowing slowly or a small stream running swiftly, and just so we have electrical currents of high amperage and low voltage, or vice versa.

The ampere is the unit of current (C.) and is just as much electricity as can be pushed through

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If we take two standard metals, and connect them into an electric circuit, the current will flow directly by the *volt*, and the amount of the current will of course be greater the difference in electric level, and the greater the difference in electric level the greater the voltage or push power.

Suppose we measure a piece of zinc and a piece of iron in an acid or other exciting fluid, the *volt* which would be supplied by the fluid is nearly the same, and the difference of potential between the two metals will be so small that the resulting voltage or push power will be very little; but still

pose the two metals to be zinc and carbon—the zinc is acted upon readily while the carbon is unaffected by the fluid, consequently these two metals give us the greatest difference of potential and a higher voltage or push power is obtained by their use than by any other metals.

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The ampere is the unit of current (C) and is just as much electricity as can be pushed through a

resistance of one ohm by one volt push power. The ampere being more current than can be used for therapeutic work, it is divided for the convenience of electro-therapeutists into 1,000 parts, called *milliamperes*.

The term *resistance* as used in an electrical sense does not differ in meaning than when the same term is used relative to the other forces and simply means that which opposes the passage of electricity through a circuit.

The *ohm* is the unit of electrical resistance (R) and is approximately equal to the resistance offered by a piece of copper wire 250 feet long and $\frac{1}{20}$ inch thick. The resistance of wires or other conducting material vary directly as their length and inversely as their cross section, and also inversely as their conductivity, therefore a short wire offers less resistance than a long one, and a thin wire offers more resistance than a thick one of the same length; much the same as a large pipe will carry more water than a small one. Of the metals pure silver is the best conductor, but copper so nearly equals it for all practical purposes that it is preferred. Platinum has five times the resistance of copper. Metals being the best conductors of electricity, any solutions of the salts of metals decrease the resistance, as for instance water containing in solution one part of salt (sodium chloride) conducts a hundred times better than ordinary water, and it is for this reason that we

... sponges and other electrodes with ... to increase their conductivity by de- ... resistance. As resistance is quite an ... be considered more in detail ... electrical measurements.

resistance of one ohm by one volt push power. The amount being more current than can be used for therapeutic work, it is divided for the convenience of electrotherapists into 1,000 parts, called milliamperes.

The type mentioned in text is an electrical apparatus that is usually portable, for use in the home or office. It is used for the treatment of various conditions, such as rheumatism, neuralgia, and other painful conditions.

The apparatus consists of a power source, a transformer, and a series of electrodes. The power source is connected to the transformer, which steps up the voltage to the required level. The electrodes are then connected to the transformer, and the current is passed through the patient's body. The current is usually passed through the body in a series of pulses, which are controlled by a switch or a timer. The treatment is usually applied to the affected area, and the patient is usually in a reclining position. The treatment is usually applied for a period of 15 to 30 minutes, and is repeated several times a day. The treatment is usually very effective, and is used for a wide variety of conditions.

sometimes wet sponges and other electrodes with salt water, i. e., to increase their conductivity by decreasing their resistance. As resistance is quite an important factor, it will be considered more in detail in the chapter on electrical measurements.

CHAPTER III.

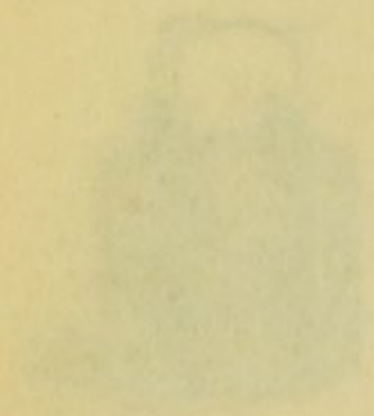
GALVANISM—BATTERY FORMATION.

The galvanic current, sometimes called the *direct* or *continuous* current, is, for therapeutic purposes, generally produced by chemical decomposition—or is merely the conversion of chemical energy into electric energy. It must be remembered that while it is impossible to change matter from one form to another, it is easy to convert one manifestation of force or energy into another; as for instance, heat energy may be converted into mechanical energy—a good example being the steam engine. It is well to also keep in mind the law of conservation of energy which teaches, “that there are no forces in nature to which the law of energy does not apply; the principle that the total energy of the universe is constant, no energy being created or destroyed in any of the processes of nature, every gain or loss in the form of energy corresponding precisely to a loss or gain in some other form or forms.” This is the great fundamental principle of modern physics, and is just as applicable to electricity as any other force.

The fact is, then, that the electrical energy we utilize for the treatment of disease, if derived from a

energy of cells is generated entirely by the chemical decomposition that takes place within the cell, and if we wish to generate electricity for any purpose, we must have a consumption of the fuel that keeps up the chemical decomposition, and this fuel must of course be renewed as required, much the same as the batteries furnish heat energy must be supplied as needed.

Although the physician would not expect his cells to furnish heat without a renewal of fuel, yet there are many there who are attracted by the order of arrangements of those who would furnish their patients with 20 or 30 cells as large as a man's hand, that is, arranged to do heavy work for a period of several years. There is no fault of the physician because he has had no special training in this direction, but it has been very discouraging to the use of electricity in medicine, because all who use such apparatus for a long period of time as absolute results are concerned.



The chemical action of a galvanic cell is shown in Fig. 1, consists of a zinc electrode in a zinc sulfate solution and a plate of copper in a copper sulfate solution. The chemical decomposition that takes place at the zinc electrode is the generating plate and causes positive

CHAPTER III.

GALVANISM—BATTERY FORMATION.

The galvanic current, sometimes called the direct or direct current, is for therapeutic purposes generally produced by thermal decomposition and is merely the conversion of chemical energy into electric energy. It must be remembered that when it is produced no energy either from one form or another, is ever destroyed, the manifestation of form of energy and location, as for instance, heat energy, may be converted into mechanical energy—light, sound, heat, and other forms. It is well known that in nature the law of conservation of energy holds, and that there are no forces in nature which create or destroy energy. This law applies to the entire universe, and the energy of the universe is neither created nor destroyed, but is conserved in the form of matter, every gain or loss in energy is accompanied by a corresponding particle to a loss of energy, and vice versa, "energy is conserved in form." This is the fundamental principle of modern physics, and applies equally to electricity as any other force.

It is to be noted, that the electrical energy we employ in the treatment of disease, if derived from a

battery of cells, is generated entirely by the chemical decomposition that takes place within the cell, and if we expect to generate electricity for any purpose, we must have a consumption of the fuel that keeps up the chemical decomposition, and this fuel must of course be renewed as required, much the same as the stove which furnishes heat energy must be supplied with coal as needed.

Although the physician would not expect his stove to furnish heat without a renewal of fuel, yet how many there are who are attracted by the seductive advertisements of those who would furnish them a battery of 20 or 30 cells as large as a man's finger, that is *guaranteed to do heavy work for a period covering years*. This is no fault of the physician, because he has had no special training in this direction, but it has been very discouraging to the use of electricity in medicine, because all who use such apparatus are doomed to failure as far as absolute results are concerned.

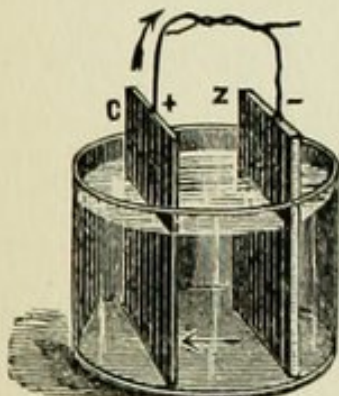


FIG. 1.

BATTERY FORMATION.

The simplest form of a galvanic cell, as shown in Fig. 1, consists of a plate of carbon (c) and a plate of zinc (z) immersed in an exciting fluid. The chemical decomposition that takes place at the zinc makes it the generating plate and causes positive

electricity to be generated there, and this flowing through to the carbon, which is of lower potential, is carried out of the cell through any conducting medium that may join the two elements together from the outside. (See direction of arrows.)

The manner of joining a number of cells together depends upon the kind of work required of them; as for instance, when we wish to treat the human body, which offers a comparatively large resistance to the passage of the current, the cells must be connected in what is called *series* (Fig. 2), in order that we get a greater voltage or push power.

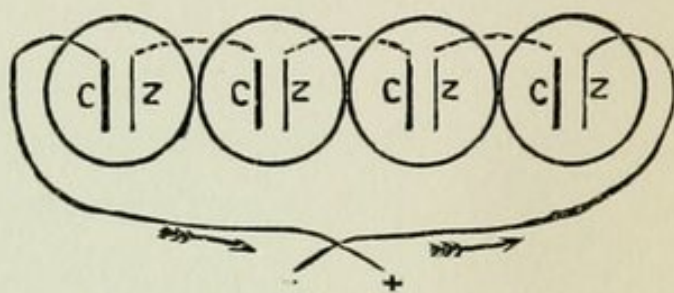


FIG. 2.

To connect cells in series we join the *unlike* elements together by means of a wire or other good conductor; that is, the zinc of first cell with the carbon of the one following until all are connected in a continuous chain. *All galvanic batteries for therapeutic purposes are connected in this manner*, each cell added increasing the pressure or voltage of the circuit. If, however, the work we would accomplish requires a larger quantity or amperage and not so much voltage (the resistance to be overcome being small) such as heating platinum electrodes for actual cautery, then the arrangement must be entirely different, the *like* elements being connected

together as in Fig. 2, which is called *multiple* or *parallel*.

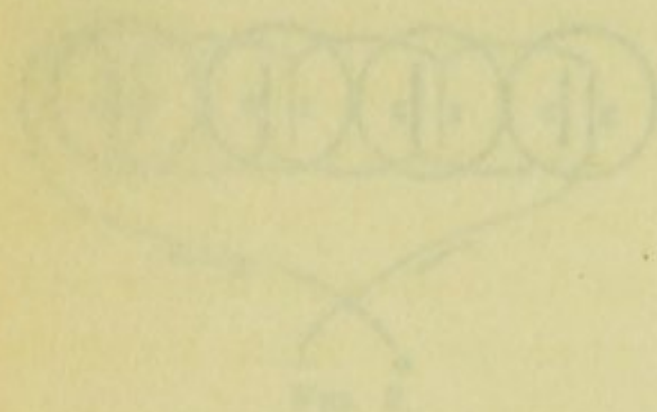


FIG. 2.

As in Fig. 3 (*multiple*) we have *four voltages* and *one ampere*, or but the same as one cell with very high resistance.

The best type of cell for a portable battery if the work to be done *will do work*, should have zinc as one of the electrodes and an exciting fluid composed of a solution of bichromate of soda and sulphuric acid, with a little mercury bisulphate added to keep the zinc elements amalgamated. In such a battery the elements should be immersed in the fluid only when it is wanted for use and removed again when the current is finished because there is a considerable amount of material going on so long as the elements remain in the fluid whether the circuit is complete or not for battery or not.

In the office or stationary form of battery—and which one is always to be preferred unless practice is confined to the country—we use some form of the Leclanche cell, in which the elements are zinc and carbon and the exciting fluid a saturated solution

electricity to be generated there, and this flowing through to the carbon, which is of lower potential, is carried out of the cell through any conducting medium that may join the two elements together from the outside. (See direction of arrows.)

The manner of joining a number of cells together depends upon the kind of work required of them. As for instance, when we wish to treat the

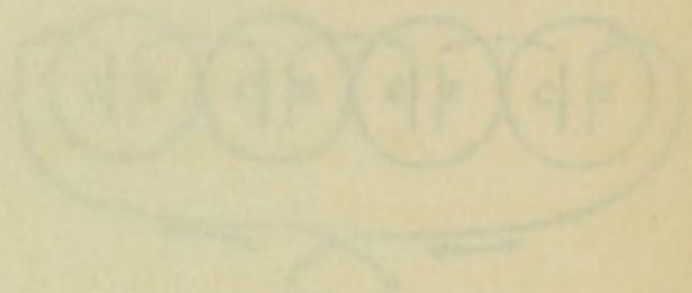


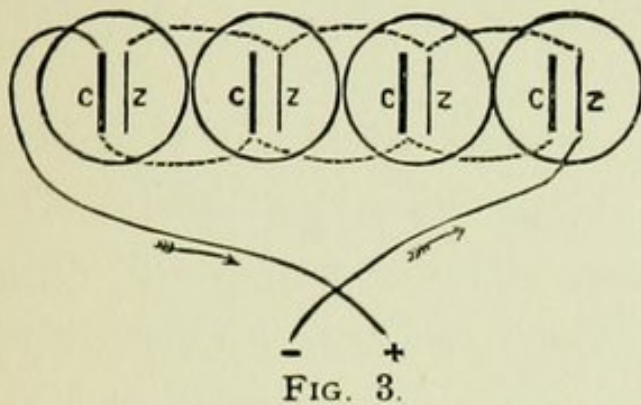
FIG. 2

muscles, which
of the current
larger quantity
of the current
the work to be
done, the cells
are connected in

series, so that we get a greater voltage or pressure.

When we wish to apply the current to the treatment of a nerve or other good conductor, the cells are connected in parallel, so that the pressure or voltage of each cell is maintained. In this manner, each cell maintains the pressure or voltage of the circuit. If, however, the work we would accomplish requires a larger quantity of amperage and not so much voltage (the resistance to be overcome being small) such as heating platinum electrodes for neural surgery, then the arrangement must be entirely different, the cells being connected

together as in Fig. 3, which is called *multiple* or *parallel*.



If each of these cells gave a pressure of one volt, and one ampere in quantity, then by the first arrangement (series) we have in the circuit *four volts* and one ampere,

while in Fig. 3 (multiple) we have *four amperes* and one volt, or just the same as one cell with very large elements.

The best type of cell for a portable battery if we would have one that *will do work*, should have elements of zinc and carbon and an exciting fluid composed of a solution of bichromate of soda and sulphuric acid, with a little mercury bisulphate added to keep the zinc elements amalgamated. In such a battery the elements should be immersed in the fluid each time it is wanted for use and removed again after the operation is finished because there is a consumption of material going on as long as the elements remain in the fluid whether the circuit is complete outside the battery or not.

In the office or stationary form of battery—and such a one is always to be preferred unless practice is strictly confined to the country—we use some form of the Leclanche cell, in which the elements are zinc and carbon and the exciting fluid a saturated solution

of ammonium chloride. The elements do not have to be taken out of the fluid in this form of cell, and they will do satisfactory work for a period of one year or more without renewal.

All battery cells are subject to what is called *polarization*, i. e., the deposition of bubbles of hydrogen upon the carbon element which will then become the generating plate and cause a current of electricity to flow from the hydrogen-covered carbon plate *toward* the zinc, thus partially neutralizing the original flow. While many methods are in vogue for preventing this they only partially do so, but owing to the fact that the larger the surface of the carbon the longer time it takes to cover it with the hydrogen bubbles, it would be proper in selecting cells, especially those to be used in stationary or office batteries, to get those having the *largest carbon surface*.

CHAPTER IV.

ELECTRICAL MEASUREMENTS.

About the year 1827 Dr. George Ohm gave us the law that bears his name and which forms the basis of all electric measurements, viz: "The strength of the current passing through any part of a circuit varies directly as the difference of potential between the extremities, and inversely as the resistance of the circuit." This may be expressed by the following equation, where E represents the electro-motive force of the battery in volts, C the current in amperes and R the total resistance in the circuit in ohms.

The potential E equal to the voltage divided by the resistance.

It is important to understand that this is no comparison with water to elucidate Ohm's law. The quantity of water that flows through the nozzle of an engine or pump will be directly proportional to the pressure with which it is urged forward by the piston. The water would correspond to the electric current and the nozzle to the circuit. The friction will represent the

of ammonium chloride. The elements do not have to be taken out of the fluid in this form of cell, and they will do satisfactory work for a period of six years or more without renewal.

All battery cells are subject to various other conditions, and in the operation of battery cells hydrogen gas is evolved which will explode if not properly vented. The electrolyte solution is also subject to various conditions, and it is necessary to keep the cells at a constant temperature. The cells should be kept in a well-ventilated room, and the electrolyte should be kept at a constant level. The cells should be kept in a well-ventilated room, and the electrolyte should be kept at a constant level. The cells should be kept in a well-ventilated room, and the electrolyte should be kept at a constant level.

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$$C = \frac{E}{R}$$

Or, the current is equal to the voltage divided by the resistance.

A very simple illustration, one that is in common use, will serve to elucidate Ohm's law. The quantity of water that flows through the nozzle of an ordinary syringe will be directly proportioned to the force with which it is urged forward by the piston; this force would correspond to the electro-motive force or voltage. The friction will represent the

resistance in the circuit. Now, if we divide the former by the latter we have the quantity of water which flows through the nozzle in a given time, representing the strength of current. If the nozzle of the syringe were longer (the pressure being the same) less water would flow, or if the hole in nozzle were decreased in size the same thing would happen, because in each case the resistance is increased. This being compared with electricity would imply that the longer or thinner the conductor the greater the resistance and consequently the less current would flow.

Let us suppose we have thirty cells each giving a pressure of one volt; if these cells were connected in *series* the pressure at the terminals would be thirty volts.

The human skin offers quite a high resistance to the passage of electricity, interposing with the ordinary sponge discs from 5,000 to 10,000 ohms, so if the proper electrodes were attached to the two terminals of this battery, which gives a pressure of thirty volts, and these electrodes were held in the hands of a person whose resistance is 6,000 ohms, we could, by Ohm's law, compute the amount of current flowing through the person, as follows:

$$\text{Current (C)} = \frac{30 \text{ Volts (E)}}{6,000 \text{ Ohms (R)}} = \frac{1}{200} \text{ Amp. or 5 milliamp.}$$

Other parts of the body vary as to their resistance to the current owing to the different texture of

the skin, while the tissues and underlying fascia are fairly good conductors and offer but little resistance. Hence the larger the electrode the less the resistance to which a large surface electrode on the abdomen is connected to one terminal of the same battery and the other terminal attached to an electrode in contact with an ocular surface in the intrapalpebral space the resistance would be much decreased and would be about 500 ohms. If the same battery we used for the other experiments, which gives a pressure of thirty volts, were used in this case it would be about 500 ohms. If we take the same battery we used for the other experiments, which gives a pressure of thirty volts, and divide the voltage as above, and by Ohm's law we get the following:

$$I = \frac{E}{R} = \frac{30}{500} = 0.06 \text{ amp. or } 60 \text{ milliamps.}$$

It is to be noted that the resistance of the body is not a constant, but varies in every experiment. It has been shown that a current of 100 milliamps will flow through the body while the same current will not flow through the same body if the resistance is increased. The question then arises, "How much resistance will the body offer?" The answer is, "Nothing, for the amount of current that will get in any electrical apparatus depends upon the resistance interposed."

If the resistance of the various parts of the human body were known, and if these were the

resistance in the circuit. Now, if we divide the current by the latter we have the quantity of water which flows through the nozzle in a given time, representing the strength of current. If the nozzle of the syringe were larger (the pressure being the same) less water would flow, or if the hole in nozzle were decreased in size the same thing would happen. In fact, in fact, as the resistance is increased. This being repeated with electricity would imply that the longer or thicker the conductor the greater the resistance and, consequently, the less current would flow.

Let us suppose we have thirty cells each giving a strength of one volt, if these cells were connected in series the pressure at the terminals would be thirty volts.

The body of the human body is a high resistance to the passage of electricity, interposing with the current a resistance from 5,000 to 10,000 ohms, so if the positive electrode were attached to the two terminals of this battery, which gives a pressure of thirty volts, and three electrodes were held in the back of a person whose resistance is 5,000 ohms, we could approximate how much the amount of current flowing through the person, is follows:

$$\text{Current } I = \frac{E}{R} = \frac{30 \text{ Volts}}{5,000 \text{ Ohms}} = \frac{3}{500} \text{ Amp. or 6 milliamps.}$$

Other parts of the body vary as to their resistance to the current owing to the different texture of

the skin, while the tissues and underlying fascia are fairly good conductors and offer but little resistance. Again, the larger the electrode the less the resistance, so with a large surface electrode on the abdomen attached to one terminal of the same battery and the other terminal attached to an electrode in contact with a mucous surface in the intrapelvic cavity, the resistance would be much decreased and instead of 6,000 ohms it would be about 300 ohms. Now take the same battery we used for the other experiment, which gives a pressure of thirty volts, and apply the electrodes as above, and, by Ohm's law, we have the following:

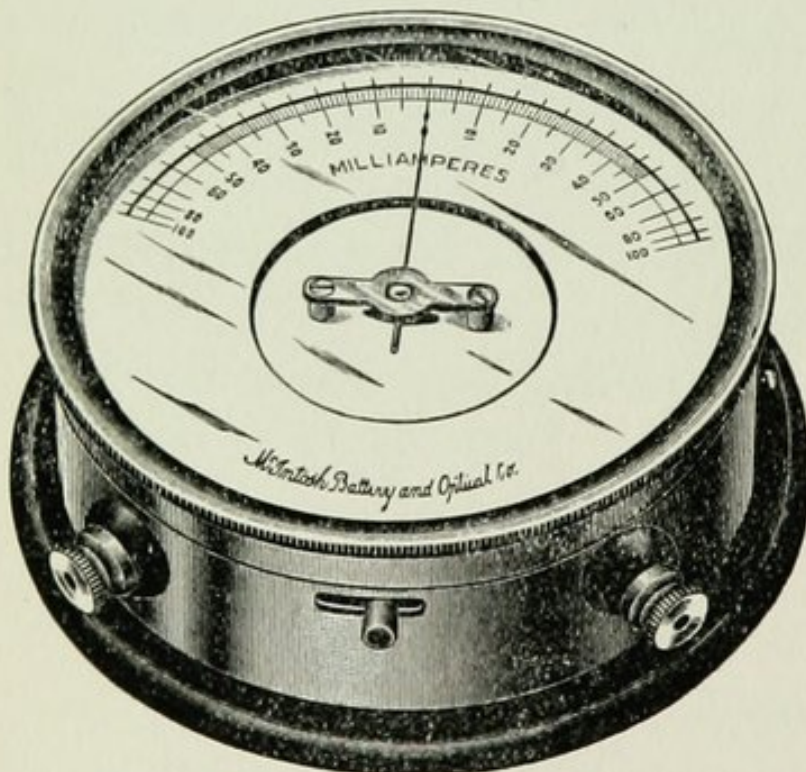
$$\text{Current (C)} = \frac{30 \text{ Volts (E)}}{300 \text{ Ohms (R)}} = \frac{1}{10} \text{ Amp. or 100 milliamp.}$$

From this we deduce the fact that the resistance or ohms plays a very prominent part in every operation by electricity, for it has been shown that a certain battery causes five milliamperes to flow through a certain part of the body while the same battery applied to another part of the same body with different electrodes allows a flow of one hundred milliamperes of current. The question then, "How many milliamperes will my battery give?" means absolutely nothing, for the amount of current we are able to get in any electrical operation depends entirely upon the resistance interposed.

If the resistance of the various parts of the human body were known, and if these were the

same in all patients, and if also the voltage of the battery were constant, then the amount of current flowing could always be reckoned by Ohm's law. But unfortunately these are variable factors, for the resistance of the body is constantly changing and the battery because of polarization and other causes is never constant, therefore it becomes absolutely necessary to have some means of determining how much current is flowing, for it is *the current that does the work*, the voltage being only the force that pushes it through.

The instrument we call the milliampere meter, which is used for determining the amount of current



MILLIAMPERE METER.

passing through the patient, should be a part of the armamentarium of every electro-therapist, for although we do not always know the exact dosage required, we at least know *how much we are using*, and with any new thera-

peutic agent this is always desirable for purposes of comparison, and then again the meter is always an index of the condition of the battery.

Not long ago a physician sent for the author to ascertain, if possible, why he was not getting results from the use of galvanism, when it was proved to him that on account of improper manipulation of his battery he had not been getting any current whatever, although he had been using his battery for a period extending several months. *He had no meter.*

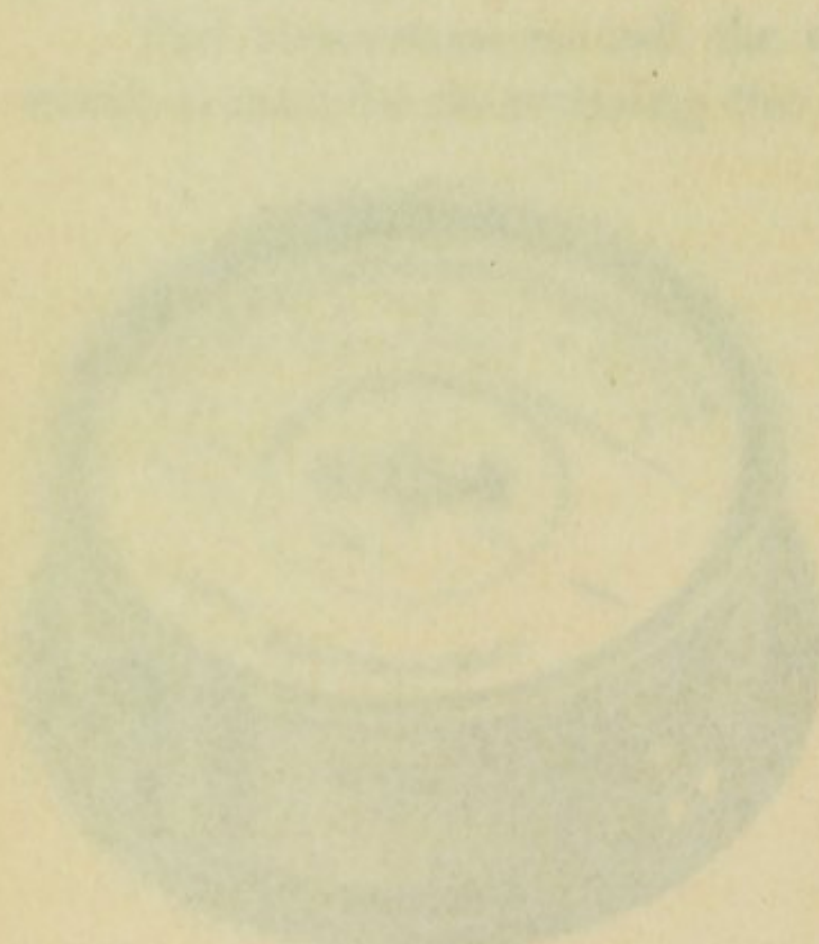
It does not mean anything to say you use five, ten or ten cells, neither is it possible to gauge the strength of current by the sensation of the patient, for the electro-sensibility of people is as variable as the temperature; and while one person will complain of a current strength of five milliamperes, another will probably feel twenty.

When a good meter is in the circuit it does not matter what the resistance of the patient, because it will show no current until the meter marks the strength desired independent of the fact of whether the circuit is made by cells or five cells.

As a matter of fact on this subject we feel impelled to say that the means for controlling the current is usually accomplished by a double rheostat or a rheostat which is quite unsatisfactory especially in case the electro-sensibility of the patient is above normal, as the adding of a single cell to the circuit oftentimes causes an intense sensation, and we are therefore unable to reach the desired dosage.

The same rheostat is applied to an instrument which has a readily variable resistance, and

same in all patients, and if also the voltage of the battery were constant, then the amount of current flowing could always be reckoned by Ohm's law. But unfortunately these are variable factors, for the resistance of the body is constantly changing and the battery constant of polarization and other causes is never constant, therefore it becomes absolutely necessary to have some means of determining how much current is flowing, and for the current that does flow, the voltage being only the force that produces it.



Wheatstone Meter

Therefore, to measure the milliamperes, instead of the amount of current passing through the patient, should be a part of the arrangement of every electro-therapeutic set, for although we do not always know the exact dosage required, we at least know how much we are using, and with any new therapy

where again this is always desirable for purposes of comparison, and then again the meter is always a guide to the condition of the battery.

Not long ago a physician sent for the author to ascertain, if possible, why he was not getting results from the use of galvanism, when it was proven to him that on account of improper manipulation of his battery he had not been getting any current whatever, although he had been using his battery for a period covering several months. *He had no meter.*

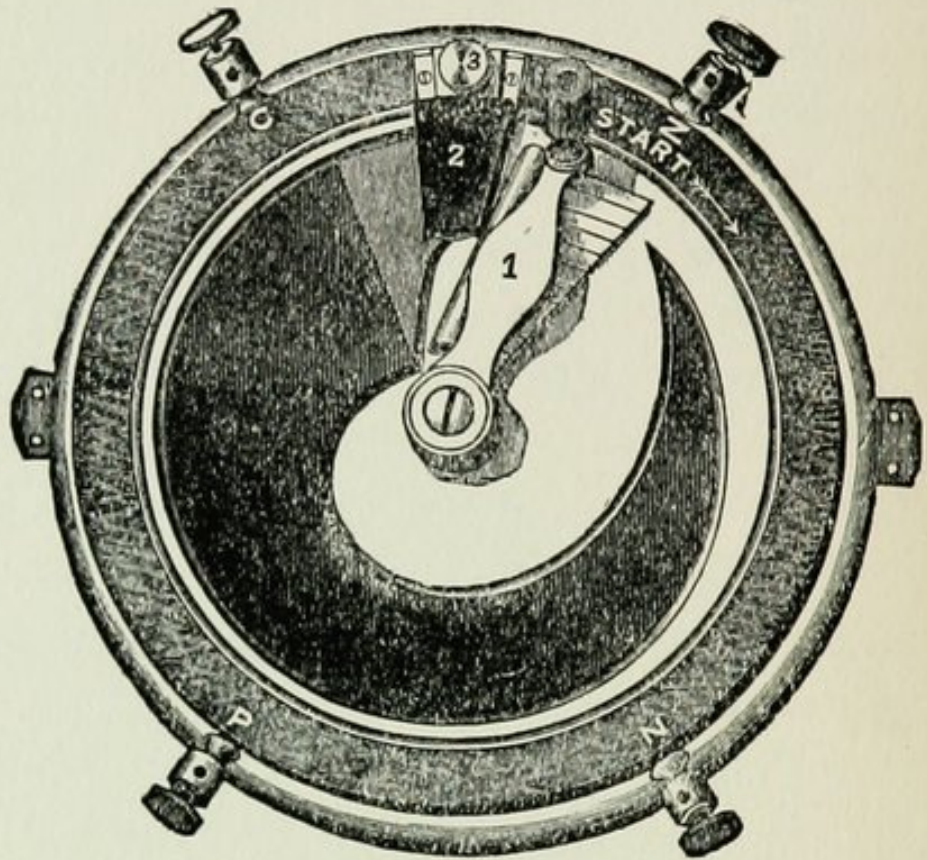
It does not mean anything to say you use five, six or ten cells, neither is it possible to gauge the strength of current by the sensation of the patient, for the electro-sensibility of people is as variable as their resistance; and while one person will complain at a current strength of five milliamperes, another will scarcely feel twenty.

With a good meter in the circuit it does not matter what the resistance of the patient, because we can turn on current until the meter marks the required dosage independent of the fact of whether we have used ten cells or five cells.

Before leaving this subject we feel impelled to say something of the means for *controlling* the current. Usually this is accomplished by a double switch or cell selector which is quite unsatisfactory, especially in case the electro-sensibility of the patient is above normal, as the adding of a single cell to the circuit oftentimes causes an unpleasant sensation, and we are therefore unable to reach the desired dosage.

The name rheostat is applied to an instrument which has a readily variable resistance, and,

for therapeutical work, one that can be increased or decreased in gradual gradations and *not by steps*. It is only necessary for us to consider the relative merits of the two varieties called the *series* and *shunt* rheostats.

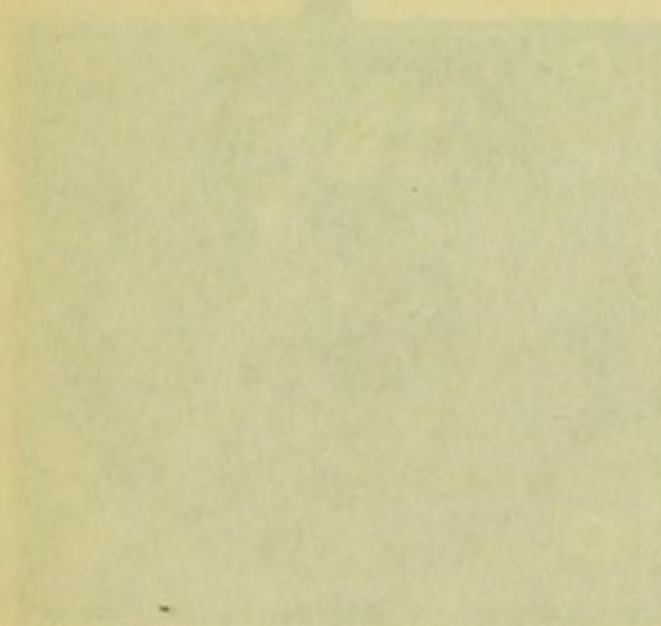


GRAPHITE SERIES RHEOSTAT.

It is not an easy thing to elucidate the laws of force by using matter as an illustration unless we can imagine certain things ; and, for the demonstration of our subject we will imagine a vertical pipe twenty feet in height which is *always* filled with water. The height of the water in the pipe expresses the *voltage* or pressure, while the water itself is *current* or amperage. A very small hole is made at the bottom of the pipe and a small stream of water will flow, but it will be with great force. The hole is made larger and more water will flow, but the *pressure remains the*

series would figuratively speaking, simply make the hole in the pipe larger or smaller, and so would increase or decrease the quantity or amperage, while the voltage or pressure is not increased or decreased correspondingly. This kind of current is called a *current of tension*, is undesirable for therapeutic work because of the pain and discomfort it causes the patient, and therefore the rheostat is fast becoming a thing of the past.

If now we take the same pipe full of water and make a hole in it one foot below the top a



certain amount of water will flow but the pressure will not be great. If, however, the hole be moved down another foot the quantity will be increased because the pressure is increased; and thus it is with a shunt rheostat.

The amount of current depends for an increase or decrease is correct upon a rise or fall of the voltage or pressure in the circuit. The same thing holds against shunt resistance applied in coils as has been stated relative to

by the operation, work, one that can be increased or decreased in gradual gradations and not by steps. It is

only necessary for us to consider the relative merits of the two methods, and to determine which is the more suitable for the purpose in hand. It is evident that the method of gradual gradations is the more suitable for the purpose in hand.

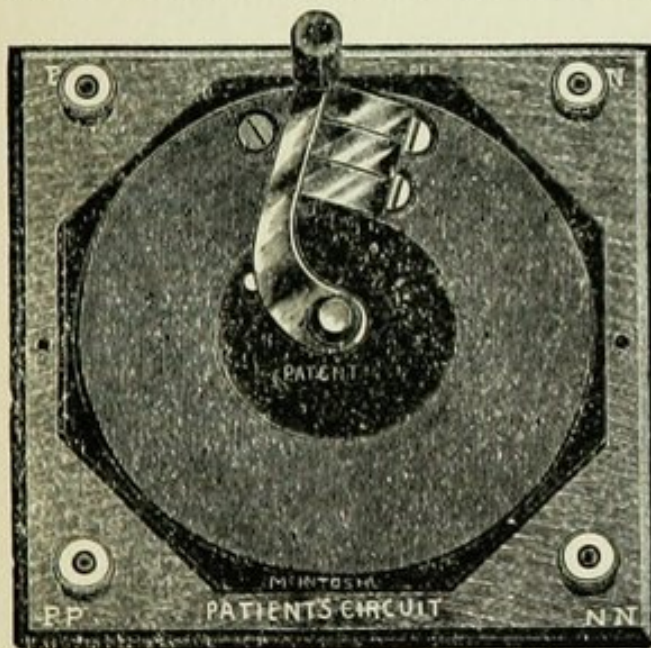


Illustration of a ship's steering wheel.

the only method of doing by using matter as an illustration which we can imagine certain things; and for the demonstration of our subject we will imagine a vertical pipe twenty feet in height which is always filled with water. The height of the water in the pipe expresses the volume of vapour, while the water itself is current or expansion. A very small hole is made at the bottom of the pipe and a small stream of water will flow, but it will be with great force. The hole is made larger and more water will flow, but the pressure remains the

same—thus a rheostat in series would, figuratively speaking, simply make the hole in the pipe larger or smaller, and so would increase or decrease the quantity or amperage, while the voltage or pressure is not increased or decreased correspondingly. This kind of current, called a *current of tension*, is undesirable for therapeutic work because of the pain and discomfort it causes the patient, and therefore the *series* rheostat is fast becoming a thing of the past.

If now we take the same pipe full of water and make a hole in it one foot below the top a certain amount of water will flow but the pressure will not be great. If, however, the hole be moved down another foot the quantity will be increased because the pressure is increased; and thus it is with a *shunt* rheo-



GRAPHITE SHUNT RHEOSTAT.

stat which depends for an increase or decrease of current upon a rise or fall of the potential or pressure in the circuit. The same objection holds against shunt resistance arranged in coils as has been stated relative to

the cell selector—the shifting of the contact lever from one coil to another causing the same shock as the adding of cells; therefore the graphite *shunt* (see cut) is the best because any increase or decrease is made in gradual gradations.

The cell selector is an excellent accessory on any battery, but it should be used in connection with a good rheostat.

the cell selector--the shifting of the contact lever from one coil to another causing the same effect as the adding of cells; therefore the graphic scale (see cut) is the best because any increase or decrease is made in gradual gradations.

The cell selector is an excellent accessory for any battery, but it should be used in connection with a good rheostat.

CHAPTER V.

POLARITY AND POLAR EFFECTS.

As has been previously observed, a battery is an apparatus for destroying, by chemical action, the equilibrium of the ether, thereby causing a difference of level, and what we call a current of electricity flows from the higher to the lower level. The higher point is called the anode or positive pole, while the lower is called the cathode or negative pole, therefore a current of electricity flows *from* the positive *to* the negative pole.

As has been stated in a previous chapter, the generation of electricity in the galvanic cells commences at the surface of the zinc below the fluid, because the chemical decomposition takes place there, and wherever there is a chemical decomposition there is a generation of electric energy. The zinc then is the positive element *within the cell*, because the current flows from that point and the carbon is the negative element; but above or *outside* of the fluid this order of things is reversed, and instead of speaking of the zinc and carbon as elements they are called *poles*; the carbon terminal is called the *positive* pole and the zinc terminal the *negative* pole.

These two poles have certain peculiar properties, both physical and therapeutical, in which they are in diametrical opposition, as the following comparative statement will show :

POSITIVE POLE.	NEGATIVE POLE.
1. Oxygen.	1. Hydrogen.
2. Acid.	2. Alkaline.
3. Will stop bleeding.	3. Increases bleeding.
4. Sedative.	4. Produces hypersensitiveness.
5. Hardens tissue.	5. Liquefies and disintegrates.
6. Is an acid caustic and the resultant cicatrix is hard and unyielding.	6. Is an alkaline caustic and the resultant cicatrix is soft and pliable.
7. Is a vaso constrictor.	7. Is a vaso dilator.

It would then seem that in the application of the galvanic current *polarity means everything* and that if the application of the positive pole were indicated the negative would surely do harm. Physicians just beginning the use of electricity will do well to keep these points in view, as success is largely dependent upon which is used for the *active* pole.

As far back as the year 1859 Funke discovered that a sound living nerve is neutral or feebly alkaline, but changed to acid on coagulation setting in, or on exhausting it by prolonged mechanical or electrical stimulation. The death of the muscle is marked by a progressive acidity and subsequent coagulation of

the muscular plasma. The same is true also of nerve substance as well. Then, if it is true that the twitch of the muscle or nerve commences when an inflamed condition sets in, it is also true that an inflamed or congestive condition is due to excessive alkalinity. These points have been well proven and we insert them here without apology or explanation.

All inflammations are due, as stated above, to excessive alkalinity of the part, not because the system contains an excess of alkali, but that we have a relative deficiency of positive normal alkalinity.

We do not here to state how we believe this relative deficiency is brought about, lest we be charged with being *ipse dixit* or deductions; but we do believe that this may not be considered a *ipse dixit* because it is due to a disturbance of the normal currents traversing the system. We do not wish to enter in this connection into any of the theories advanced by Dr. J. Mount in his book, "The Cause of Disease," but we point to the one which we believe is the correct one, that normal electricity is the cause of life. It is the prime factor in all the functions of the system, of chemical action, of nutrition, of growth, of repair, of health. That without it there is no life, no vitality, no existence. It is the cause of all life, consequently it is the cause of all health, and it is the cause of all disease, which is life itself, or its cause.

Now, if then when we place the positive electrode over an inflamed and painful surface that the

These two poles have certain peculiar properties, both physical and therapeutical, in which they are in diametrical opposition, as the following comparative statement will show:

POSITIVE POLE.	NEGATIVE POLE.
1. Oxygen.	1. Hydrogen.
2. Acid.	2. Alkaline.
3. Will stop bleeding.	3. Increases bleeding.
4. Solidifies.	4. Produces hyperæmia.
5. Hardens tissue.	5. Liquefies and disintegrates.
6. Is an antiseptic and disinfectant.	6. Is an alkaline caustic and the resultant cicatrized tissue is soft and pliable.
7. Is a vaso-constrictor.	7. Is a vaso-dilator.

It is important to note that the application of the positive pole to a part of the body will cause a vaso-constriction and that if the negative pole were indicated the opposite would surely do harm. Physicians beginning the use of electricity will do well to keep these points in view, as success is largely dependent upon which is used for the active pole.

As far back as the year 1853 Fuchs discovered that a severed living nerve is neutral or feebly alkaline, but changed to acid on coagulation setting in, or on exposing it by prolonged mechanical or electrical stimulation. The death of the muscle is marked by a progressive acidity and subsequent coagulation of

the muscular plasma. The same is true also of nerve substance as well. Then, if it is true that the death of the muscle or nerve commences when an acid condition sets in, it is also true that an inflamed or overactive condition is due to excessive alkalinity. These points have been well proven and we insert them here without apology or explanation.

All inflammations are due, as stated above, to excessive alkalinity of the part, not because the system contains an excess of alkali, but that we have an unequal distribution of probable normal alkalinity.

We almost fear to state how we believe this pathological condition is brought about, lest we be charged with being too ultra in our deductions; but a few years hence a writer may not be considered a "crank" who advocates that it is due to a disturbance of the normal electrical currents traversing the body; and we are glad to quote in this connection from such eminent authority as Dr. J. Mount Bleyer, who says: "Yet all this points to the one conclusion and the one deduction, that animal electricity comes first; that it is the prime factor in all the processes of change, of chemical action, or otherwise, within the living body. That without its stimulus of polarization no chemical action can be called into life, consequently none can go on, and tissue metamorphosis, which is life itself, must cease."

Why is it then when we place the positive pole over an inflamed and painful surface that the

inflammation and pain subsides? Oxygen is set free at the positive pole. Oxygen is an acid maker and the part in contact with this pole being changed to a condition of acidity, the temporary death of the part has commenced, or is in a state of sedation, evinced by a circumscribed anæsthesia. But what has become of the alkalinity that existed previous to the application of the positive pole? It certainly has not been neutralized by the acidity of that pole, because that would necessitate an evolution of gas which has not taken place.

Alkalies are electro-positive substances and *have affinity for the negative pole.* Consequently the excess of alkali at the point of inflammation is transferred to the neighborhood of the negative pole, which immediately *assumes a hypersensitive condition*, proving that excessive alkalinity causes inflammation, because the part was perfectly normal before the application of the negative pole.

The so-called anæsthesia produced by a rapidly interrupted induction or faradic current is brought about in a different manner than with galvanism and is more the result of mechanical than chemical action; the rapid impulses given the muscles by a high frequency induction current brings on a tetanic spasm which soon wears it out, causing it not only to lose its normal animal cur-

not but to assume an acid condition, which, in this instance, is not due to polar action or with the position of a galvanic or direct current, but to swelling of the temporary shock of the part, arising from excessive and prolonged electrical stimulation.

Muscles exhausted by repeated shocks of inducing electricity present very small traces of the residual current (Du Bois-Reymond), and the various effects of violent or repeated electrical discharges on muscular irritability have long been known. Veratrine rapidly renders the muscle non-irritable and acid (Schiff). It then applies itself after the cessation of irritability and the residual current is *progressive acidulation* (Schiff).

The amount of electricity through any resistant pathway is always accompanied by the evolution of heat, and the heat evolved is considerable. It is present at the point where the current is applied in contact with the skin, and the heat evolved is greater in proportion to the amount of electricity than in any other condition. It has been used by some writers to destroy the inflammation in rheumatism, and such conditions are consistent with the fact that the greater the heat the higher the fever is produced.

inflammation and pain subsides? Oxygen is set free at the positive pole. Oxygen is an acid and the gas in contact with the pole being changed to a solution of acidity, the respiratory apparatus which is normally in a state of alkaline reaction by a chemical reaction is set free from the alkalinity that existed at the positive pole. The oxygen set free is neutralized by the acidity of the gas which would normally be set free at the positive pole.

It is a well known fact that the positive substances which are set free at the positive pole are the cause of the inflammation. Consequently the removal of the positive substances from the positive pole is the cause of the removal of the inflammation. The removal of the positive substances from the positive pole is the cause of the removal of the inflammation. The removal of the positive substances from the positive pole is the cause of the removal of the inflammation.

It is a well known fact that the positive substances which are set free at the positive pole are the cause of the inflammation. Consequently the removal of the positive substances from the positive pole is the cause of the removal of the inflammation. The removal of the positive substances from the positive pole is the cause of the removal of the inflammation.

rent but to assume an *acid* condition, which, in this instance, is not due to polar action as with the positive of a galvanic or direct current, but by bringing on the temporary death of the part by fatigue from excessive and prolonged electrical stimulation.

Muscles exhausted by repeated shocks of induction electricity present very small traces of the muscular current (Du Bois-Reymond), and the injurious effects of violent or repeated electrical discharges on muscular irritability have long been known. Veratrine rapidly renders the muscle rigid, unirritable and *acid* (Schiff). It then appears that after the cessation of irritability and the muscular current a *progressive acidulation* commences.

The passage of electricity through any resisting medium is always accompanied by the evolution of heat, and the skin offering considerable resistance, heat is produced at the point where each electrode comes in contact with the skin, because that is the point of greatest resistance; and we have a consequent hyperæmia of those parts. This fact has been used by some writers against the use of electricity where inflammations exist, as all such conditions are coexistent with heat, and the greater the heat the higher the fever or inflammation.

Nothing can be more misleading. As Dr. Burr says, "It is not heat but poison which is the disturbing element. Heat is a symptom, one of the effects of the operating toxæmia, hence its reduction cannot eliminate toxins or destroy microbes."

Physicians oftentimes have brilliant results only because the proper pole was accidentally employed, but there need be no guesswork nor empiricism if the fundamental physics of polarity have been learned; and you will neither try to stop hæmorrhage or allay pain with the *negative* pole.

CHAPTER VI.

ELECTROLYSIS--CATAPHORESIS.

Electrolysis is the separating or breaking up of a substance into its elements by electricity, and certain conditions are necessary before this can take place. *Viz.* The substance or electrolyte must be a fluid or semifluid; it must be a conductor of electricity, and one of its constituent elements must be a metal or salt of a metal. Hydrogen is considered a metal, and water being a compound of oxygen and hydrogen, it may be supposed that anything containing water fulfills all of the above conditions, and such is true provided the water is in a state of fluidity, but although we call it water, it is not possible to separate it by electrolysis, because being a solid it does not fulfil all the necessary conditions. Fat and oils although fluids are not capable of being electrolysed because they are non-conductors. When any substance is decomposed by electricity, the products resulting from such decomposition are called ions; those ions which appear at the anode or positive pole are called "anions,"

Nothing can be more misleading. As Dr. Hart says, "It is not heat but poison which is the disturbing element. Heat is a symptom, one of the effects of the operating toxemia, hence its reduction cannot eliminate toxins or destroy germs."

Provisional attention to the patient's condition may be necessary, but the primary aim is to remove the poison. The patient's condition is not the cause of the disease, but the result of it. The patient's condition is not the cause of the disease, but the result of it. The patient's condition is not the cause of the disease, but the result of it.

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When any substance is decomposed by electricity, the products resulting from such decomposition are called *ions*; those ions which appear at the anode or positive pole are called "*anions*,"

and those which appear at the kathode or negative pole, "*kathions*."

The anions are electro-negative and are repelled by the negative pole, because they are the same potential as that pole. The kathions are electro-positive, and being repelled by the positive pole, whose potential is the same, they are drawn to the negative pole in accordance with the well-known law that "unlike poles attract, like poles repel."

The destruction of superfluous hair, warts, moles, *nævi*, etc., all come under the head of electrolytic work, and the products of decomposition in such work are taken up by the absorbents.

In nearly all cases electrolysis of tissue is accomplished by the use of the negative for the active pole, because it acts as an alkaline caustic and has a disintegrating or liquefying effect, while the positive pole, on account of its acidity, has a tendency to harden, dry and produce coagulation of tissue.

The process of introducing medicines into the body by the aid of electricity is termed "*cathoresis*," and as many conflicting statements appear in the literature upon this subject, it is well to consider it in detail from a *physical* standpoint.

Because a constant current goes from the positive pole toward the negative, it is generally

supposed that all instruments must be placed upon the positive pole, so as to be *forced*, as it were, into the tissue by the *deflection* of the current stream. Such is not the case, however, for catharodes by an electrolytic process, and in every instance the current is broken up into its elements, each of them going toward the negative pole and none toward the positive, according as they are electro-negative or electro-positive.

Gold, silver, platinum and oxygen are among the electro-negative elements and have a strong affinity for the positive pole; therefore, when treating, for instance, an enlarged thyroid gland with solution of potassium iodide, we must use the solution on the *negative* pole if we wish to obtain the beneficial effects of the iodine.

Generally all the metals, so far as we know, are electro-positive and appear at the negative pole; if, therefore, a solution of potassium iodide on the negative pole is applied to the throat through the catharode, the potassium iodide, which is decomposed at the negative pole, will be transferred to the positive pole, while the iodine, which, of course, will remain at the negative pole, for which it has an affinity, and which, if not even have a local application of the current, because all of it would be left to the catharode.

and those which appear at the kathode or negative pole, "kathions."

The anions are electro-negative and are repelled by the negative pole, because they are the same potential as that pole. The kathions are electro-positive, and being repelled by the positive pole, whose potential is the same, they are drawn to the negative pole in accordance with the well-known law that unlike poles attract the opposite.

The migration of substances has, warm, normal, and cold current, all being away from the positive pole, and toward the negative pole. In the case of warm current, the migration of substances is toward the negative pole, and is in accordance with the well-known law that unlike poles attract the opposite. In the case of cold current, the migration of substances is toward the positive pole, and is in accordance with the well-known law that like poles repel the like.

The process of introducing medicines into the body by the aid of electricity is termed "ionization," and as many conflicting statements appear in the literature upon this subject, it is well to refer in detail from a paper published in the

because a constant current goes from the positive pole toward the negative, it is generally

supposed that all medicament must be placed upon the positive pole, so as to be *forced*, as it were, into the tissues by the *direction* of the current alone. Such is not the case, however, for cataphoresis is an electrolytic process, and in every instance the medicament is broken up into its elements, some of them going toward the negative pole and some toward the positive, according as they are electro-negative or electro-positive.

Iodin, bromin, chlorin and oxygen are anions or electro-negative elements and have a strong affinity for the positive pole; therefore, when treating, for instance, an enlarged thyroid gland with solution of potassium iodide, we must use the solution on the *negative* pole if we wish to utilize the resolvent effects of the iodin.

Nearly all of the metals, so far as we know, are kathions and appear at the negative pole; if, then, we put a solution of potassium iodide on the positive pole and complete the circuit through some conducting medium, the potassium hydrate, being a metal and a kathion, will be transferred through the medium to the negative pole, while the iodine, being an anion, will remain at the positive pole, *for which it has an affinity*, and we would not even have a local application of the iodine, because *all of it* would be left on the electrode.

Binary compounds are composed of a base and an acid or that which takes the place of an acid. The acid or that which takes its place (the iodine in potassium iodide takes the place of an acid) is an electro-negative element or anion, all the bases are electro-positive or kathions, and if we were using a solution of morphia sulph. or cocaine hydrochlor., we would apply from the *positive* pole, when the base, which in this instance we wish to utilize, will be transferred through the tissues to the negative pole, *for which it has an affinity*. When using a solution of potassium iodide it is not the purpose of the operation to convey the potassium or base through the underlying tissue, but the iodine.

In order to prove conclusively that cataphoresis is an electrolytic process and not the forcing of the medicament in the direction of the current, the reader's attention is called to the following experiments:

EXPERIMENT 1. The center test tube (Fig. 4) contains a solution of potassium iodide and the test tube at either end contains starch water. The tubes are connected one to the other by a strip of blotting paper, which has thoroughly been saturated with water before putting into the solution to prevent the possibility of capillary attraction. The positive pole of a constant current is attached to the left hand tube and the

negative pole to the right hand tube, both having platinum terminals.

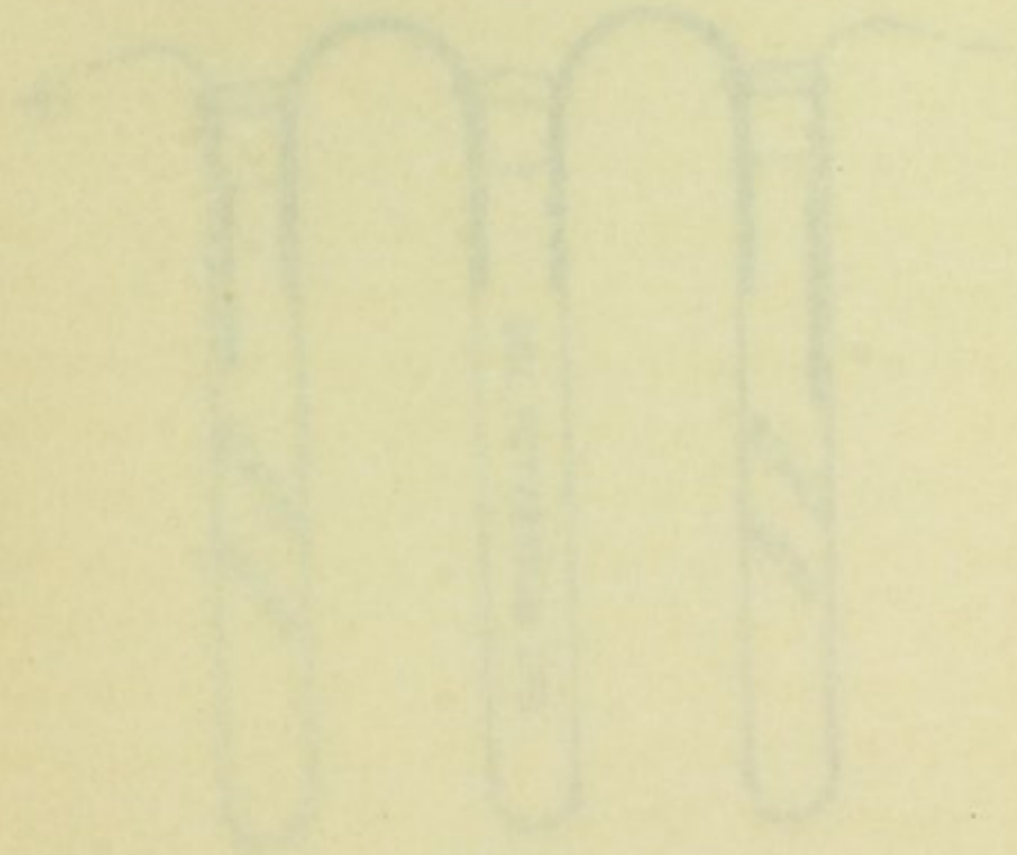


Fig. 1

The apparatus is arranged as shown in the diagram, the two tubes containing potassium sulphate solution, the left tube being connected to the positive pole of the battery, and the right tube to the negative pole. The tubes are connected to a circuit indicated by lines at the top. The left tube contains a dark, dense substance at the bottom, while the middle and right tubes are mostly empty. The tubes are connected to a circuit indicated by lines at the top.

As a result of the electro-thermodynamical operation, the dark substance in the left tube containing potassium sulphate solution migrates to the electro-positive electrode (platinum) and the electro-negative electrode. The latter happens in this experiment, the dark substance in the left hand tube showing the

Binary compounds are composed of a base and an acid or that which takes the place of an acid. The acid or that which takes its place (the iodine in potassium iodide) takes the place of an acid it is an electro-negative element or anion, all the bases are electro-positive or cations, and if we were using a battery of zinc and copper or certain hydrochloric, we would apply from the positive pole, when the base, which is the substance we wish to analyze, has been dissolved through the change to the negative pole, we would use as a guide. When using a battery of potassium and zinc, we would use the positive pole connected to the positive pole of the battery, and the negative pole connected to the negative pole of the battery.

The following is a description of the apparatus used in the experiment. It consists of two glass tubes, one of which is connected to the positive pole of the current, the other to the negative pole. The tubes are connected as follows:

The apparatus is shown in Fig. 4. It consists of a battery of potassium iodide and the left tube of the battery is connected to the positive pole of the current and the right tube to the negative pole. The tubes are connected as follows: a strip of blotting paper, which has been thoroughly wetted with water before use, is placed over the tubes to prevent the possibility of capillary action. The positive pole of a constant current is attached to the left hand tube and the

negative pole to the right hand tube, both having platinum terminals.

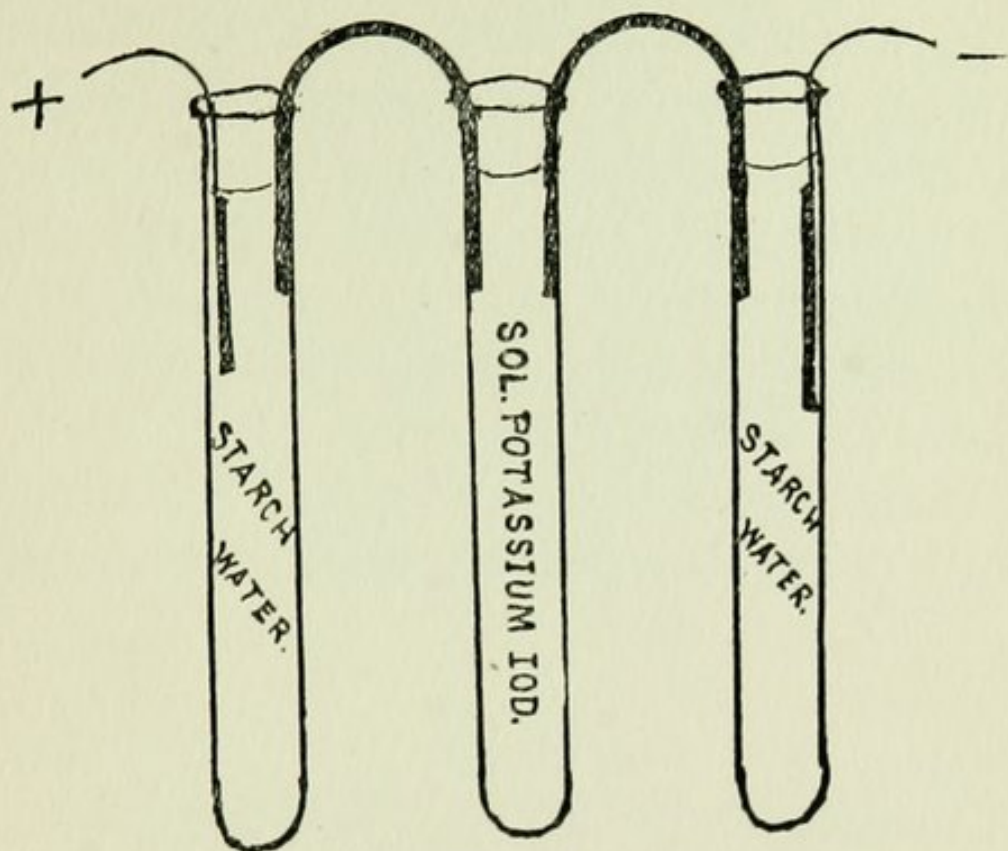


FIG. 4.

ARGUMENT 1. If cataphoresis is purely a physical operation, that is, if substances are transmitted from one pole to the other by a *forcing* of the current from positive to negative, then some of the solution of potassium iodide would be forced into the right hand tube and would be evident by a blue color. If, however, cataphoresis is an electrolytic operation, then the contents of the tube containing potassium iodide will be broken up, the electro-positive elements going one way and the electro-negative the other. The latter happens in this experiment, the deep blue color in the *left hand tube* showing the

formation of the iodide of starch in this tube. We will now continue the experiment reversing the polarity, when the current enters at the right hand tube, and in a few minutes the iodide of starch solution in the left hand tube is again broken up, the free iodine going into the middle tube in the *reverse direction of the current* and finally being deposited in the right hand tube, evidenced by its deep blue color.

EXPERIMENT 2. A glass tube 15 centimeters in length (Fig. 5) is loosely filled with absorbent

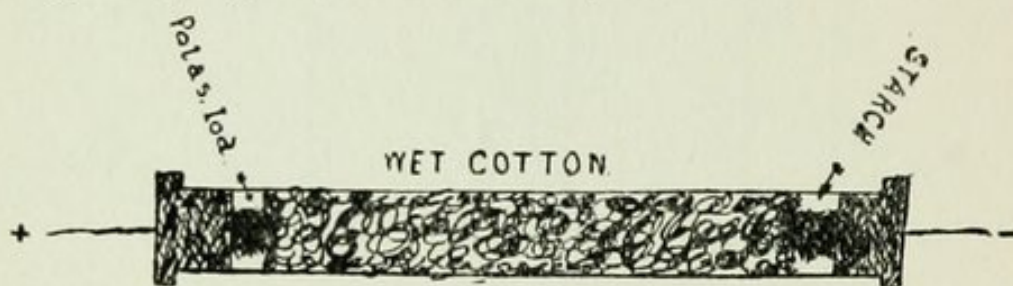


FIG. 5.

cotton to within one centimeter of each end. Acidulated water is now poured into one end of the tube until the cotton is thoroughly saturated. A small wad of cotton is attached to the positive terminal of a constant battery, and saturated with the solution of potassium iodide. Another wad of cotton is placed upon the negative platinum terminal and saturated with a solution of starch. A current of 60 ma. is now passed through the tube for eight minutes, when the positive terminal, which was saturated with the potassium iodide, changes to a *deep brown color*, showing free iodine, while the negative terminal

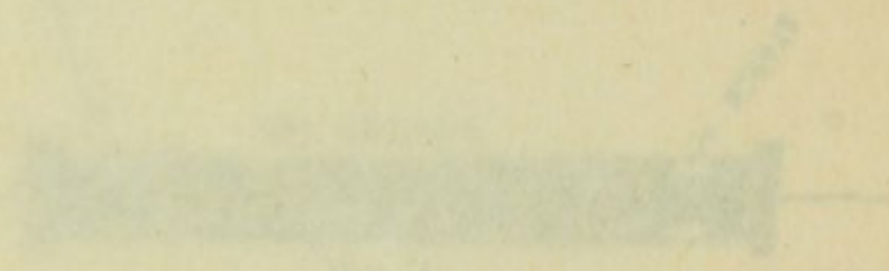
remains exactly the same color as at first. The polarity is now reversed, which would bring the positive terminal in connection with the starch electrode and the negative terminal in contact with the solution of potassium iodide. With the same current strength, in 14 minutes the iodine end that was connected with the negative terminal is thoroughly decolorized, while the other end of the tube containing the starch electrode has turned a deep blue, showing that the transmission of the iodine has taken place through the tube in a *reverse direction to the current*.

ARGUMENT 2. If cataphoresis is a purely physical forcing of the medication in the *direction of the current*, then the solution of potassium iodide in the first part of this experiment would have been forced toward the negative pole, and should have made itself known by the blue color of the starch electrode; such, however, did not take place. In the latter portion of this experiment, if cataphoresis were the physical forcing of the current, then the solution of potassium iodide, which is at the negative end of the tube would have remained there as such, while from the positive end the starch should have been forced through, producing a blue color at the negative end; the reverse, however, happened.

EXPERIMENT 3. The positive terminal having a pad of cotton saturated with the solution of cocaine hydrochlorate, while the cotton at the negative terminal is simply wet with water. It must

oxidation of the iodide of starch in this tube. We will now perform the experiment reversing the polarity, when the current enters at the right hand tube, and in a few minutes the iodide of starch which in the left hand tube is again oxidized, the two tubes being now the middle tube. The middle tube is connected with the positive terminal of the current and the right hand tube with the negative terminal, but does not undergo any change.

The apparatus is 25 centimeters long, and is filled with absorbent paper.



Two lines of platinum are placed at each end of the tube, one at each end of the tube, and the other at the middle of the tube. The middle tube is thoroughly saturated with a solution of potassium iodide. The positive terminal is connected to the positive terminal of the battery, and saturated with a solution of potassium iodide. Another wire of platinum is placed upon the negative platinum terminal and saturated with a solution of starch. A current of 50 ma. is now passed through the tube for eight minutes, when the positive terminal, which was saturated with the potassium iodide, changes to a deep brown color, showing free iodine, while the negative terminal

remains *exactly the same color as at first*. The polarity is now reversed, which would bring the positive terminal in connection with the starch electrode and the negative terminal in contact with the solution of potassium iodide. With the same current strength, in 14 minutes the iodine end that was connected with the negative terminal is thoroughly *decolorized*, while the other end of the tube containing the starch electrode has turned a *deep blue*, showing that the transmission of the iodine has taken place through the tube in a *contrary direction to the current*.

ARGUMENT 2. If cataphoresis is a purely physical forcing of the medicament in the *direction of the current*, then the solution of potassium iodide in the first part of this experiment would have been forced *toward* the negative pole, and would have made itself known by the blue color of the starch electrode; such, however, did not take place. In the latter portion of this experiment, if cataphoresis were the physical forcing of the current, then the solution of potassium iodide, which is at the negative end of the tube would have remained there as such, while from the positive end the starch would have been driven through, producing a *blue color at the negative*; the reverse, however, happened.

EXPERIMENT 3. The positive terminal having a wad of cotton saturated with the solution of cocaine hydrochlorate, while the cotton at the negative terminal is simply wet with water. It must

here be stated that the solution of cocaine has a strong reaction of hydrochloric acid, and this acid cannot be taken from the solution without impairing the chemical affinity of the solution; but after the passage of a constant current through the tube for ten minutes, the cocaine appears *at the negative terminal*, evidenced by an anæsthetic effect upon the tongue; but the acid reaction which should have been present if the *solution* of cocaine were transmitted through the medium was entirely absent, an *alkaline action* being present instead, proving that the cocaine, or base, has been *separated by electrolytic action* from the acid which held it in combination.

It may be claimed that the foregoing are merely experiments in electrolytic work, and we do not deny it; but then they are demonstrations of cataphoresis as well, for all the conditions are the same as when medicines are administered by electricity—the wet cotton corresponds to the human body, while the positive and negative poles (either one or both containing medicament) have contact with it, and the action that takes place in these experiments occurs in the living tissue, except that in the latter it is more rapid.

From the foregoing physical facts we may formulate the following general rule: *If we wish to transmit the acid, or that which takes its place, into the tissues, the medicament must be placed upon the negative pole; but if it is the base we wish to utilize then the medicine must be used on the positive pole.*

CHAPTER VII.

METALLIC ELECTROLYSIS.

There is no branch of electrolytic work that covers such a range in the therapeutics of electricity as that consisting of the introduction of the salts of metals into the body and which is called *metallic electrolysis*.

Oxygen combines with all the baser metals, forming oxides; and if one of these metals be used as the positive pole of a galvanic current the oxygen which has an affinity for that pole, immediately combines with the electrode; if, now, the electrolyte contains sodium chloride (common salt) and the oxide of the metal combines with the water, the salt set free, thus forming the chloride of the metal.

The fluids of the body all contain sodium chloride, one of the factors necessary to obtain any of the oxides of the baser metals, and when applied the positive galvanic current to any part of the body where the electrode is of a noble metal, such as copper, zinc, iron, etc., we have an application of the oxychloride of such metal at the point where the electrode comes in

have been stated that the solution of cocaine has a strong reaction of hydrochloric acid, and this acid cannot be taken from the solution without impairing the chemical affinity of the solution; but after the passage of a constant current through the tube for ten minutes, the cocaine appears at the negative terminal, evidenced by an anesthetic effect upon the tongue, but the acid reaction which should have been present if the solution of cocaine were transferred through the medium was entirely absent, an alkaline action being present instead, proving that the cocaine base has been separated by electrolytic action from the acid which held it in combination.

It may be claimed that the foregoing are purely experiments in electrolytic work, and we do not know, but that they are demonstrations of what occurs in vivo, for all the conditions are the same as when medicines are administered by electricity. The positive terminal corresponds to the positive half, while the positive and negative poles (either one or both containing medicament) have contact with it, and the action that takes place in these experiments occurs in the living tissue, except that in the latter it is more rapid.

From the foregoing physical facts we may formulate the following general rule: *If we wish to separate the acid, or that which takes its place, into the tissue, the medicament must be placed upon the negative pole; but if the base we wish to utilize then the medicine must be used on the positive pole.*

CHAPTER VII.

METALLIC ELECTROLYSIS.

There is no branch of electrolytic work that has so wide a range in the therapeutics of electricity as that consisting of the introduction of the salts of metals into the body and which is called *metallic electrolysis*.

Oxygen combines with all the baser metals, forming oxides; and if one of these metals be used on the positive pole of a galvanic current the oxygen, which has an affinity for that pole, immediately combines with the electrode; if, now, the electrolyte contains sodium chloride (common salt) then the oxide of the metal combines with the hydrochloric acid set free, thus forming the *oxychloride* of the metal.

The fluids of the body all contain sodium chloride, one of the factors necessary to obtain any of the oxychlorides of the baser metals, and when applying the positive galvanic current to any part of the body where the electrode is of soluble metal, such as copper, zinc, iron, etc., we make an application of the oxychloride of such metal at the point where the electrode comes in

contact with the body, which is carried still deeper into the tissues by cataphoric action.

The deposition of this metallic salt is much more marked when the electrode is used subcutaneously or on a mucous surface, because of the greater supply of sodium chloride and lessened resistance; but where application is made to the skin, it becomes necessary to moisten the part with salt water or dip the electrode in the same solution.

So far the application of the copper salts seems to be the most valuable, and such application is commonly called *cupric electrolysis*. The oxychloride of copper is a powerful antiseptic, having eight times the microbicidal power of the current itself and is indicated in all pathological conditions dependent upon germ origin.

In such cases as trachoma, lupus, indolent ulcers, endometritis, fistulous tracts and many other germ troubles its action is not excelled by any other remedy. The application has its advantages and disadvantages, and among the former may be mentioned the fact that inasmuch as the *polar* effect of the current is *expended upon the metal* composing the electrodes it is not so apt to cauterize the tissue in contact with the electrode, and consequently rarely leaves that undesirable hard cicatrix which characterizes an application of the positive pole to a mucous surface. The

principal disadvantage is the sticking of the electrode, which always occurs when a bare metal attached to the positive pole is applied to a mucous surface; this is avoided to a certain extent by gently moving or rotating the electrode while the current is being applied, but if it does happen to stick in spite of this precaution, then it will be necessary, at the end of the seance, to *reverse the current* for a few minutes in order to free the electrode; but be sure that the current is *turned off* before attempting to reverse its direction, as otherwise the patient will receive an unpleasant shock.

When making intravaginal applications with a copper electrode the author always covers the whole part of the electrode with wet absorbent cotton, thus avoiding the sticking of the metal, and finds that the metallic salt is deposited in the tissues almost as well as when used without the cotton. In the case of the latter it would be better to attach the metal where practicable with absorbent cotton or Spanish leather to prevent its sticking. In general it is preferred the priority for the applications of zinc elements if they attached to the positive pole and all metals having an affinity for that pole, some of the perchloride of zinc may be taken from the tissues and reduced to metallic zinc in the form of metallic copper, the perchloride of zinc being a powerful cathartic, the use of that metal is almost limited to

contact with the body, which is carried still deeper into the tissue by cataphoric action.

The deposition of this metallic salt is much more marked when the electrode is used subcutaneously or on a mucous surface, because of the greater supply of sodium chloride and lessened resistance, but when application is made to the skin, it becomes necessary to moisten the part with salt water or to dip the electrode in the same solution.

So far the application of the copper salts resembles that of zinc, and such application is frequently called *cupro-cathodesis*. The oxydation of the metal is somewhat striking, having approximately the appearance of the current leaving the positive pole of the battery, and the conditions are similar to those of the zinc electrode.

The best form of electrode is a cup, indolent, and of moderate size, and many forms have been devised, but none so good as that of the *cupro-cathode*. The application has its advantages and disadvantages, and among the former may be mentioned the fact that so much as the force of the current is expended upon the electrolysis of the electrode it is not so apt to penetrate the tissue in contact with the electrode, and consequently rarely leaves that undesirable firm crust which characterizes an application of the positive pole to a mucous surface. The

principal disadvantage is the sticking of the electrode, which always occurs when a bare metal attached to the positive pole is applied to a mucous surface; this is avoided to a certain extent by gently moving or rotating the electrode while the current is being applied, but if it does happen to stick in spite of this precaution, then it will be necessary, at the end of the seance, to *reverse the current* for a few minutes in order to free the electrode; but be sure that the current is *turned off* before attempting to reverse its direction, as otherwise the patient will receive an unpleasant shock.

When making intravaginal applications with a copper electrode the author always covers the metal part of the electrode with wet absorbent cotton, thus avoiding the sticking of the metal, and finds that the metallic salt is deposited in the tissues almost as well as when used without the cotton; in fact we believe it would be better to *always cover the metal* where practicable with absorbent cotton or chamois leather to prevent its sticking, because when we reverse the polarity for that purpose the active electrode is then attached to the negative pole and, all metals having an affinity for that pole, some of the oxychloride of copper will be taken from the tissues and *redeposited upon the electrode* in the form of metallic copper.

Oxychloride of zinc being a powerful escharotic, the use of that metal is almost limited to

the application to the stump after excision of malignant growths, recurrent cancers, etc., although in many uterine lesions Dr. G. Betton Massey strongly recommends the application of a zinc and mercury amalgam by means of the positive pole.

When using an iron or steel electrode on the positive pole we get all the styptic and tonic effects of the iron locally applied. We have an ocular demonstration of this when the wrong pole happens to be used in removing a hair, viz., leaving a black tattoo mark of the oxide of iron under the epidermis which is not easily removed.

CHAPTER VIII.

PARADISUM; MAGNETISM.

The electrical fluid largely pre-occupies the field of research, because that current manifests its effects in a very striking manner, and gives rise to a number of phenomena, both of which are of a very singular nature.

The electrical fluid is a very singular current, and is distinguished from all other fluids, or from any other fluid, by its power of attraction and repulsion, and by its power of exciting heat, and of producing light, and of producing a variety of other effects, which are all of a very singular nature.

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We have three kinds of magnets, viz. the natural magnet, the piece of hard-

the application to the stump after excision of malignant growths, recurrent cancers, etc., although in many uterine lesions Dr. G. Bolton Hillyer strongly recommends the application of a zinc and mercury ointment by means of the positive pole.

When using an iron or steel electrode on the negative pole we get all the septic and tonic effects of the iron locally applied. We have an even demonstration of this when the wrong pole happens to be used in removing a hair, viz., leaving a black tattoo mark of the oxide of iron under the epidermis which is not easily removed.

CHAPTER VIII.

FARADISM—MAGNETISM.

The electrical fakir largely prefers the field of faradism, because that current manifests itself by a buzzing noise, more or less intense and gives a current of considerable sensation, both of which tend to impress the patient.

The physics of the faradic or induced current is somewhat more complex than the galvanic or direct current, and ever since the first induction apparatus was made by Faraday, in England, and Henry, in America, so many changes have been made and so many forms suggested by the various manufacturers, that the average physician is totally at sea relative to the best faradic apparatus for therapeutic purposes.

We will here consider briefly enough of the rudimentary physics of faradism so that the various fads and conflicting statements instituted by manufacturers may not be the means of depleting the purse of the credulous and too trusting physician.

We have three kinds of magnets, viz., the lodestone or *natural* magnet, the piece of hard-

ened steel which, when once magnetized, retains its magnetism and is called the *permanent* magnet and the *electro-magnet*, which is usually a very soft iron core surrounded by a coil of insulated wire in which magnetism is induced by a flow of electricity through the coil of wire. The value of the electro-magnet depends upon the fact of its being enabled to rapidly acquire its magnetism on the passage of the magnetizing current and as readily to lose its magnetism on the cessation of such current.

For purposes of illustration please imagine that a certain bar of soft iron is closely packed with an innumerable, indefinite number of small, endless chains which, when a current of electricity is passed around the bar, are thrown out as in

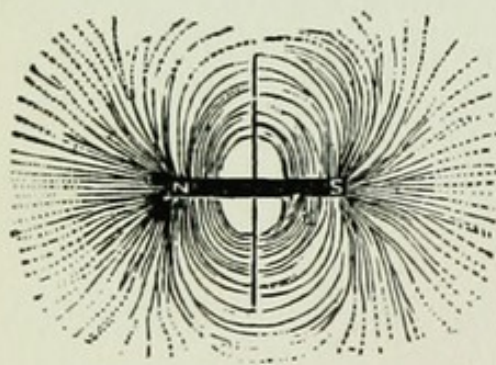


FIG. 6.

Fig. 6, but are immediately withdrawn again when the current around the bar is stopped. These imaginary chains we call the *magnetic lines of force*, and they are supposed to know no barrier

and travel in closed paths from N (north pole) to S (south pole), much the same as a current of electricity goes *from* the positive *to* the negative pole.

Another simple experiment will serve to show what we mean by an induced current: If I take two ends of a noncurrent bearing wire in my hands

and suddenly move this loop into a magnetic field, i. e., into a field permeated by magnetic lines of force; an electro-motive force is generated in the wire *at the time of the transfer only*; but when I again remove the loop from the magnetic field no other E. M. F. is induced in the wire during the transfer, but flowing in an opposite direction from the first. The quicker I make the transfer of the wire in and out of the magnetic field, the higher the E. M. F. induced in the wire. In a nutshell these are the prime principles of every Faradic battery, except that in the latter the magnetic field is the variable factor, while the wire remains stationary.

No change can be detected in the wire so long as it remains at rest relative to these lines of force, but if motion takes place so that the wire is moved with more or less of the lines, then an E. M. F. is generated along the wire during the change.

We will now apply these principles to the Faradic or inductive coil, and in order to make the matter plainer we will show (Fig. 7) a diagram of an induction apparatus.

As will be seen by this diagram, the essential parts of every Faradic coil are, viz.: (1) a primary coil directly surrounding a (2) soft iron core; a secondary coil surrounding the primary, but electrically insulated from it; an automatic interrupter for interrupting the current from the battery cells.

soft steel which when once magnetized, retains its magnetism and is called the *permanent magnet* and the *air-core magnet*, which is usually a very soft iron core surrounded by a coil of insulated wire in which magnetism is induced by a flow of electricity through the coil of wire. The value of the air-core magnet depends upon the fact of its being able to rapidly acquire its magnetism on the passage of the magnetizing current and as ready to lose its magnetism on the cessation of such current.

For purposes of illustration please imagine that a certain bar of soft iron is closely packed with an innumerable, indefinite number of small, circular chains which when a current of electricity is applied around the bar are thrown out as in Fig. 5, but are immediately withdrawn again when the current around the bar is stopped. These imaginary chains we call the *magnetic lines of force*, and they are supposed to know no barrier whatever in their path from N (north pole) to S (south pole) with the same as a current of electricity goes from the positive to the negative pole.

Another simple experiment will serve to show what we mean by an induced current: If I take one end of a soft-iron bearing wire in my hands

and suddenly move this loop into a magnetic field, i. e., into a field permeated by magnetic lines of force, an electro-motive force is generated in the wire *at the time of the transfer only*; but when I again remove the loop from the magnetic field another E. M. F. is induced in the wire during the transfer, but flowing *in an opposite direction* from the first. The quicker I make the transfer of the loop in and out of the magnetic field, the higher the E. M. F. induced in the wire. In a nutshell these are the prime principles of every faradic battery, except that in the latter the magnetic field is the movable factor, while the wire remains stationary.

No change can be detected in the wire so long as it remains at rest relative to these lines of force, but if motion takes place so that the wire is linked with more or less of the lines, then an E. M. F. is generated along the wire during the change.

We will now apply these principles to the faradic or induction coil, and in order to make the matter plainer we will show (Fig. 7) a diagram of an induction apparatus.

As will be seen by this diagram, the essential parts of every faradic coil are, viz.: (1) a primary coil directly surrounding a (2) soft iron core; a secondary coil surrounding the primary, but entirely insulated from it; an automatic hammer for interrupting the current from the battery cells.

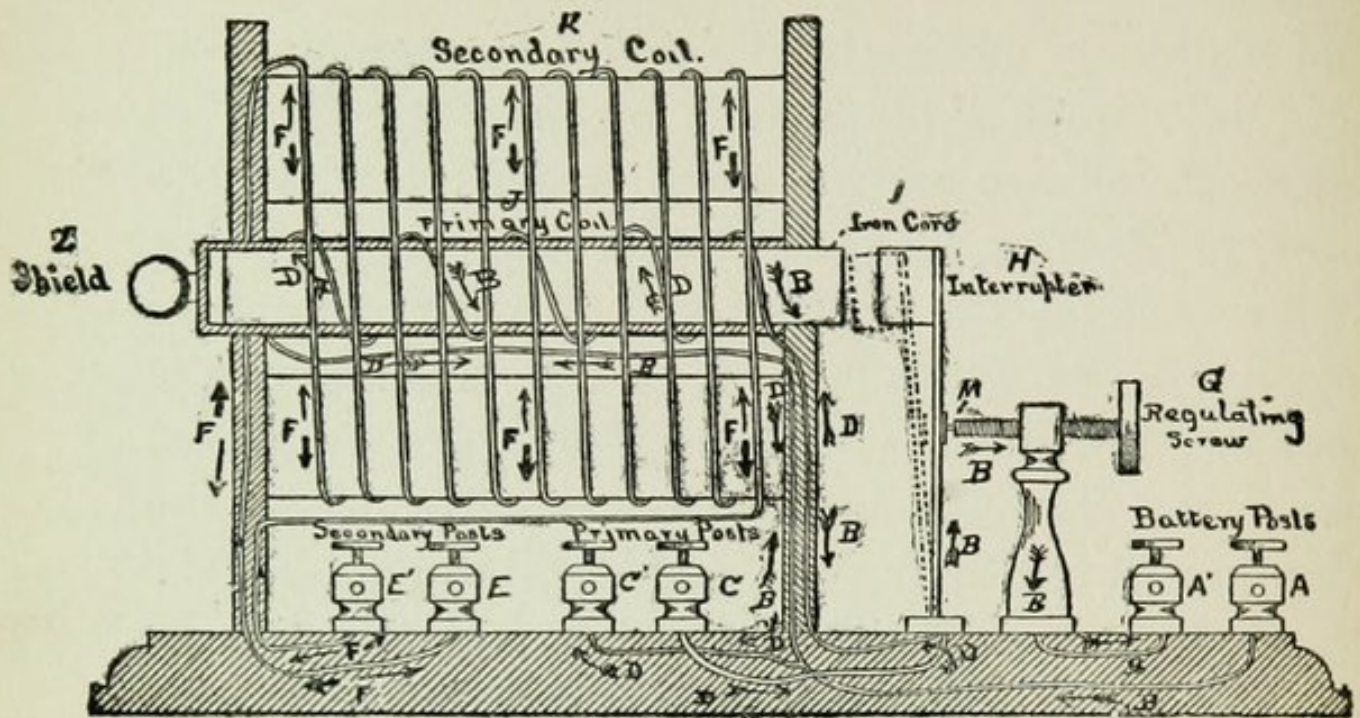
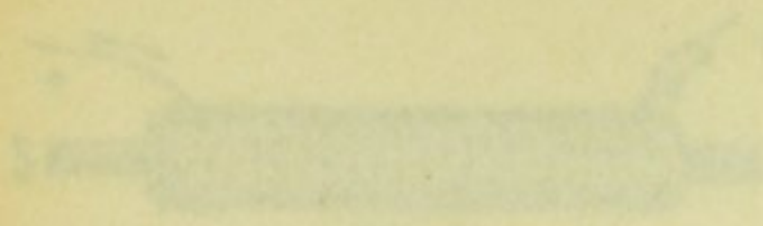


FIG. 7.

Fig. 8 would represent the soft iron core and primary coil of a faradic battery; this core is not a magnet until a current of electricity flows through the wire which surrounds it, when it becomes strongly magnetized and throws out lines of magnetic force, as in Fig. 6, which, in their effort to travel in a circuit from the north to the south pole of the magnet, thread through the convolutions of wire composing the coil and induce a current of electricity to flow in one direction during the influx of the magnetic lines and in the opposite direction at the time of their withdrawal. Just as the current was generated in the loop of wire when held in the hands by being moved into and taken out of a magnetic field, except in this instance the magnetic lines go into the convolutions of wire



Instead of the wire being moved into the magnetic field.

This storage spring and withdrawal of the magnetic lines may be easily understood by referring to Fig. 6. The slotted spring is fixed in the slot of A , just below the point of the thumb-screw, C , at A_2 , and it is at this point that the circuit is the "make" and "break." When the current flows through the primary, i. e., the coils of the wire directly surrounding the iron core, the latter is magnetized and throws out lines of force, as in Fig. 7, which permeate the convolutions of both the primary and secondary coils; at the same instant, how-

ever, the magnetic lines are attracted toward A_2 , which breaks the contact at A_1 , and the current stops flowing through the primary and the core loses its magnetism and the lines of force are withdrawn from the convolutions of wire, thus

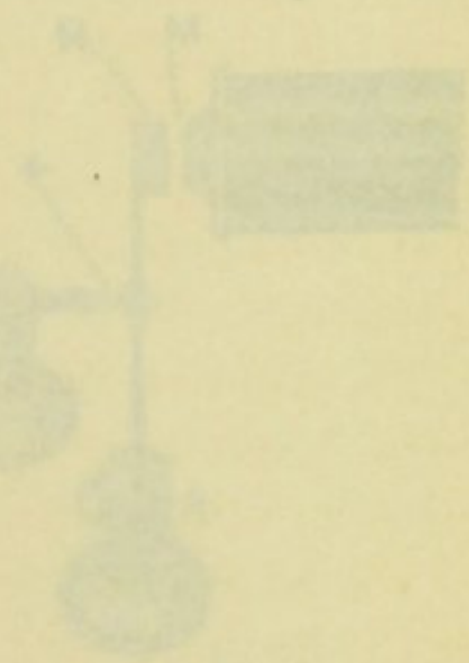
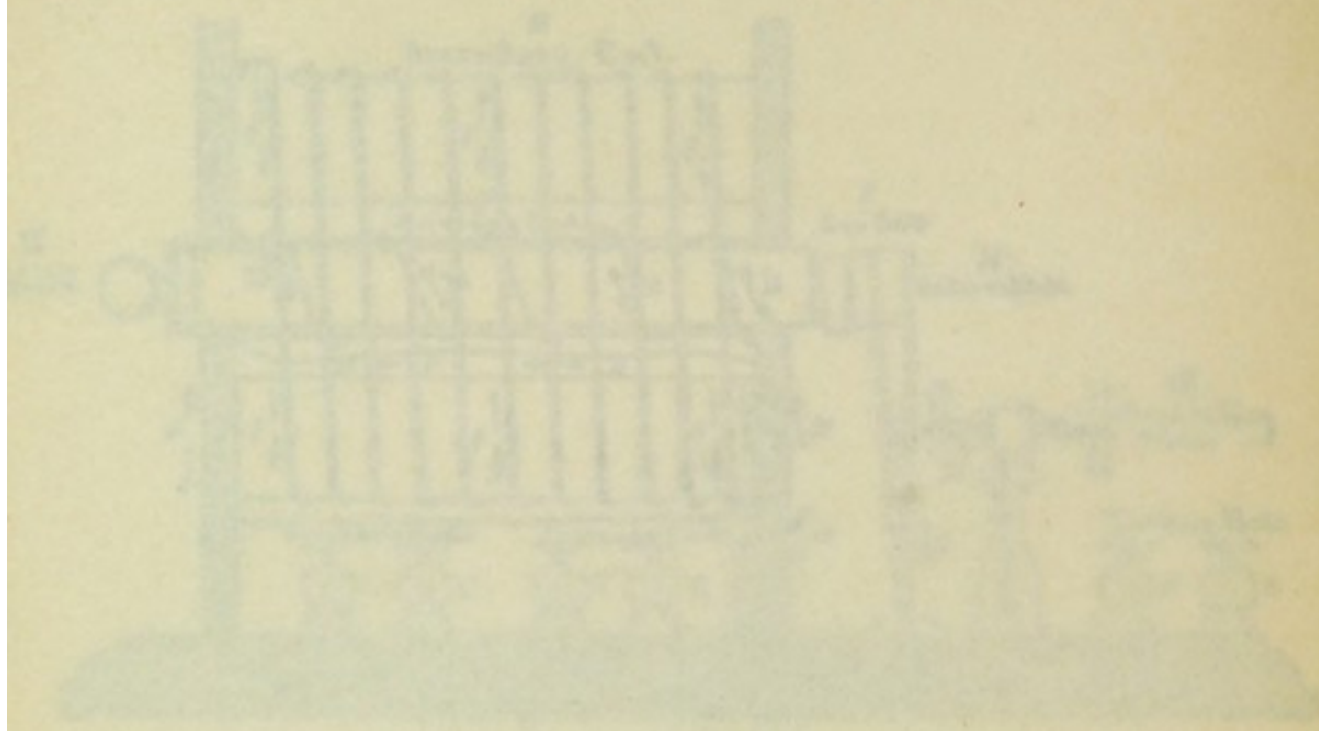


Fig. 7.

preventing the reverse current above referred to. For greater number of turns of wire in the coil, say, in other words, the more times we can



The apparatus is designed for the treatment of various conditions, particularly those involving the nervous system. It consists of a central column with a horizontal bar across its middle. The bar is labeled 'ELECTRO-DEPOSITED COPPER' and has two terminals extending from it. The column is supported by a base and has various components labeled with letters and numbers, including 'A', 'B', 'C', 'D', 'E', 'F', 'G', 'H', 'I', 'J', 'K', 'L', 'M', 'N', 'O', 'P', 'Q', 'R', 'S', 'T', 'U', 'V', 'W', 'X', 'Y', 'Z', '1', '2', '3', '4', '5', '6', '7', '8', '9', '10', '11', '12', '13', '14', '15', '16', '17', '18', '19', '20', '21', '22', '23', '24', '25', '26', '27', '28', '29', '30', '31', '32', '33', '34', '35', '36', '37', '38', '39', '40', '41', '42', '43', '44', '45', '46', '47', '48', '49', '50'. The diagram shows a complex arrangement of wires, coils, and mechanical parts, typical of early electro-therapeutic equipment.

The text below the diagram is very faint and difficult to read, but it appears to be a detailed description of the apparatus and its use. It likely discusses the electrical characteristics of the components, the method of application, and the types of conditions for which it is intended. The text is arranged in several paragraphs, providing a comprehensive overview of the device.

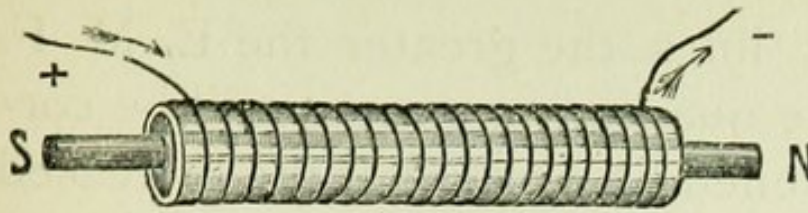


FIG. 8.

instead of the wire being moved into the magnetic field.

This alternate influx and withdrawal of the magnetic lines can be easily understood by referring to Fig. 9. The slender spring fastened in the slot at R *just touches* the point of the thumb-screw, T, at X, and it is at this point that the circuit in the primary wire is "made" and "broken." When the current flashes through the primary, i. e., the coils of the wire directly surrounding the iron core, the latter is magnetized and throws out lines of force, as in Fig. 6, which permeate the convolutions of both the primary and secondary coils; at the next instant, however, by magnetic action the hammer, H, is drawn toward M, which breaks the contact at X, and as the current ceases to flow through the primary coil, the core loses its magnetism and the lines of force are withdrawn from the convolutions of wire, thus generating the inverse current above referred to.

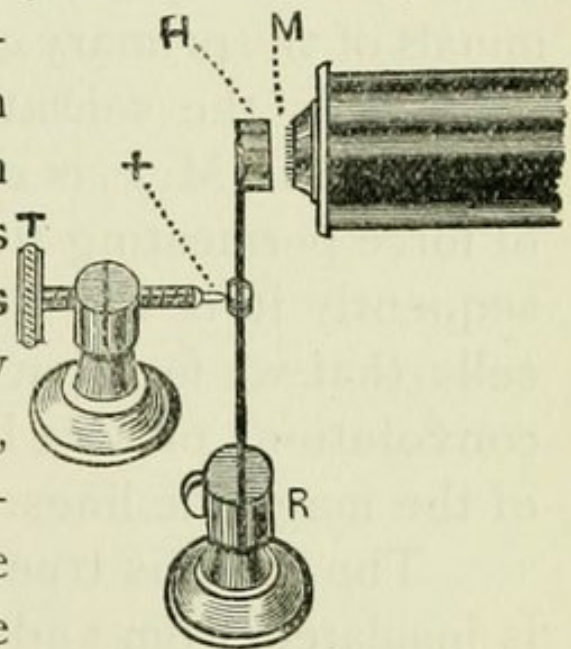


FIG. 9.

The greater number of turns of wire in the coil, or, in other words, the more times we can

cut the magnetic lines, the greater the E. M. F. generated, but the quantity or current will be correspondingly lessened on account of the increased resistance of the wire.

From a careful study of the foregoing principles it will be apparent that the induced current we use in every faradic apparatus is obtained by the agency of magnetism, and the principal office of the primary or inner coil directly surrounding the soft iron core is to convey the current from the battery cell around the core, thus magnetizing it. One or two galvanic cells are sufficient to operate a faradic coil, and although it would be impossible to detect a current from these cells by the sensation, yet when we take hold of the terminals of the primary coil that is operated by these same cells the sensation is considerable. This increased E. M. F. is caused by the magnetic lines of force permeating the convolutions of wire, consequently it is not the current from the battery cells that we feel, but the current *induced* in the convolutions of wire by the influx and withdrawal of the magnetic lines.

The same is true of the secondary coil, which is insulated from and has no connection with the primary, and, therefore, could not be influenced by the current from the battery cells, except that the more cells we add to any faradic apparatus the greater magnetic saturation of the core, and,

consequently, the higher the inductive force induced in both primary and secondary coils.

The primary coil will induce the proportionally less a course wire secondary coil and a greater quantity because it is wound with fewer turns than the secondary, but having a shorter length of turns the voltage will be correspondingly decreased, therefore the term "current of capacity," generally used in connection with course wire coils, only means, therapeutically speaking, that the patient receives less current because the voltage is lower.

The secondary coil being wound with finer wire, we have cut the lines of force thrown out by the magnet many more times than with the coarser primary wire, and, therefore, have a higher induced E. M. F., and our patient receives more sensation than from the primary; but the greater length of wire in the secondary offering a greater resistance to the passage of the current we get less quantity, and by adding sufficient wire may obtain a current stimulating the "static," in which the voltage is very high and the quantity so small as to be almost unappreciable.

* The faradic current is a general tonic in its nature, assisting metabolic action and eliminating waste products, but is more mechanical than medicinal. Its greater value is in the slower interruptions, and the improvement in faradic coils will not be in putting a great length of wire in the secondary coil.

of the magnetic lines, the greater the E. M. F. generated, but the quantity of current will be correspondingly lessened on account of the increased resistance of the wire.

From a careful study of the foregoing paragraphs it will be apparent that the induced current of any inductive apparatus is practically proportional to the rate of change of the magnetic lines of force, and inversely proportional to the resistance of the circuit. The rate of change of the magnetic lines of force is determined by the rate of change of the current in the primary circuit, and this rate of change is determined by the frequency of the alternating current. The resistance of the circuit is determined by the length and thickness of the wire, and the number of turns in the coil. It is therefore evident that the induced current will be greatest when the rate of change of the magnetic lines of force is greatest, and the resistance of the circuit is least. This is the principle upon which the induction coil is constructed, and it is the reason why the induced current is so much greater than the current in the primary circuit.

The secondary coil of the induction coil is insulated from the primary coil, and has no connection with the battery cells, and therefore, could not be affected by the current from the battery cells, except the direct cells we add to any faradic apparatus. The greater saturation of the core, the

consequently, the higher electro-motive force induced in both primary and secondary coils.

The primary coil will answer therapeutically for a coarse wire secondary and give a current of more quantity because it is wound with coarser wire than the secondary, but having a fewer number of turns the voltage will be correspondingly decreased, therefore the term "current of quantity," generally used in connection with coarse wire coils, only means, therapeutically speaking, that the *patient receives less current* because the voltage is lower.

The secondary coil being wound with finer wire, we have cut the lines of force thrown out by the magnet many more times than with the coarser primary wire, and, therefore, have a higher induced E. M. F., and our patient receives more sensation than from the primary; but the greater length of wire in the secondary offering a greater resistance to the passage of the current we get less quantity, and by adding sufficient wire may obtain a current simulating the "static," in which the voltage is very high and the quantity so small as to be almost inappreciable.

The faradic current is a general tonic in its nature, assisting metabolic action and eliminating waste products, but is more mechanical than medicinal. Its greater value is in the slower interruptions, and the improvement in faradic coils will not be in putting a great length of wire in the secondary coil.

The so-called local anæsthesia produced by rapidly alternating high tension currents is simply done by tetanizing and fatiguing the muscle or nerve, and the writer does not believe it is as good or permanent as the relief of similar cases brought about by the action of the positive pole of the galvanic battery.

Let your faradic battery have a good primary coil with sufficient wire to thoroughly magnetize the core, and a secondary coil of finer wire probably about 1,000 yards in length, and an interrupter giving from forty or fifty up to 4,000 or 5,000 interruptions per minute, and trust its manufacture to some reliable firm, and you will not be disappointed in the results obtained from the apparatus.

CHAPTER IX

PHYSIOLOGIC ELECTRICITY—STATIC CHARGE

It is not intended to give the reader a full description and therapeutic purposes of this powerful and interesting source of electricity, but to point out its value in the treatment of certain conditions.

The static charge is produced by the friction of two different substances. It is a very powerful force and is used in the treatment of many conditions.

The application of a static charge is very simple. It is done by rubbing the hand over the body part to be treated. The charge is then applied to the body part. The treatment is very simple and can be done by anyone.

The so-called local anesthesia produced by rapidly alternating light electric currents is simply done by tetanizing and relaxing the muscle or nerve, and the writer does not believe it is as good or permanent as the relief of similar cases brought about by the action of the positive pole of the galvanic battery.

Let your faradic battery have a good primary coil with sufficient wire to thoroughly magnetize the core, and a secondary coil of some size, probably about 1000 turns in length, and an induction coil with 1000 turns on a soft iron core, and you will be able to produce a powerful current for the treatment of the various cases mentioned above.

CHAPTER IX.

FRANKLINIC ELECTRICITY—STATIC CHARGE.

It is only considered advisable to give the reader a few of the principal physical and therapeutic properties of static electricity, believing that any attempt at elaboration might cause confusion, and realizing that correct methods are only gained by experience.

No two operators exactly agree as to the technique to be employed, although the results obtained may be the same, therefore it must be left largely to the operator, who will discover something new and interesting each time the machine is used.

This manifestation of electrical energy properly belongs to that class called "high potential, high frequency currents," in which the voltage is enormous, while the amperage is infinitesimally small, and when we come to consider the fact that it requires about 50,000 volts pressure to force a spark across one inch of air space the tremendous potential energy of static machines becomes apparent, for they are often capable of giving a ten or twelve inch spark.

It is evident, therefore, that the therapeutical effects obtained are not due to electrolytic conduction, because there is little to conduct (competent observers asserting that the amperage generated by the ordinary machines is about .005 milliampere), these effects being mainly due to its oscillatory or vibratory character.

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

In a former chapter we noted the fact that in health the nerves are all in a state of vibration, and when they lose their vibratory action their function is destroyed and degenerative changes commence. A very simple illustration will serve to show how static electricity does its work and why it is especially adapted for the treatment of disturbances of the nervous system.

We will take five tuning forks—A, B, C, D and E—and place them in an upright position on a sounding board; if, now, we take an extra C tuning fork, and, after causing it to vibrate, bring it in contact with the sounding board, the other C fork will vibrate in unison with it, but none of the others are affected, because the rate of vibration necessary to produce the tone of C is different from that which produces A or B. The nerves

In normal condition vibrate differently, and each one will respond only to the vibration that suits it; when the function of a nerve is destroyed, a stimulus necessary to bring it within the range of its range of vibration equal to its own.

In static electricity we have a wide range of vibrations from a low up to many millions per second, and as long as the patient comes within this range of excitation each nerve is taking the vibration which suits it, which would account, in a measure, for the almost magical results we sometimes have in certain forms of neuralgia, migraine,

and other conditions. Accurate localization is essential for success with any treatment. Although cites several cases which have been under his care at various times in which the progress was perceptible when he applied the electricity to a certain area of the body which he believed to be affected; but when, by further consideration of the symptoms, a different part of the organ appeared to be at fault, and he altered the localization of the current, a permanent cure was obtained. Such occurrences, however, not only give strong support to the theory of the so-called "focal" conditions of brain centers which are improved by artificial electricity applied to the diseased area, but it likewise affords a good deal of evidence in support of the theory which holds that the influence of suggestion, for which nothing and anything is claimed in ther-

It is evident, therefore, that the therapeutical effects obtained are not due to electrolytic conditions because there is little to no contact (competent electrodes) and the average voltage generated by the generator is about 200 milliamperes. The electrical energy which has to be oscillatory or vibratory.

When the apparatus is set up, however, the prime frequency of the generator is set up, and the circuit is closed, and the electrical energy which is produced is the circuit, the electrical energy is set up.

It is evident, therefore, that the fact that it is in a state of vibration, and that the electrical energy which is produced is the circuit, the electrical energy is set up, and the electrical energy which is produced is the circuit, the electrical energy is set up.

As will be seen, the electrical energy is set up, and the electrical energy which is produced is the circuit, the electrical energy is set up, and the electrical energy which is produced is the circuit, the electrical energy is set up.

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In static electricity we have a wide range of vibration, from a few up to many millions per second, and as long as the patient comes within this area of oscillation each nerve is taking the vibration which suits it, which would account, in a measure, for the almost magical results we sometimes have in certain forms of neuralgia, migraine, etc.

Accurate localization is essential for success with any treatment. Althaus cites several cases which have been under his care at various times in which no progress was perceptible when he applied the electricity to a certain area of the brain which he believed to be affected; but when, on further consideration of the symptoms, a different district of the organ appeared to be at fault, and he altered the localization of the current, a successful result was obtained. Such occurrences, he says, not only give strong support to the theory that an unsatisfactory condition of brain currents may be improved by artificial electricity applied to the diseased area, but it likewise affords a proof that the influence of suggestion, for which now everything and anything is claimed in thera-

peutics, does not enter to any extent as a factor into electro-therapeutics, because, if suggestion were the active agent, it is much more likely that it would do its work in the beginning of the treatment than after the latter had been for some time ineffectual, whereby any suggestive force inherent

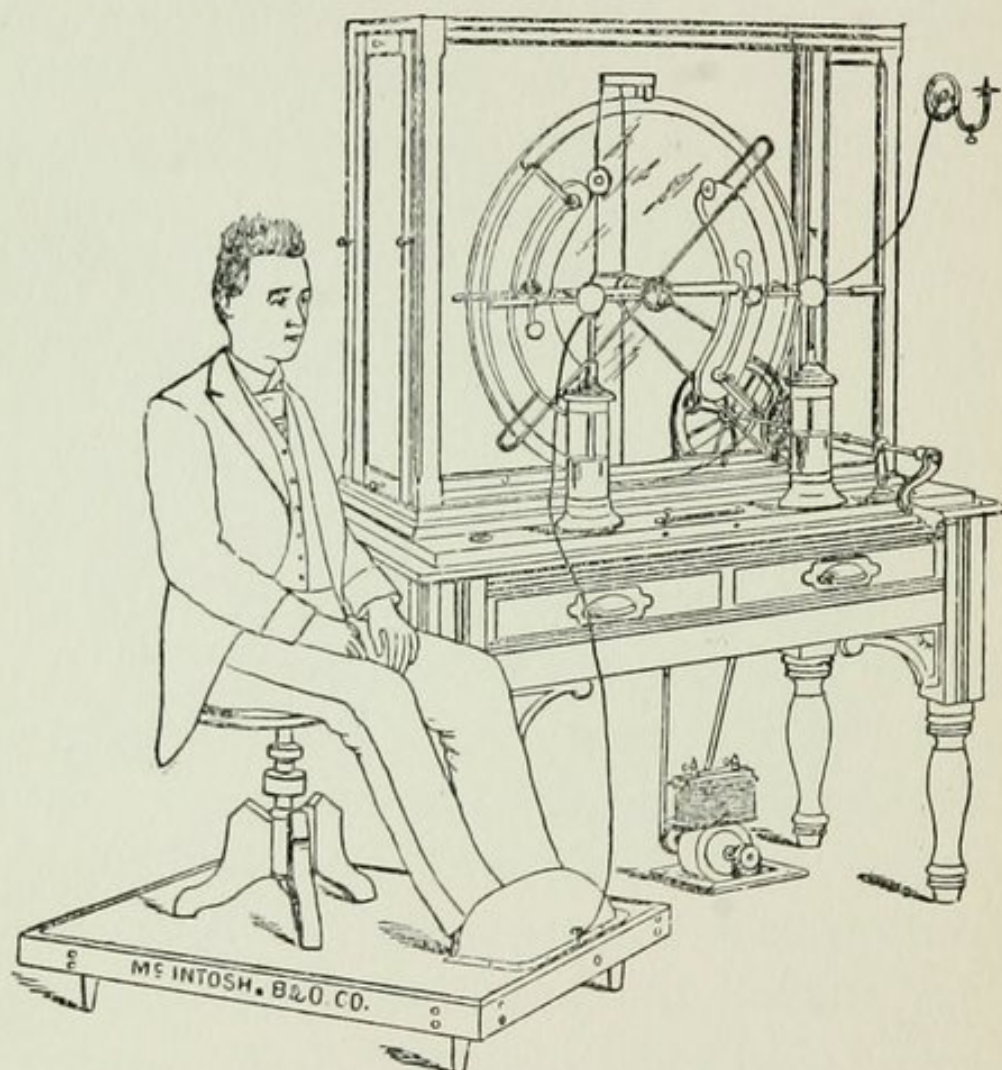


FIG. 10.

to the proceeding must have been lessened rather than increased.

The most popular treatment with this form of electricity is what is called *static insulation*.

Fig. 10 shows *positive* insulation. The patient seated on a insulated platform is connected with the

positive jar of the machine while the other jar is "grounded" or brought to zero-potential by being connected to the earth through a gas or water pipe.

In this operation the potential of the patient is raised to that of the machine, which is very high, and as long as the treatment is continued all the nerves, as it were, are on a vibratory strain.

Another very popular treatment with static electricity is the *static bath or breeze* (Fig. 11) which is given by placing the patient on an insulated platform connected with one of the jars on the machine, while the other jar has connection with an inverted crown electrode suspended about two or three feet above the head.

The sensation produced by this treatment is quite pleasant to most patients, the feeling being somewhat like a breeze on the head. Its action is that of a sedative and it is especially indicated in cases of migraine, insomnia, etc.

The so-called static induced current which has been elaborated and brought to the attention of the profession by Dr. Wm. J. Morton, of New York, is the current from the outside coating of the jar. It is taken from the binding screw at the base of the machine by means of a rod and in sensation closely resembles the current from a faradic coil, although it widely differs from that current in both physical and physiological properties, being capable of produc-

power, does not enter to any extent as a factor into electro-therapeutics, because, if suggestion were the active agent, it is much more likely that it would do its work in the beginning of the treatment than after the laying has been for some time in effect, when by any suggestive force inherent



in the mind would have been lessened rather than increased.

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This is known as *positive insulation*. The patient seated on a insulated platform is connected with the

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In this operation the potential of the patient is raised to that of the machine, which is very high, and as long as the treatment is continued all the nerves, as it were, are on a vibratory strain.

Another very popular treatment with static electricity is the *static bath* or *breeze* (Fig. 11) which is given by placing the patient on an insulated platform connected with one of the jars on the machine, while the other jar has connection with an inverted crown electrode suspended about one to three feet above the head.

The sensation produced by this treatment is quite pleasant to most patients, the feeling being as a gentle breeze on the head. Its action is that of a sedative and it is especially indicated in cases of migraine, insomnia, etc.

The so-called static induced current which has been elaborated and brought to the attention of the profession by Dr. Wm. J. Morton, of New York, is the current from the outside coating of the jars. It is taken from the binding posts in the base of the machine by means of a switch, and in sensation closely resembles the current from a faradic coil, although it widely differs from that current in both physical and therapeutical properties, being capable of produc-

ing a muscular contraction after both faradic and galvanic irritability has ceased.

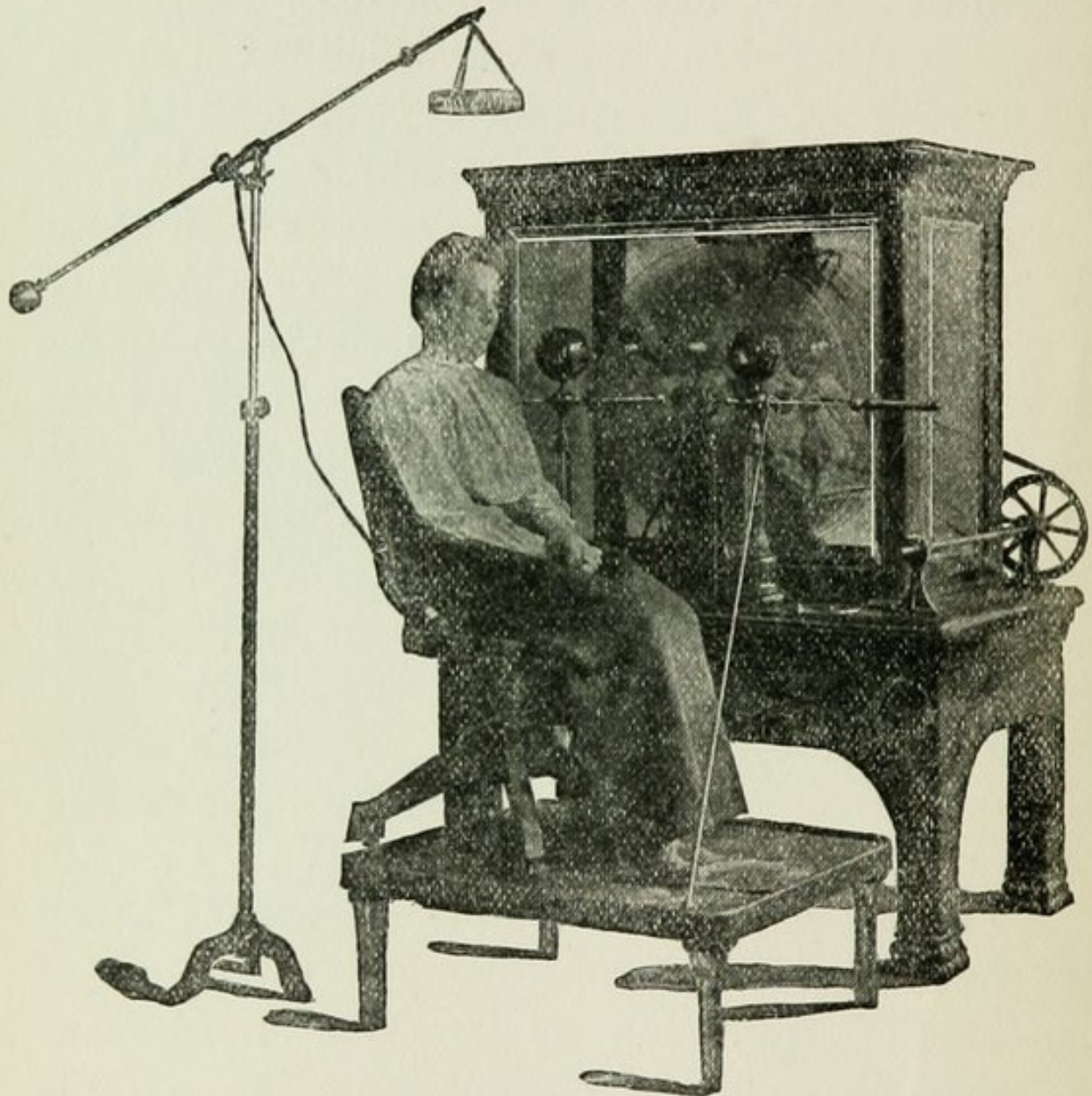


FIG. 11.

In conclusion and briefly, static electricity is an equalizer of the nervous forces, hastens the elimination of waste products, such as urea, carbon dioxide, etc., and causes a dilatation of the cutaneous vessels.

For the better guidance of the reader in the application of static electricity, we insert here a working schedule for the arrangement of machine and patient, with instructions for use.

FACTICAL HINTS AS TO ADMINISTRATION OF STATIC CURRENTS

ARRANGEMENT OF MACHINE AND PATIENT

MACHINE	ARRANGEMENT OF MACHINE AND PATIENT	INDICATIONS
<p>1. The patient should be seated in a chair, and the machine should be placed in front of him, so that he can see the electrodes and the points of application.</p>	<p>2. The patient should be placed in a position in which the current can be applied to the part of the body to be treated.</p>	<p>3. The current should be applied to the part of the body to be treated.</p>
<p>4. The patient should be placed in a position in which the current can be applied to the part of the body to be treated.</p>	<p>5. The patient should be placed in a position in which the current can be applied to the part of the body to be treated.</p>	<p>6. The current should be applied to the part of the body to be treated.</p>
<p>7. The patient should be placed in a position in which the current can be applied to the part of the body to be treated.</p>	<p>8. The patient should be placed in a position in which the current can be applied to the part of the body to be treated.</p>	<p>9. The current should be applied to the part of the body to be treated.</p>
<p>10. The patient should be placed in a position in which the current can be applied to the part of the body to be treated.</p>	<p>11. The patient should be placed in a position in which the current can be applied to the part of the body to be treated.</p>	<p>12. The current should be applied to the part of the body to be treated.</p>
<p>13. The patient should be placed in a position in which the current can be applied to the part of the body to be treated.</p>	<p>14. The patient should be placed in a position in which the current can be applied to the part of the body to be treated.</p>	<p>15. The current should be applied to the part of the body to be treated.</p>

ing a muscular contraction, after both faradic and galvanic irritability has ceased.

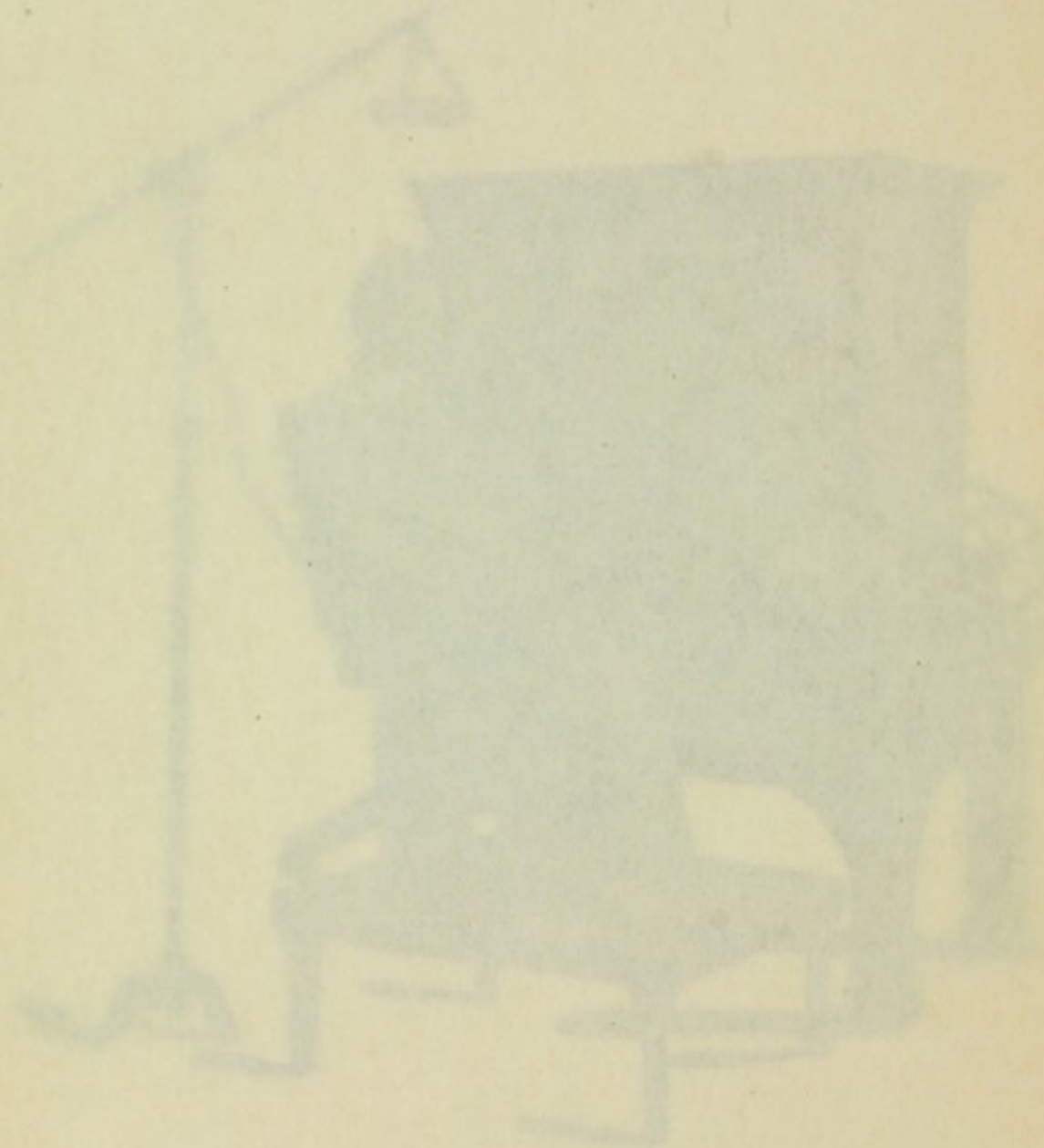


FIG. 11.

In description and briefly, static electricity is a property of the nervous forces, hastens the elimination of waste products, such as urea, carbon dioxide, and the normal regulation of the cutaneous vessels.

For the better guidance of the reader in the application of static electricity, we insert here a working schedule for the arrangement of machine and patient, with indications for use.

PRACTICAL HINTS AS TO ADMINISTRATION OF STATIC CURRENTS

NAME OF CURRENT	ARRANGEMENT OF MACHINE AND PATIENT	INDICATIONS FOR USE
Negative Head Breeze	Jars removed, prime conductors drawn out beyond sparking distance. Patient connected to the <i>positive</i> side of machine. Negative connected to crown electrode placed from one to three feet above head of patient. Time of sitting, 15 to 30 minutes.	Neurasthenia, insomnia and general nervous conditions. First half of treatment for Chronic Bright's Disease.
Positive Breeze	Same as above, except polarity is reversed.	Migraine; cerebral hyperemia, etc.
"Static Surgings" Morton Wave Current Alternating Potential (Monell)	Jars on. Ball or sponge disc electrode attached to top of one jar. The other jar is "grounded." The electrode is now held against the <i>bare skin</i> of the patient at any desired point and the prime conductors are gradually separated until the limit of tolerance of the patient is reached. The range of spark gap is usually from $\frac{1}{2}$ to 4 inches. The speed of the machine should be so governed as to give about 3 or 4 sparks per second. A strip of metal on the spine, or other forms of electrode may be attached to the body at any point. Time of sitting, 10 minutes.	Specific in Neuritis. Deep and Painless Massage.
Positive Insulation	Jars removed. Prime conductors beyond sparking distance. Patient attached to positive side of machine. Negative to ground. Time of sitting, 15 to 30 minutes. NOTE. In giving this treatment be careful not to come too close to the patient, as a very unpleasant shock may be given.	Stimulant to Nervous centers. Nervous Prostration etc. Last half of treatment in Chronic Bright's Disease.
Negative Insulation	Same as above, but with reverse polarity.	Depressant.

Static Induced Current	<p>Jars on. Switch pointer on "spray" or "induced." The conducting cords or chains are attached to the posts on <i>base</i> of machine; one is attached to the patient by means of a foot plate or otherwise, the other to a suitable electrode in the hands of the operator. The machine is started with the prime conductors <i>actually touching</i> each other, and after the machine is generating, they are carefully separated until a current strong enough is obtained (about 1-16 to $\frac{1}{4}$ inch). NOTE. This current is always better applied to the <i>bare</i> skin.</p>	<p>Highly sedative Rheumatism Massage.</p> <p>For all purposes where faradism would be indicated.</p>
Single Spray	<p>Jars removed. Prime conductors beyond sparking distance. Patient is attached to positive or negative side of machine as desired. The single point electrode is attached to other side and held from 6 to 10 inches from the body of the patient at the point to be treated. Time of sitting, 10 to 15 minutes.</p>	<p>Local Sedation.</p>
Multiple Spray	<p>Same as "single spray" except that an electrode having a number of points is used.</p>	<p>Same as above to cover larger space.</p>
Roller Massage	<p>Jars on. Switch pointer on "spark." Patient attached to top of one of the jars, the other to roller electrode. The machine must be started with the prime conductors <i>actually touching</i>. They are then carefully separated until the resistance of the patient's clothing is overcome.</p> <p>NOTE. The circuit is milder when the jars are removed. In either case, however, the current must be applied <i>through the clothing</i> and not on the bare skin.</p>	<p>Counter irritation in cold joints.</p> <p>Massage.</p>
Direct Spark	<p>Jars on. Switch pointer on "spark." Patient attached to top of one jar—the other to ball electrode. The prime conductors are now separated 5 or 6 inches and the ball held close enough to the body of the patient to allow a spark to jump across. This treatment is painful.</p>	<p>Deep impressions to paralyzed muscles.</p>
Induced Spark	<p>Same as above, except that jars are removed. Not so painful.</p>	<p>Same as above counter irritation.</p>
To find the polarity of a static machine	<p>Start the machine in action and separate the prime conductors about $\frac{1}{2}$ inch. The <i>white</i> end of spark indicates the <i>positive</i>. If now the prime conductors are pulled out several inches the heavy or white end of the spark is on the <i>negative</i> side. If the jars are on, the switch pointer must be on "spray."</p>	
To attach the Crooke's Tube	<p>The positive or anodal end of the tube terminates in a <i>flat</i> piece of platinum and extends to the middle of the tube.</p> <p>The negative or cathodal end is a <i>cup-shaped</i> piece of aluminum and does not extend into the bulb of the tube.</p> <p>The positive end of the tube must be attached to positive side of machine and the negative end to the negative side.</p>	

CHAPTER X.

ROENTGEN X-RAYS.*

On Dec. 4, 1895, William Conrad Roentgen made a paper before the Physico-Medical Society of Würzburg, in which he described what he called "X-rays."

His discovery soon claimed the attention of scientists and laymen in the entire world, more particularly in England, because it was the first time that the rays could not only be made to pass through bodies like paper and wood, but also through the bodies and bones of living animals. X-rays could be used to examine the interior of the body.

Roentgen's discovery was a great step toward the knowledge of the structure of the body. It was the first time that the interior of the body could be examined without the use of a knife. This was a great discovery, and it was the first time that the interior of the body could be examined without the use of a knife.

In several respects they resemble light. — by traveling in a straight line, affecting photographic plates,

* The assistance for this work by Gordon G. Swartz, B. S., Professor of Radio-Therapy and Physio-Chemistry, Illinois School of Dental Therapeutics; Surgeon-in-Chief, People's Hospital; Assistant Professor Surgery Post-Graduate Medical School; President of the Electro-Medical Society.]

PHYSIOLOGICAL PRACTICE

The first part of the book is devoted to a description of the various organs of the human body, and the manner in which they are situated and connected with each other. It is a very interesting and useful work, and one which every student of medicine should possess.

The second part of the book is devoted to a description of the various diseases of the human body, and the manner in which they are contracted and propagated. It is a very interesting and useful work, and one which every student of medicine should possess.

The third part of the book is devoted to a description of the various remedies of the human body, and the manner in which they are administered and their effects. It is a very interesting and useful work, and one which every student of medicine should possess.

The fourth part of the book is devoted to a description of the various operations of the human body, and the manner in which they are performed and their effects. It is a very interesting and useful work, and one which every student of medicine should possess.

The fifth part of the book is devoted to a description of the various symptoms of the human body, and the manner in which they are observed and their effects. It is a very interesting and useful work, and one which every student of medicine should possess.

CHAPTER X.

ROENTGEN X-RAYS.*

On Dec. 4, 1895, William Conrad Roentgen read a paper before the Physico-Medical Society of Würzburg, in which he described what he called the "X-Rays."

The discovery at once claimed the attention of scientific men throughout the entire world, more particularly the medical profession, because it was early discovered that the bones could not only be plainly seen, but foreign bodies like bullets and other substances opaque to these rays could be located within the body.

Although it has been seven years since their discovery, we seem to be yet entirely ignorant of their true nature, although a great number of investigators have advanced theories more or less plausible, the generally accepted opinion being that they are some form of irregular longitudinal vibration.

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[* Written expressly for this work by Gordon G. Burdick, M. D., Professor of Radio-Therapy and Photo-Chemistry Illinois School of Electro-Therapeutics; Surgeon-in-Chief People's Hospital; Associate Professor Surgery Post-Graduate Medical School; President Chicago Electro-Medical Society.]

films, exciting fluorescence, and not being deflected by a magnet — which has led to the popular theory that they are light waves, which, if they were visible, would appear beyond the violet end of the spectrum. They differ materially from light, however, in the fact that they cannot be refracted or polarized, do not affect the retina and pass through some substances which light cannot penetrate.

The X-Ray will pass through nearly every known substance, as flesh, bone, paper, leather and metals of various kinds when in thin layers. The denser metals absorb more of the ray than the lighter ones, as while aluminum is very transparent to the ray, lead and platinum absorb more than any other known metals.

Roentgen stated in his original communication that the transparency of different substances of equal thickness depends on their density, which is true of other substances than metals as the transparency increases far more rapidly than the density decreases.

ABSORPTIVE POWERS ON HUMAN TISSUE.

As water is the chief constituent of tissue and its heaviest element is oxygen with an atomic weight of 16, it will absorb more of the rays than fat which is lighter in its atomic weight and is more readily traversed by the ray. Muscle, tendon and nerve tissue differ very slightly from the atomic weight of water, and absorb the ray at about the same ratio. Bone being rich in calcium, having an atomic weight of 40, will absorb nearly three times

the amount of the ray as the rest of the tissues of the human body. Gases and air, owing to their low atomic weight, may be regarded as nearly transparent to the X-ray.

THE DEVELOPMENT OF THE CROOKED TUBE.

To Faraday belongs the credit of experimenting with tubes from which the air had been pumped, and to him we owe the terms "Anode" and "Cathode" as applied to the vacuum tube in use. Crookes revised the terms as applied by him to the poles of a battery to apply to the terminals of a discharge tube—"Anode" to that terminal by which the current enters the tube, and "Cathode" that terminal by means of which the current finds exit into the air.

Crookes discovered the ray given off from the cathode, and called it the *cathode ray*.

Following the discovery of Faraday came Crookes, who by improving the pump succeeded in producing a high vacuum in the tube, and experiments were made by discharging the tube with various gases, and by introducing into the tube various salts of various chemicals. In a discharge tube a high vacuum is obtained and the current of electricity passed through it. Fluorescent effects of the most brilliant description were observed, and by making the tubes of different kinds of glass, iridescent colors of a startling character were observed. Crookes turned his discovery to a commercial advantage by making display tubes

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Faraday discovered the ray given off from the cathode terminal and called it the *cathode ray*.

Following the investigations of Faraday came Geissler, who by improving the pump succeeded in getting a better vacuum in the tube, and experimented by exhausting the air and filling the tube with gases of various kinds, discovering that solutions and salts of various chemicals behaved in a peculiar manner when sealed in a vacuum tube and a current of electricity passed through it. Fluorescent effects of the most brilliant description were produced, and by making the tubes of different kinds of glass, iridescent colors of a startling character were observed. Geissler turned his discovery to a commercial advantage by making display tubes

for entertainment purposes, and in no small way deserves credit for attracting attention to this mysterious *cathode ray*.

Following Geissler came Prof. Hertz, better known as the discoverer of the so-called *Hertzian waves*, used in wireless telegraphy. Hertz sealed into a vacuum tube, photographic films covered by metallic figures, and demonstrated that the cathode ray had photographic properties. He also discovered that the cathode ray could be focused by curving the cathode disc, and that the ray could be deflected by means of a magnet.

The scientific world was startled in 1887 by the announcement of Sir Wm. Crookes, of the discovery of a new state of matter which he called "*radiant*," which he elucidated by a most elaborate series of experiments, and the invention of some of the most wonderful vacuum tubes.

He conceived of matter as existing in a state of ether, and to demonstrate his ground constructed a vacuum tube which was exhausted to the one-millionth part of an atmosphere, and by sealing into the tube, in the path of the cathode ray, a rotating vane was able to make it rotate in either direction at will by deflecting the cathode ray on alternate sides by means of a magnet, demonstrating to the scientific mind the fact that the cathode stream was made up of solid particles, and that they were of sufficient weight, and traveled at a high enough velocity to enable them to rotate the vane at a high speed while in their path.

He also discovered the fact that the mechanical energy of the cathode stream could be converted into heat by placing a piece of refractory metal in its path and bringing it to a sharp focus on the target by curving the cathode--the metal was brought to a red-hot temperature in a short time, and if sufficient energy was imparted to the tube, the target would be melted, due to the bombardment of the particles in the cathode stream. The heat generated being caused by the sudden arrest of solid particles traveling at an enormous velocity, the impulse of the blow setting the molecules of the metal in rapid vibration.

By curving the inside of the tube with various radii, Crookes demonstrated the fact that the cathode rays would cause fluorescence, emitting a magnificent glow when a current was passed through the tube. By inserting in the path of the cathode stream a piece of metal brought to a focus, a refractory refractory metal, he observed that it would cause a glow to be thrown upon the wall of the tube, the glowing due to the stream was arrested by solid bodies in their path. By constructing the cathode of metal he caused a fine deposit of the metal to be thrown from the cathode and deposit itself upon the glass surface of the tube, and by making the cathode of different shapes he found it would deposit a shadow of its shape upon the glass, proving the actual transfer of solid particles from the cathode to the opposite wall of the tube. It was also found

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He also discovered the fact, that the mechanical energy of the cathode stream could be converted into heat by placing a piece of refractory metal in its path and bringing it to a sharp focus on the target by curving the cathode—the metal was brought to a red-hot temperature in a short time, and if sufficient energy was imparted to the tube, the target would be melted, due to the bombardment of the particles in the cathode stream. The heat generated being caused by the sudden arrest of solid particles traveling at an enormous velocity, the impulse of the blow setting the molecules of the metal in rapid vibration.

By coating the inside of the tube with various salts, Crookes demonstrated the fact that the cathode ray would cause fluorescence, emitting a magnificent glow when a current was passed through the tube. By inserting in the path of the cathode stream but not brought to a focus, a refractory piece of metal, he observed that it would cause a shadow to be thrown upon the wall of the tube, thus proving that the stream was arrested by solid bodies in their path. By constructing the cathode of tin he caused a fine deposit of the metal to travel from the cathode and deposit itself upon the inner surface of the tube, and by making the cathode in different shapes he found it would deposit a stencil of its shape upon the glass, proving the actual transfer of solid particles from the cathode to the opposite wall of the tube. It was also found

that, if the degree of exhaustion was carried so far that the gas was all removed from the tube, the electric current would not pass through it, thus proving that particles were necessary in the tube in order to obtain the cathode ray.

Paul Leonard, a pupil of Professor Hertz, conceived the idea of sealing into the end of the tube opposite the cathode a thin piece of aluminum one millimeter in thickness, and succeeded in bringing the cathode ray outside the tube, where he found it would reduce photographic salts, cause fluorescence and could be deflected by a magnet. He thus demonstrated that it would penetrate four inches of air, but by sealing on a tube opposite the aluminum window and exhausting the air from it, he found the ray would pass four feet in the tube with rarified gas. The only reason he did not discover the X-Ray was because he did not use apparatus sufficiently strong.

Roentgen, while carrying out Leonard's experiments, discovered the mysterious radiation, which, after four months' investigation, he was compelled to call the *X-Ray*, owing to its being an unknown force that seemed to obey no known mathematical law.

He at first thought he had discovered a new form of light, and endeavored to refract it by means of prisms made from rock crystals, vulcanite and metal prisms of various kinds, but was utterly unable to get a diffraction band. He did

got a curious result when attempting to reflect the ray — he found that a piece of metal placed *near* a photographic plate would impress its form on the plate, but no difference was observed when the metal was polished or not. It has since been found that the image of the metal may be detected or impressed on a plate when six inches from it, and a large distance between it and the sensitive film. This has been explained by physicists on the theory that the X-Ray, coming in contact with a hard, refractory substance, gives rise to other longitudinal rays similar in character to the X-Ray, that have photo-chemical qualities, and the phenomena observed as a reflection is supposed to be due to these rays sent off in the same plane as the actual ray in relation to the plate.

We found this unknown radiation would pass through substances opaque to ordinary light, and through a few of the hardest to flesh, leather, paper, wood, etc. but the absorption was equal to the thickness of the substance through which it passed, so that the bones were conspicuous when exposed or photographed, owing to the calcium salt they contained increasing the specific gravity.

Röntgen detected the radiation at a distance of four feet from the tube, but by the use of our modern apparatus the writer has been able to detect the ray at one hundred and seventy-five feet from the generator by means of its fluorescent powers on the screen.

When the degree of exhaustion was varied, it was found that the more exhausted the patient was, the more gas was removed from the system. It was also found that the current would not pass through the system if the gas particles were necessary to the circuit. The cathode ray was also found to be very effective in the treatment of various conditions of the system. It was found that the current would not pass through the system if the gas particles were necessary to the circuit. The cathode ray was also found to be very effective in the treatment of various conditions of the system.

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He found this unknown radiation would pass through substances opaque to ordinary light, and obeyed a law of absorption in flesh, leather, paper, bone, etc.; that the absorption was equal to the specific gravity of the substances through which it passed, so that the bones were conspicuous when viewed or photographed, owing to the calcium salts they contained increasing the specific gravity.

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CORPUSCLES, SYNONOMOUS WITH IONS AND ELECTRONS.

In order to understand the action going on in a vacuum tube we must know what is meant by these terms. Corpuscles are the component parts of any atom derived from any substance, and may be defined as the lowest form of chemical life, the indivisible residue left from the dissociation of atoms from any molecule. These corpuscles are endowed by physicists with certain characteristics possessed by no other substance in nature. They are represented as being ready to form chemical combination under the action of any stimulation, and possess the peculiar property of taking on and parting with a polarity when brought into contact with any polarized substance. It is this peculiarity that explains the cathode stream. On the passage of the current through the tube the ions are polarized and arrange themselves along the lines of force, making a passage for the current. On approaching the cathode terminal they have imparted to them a negative charge, and under the proven phenomena, that like poles repel like poles, are immediately shot off at a high velocity to the target, which is polarized positively. On reaching the target a violent blow is administered to it, and immediately the polarity changes and the ion is again shot off at the same speed with which it came. The process is constantly repeated until the energy of the blow delivered by the ion in its flight from the cathode

As the anodal target starts the molecules of the target into vibration, rapidly heating it, and giving rise to the peculiar vibration known as the X-Ray. The number of ions within certain limits the more rapidly they travel, and by imparting a sharper blow to the target give rise to a more rapid vibration of the molecules of the metal, emitting a ray of greater wave length that will travel a greater distance from the tube. This ray has greater penetrating force, but loses rapidly its electrochemical efficiency until, in one high tube tested by the writer, it was completely lost. For the present it may be said that the X-Ray is formed by the sudden arrest of the cathode stream by some obstructive substance in its path, which may be a sharply edged or even the walls of the tube.

EXPERIMENTAL PHYSICS WITH IONS AND ELECTRICITY

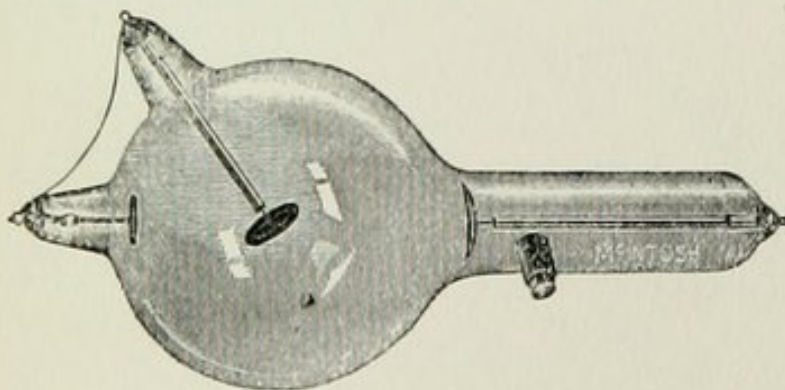
To understand the action going on in a discharge tube we must know what is meant by these terms. The atoms are the component parts of any gas which flows into a substance, and may be defined as the smallest units of chemical life, the indivisible units left after the dissociation of atoms from molecules. These particles are endowed with certain characteristics possessed by molecules of the same nature. They are represented as moving in forest chemical combination, under the action of an illumination, and possess the capacity of taking on and parting with a positive charge. It is this peculiarity that explains the phenomena. On the passage of the current through the tube the ions are polarized and travel parallel to the lines of force, making a positive charge. On approaching the cathode a positive charge is imparted to them a positive charge and under the proved phenomena, that the positive ions, are immediately shot off at a high velocity to the target, which is polarized positively. On reaching the target a violent blow is administered to it, and immediately the positive charge and the ion is again shot off at the same velocity with which it came. The process is repeated until the energy of the blow imparted by the ion is its flight from the cathode.

to the anodal target starts the molecules of the target into vibration, rapidly heating it, and giving rise to the peculiar vibration known as the X-Ray. The smaller the number of ions within certain limits the more rapidly they travel, and by imparting a heavier blow to the target give rise to a more rapid vibration of the molecules of the metal, making a ray of greater wave length that will travel a greater distance from the tube. This ray has greater penetrating force, but loses rapidly its photo-chemical efficiency until, in one high tube owned by the writer, it was completely lost. For the present it may be said that the X-Ray is formed by the sudden arrest of the cathode stream by some refractory substance in its path, which may be a metallic target or even the walls of the tube.

CHAPTER XI.

THE CROOKES' TUBE.

The tubes that were used at the time of Roentgen's discovery were the well-known pear-shaped variety of Sir Wm. Crookes' experimental outfit, and were without a metallic target. The cathode rays were not brought to a focus, but were diffused over the opposite end of the tube. We were unable to use much energy with a tube of this kind, owing to the heating effect on the walls of the tube from the bombardment by the cathode ray, and consequently on the announcement of Roentgen's discovery a determined attempt was made to perfect a tube that might be used to obtain more powerful effects. The results can be judged by the statement that while it took about two minutes to photograph a hand with the original pear-shaped tube, the denser parts of the body can now be taken in less than one minute.



GERMAN TUBE.

The first improvement in the development of a modern tube consisted in placing a platinum target in the

path of the cathode ray, which was brought to a short focus, making it possible to invade all parts of the body with the ray. Still the exposures were usually prolonged and the results doubtful, owing to the thin target developing sufficient heat to melt it when the current was pushed beyond a certain point. By increasing the size of the target, and constructing it of other metals the energy of the largest apparatus may now be sent through even without danger for at least two minutes—long enough to obtain the most difficult skiagraph.

The extensive use of the new tubes has demonstrated the fact that the degree of exhaustion is increased rapidly on large apparatus until after a few hours' use the vacuum increases to such a point that the existing current can no longer be forced through it. Others have therefore been compelled by experiment to find some method of regulating the vacuum in a tube while it was in use.

VACUUM TUBES.

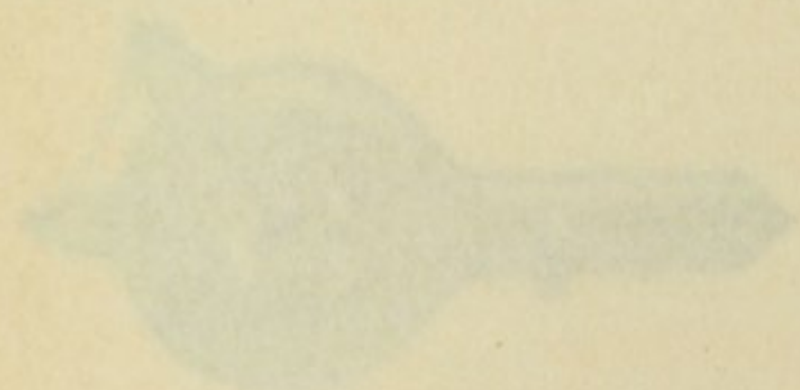
Let us study for a few minutes the meaning of the term vacuum, and in order to do so we must look up the molecular theory briefly in order that we may have a working knowledge of the subject.

We know the atmosphere is under a pressure of about fifteen pounds at the surface of the earth; therefore let us conceive of the atmosphere being composed of spherical bodies—called molecules—and held together by this pressure. The pressure being great, considerable friction is caused by their move-

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The Crookes' tube was used at the time of Roentgen's discovery with the well-known pear-shaped glass tube of Crookes' experimental outfit, and the results were the same. The cathode rays were not directed to a focus, but were diffused over the opposite end of the tube. We were unable to get much current with a tube of this kind, owing to the leakage of gas on the walls of the tube from the bombardment by the cathode ray, and consequently on the improvement of Roentgen's discovery a development was made to perfect a tube that might be used to obtain more powerful effects. The results can be judged by the statement that while it took about two minutes to photograph a hand with the original pear-shaped tube, the same parts of the body can now be taken in less than one minute.



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path of the cathode ray, which was brought to a sharp focus, making it possible to invade all parts of the body with the ray. Still the exposures were unduly prolonged and the results doubtful, owing to the thin target developing sufficient heat to melt it when the current was pushed beyond a certain point. By increasing the size of the target, and constructing it of other metals the energy of the largest apparatus may now be sent through them without danger for at least two minutes—long enough to obtain the most difficult skiagraph.

The extensive use of the new tubes has demonstrated the fact that the degree of exhaustion is increased rapidly on large apparatus until after a few hours' use the vacuum increases to such a point that the exciting current can no longer be forced through it. Makers have therefore been compelled to experiment to find some method of regulating the vacuum in a tube while it was in use.

VACUUM TUBES.

Let us study for a few minutes the meaning of the term *vacuum*, and in order to do so we must take up the molecular theory briefly in order that we may have a working knowledge of the subject.

We know the atmosphere is under a pressure of about fifteen pounds at the surface of the earth; therefore, let us conceive of the atmosphere being composed of spherical bodies—called molecules—held together by this pressure. The pressure being great, considerable friction is caused by their move-

ments and it is this fact that prevents the atmosphere from becoming a good conductor of electricity, but by enclosing these molecules in the rigid glass walls of a tube, and applying a pump to remove the pressure, and a certain proportion of the molecules, it is found in practice that, as the exhaustion is continued, and the molecules separated from each other, they become better conductors of electricity, and while the first spark sent through the tube is white and zigzag and emits a crackling noise, it soon changes to a deep purple and passes noiselessly directly from one terminal to the other. We know that molecules are again subdivided into bodies called atoms, and by carrying our exhaustion far enough we cause a complete breaking up of the molecular form, and liberate the atoms in the tube, and as soon as this occurs the character of the electric discharge changes ; sparks disappear from the tube, and a bluish glow takes their place, and we have what is known as a *Geissler vacuum*. By increasing the degree of exhaustion and removing more of the atoms, the discharge changes again in character, and a bluish white discharge takes place in the tube. Now it at once becomes apparent to the reader that physicists would be unable to explain certain phenomena connected with electricity, especially in regard to vacuum work, without again subdividing the atoms into *corpuscles*, of which each atom contains a great number. So when the exhaustion is carried still farther by

revolve of the mercury pump we cause a dissociation of atoms, and liberate corpuscles in the tube, when it is said to have *crossed the line*, and the entire character of the phenomena changes. A dividing line is now formed opposite the plane of the target, and the color changes from a bluish white to a deep green if uranium is contained in the glass, or in certain other kinds of glass, a yellowish color is given off. The cathode stream may be seen focused in the target as a bluish ray, and by viewing the tube through a screen, to be described later, slight fluorescent effects are noted, and the shadow of the hand may be seen as it passes back and forth across the screen. By continuing the action of the pump it is seen that the fluorescence of the screen increases in brilliancy until the bones stand out in relief, while the flesh is transparent. The cathode ray now becomes invisible--all blue light coming from the tube--and by continuing the process of pumping and separating the cathode ions, giving them a chance to travel at a higher rate of speed, the bones have become glorified and are transparent to the ray projected on the screen, and eventually a degree of exhaustion is obtained where the bones and flesh are so transparent that the image of them entirely disappears.

The degree of exhaustion has great importance with reference to the purpose for which the tube is to be used. When the tube has *crossed the line*,

atoms and it is this fact that prevents the atmosphere from becoming a good conductor of electricity, but by subdividing these molecules in the rigid structure of a tube, and applying a pump to remove the air, and a certain proportion of the molecules will break up so soon that, as the exhaustion is increased, and the molecules separated from each other, they become better conductors of electricity and when the first spark sent through the tube is produced, it emits a crackling sound and a discharge of a deep purple and passes rapidly from one end of the tube to the other, the molecules are again subdivided into submolecules, and by carrying our exhaustion further, we cause a complete breaking up of the molecules, and liberate the atoms in the tube, and as soon as this occurs the character of the electric discharge changes; sparks disappear from the tube, and a bluish glow takes their place, and we have what is known as a *Gauster vacuum*. By increasing the degree of exhaustion and removing more of the atoms, the discharge again changes in character, and a bluish white discharge takes place in the tube. Now it at once becomes apparent to the reader that physicists would be unable to explain certain phenomena connected with electricity, especially as regards to vacuum work, were not again subdividing the atoms into *subparticles*, of which each atom contains a great number. As soon as the exhaustion is carried still farther by

means of the mercury pump we cause a dissociation of atoms, and liberate corpuscles in the tube, when it is said to have *crossed the line*, and the entire character of the phenomena changes. A dividing line is now formed opposite the plane of the target, and the color changes from a bluish white to an apple green if uranium is contained in the glass, or in certain other kinds of glass, a yellowish color is given off. The cathode stream may be seen focused in the target as a bluish ray, and by viewing the tube through a screen, to be described later, slight fluorescent effects are noted, and the shadow of the hand may be seen as it passes back and forth before the screen. By continuing the action of the pump it is seen that the fluorescence of the screen increases in brilliancy until the bones stand out in bold relief, while the flesh is transparent. The cathode ray now becomes invisible — all blue light having disappeared from the tube — and by continuing the process of pumping and separating the corpuscles more and more, giving them a chance to travel at a higher rate of speed, the bones have become illuminated and are transparent to the ray as viewed on the screen, and eventually a degree of exhaustion is obtained where the bones and flesh are so transparent that the image of them entirely disappears.

The degree of exhaustion has great importance with reference to the purpose for which the tube is to be used. When the tube has *crossed the line*,

and is full of corpuscles, considerable friction is caused by their movements. They travel at a slower velocity and the tube is said to be *low* or *soft* and the wave length is shorter—consequently while it is rich in photo-chemical effects it does not have velocity enough to penetrate the tissues to any great depth, but by removing more of the corpuscles by means of the pump we increase the speed at which they travel by reducing the friction element, and a longer wave length is given off, which penetrates the tissues more deeply, still retaining, however, its photo-chemical action somewhat diminished, and we call this a *medium* tube.

By long use we exhaust the tube of more corpuscles by compelling them to unite electrolytically with the metal of the cathode or anode, and, in some tubes, with the glass walls, and after a certain amount of use it is found that the bones when viewed on the screen have disappeared as well as the flesh, and a slight shadow only is noticed when the hand is passed before the screen. Bright patches of green can be seen in different parts of the tube, and the current shows a disposition to spray off the conducting wires, at times to even jump over the tube. It is then said to be *high* or *hard*, and is practically useless for further X-Ray work until it has been submitted to a process that will restore to it more corpuscles.

METHODS OF REGULATING TUBES.

The first successful way of reducing the vacuum

of a tube that had become hard was by the simple procedure of placing it in a soft soap, wrapped in fire felt, and by gradually increasing the temperature until about 475° F. was obtained, which is sufficient to drive the compounds from the surface for some time they have formed with the walls of the tube. They are now at liberty to again circulate under the influence of the current. It has been found in practice that baking a tube reduces its *leak* the less, so that it is best to remove the tube from the oven as soon as perfectly cool and put it on the coil. When the current is first turned on a bluish white light is seen, but if run steadily for twenty minutes the blue will appear and green light is noticed. The X-Ray may be seen coming and going by flashes, but by continuing the process a short time they remain permanent, and the current may be turned off. The area of usefulness gradually diminishes as the coil is run, and at last the tube must be removed and replaced. Another useful way with cheap tubes is to reverse the poles and run the current backward for nearly one hour, when sufficient compounds are driven off from the cathode to restore the tube to usefulness for a short time.

These methods being attended with considerable work, beside not reducing the tube to any extent, gave rise to a demand for something automatic and brought out the "Sayan Regulator," now universally known as the Queen patent rego-

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minished, and we call this a *medium* tube.

By turning up the exhaust the tube of more cor-
puscles by compelling them to unite electrolytically
with the metal of the cathode or anode, and, in
some tubes, with the glass walls, and after a certain
amount of time is allowed that the tubes when viewed
by the camera are discolored as well as the flesh,
and a slight degree of redness is noticed when the hand
is placed within the tubes. Bright patches of
discoloration appear in different parts of the tube, and
the vacuum pump is disengaged to spray off the
discoloring matter which may even jump over the
tube. This tube may be *high* or *hard*, and is
generally used by neither X-Ray work until it
is found to be used in a process that will restore to
its original condition.

METHOD OF REGULATING TUBES.

The most successful way of reducing the vacuum

of a tube that had become *hard* was by the simple procedure of placing it in a cold oven, wrapped in fire felt, and by gradually increasing the temperature until about 480° F. are obtained, which is sufficient to drive the corpuscles from the chemical formations they have formed with the walls of the tube. They are now at liberty to again circulate under the influence of the current. It has been found in practice that baking a tube reduces it *below* the line, so that it is best to remove the tube from the oven as soon as perfectly cool and put it on the coil. When the current is first turned on a bluish white light is seen, but if run steadily for twenty minutes the line will appear and green light is noticed. The X-Ray may be seen coming and going by flashes, but by continuing the process a short time they remain permanent, and the current may be turned off. The time of usefulness gradually diminishes after each treatment until at last the tube must be opened and repumped. Another useful way with cheap tubes is to reverse the poles and run the current backward for nearly one hour, when sufficient corpuscles are driven off from the cathode electrode to restore the tube to usefulness for a short time.

These methods being attended with considerable work, beside not reducing the tube to any exact point, gave rise to a demand for something automatic and brought out the "Sayan Regulator," now universally known as the Queen patent regu-

lator. Sayan, in his experiments, took advantage of the well-known fact that caustic potash absorbs moisture under all conditions, and will part with it under the influence of heat, so he constructed an auxiliary tube of small resistance and focused the cathode ray upon a small platinum anode, which carried a wire through the glass into a tube of caustic potash. By pumping the large tube to a very high vacuum he made its resistance too high for the current to pass, consequently it passed through the small tube first, causing the anode to become red hot by the bombardment of the cathode ray and by transmitting the heat from the wire to the potash bulb, moisture was driven off, lowering the vacuum in the large tube. In order to have a wide range of regulation a shunt spark gap was attached to the cathode of the small tube and by adjusting it at a variable distance from the cathode terminal of the large tube, more or less vapor was driven off as required, and the vacuum in the large tube was completely under control. The smaller the spark gap the lower the vacuum in the large tube, and by having the spark gap set at a certain distance, the vacuum of the large tube would remain stationary, as a spark would pass over the shunt from time to time, driving more moisture into the large tube as needed. As soon as the tube cools the moisture is again absorbed by the potash, and the large tube regains its former high vacuum. This tube is the finest in principle of any of the so-

of regulation tubes, unfortunately, however, *Osaka & Co.*, with a lamentable lack of enterprise do not construct them large or strong enough for the more powerful apparatus. These tubes can be run for hours on a light current, maintaining their vacuum steadily, and are ideal for treating purposes. But the anode can be melted in less than one hour when used for skiographic purposes, because although made of heavy platinum its bulk is small, and it does not conduct the heat off as fast as formed. It is almost useless with this tube not to place the regulator in a sink of water or the tube will speedily become fused and useless for all purposes.

The same principle as the same principle was used by *Osaka & Co.* in their *Electric Co. Lamp Dept.* apparatus. It consists of a sink of potash in which is placed a large tube, and heating apparatus is placed around the tube when the tube was used. The regulator is connected using to the regulator of the apparatus. The application of the current is made by the regulator for practical purposes. It is used chiefly for another tube containing a copper salt solution of dry-plate direct connection with the cathode. This apparatus is used to-day with the addition of a modified regulator containing some barium salt, which, by reducing the resistance of the shunt, causes the current to pass through the regulator, driving oxygen from the tube which lowers its vacuum, by setting the shunt at a certain point, making the vacuum

In his experiments, he took advantage of the well known fact that caustic potash absorbs moisture under all conditions, and will part with it under the influence of heat, so he constructed an apparatus of small size and focused the electric current on a small platinum anode, which was placed in a tube of glass into a tube of glass. By connecting the large tube to a vacuum pump the resistance was too high for the current to pass, consequently it passed through the small tube, causing the anode to become red hot by the bombardment of the cathode rays and by conducting the heat from the wire to the small tube, as soon as it was taken off, lowering the resistance in the large tube. In order to have a wide range of resistance a short spark gap was attached to the end of the small tube and by adjusting it to a variable distance from the cathode in the large tube, more or less vapor was produced and the stream in the large tube was accordingly changed. The smaller the distance from the point of vacuum in the large tube, and by adjusting the spark gap set at a certain distance, the amount of vapor in the large tube would remain constant, and could pass over the small tube and be drawn more moisture into the large tube. As soon as the tube cools the vapor is again absorbed by the potash, and the large tube regains its former high vacuum. This apparatus is based in principle of any of the so-

called regulation tubes, unfortunately, however, Queen & Co., with a lamentable lack of enterprise do not construct them large or strong enough for the more powerful apparatus. These tubes can be run for hours on a light current, maintaining their vacuum steadily, and are ideal for treating purposes, but the anode can be melted in less than one minute when used for skiagraphic purposes, because although made of heavy platinum its bulk is small, and does not conduct the heat off as fast as formed. Care should be used with this tube not to place the shunt nearer than one inch, or the tube will speedily become black, and ruined for all purposes.

A modification of this same principle was used by the Edison General Electric Co. Lamp Dept. for a short time by enclosing a stick of potash in a bulb connected with the large tube, and heating it by means of an alcohol lamp when the tube was used. The difficulties encountered owing to the breaking of the glass by the injudicious application of heat, and reducing the vacuum too far for practical use, led to its being abandoned shortly for another tube containing a copper salt that gave off oxygen by direct connection with the current. This method is used to-day with the addition of a muffled spark gap containing some barium salt, which, by lowering the resistance of the shunt, causes the current to pass through the regulator, driving oxygen gas into the tube which lowers its vacuum, by setting the shunt at a certain point, making the vacuum

stationary as long as required. The arrangement is very fine and gives good satisfaction in practice.

A good regulator comes to us from a foreign land made by Mr. Carl Mueller of Germany. He has constructed his anode of selenium-iron, a very refractory alloy of iron, and one that does not give off much gas under the influence of the current. The anode is made very large in order to absorb the heat and the regulator contains some salts that gives off nitrogen gas under the influence of the current when connected with the negative wire. The tube may be reduced in a few seconds as far as required under a weak current, and unlike the other tubes maintains its vacuum for a considerable time afterward. As these tubes come to this country they have a shunt spark gap similar to the Queen patent for constant regulation. A unique feature is a means of raising the vacuum as required; this is accomplished by putting into the regulator an iridio-platinum spiral wire, which under the influence of the current from positive wire, throws off nascent platinum in a fine shower which absorbs the free corpuscles, gradually raising the vacuum in the tube. Usually five minutes is required to bring a tube from a low to a very high vacuum. These tubes will stand the current from the heaviest apparatus for two minutes without danger, the only serious drawbacks being the initial high price and the fact that so many tubes are sent out by the manufacturer that are not annealed, causing them

to break on cooling after use. Below we give illustration and description of the Muller tube.



MULLER TUBE.

The secondary tube B is joined to the main tube K (see figure) by means of a short tube A; the air space of B is in direct connection with that of K. B is supplied with a cathode C made of a substance which, as soon as the current is conducted through B in the direction shown, immediately delivers a certain quantity of gas, thus reducing the hardness of the tube. The conduction of the current through the secondary tube is effected by approaching to a certain air-distance, the brass bar E which is connected with the cathode C, and movable on it by means of a turning joint, to the cathode in the main tube K; this distance to be from about two to three inches if the X-Rays are to be applied to a pelvis, and from about one to two inches if to a hand.

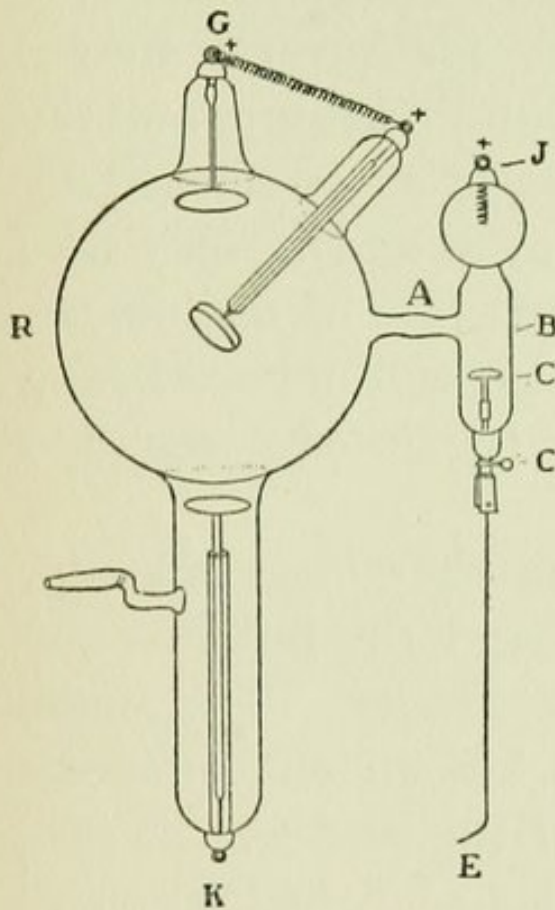
The regulation is proved by the electricity passing as a current of sparks between K and R.

Another foreign made tube with an electric regulator is the Voltohm. It is in most respects a

whenever it is required. The arrangement is such that the gas gives great satisfaction in practice.

Another important device is an iron from a foreign manufacturer, the name of which is not known. He has constructed his kind of selenium-iron, a very interesting alloy, which does not give off selenium, but it is the influence of the current, the current being very large in order to absorb the selenium. The alloy contains some salts that give off selenium, but under the influence of the current which is attracted with the negative wire, the selenium may be reduced in a few seconds as far as required, and unlike the other alloys, it remains in vacuum for a considerable time afterwards. As these tubes come to this country they have a short space gas similar to the Queen patent for constant regulation. A unique feature is a device of raising the vacuum as required; this is accomplished by putting into the regulator an electroplated metal wire, which under the influence of the current from positive wire, throws off a current of gas into a gas shower which absorbs the gas, gradually raising the vacuum in the tube. Usually the vacuum is required to bring a tube from a low to a very high vacuum. These tubes will stand the extent from the heaviest vacuum for two minutes without danger, the very high vacuum being the initial high price and the fact that in many tubes are sent out by the manufacturer that are not annealed, causing them

to break on cooling after use. Below we give illustration and description of the Mueller tube.



MUELLER TUBE.

The secondary tube B is joined to the main tube R (see figure) by means of a short tube A; the air space of B is in direct connection with that of R. B is supplied with a cathode C made of a substance which, as soon as the current is conducted through B in the direction shown, immediately delivers a certain quantity of gas, thus reducing the hardness of the tube. The conduction of the current through the secondary tube is effected by approaching

to a certain air-distance, the brass bar E which is connected with the cathode C, and movable on it by means of a turning-joint, to the cathode in the main tube K; this distance to be from about two to three inches if the X-Rays are to be applied to a pelvis, and from about one to two inches if to a hand.

The regulation is proved by the electricity passing as a current of sparks between K and E.

Another foreign-made tube with an electric regulator is the Voltohm. It is in most respects a

very fine tube, and will stand a very heavy current for a long time, but the regulator is not worthy of the name. The anode is made of copper covered with a thin platinum layer, and causes considerable annoyance by giving off gas for several weeks, when suddenly it runs too high in vacuum and the regulator must be used; this is accomplished by connecting the positive wire to it, and it may take thirty minutes to reduce it to a state of usefulness. After a few times the regulator will not work, and the tube must be baked to regain the required vacuum.

The Gunlach tube is another ideal tube for skiagraphic work, as it will stand the heaviest current for five minutes without danger. The anode is constructed of steel, which has an enormous radiating surface to conduct off the heat as it is generated. The regulator consists of a metallic stem inserted in the glass surrounded by some salt, and by heating the stem, gas is driven off. It works perfectly a few times, and then resort to baking must be had.

Another and more perfect regulator that has been used by the writer, and which he has had under trial for two years, consists of a metallic connection that may be attached to any tube, and when the tube becomes too high from use the air is admitted in minute quantities as desired. They are expensive at present, as only one mechanic has been found in the country who is able to do the work

accurately enough to make it a perfect success. No effort has been made to introduce them as yet, as it is desired to test them out thoroughly and perfect the apparatus before placing them upon the market. A regulator of this description has recently come from Germany, but is so complicated that only a few will work, proving a source of annoyance.

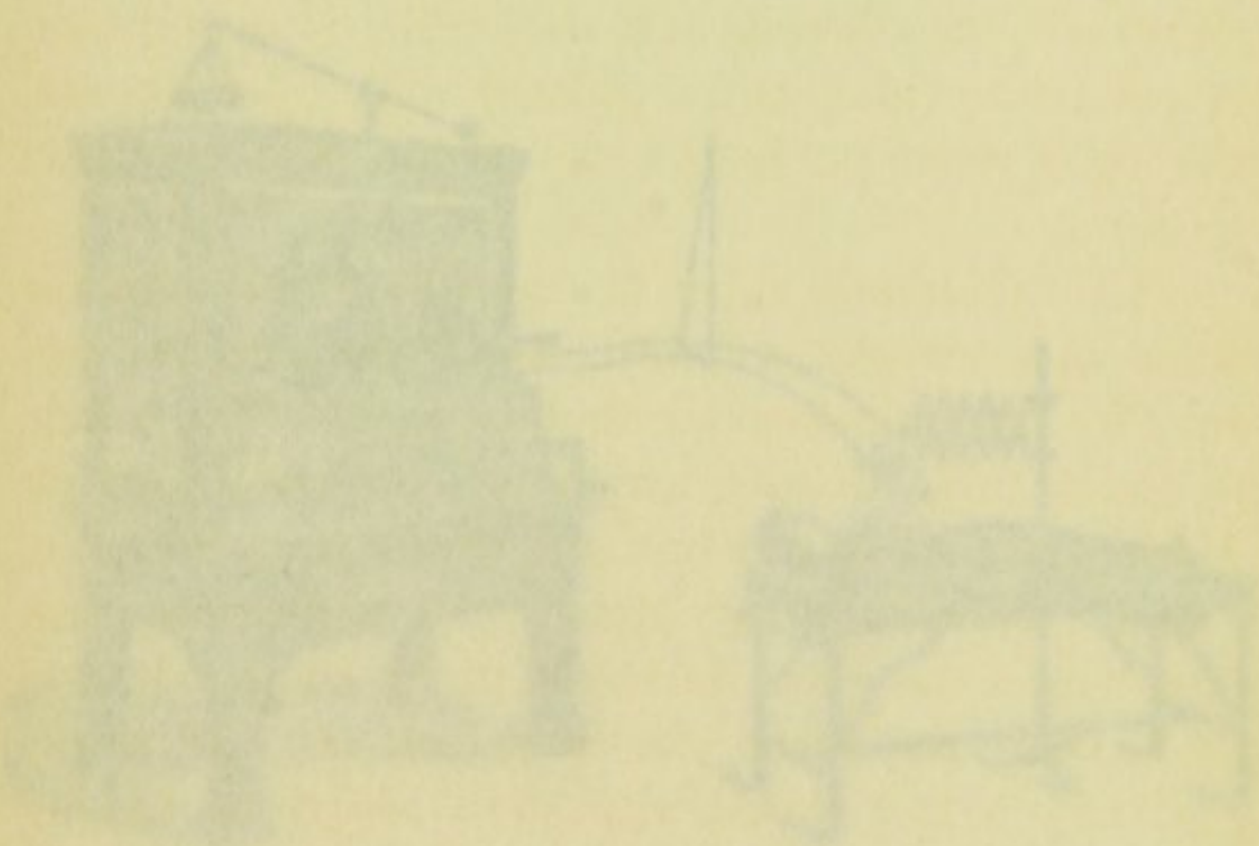


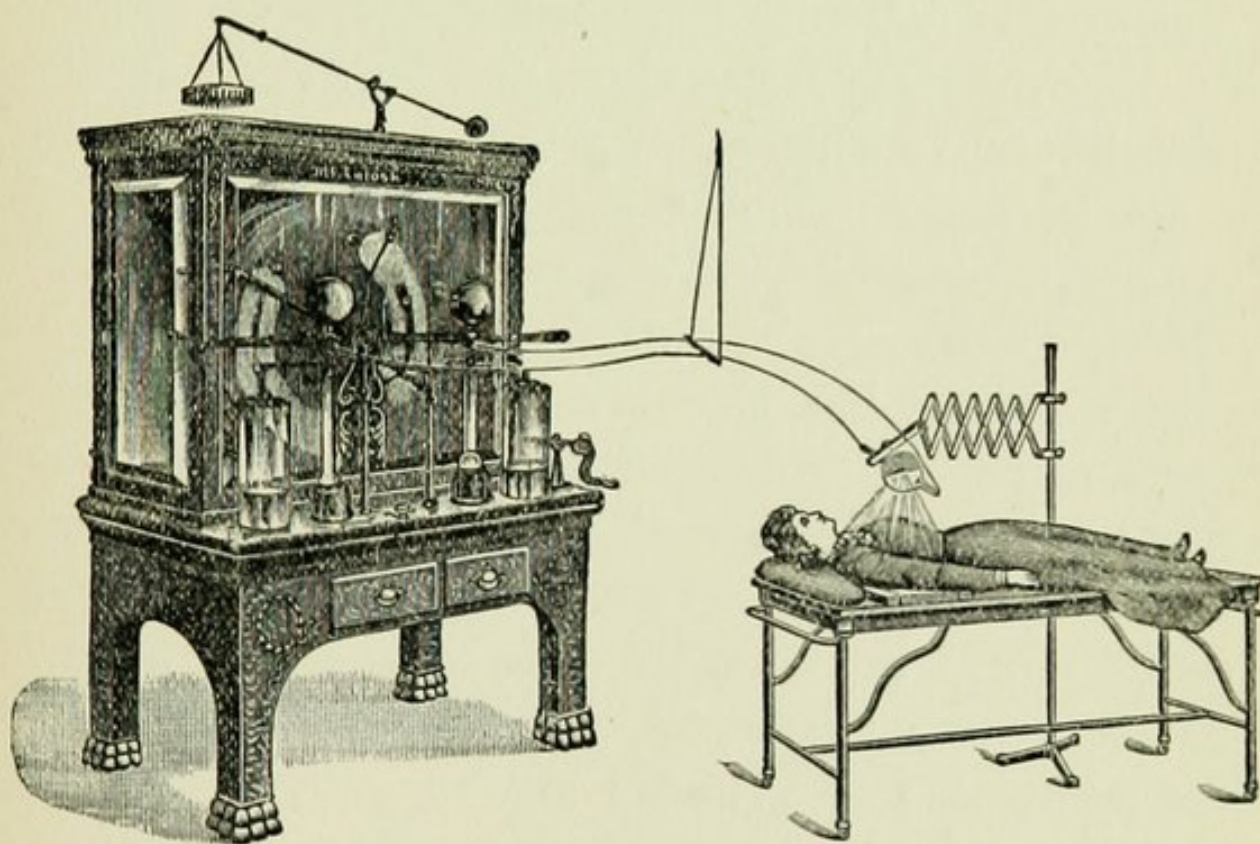
Fig. 1. Electro-therapeutic machine.

very fine tube, and will stand a very heavy current for a long time, but the regulator is not worthy of the name. The mode is made of copper covered with a thin platinum layer, and causes considerable trouble by giving off gas for several weeks. It is difficult to keep the high vacuum and the regulator does not work; this is accomplished by the platinum wire to it, and it may take several months to get it to a state of usefulness. In the meantime the regulator will not work, and the gas will be forced to regain the required pressure.

The second mode is another ideal tube for the purpose, and it will stand the heaviest current for long periods without danger. The mode is made of metal, which has an enormous capacity to absorb and give off the heat as it is generated. The regulator consists of a metallic stem inserted in the glass surrounded by some salt, and by heating the stem gas is driven off. It works perfectly a few times, and then resort to baking must be had.

Another and more perfect regulator that has been used by the writer, and which he has had under trial for two years, consists of a metallic connection that may be attached to any tube, and when the tube becomes too high from use the air is admitted in minute quantities as desired. They are expensive at present, as only one mechanic has been found in the country who is able to do the work

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TAKING A RADIOGRAPH OF THE CHEST.

CHAPTER XII.

X-RAY EQUIPMENT.

The X-Ray may be obtained from a variety of generators in common use throughout the world. The Static machine is in use perhaps in greater number than any other type, and they occur in several different forms, all of which have their advantages, as well as some undesirable features. The types have been divided into what are known as the Holtz, Toepler-Holtz and Wimshurst.

The Holtz has the advantage of greater storage and generating capacity of its plates for a given number while the current is generated at a higher molecular vibration. There is less leakage of current than is common in other types. Unfortunately, however, other factors are present that make the possession of a Holtz machine anything but a pleasure. It is necessary to introduce in the Holtz machine a small Wimshurst or Toepler-Holtz in order to give it its initial charge, as the machine does not retain a charge for any length of time, making it necessary to determine the polarity of the machine each time it is started, and frequently having to arrange the tubes differently because of this difficulty. The cases, as constructed, are ordinarily not moisture proof, and consequently an un-

slightly moist calcium chloride is necessary in most machines of this type all the time.

The Toepfer-Holtz machine has perhaps given more satisfaction than any other type for X-Ray work, as it can be depended on to work any day in the year. It rarely changes its polarity when the atmosphere is free from moisture, retains its charge for long periods of time, and gives sufficient intensification of the current generated to make good photochemical rays. It is not necessary to run it at a very high speed, 1,000 to 1,500 revolutions per minute being sufficient for the majority of X-Ray work.



Toepfer-Holtz Machine.

The Weston type is the same in principle, but unfortunately cannot be built sufficiently large to generate current for rich photochemical rays owing to the inability of manufacturers to rotate the plates in opposite directions without the use of belts, which are always a nuisance.

The plates turning in opposite directions develop nearly double the amount of current that is generated in the ordinary type of machines.

The Voss type does not offer anything that can

CHAPTER XII.

SEAWAY EQUIPMENT.

The Seaway may be described as a variety of equipment for use on the water. The main part of it is the carriage in ground, which is the only part that they carry on the water. It is a very simple and cheap piece of equipment, and it is very useful in many cases. It is a very simple and cheap piece of equipment, and it is very useful in many cases.

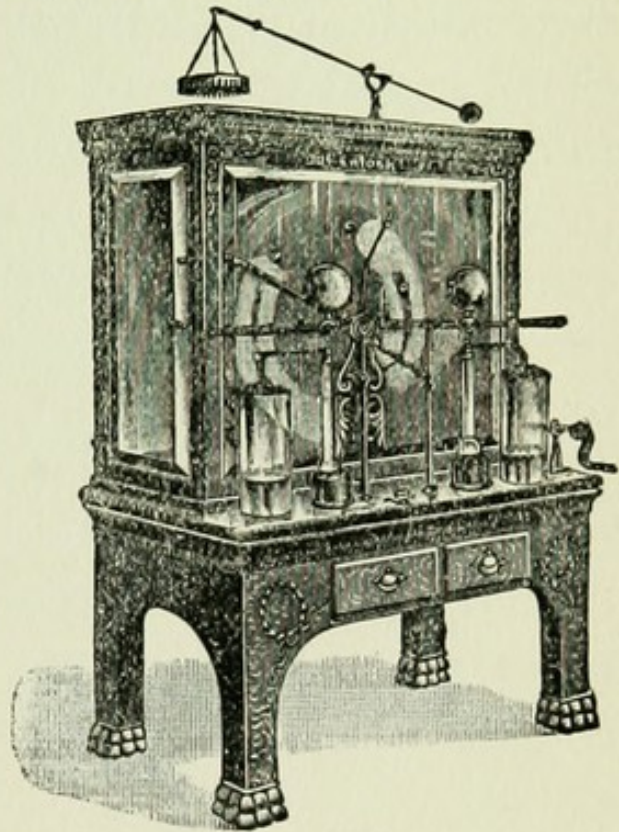
The main part of the equipment is the carriage in ground, which is the only part that they carry on the water. It is a very simple and cheap piece of equipment, and it is very useful in many cases. It is a very simple and cheap piece of equipment, and it is very useful in many cases.

sightly mass of calcium chloride is necessary in most machines of this type all the time.

The Toepler-Holtz machine has perhaps given more satisfaction than any other type for X-Ray work, as it can be depended to work any day in the year. It rarely changes its polarity when the atmosphere is free from moisture, retains its charge for long periods of time, and gives sufficient interruption of the current generated to make good photo-chemical rays. It is not necessary to run it at a very high speed, from 400 to 600 revolutions per minute being sufficient to do fairly satisfying X-Ray work.

The Wimshurst is the ideal in principle, but unfortunately cannot be built sufficiently large to generate current for rich photo-chemical rays owing to the inability of manufacturers to rotate the plates in opposite directions without the use of belts, which are always a nuisance. The plates turning in opposite directions develop nearly double the amount of current that is generated in the ordinary type of machines.

The Voss type does not offer anything that can-



TOEPLER-HOLTZ MACHINE.

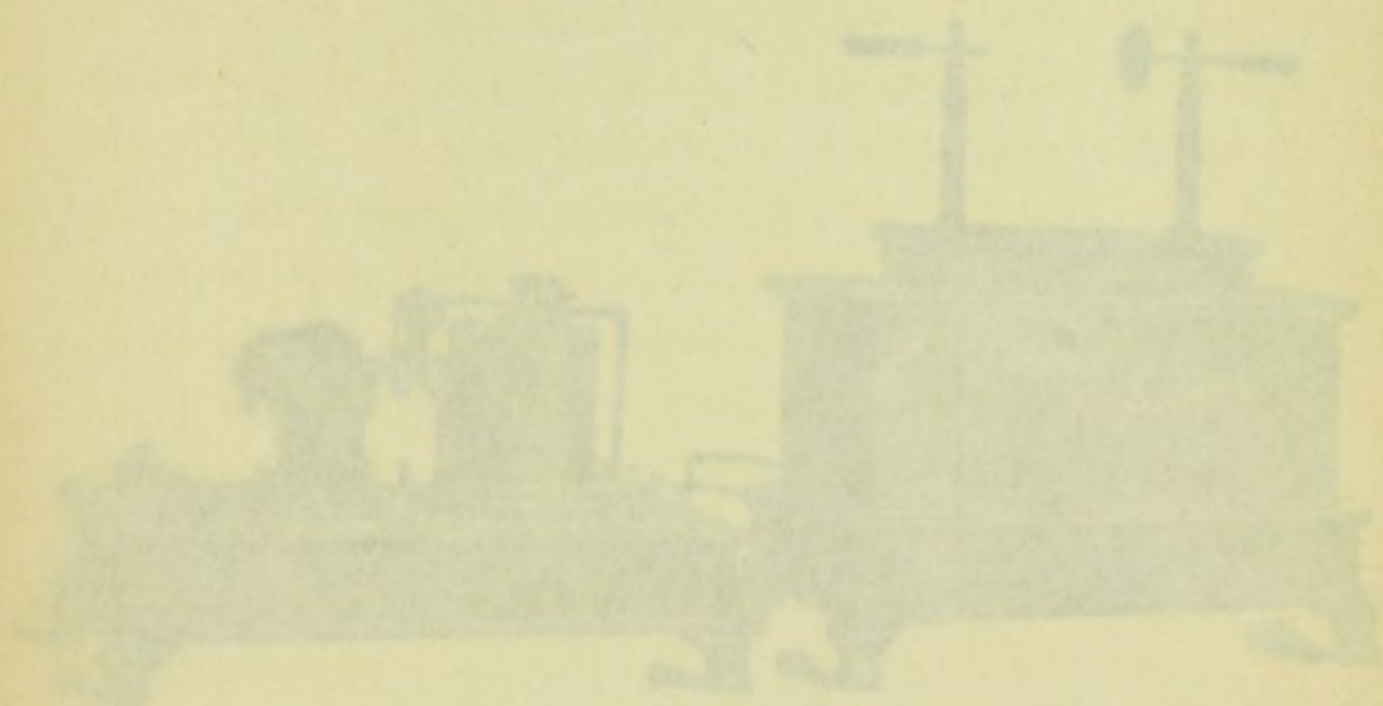
not be done by other well tried machines, therefore, we will not use space to consider it.

Storage batteries controlled by means of a rheostat will give very satisfactory X-Rays when connected direct to the tube through a suitable resistance, but the great number necessary in order to overcome the resistance of an ordinary vacuum tube makes it impracticable. About 40,000 cells connected in series would give about 80,000 volts pressure and is sufficient to overcome the resistance of our best type of tubes.

Ruhmkorff induction coils or modifications of them are the most successful form of apparatus to develop the Roentgen ray at a wave period that gives a ray that is richest in the peculiar photo-chemical reduction that accompanies this unknown radiation.

The ordinary Ruhmkorff coil is not satisfactory owing to the great difference of potential between the different layers of the secondary, making them break down frequently, and causing expensive repairs, but as modified by Ritchie, who used spool winding, the difference of potential between each layer of the secondary is never greater than 120 volts pressure, each being insulated by a heavy shellac paper tested to withstand at least 500 volts, making a perfectly safe coil which rarely breaks down even under extreme abuse. By putting the Ritchie bobbins in a box and insulating it with re-

used hard oil no trouble is experienced by the most kind of usage.



THE LUSCHKA COIL.

The general improvement in the manufacture of insulating material has had a great deal to do with the successful working of the coil, as the primary is insulated from the secondary by a tube made from pressed mica and shellac, making a break-down nearly unknown. The advantage of the coil over the static machine is due to the peculiar way we derive our current from it. In order to obtain induction in the secondary coil we must send a current through the primary, and interrupt it at frequent intervals, as the current induced in the secondary flows in one direction at each, and when the current is reversed in the primary the induced current in the secondary flows in the opposite direction. (See page 49.)

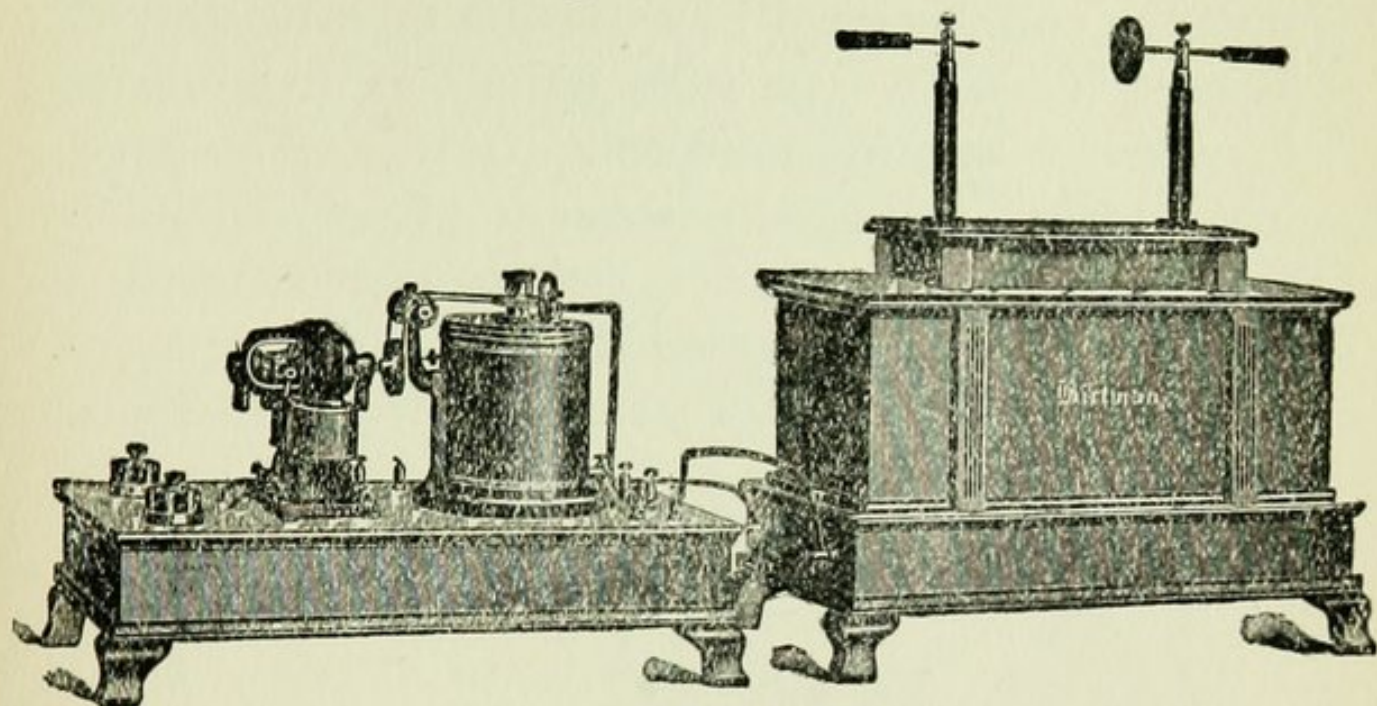
can be done by other well tried machines, therefore, we will not use space to consider it.

Storage batteries controlled by means of a rheostat will give very satisfactory X-Rays when connected direct to the tube through a suitable resistance, but the great number necessary in order to obtain the low resistance of an ordinary vacuum tube require a large expenditure. About 40,000 cells of Leclanché or similar type give about 80,000 volts potential which is sufficient to overcome the resistance of a vacuum tube of 1000 ohms.

Experiments have been made with modifications of the transformer and autotransformer form of apparatus to produce the discharge at a wave period that gives a ray that is similar to the peculiar phototube discharge, but these experiments have not shown this unknown discharge.

The autotransformer method is not satisfactory because of the great difference of potential between the primary and secondary, making them very wide frequency, and causing expensive resistance not as indicated by Kitchin, who used spool winding, the difference of potential between each turn of the secondary is never greater than 120 volts, and the primary is being insulated by a heavy coating of varnish so as to stand at least 500 volts, giving a primary wire coil which rarely breaks down under ordinary abuse. By putting the transformer in a box and insulating it with re-

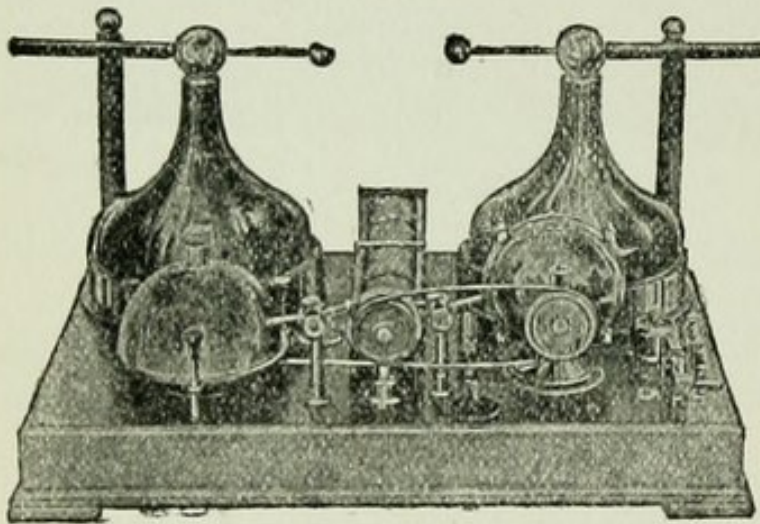
finest hard oil no trouble is experienced by the heaviest kind of usage.



THE LUSCHKA COIL.

The general improvement in the manufacture of insulating material has had a great deal to do with the successful working of the coil, as the primary is insulated from the secondary by a tube made from pressed mica and shellac, making a break down nearly unknown. The advantage of the coil over the Static machine is due to the peculiar way we derive our current from it. In order to obtain induction in the secondary coil we must send a current through the primary, and interrupt it at frequent intervals, as the current induced in the secondary flows in one direction at *make*, and when the current is *broken* in the primary the induced current in the secondary flows in the opposite direction. (See page 49.)

A description of generating apparatus would not be complete without studying for a few minutes the coil designed by a Boston investigator, T. Benton Kinraide, as it is so unique as to compare favorably with other modern apparatus. The peculiar winding makes the element of self-induction the most prominent factor, and renders secure the insulation. This coil resembles the high frequency coils made by Nickola Tesla in its peculiar effects,



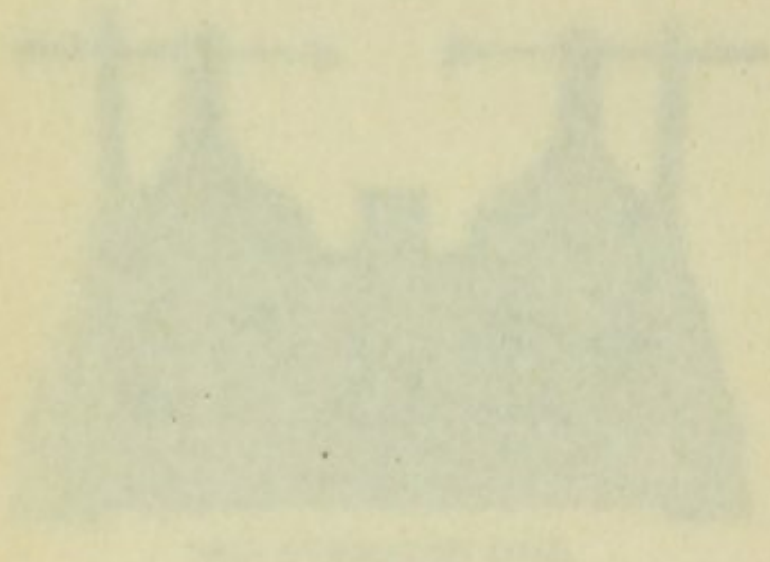
THE KINRAIDE COIL.

inasmuch as the air around the terminals is polarized so strongly that the discharge shows a disposition to go off into space rather than pass through the polarized airspace

to its neighboring pole. Some of the most marvelous graphic delineations of discharge effects may be obtained upon the surface of photographic plates by laying one plate upon either terminal and approaching it by different shape electrodes, and the pictured effect is distinctively different when laid upon each pole. A reproduction of some of these marvelous electrographs may be seen in the *Century Monthly Magazine* of July, 1902, and can be studied with profit. Apparently satisfactory X-Ray work may be obtained with this type of

exposure after its use is thoroughly leveled. Although exposures must be necessarily prolonged due to the dispersive effects of its discharge and its tendency to leave the conducting wires and spread all into space. Considerable induced energy is felt by the patient while undergoing an exposure with this type of coil, and to avoid irritating the skin this must be overcome by interposing a gilt sheet, and grounding by connecting it to a water pipe. The water cooled spark gap is a very desirable feature of this apparatus, inasmuch as arcing is taken away with entirely. Good fluoroscopic quality may be obtained by connecting one terminal of the spark to the tube and grounding the other end. The instrument, as turned out for the market, is a complete piece of apparatus.

A description of generating apparatus would not be complete without studying for a few minutes the work done by a former investigator, T. Brown, who has written a paper as to comparative high frequency apparatus. The peculiarity of the discharge of self-induction apparatus is that the discharge is not uniform, and readers secure the following description of the high frequency discharge of Brown's type as its peculiar effects.



inasmuch as the air around the terminals is polarized so strongly that the discharge shows a disposition to go off into space rather than pass through the polarized air space

around the terminals. Some of the most marvelous and beautiful illustrations of discharge effects may be obtained when the action of photographic apparatus is used. The discharge from either terminal and approaching it by different shape electrodes, and the distance, that is, dielectrically different media, will give different results. A reproduction of some of these beautiful photographs may be seen in the *Electric Magazine* of July, 1902, and the following will give an apparently satisfactory idea of what may be obtained with this type of

apparatus after its use is thoroughly learned, although exposures must be necessarily prolonged, due to the dispersive effects of its discharge and its tendency to leave the conducting wires and travel off into space. Considerable induced spray is felt by the patient while undergoing an exposure from this type of coil, and to avoid irritating the skin this must be overcome by interposing a gilt screen and grounding by connecting it to a water pipe. The water cooled spark gap is a very desirable feature of this apparatus, inasmuch as arcing is done away with entirely. Good fluoroscopic effects may be obtained by connecting one terminal alone to the tube and grounding the other wire. The instrument, as turned out for the market, is a superb piece of apparatus.

CHAPTER XIII.

* X-RAYS IN THE TREATMENT OF CANCER AND OTHER MALIGNANT DISEASES.

Realizing that the reporting of immature results and deductions has been the bane of current medical literature, we have deferred giving for publication our experience with the X-Rays in the treatment of malignant diseases, because we wished to give the remedy the test of time. Since, however, so many articles have appeared lately upon this subject, based upon the reports of a few isolated and indefinitely stated cases with poor histories, we venture, at the risk of being accused of prematurity, to express our opinion upon the therapeutics of the X-Ray.

This is only a preliminary report, but the writer wishes to state that the conclusions herein arrived at are not based upon cases of doubtful diagnosis, for most of them have been post-operative, and therefore the question of diagnosis is not an open one. We have treated, with the X-Ray, during the larger part of the past year, an average of over

* Written expressly for this work by Emil H. Grubbe, B. S., M. D., Professor of Radiography, X-Ray Therapeutics and Electro-Physics Illinois School of Electro-Therapeutics.

hundreds of patients each day, which we believe to be the largest number of daily X-Ray treatments yet reported by any individual. Having had such a large number of cases to study from, and doing general practice work in this line we have of course formed some opinion of the value of this treatment, and although we do not wish to be understood as announcing this as our final opinion, owing to the fact that time may materially change it, we present what we have learned to the profession for what it may be worth.

The use of the X-Ray as a therapeutic agent is not so new as many would suppose; in fact, several X-Ray operators have patients now under their care who have been discharged symptomatically by the X-Ray more than two years ago.

As our first treatment was taken largely on faith, and the value of the X-Ray as a therapeutic agent appears in nearly all the best medical journals, and it came to our attention to report that an agent which has been used for years on the most famous hospitals of the world at once must have some merit. If the results obtained by dozens of different operators in treating hundreds of cases all been equally good, have they all been spontaneous cures? No, they are not. The only logical conclusion which is possible to form is, that there must be great

CHAPTER XIII

THE VALUE IN THE TREATMENT OF CANCER AND OTHER MALIGNANT DISEASES

Having first reported the results of immature results and observations, we have been the basis of current use of the X-ray, we have deferred giving for publication our experience with the A-Rays in the treatment of malignant diseases, because we wished to give the reader the best of time. Since, however, so many articles have appeared lately upon this subject, based upon the reports of a few isolated and not generally stated cases with poor histories, we thought it the best of being accused of premature publication to report our opinion upon the therapeutic value of the X-Ray.

This is only a preliminary report, but the writer believes that the conclusions herein arrived at are not based upon cases of doubtful diagnosis, and that the results have been satisfactory. The value of the X-ray in diagnosis is not as great as it is in therapy, with the X-Ray, being used in the treatment of the tumor, an average of 50 per cent of the cases are cured.

This report is the work of Will H. Thomas, M. D., of the University of California, X-Ray Therapeutic Department, University of California, San Francisco, California.

seventy patients each day, which we believe to be the largest number of daily X-Ray treatments yet reported by any individual. Having had such a large number of cases to study from, and doing pioneer work in this line we have of course formed some opinion of the value of the treatment, and although we do not wish to be understood as announcing this as our final opinion, owing to the fact that time may materially change it, we present what we have learned to the profession for what it may be worth.

The use of the X-Ray as a therapeutic agent is not so new as many would suppose; in fact, several X-Ray operators have patients now under observation who have been discharged symptomatically cured by the X-Ray more than two years ago.

At first the treatment was taken largely on faith; but now, facts illustrating the value of the the X-Ray as a therapeutic agent appear in nearly every issue of most medical journals, and it must be familiar to everyone that an agent which can demand the attention of so many minds from all parts of the world at once must have some merit. Have the results obtained by dozens of different writers in treating hundreds of cases all been exceptional? Have they all been spontaneous cures? Certainly not. The only logical conclusion which it is possible to form is, that there must be great

value in the use of the X-Ray for therapeutic purposes.

As a remedy for lupus this treatment has successfully passed through the crucial test of practical experience. None who have experience will gainsay that. Since it is a fact conceded by everybody who has investigated the subject, that tropic changes — such as dermatitis, exfoliation of the skin — falling off of the hair and nails result from exposure to X-Rays, and since it is also a fact that lupus and epithelioma are cured, clinically at least, by the X-Rays, why may not this agent be of value in the more malignant or deeper seated affections?

Aside from the speculative part of the value of the X-Ray, it certainly is perfectly logical from every standpoint to suppose that if we admit tuberculosis of the skin curable, which we must from statistics at hand, that tuberculosis of the lungs or the bones, and other forms of this disease must be amenable to this treatment, for tubercular conditions are similar in whatever part of the body they may be found. Again, if we admit that epitheliomas are curable by the X-Ray — and no one in the present light of things can doubt that — we can also suppose that cancer in any other part of the body is amenable to this treatment. First, because cancer tissue is primarily the same in whatever part of the body it may be found, being composed of epithelial cells; and second, because of the ability of the X-Ray to penetrate tissue — there

is no part of the body which is beyond its reach.

Many theories have been advanced as to the action of the X-Rays in the various conditions for which it has been used. By some the belief is held that restitution of the tissues takes place under X-Ray treatment; that is, cancer tissue becomes transformed, or is developed into normal tissue. Others, taking for granted that the parasitic or bacterial theories of the origin of some of the diseases treated by the X-Ray have been conclusively proven, believe that the X-Ray, due to its aseptic action, destroys these conditions. These theories seem rather far-fetched, however; for, aside from the lack of proof of the parasitic or bacterial origin of the diseases referred to, it does not seem probable, from observations which have been made by various investigators, that the success of the X-Ray treatment in these diseases is exclusively due to aseptic action, but power which it may possess.

Personally, we believe the action of the X-Ray to be similar to all the diseases in which it has been employed with good effect, and that that action is most readily explained when viewed from the standpoint of the theory of phagocytosis, followed by regeneration.

First, it must be admitted that, aside from whatever chemical or electric property the X-Ray may possess, the sum total of its action is that of an irritant. Now, if we irritate a certain part of the body by making frequent X-Ray exposures we pro-

value is the use of the X-Ray for therapeutic purposes.

As a remedy for burns, this treatment has successfully passed through the crucial test of practical experiments. Those who have experience will testify that there is a fact conceded by everybody who has investigated the subject, that tropic ulcers—such as dermatitis, exfoliation of the skin—falling off of the hair and nails result from exposure to X-Rays, and since it is also a fact that lupus and carcinoma are cured, clinically at least, by the X-Rays, why may not this agent be of value in the more malignant deeper seated affections?

Apart from the speculative part of the value of the X-Ray, it certainly is perfectly logical from every standpoint to expect that if we admit tuberculosis of the skin possible, which we must from analogy at least, that tuberculosis of the lungs or the bones and other tissues of this disease must be curable by this treatment, for tubercular coagulations are curable in whatever part of the body they may be found. Again, if we admit that epitheliomas are curable by the X-Ray—and no one in the scientific light of things can doubt that—we can also suppose that cancer in any other part of the body is amenable to this treatment. First, because cancer tissue is primarily the same in whatever part of the body it may be found, being composed of epithelial cells; and second, because of the ability of the X-Ray to penetrate tissue—there

is no part of the body which is beyond its reach.

Many theories have been advanced as to the action of the X-Rays in the various conditions for which it has been used. By some the belief is held that restitution of the tissues takes place under X-Ray treatment; that is, cancer tissue becomes transformed, or is developed into normal tissue. Others, taking for granted that the parasitic or bacterial theories of the origin of some of the diseases treated by the X-Ray have been conclusively proven, believe that the X-Ray, due to its actinic action, destroys these conditions. These theories seem rather far-fetched, however; for, aside from the lack of proof of the parasitic or bacterial origin of the diseases referred to, it does not seem probable, from observations which have been made by various investigators, that the success of the X-Ray treatment in these diseases is exclusively due to any bactericidal power which it may possess.

Personally, we believe the action of the X-Ray is the same in all the diseases in which it has been found of value, and also that that action is most plausibly explained when viewed from the standpoint of the theory of phagocytosis, followed by leucocytolysis.

First, it must be admitted that, aside from whatever chemical or electric property the X-Ray may possess, the sum total of its action is that of an irritant. Now, if we irritate a certain part of the body by making frequent X-Ray exposures we pro-

duce ultimately a simple local inflammation. Inflammation means the determination of much blood to the part, hypermia, due to the increased volume of blood. Leucocytes accumulate in large quantities, and finally stasis occurs, the circulation being cut off, the part dies for want of nourishment. When no suitable nutritional material is at hand there is developed a tendency towards degeneration. No doubt this degeneration is partly at least due to an accumulation of the products of the metabolism of cells.

Primarily, then, the X-Ray affects the essential tissue-forming elements of the body. The parts which are walled off decompose chemically, and are either discharged or absorbed. The rapid decrease in the size of some growths under X-Ray treatment also points to a more general or systemic action, probably due to stimulation of the lymphatics.

The fact that nearly every case — no matter how severe — treated by the X-Ray seems to improve at the beginning of the treatment, shows that it exerts an influence which is not only local but also systemic. From our personal observations upon several hundred patients we come to the conclusion that the nutrition of the entire system is affected through reflex action, probably, and this produces a general stimulating and tonic effect. As to the special characteristics of the X-Ray in different conditions our experience teaches that the

condition of all patients is increased. It is surprising how long life may be maintained in some cases, as for instance pain is found in the majority of cases, although if a neuritis is coincident with cancer, especially in breast cases, very little can be done by the relief of the pain.

Particular conditions, especially lupus vulgaris, may now more favorably affected by the X-Ray. In the case of the agent the following is the manner in which we should classify the diseases for which the X-Ray treatment has been given, and the points in which we should expect results, relative to lupus, epithelioma nodular returns post-operative, primary brain cases, tuberculosis of the soft parts of the bones, cancers of soft parts of the head, sarcomas, osteosarcomas.

In the following classification we do not wish to imply the assumption that all the above-named conditions have definitely been cured by X-Ray treatment. However, the effect we are not yet at all sure. We are not ignorant, though we have that all diseases can be permanently cured or cured at least by any other known method of treatment, we do believe that the X-Ray has established a new field in the therapeutics of lupus and epithelioma. Not only that but the future will see a wider application in the treatment of patients immediately after operation to prevent the possibility of recurrences.

Without in any way wishing to depreciate the

does not constitute a simple local inflammation. Inflammation means the determination of much blood to the part, hyperemia, due to the increased volume of blood. Cancerous degeneration is large quantities of cellular material, the circulation being cut off, the part is left to rot. When an excessive amount of material is at hand there is a tendency to cellular degeneration. No doubt the hyperemia is partly at least due to an accumulation of the products of the metabolism of the part.

There is also the X-Ray affects the essential constituents of the body. The parts about the part of the body chemically, and the parts are changed or absorbed. The rapid growth of the part under X-Ray treatment is due to a more general or systemic effect, probably due to stimulation of the system.

It is also true that nearly every case—no matter how severe—treated by the X-Ray seems to improve. The improvement of the treatment, shows that the X-Ray is a factor which is not only local but systemic. From our personal observations of patients treated with X-rays we come to the conclusion that the stimulation of the entire system is a direct average result, probably, and this produces a general stimulating and tonic effect. As to the local characteristics of the X-Ray in various conditions our experience teaches that the

vitality of all patients is increased. It is surprising how long life may be maintained in some cases. Relief from pain is found in the majority of cases, although if a neuritis is coexistent with cancer, especially in breast cases, very little can be done for the relief of the pain.

Tubercular conditions, especially lupus vulgaris, have been most favorably affected by the X-Ray. In our own use of this agent the following is the order in which we should classify the diseases for which the X-Ray treatment has been given, and the order in which we should expect results, relatively: Lupus, epithelioma, nodular returns (post-operative), primary breast cases, tuberculosis of the lungs, tuberculosis of the bones, cancers of soft internal organs, sarcomas, osteo-sarcomas.

In making this classification we do not wish to impart the knowledge that all the above-named conditions have positively been cured by X-Ray treatment. Statistics to that effect are not yet at hand. We are not optimistic enough to assert that all cancers can be permanently arrested or cured by this or any other known method of treatment, but we do believe that the X-Ray has established for itself a field in the therapeutics of lupus and epithelioma. Not only that, but the future will see its greatest application in the treatment of patients immediately after operation to prevent the possibility of recurrences.

Without in any way wishing to depreciate the

splendid work of surgery, we must say that recurrences are only too numerous. It is a well known fact that in only a small percentage of the cases of cancer operated upon does the growth fail to return. Concerning the status of the value of the surgical treatment of carcinoma, we quote from an editorial of the *Medical Record* of April 5, 1902, where Dr. George T. Shrady says: "We know our limitations in the radical surgery of carcinomatous diseases, and we recognize the fact that our best efforts do not cure, but only in a small proportion of cases annihilate the neoplasm."

It is not recommended that the X-Ray take the place of the knife in primary or operable malignant growths, but the results so far obtained by X-Ray treatment following operation are certainly sufficient to warrant the careful consideration of the profession. In general, the results of X-Ray treatment speak for themselves, and it is unnecessary to present here any argument concerning the practicability of the use of this agent. Enough has already appeared upon this in medical literature.

It may be well, however, to point out that the whole matter resolves itself into the question of a proper understanding of X-Ray phenomenon. It is the correct use of this agent for special conditions with ability to vary its power when necessary that is essential for obtaining proper results, and not its use in the haphazard manner which is so common to-day, when, through ignorance of its

of the X-Ray, which is hailed as a triumph by the physician in his struggle against tubercular and cancerous conditions, it becomes a dangerous force in the hands of the incompetent operator. We must not forget that we have a great variety of X-Rays to deal with; in fact, to use a comparison, the variation in quantity and quality of X-Rays obtainable with one piece of apparatus is much greater than all the varieties and qualities of tones which may be produced upon the keyboard of a piano. Hence, different tissues demand different degrees of X-Ray value.

When we understand these facts we can readily see why the treatment of an epithelioma must be different from the treatment of carcinoma or lupus vulgaris. It is also probably accounts for much of the "dermatitis" which exists to-day in connection with the use of the X-Ray.

The "dermatitis" produced by the so-called X-Ray "burns" is a very common occurrence of the skin, and is due to the production of a "dermatitis." It is the result of an excessive absorption of the X-Ray rays, but as X-Ray "burns" need never be considered serious. This statement is the essence of the many bold announcements which have appeared concerning the "dangers of exposure under X-Ray exposures." Relatively the inflammatory reaction, or dermatitis produced by the X-Ray is harmless, and, in most cases, if the

of the work of surgery, we must say that recurrence is not only too numerous. It is a well known fact that in many a small percentage of the cases of carcinoma of the breast the growth fails to return. However, the prognosis of the value of the surgical treatment of carcinoma, we quote from an editorial in the *British Medical Journal* of April 4, 1914, where Dr. Campbell says: "The value of X-rays for limitations of the growth of carcinoma of the breast is not to be estimated by the number of cases which have been cured by a small proportion of cases treated by this method."

It is not to be understood that the X-Ray take the place of the knife in the treatment of operable malignancies. The results obtained by the use of X-rays in the treatment of carcinoma are certainly most encouraging, but the consideration of the value of X-rays in general, the results of X-Ray treatment of carcinoma, and it is unnecessary to discuss the value of any argument concerning the value of X-rays in the treatment of carcinoma. Enough has been said in this regard in the literature.

It may be well, however, to point out that the value of X-rays is not to be determined by the question of a proper understanding of X-Ray phenomenon. It is the correct use of this agent for special indications, which ability to vary its power when necessary that is essential for obtaining proper results, and not the use in the haphazard manner which is so common to-day when, through ignorance of its

virtues, the X-Ray, which is hailed as a triumph by the physician in his struggle against tubercular and cancerous conditions, it becomes a dangerous force in the hands of the incompetent operator. We must not forget that we have a great variety of X-Rays to deal with ; in fact, to use a comparison, the variation in quantity and quality of X-Rays obtainable with one piece of apparatus is much greater than all the varieties and qualities of tones which may be produced upon the keyboard of a piano. Again, different tissues demand different degrees of X-Ray value.

When we understand these facts we can readily see why the treatment of an epithelioma must be different from the treatment of carcinoma or lupus. Ignorance of these facts probably account for much of the difference of opinion which exists to-day regarding the therapeutic value of the X-Ray.

A few words concerning the so-called X-Ray "burns." The continued administration of the X-Ray in any one locality produces, due to its irritating influence, at first a dermatitis. If the treatments are unduly continued ulceration of the tissues may occur, but an X-Ray "burn" need never be considered serious. This statement is made because of the many bold announcements which have appeared concerning the "dangers of burning under X-Ray exposures." Relatively, the inflammatory reaction, or dermatitis, produced by the X-Ray is harmless, and, in most cases, if the

parts were not meddled with by the application of strong chemicals, especially carbolic acid, in some form or other (which, of itself, may cause gangrene), nature would assert her power and make repairs. We believe we have "burned" every patient treated, and several of them have been "burned" repeatedly. Concerning the development of the dermatitis we find that susceptibility varies considerably. Certain individuals develop a decided reaction after the first treatment, whereas others resist the action of the rays to such a degree that it is only after from one to two months of daily treatment that we are able to develop a reaction. In one case daily treatments were given for over two years, and although the tube has been placed very near the body nothing more than a slight redness has developed. It is evident from this that an idiosyncrasy must exist.

To prevent the action of the rays upon surrounding tissues a special lead-foil mask is used which resists the passage of rays to healthy parts. Another precaution might be recommended in order that the "burning" stage may be retarded—it is the application of plain vaseline to the parts exposed directly to the rays. This substance retards the superficial irritation very much, and is especially useful when treating the deeper tissues, and where there is no open ulcer. In all open or broken down conditions a dermatitis should be rapidly produced.

In conclusion, we wish to submit the following deductions:

1. The X-Ray is the most remarkable therapeutic agent of the last decade.

2. In properly selected cases of so-called "incurable conditions" the X-Ray has brought about remarkable results.

3. Relief from pain is one of the most prominent features of the treatment.

4. Retrogressive changes are noticed in all primary cancer or tubercular growths.

5. The X-Ray has a pronounced effect upon several cancers.

6. The greatest value of the X-Ray is obtained in treating post-operative cases to prevent recurrence.

7. The proportion of clinical cures obtained by this treatment is greater than that obtainable by any other method of treatment.

8. We are positively justified in assuming an efficiency of 50% for X-Rays.

9. The peculiarities of each case must be studied in order to get the best results—i. e., no strict rules for treatment can be laid down.

10. Dermatitis, if properly produced, is within certain limits, a desirable feature of X-Ray treatment.

11. Since the vacuum of an ordinary X-Ray tube changes constantly such tubes are useless for Radio-Therapeutic work, and only tubes which

parts were not maddled with by the application of strong chemicals, especially carbolic acid, in some form or other (which, of itself, may cause gangrene), nature would exert her power and make repairs. We believe we have "burned" every patient treated, but several of them have been "burned" repeatedly. Concerning the development of the dermatitis which the rays produce, its susceptibility varies considerably; certain individuals develop a decided reaction after the first treatment, whereas others resist the action of the rays to such a degree that it is only after three or four or five months of daily treatment that they are able to develop a reaction. In one case daily treatments were given for over two years, and although the tube has been placed very near the body during these years there is a slight redness has developed. It is evident from this that an idiosyncrasy exists.

To prevent the action of the rays upon surrounding tissues a special lead-foil mask is used which prevents the passage of rays to healthy parts. Another precaution might be recommended in order that the rays may be retarded—it is the application of glass vasoline to the parts exposed directly to the rays. This substance retards the absorption of rays very much, and is especially useful when treating the deeper tissues, and where there is no open ulcer. In all open or broken down conditions a dermatitis should be rapidly produced.

In conclusion, we wish to submit the following deductions:

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4. Retrogressive changes are noticed in all primary cancer or tubercular growths.

5. The X-Ray has a pronounced effect upon internal cancers.

6. The greatest value of the X-Ray is obtained in treating post-operative cases to prevent recurrence.

7. The proportion of clinical cures obtained by this treatment is greater than that obtainable by any other method of treatment.

8. We are positively justified in assuming an idiosyncrasy to X-Rays.

9. The peculiarities of each case must be studied in order to get the best results—i. e., no strict rules for treatment can be laid down.

10. Dermatitis, if properly produced, is within certain limits, a desirable feature of X-Ray treatment.

11. Since the vacuum of an ordinary X-Ray tube changes constantly such tubes are useless for Radio-Therapeutic work, and only tubes which

allow of perfect control of vacuum should be used.

12. The X-Ray has a selective influence upon cells of the body. Abnormal cells are affected more readily than the normal.

13. Hemorrhages and discharges are decidedly lessened and ultimately cease in the majority of cases.

14. Even in the hopeless, inoperable cases the X-Ray prolongs life, makes the patient comfortable and the last hours free from pain.

The use of the X-Ray is, without doubt, a highly valuable addition to the therapeutics of malignant diseases, and cannot demand too much attention from the progressive physician.

Whatever may be its real action in these diseases the results obtained certainly have been astonishing, and while it would be premature to claim that malignant diseases can positively be cured, the future may prove that the most radical claims are not impossible of realization.

CHAPTER XIV.

CONSTIPATION.*

Could we name all the diseases that result from constipation we would cover a large percentage of the ills to which flesh is heir.

Proper elimination is the chief factor in maintaining good health, and the principal eliminating organs are the intestines, kidneys and skin, named in the order of their importance. The entire digestive tract, some twenty-five feet in length, suffers if there is insufficient excretion from the intestines, the degree of suffering depending upon the cause of the trouble. But the failure to eliminate reacts upon the entire system.

Nature seeks to establish an equilibrium. The result is that the kidneys and skin are overtaxed. The lungs, attempting to do the work they were never intended to perform, are irritated in consequence, and tuberculosis results. Not uncommonly is this the indirect cause of Bright's Disease.

The skin, not unwilling to share its part of the burden, attempts to eliminate toxic substances intended for other channels, which are frequently the

*Written expressly for this work by May Cushman Rice, M. D., Professor of Electrolysis and General Clinician Illinois School of Electro-Therapeutics.

effect of perfect control of vacuum should be kept in mind.

12. The X-Ray has a selective histological effect on the body. Abnormal cells are destroyed more readily than the normal.

13. Stenoses and discharges are relieved by the X-ray. Abnormality ceases in the process.

14. The X-ray is a powerful agent in the treatment of the

various forms of cancer. The X-ray is a powerful

agent in the treatment of the various forms of cancer.

15. The X-ray is a powerful agent in the treatment of the

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agent in the treatment of the various forms of cancer.

16. The X-ray is a powerful agent in the treatment of the

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Nature seeks to establish an equilibrium. The result is that the kidneys and skin are overtaxed. The former, attempting to do the work they were never intended to perform, are irritated in consequence, and inflammation results. Not uncommonly is this the indirect cause of Brights disease.

The skin, not unwilling to share its part of the burden, attempts to eliminate toxic substances intended for other channels, which are frequently the

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cause of acne, urticaria and like lesions, and so it becomes apparent that, in spite of all efforts of kidneys and skin, the great mass of toxic substances, generated in the alimentary canal, are absorbed by the general system.

The nervous system also suffers from the poison, and headaches and neurasthenia result.

The circulatory system is impaired, and the blood, loaded with toxic material, deteriorates, evidenced by a decrease in the number of red blood corpuscles.

As direct results of improper evacuation of the intestines a catarrh of the mucous lining of both stomach and bowels is induced, the tongue is coated, the appetite lost, and, either through the taking of an insufficient quantity of food or failure of assimilation, nutrition is impaired.

Mechanical obstructions, ulceration and hæmorrhoids are also of frequent occurrence. In fact, we might go on indefinitely enumerating the evil consequences of constipation.

To cure a case of constipation is to restore to good health in a large percentage of cases. It is as important to the patient, and should be as great a credit to the physician as is a successful operation for appendicitis to the surgeon.

To prescribe laxatives for habitual use is to temporarily relieve only, and to permanently increase the difficulty; but in electricity we have a

cause of acne, urticaria and like lesions, and so it becomes apparent that, in spite of all efforts of kidneys and skin, the great mass of toxic substances generated in the alimentary canal, are absorbed by the general system.

The nervous system also suffers from the poison, and the tachycardia and neurasthenia result.

The circulatory system is impaired, and the blood, loaded with toxic material, deteriorates, evidenced by a decrease in the number of red blood corpuscles.

The patient complains of the upper irritation of the mouth, and of the anxious feeling of both the stomach and the tongue is coated, and the patient may suffer through the taking of food, the appearance of a bad or failure of assimilation, and the result is a failure.

The patient, who exhibits irritation and hemorrhage, may be treated by the use of the evil condition of the system.

The primary aim of treatment is to restore to normal the percentage of casts. It is necessary to do this, and should be as great a success as possible as a successful operation is to be performed on the tongue.

The primary aim for habitual use is to establish a permanent cure, and to permanently increase the efficiency; but in electricity we have a

therapeutic agent for the permanent relief of this ailment that cannot be overestimated.

A common factor in the cause of constipation is *relaxation of the abdominal muscles*, the production of which is due to neglect, sedentary habits and corsets. All that is necessary to relieve this condition is to impart a better tone to these muscles by the use of a galvanic current, interrupted about 100 times per minute. Two small hand sponges, thoroughly wet and soaped, are held about three inches apart and passed over the abdominal wall in the direction of the colon. A current strength of from 15 to 20 ma., which is sufficient to produce strong muscular contractions over motor points, is maintained for five minutes. The positive sponge is now placed *stabile* over the liver, and the negative used *labile* as before for 2½ minutes; then, for the same length of time, place the positive over the sigmoid flexure, the negative *labile* as before.

The entire treatment occupies ten minutes and should be given daily until there is a decided improvement. This will vary from three to ten days, according to the case. The treatments are then given three or four times a week for two or three weeks.

As a rule no evacuation follows the treatment, but one takes place the next day. The use of faradism, while much lauded by some writers, has not

proved as successful in the hands of the writer as the above technique.

The electro-static-wave current or surging, on the other hand, is even more universally beneficial than the interrupted galvanic. This is given in the same manner as any other surging. (See page 59.) The patient, sitting upon the side of the chair upon the insulated platform, inserts a rectal electrode with a metallic surface, and so made that the metal is grasped by the sphincter, and is not allowed to pass higher up. The jars are on, switch on spark, negative pole grounded. The prime conductors, together at first, are gradually separated until there is a spark gap of at least six or eight inches.

This treatment is painless. It produces a powerful massage, which affects the entire alimentary canal. This is given for twenty minutes daily, until there is an improvement, then every other day.

In some cases evacuation occurs the following day; in others two, three or more treatments are necessary before obtaining a result.

It is essential that all laxatives be discontinued at the beginning of treatment. Every effort is made to assist by proper diet and attention to the calls of nature. *Water* is prescribed to be taken systematically, two glasses four times a day; the first thing in the morning, midway between the meals and at bedtime, gradually increasing this, if possible, to four glasses four times a day. Many patients are very reluctant to take even a moderate

quantity of water. This, we believe, partly responsible for this trouble. However, some who have occasionally tried the drinking of water without the medicine have been obliged to continue taking medicine. In very obstinate cases, especially if the patient suffers from headache and discomfort, if the bowels do not move for two or three days, an enema may be allowed, but in the majority of cases neither laxatives nor enemias are advisable.

One case was cured in three treatments, another in seven, another in ten, one in twelve, and others required from three to six weeks. Six weeks is sufficient for the most obstinate cases. The above list of patients who could not remember the time when they were not dependent upon laxatives.

After a cure is effected an occasional treatment is sometimes necessary, possibly once in a month or two, especially if the patient gets careless about his diet, habits, etc.

A loss of sensibility of the nerves of the rectum is another common cause of constipation. This is generally due to neglect. The mucous membrane becomes relaxed, and the feces are retained. The remedy is the same as for the above, and is given in the same manner.

If the constipation is caused by a lowered secretion of the glands of the intestines, as is frequently the case from errors in diet, not eating a sufficient amount of coarse food, the habitual use of glycerine suppositories and enemias, the negative pole of the galvanic current is chosen. A metal electrode

proved as successful in the hands of the writer as the above technique.

The electro-static current or surging, on the other hand, is even more universally beneficial than the interrupted galvanic. This is given in the same manner as any other surging. (See page 53.) The patient sitting upon the side of the chair upon the rubber platform, insert a rectal electrode into the rectum as far as possible so that the metal is in contact with the mucous membrane and is not allowed to bow out or to irritate. The patient on switch on spark, and the current is given. The prime conductors, positive and negative, are gradually separated until there is a distance of at least six or eight inches.

This treatment is given. It produces a powerful stimulation which affects the entire alimentary tract. This is given for twenty minutes daily, and gives more improvement than every other day.

In some cases stimulation occurs the following day. In other cases three or more treatments are necessary before obtaining a result.

It is essential that the treatment be discontinued as soon as the patient is able to walk. Every effort is made to avoid any undue strain and attention to the state of the bowels. Water is prescribed to be taken abundantly, one glass four times a day; the first glass is the evening, midway between the usual and at bedtime, gradually increasing this, if possible, to four glasses four times a day. Many patients are very reluctant to take even a moderate

amount of water. This, we believe, partly responsible for this trouble. However, some who have persistently tried the drinking of water without the treatment have been obliged to continue taking laxatives. In very obstinate cases, especially if the patient suffers from headache and discomfort, if the bowels do not move for two or three days, an enema may be allowed, but in the majority of cases neither laxatives nor enemas are advisable.

One case was cured in three treatments, another in seven, another in ten, one in twelve, and others were cured in from three to six weeks. Six weeks is sufficient for the most obstinate cases. The above were all patients who could not remember the time when they were not dependent upon laxatives.

After a cure is effected an occasional treatment is sometimes necessary, possibly once in a month or two, especially if the patient gets careless about his diet, habits, etc.

A loss of sensibility of the nerves of the rectum is another common cause of constipation. This is generally due to neglect. The mucous membrane becomes tolerant, and the faeces are retained. The *surging* is as useful for this as for the above, and is given in the same manner.

If the constipation is caused by a lessened secretion of the glands of the intestine, as is frequently the case from errors in diet, not eating a sufficient amount of coarse food, the habitual use of glycerine suppositories and enemas, the negative pole of the galvanic current is chosen. A metal electrode

is carefully covered with chamois skin or a glove finger, then thoroughly wet and inserted into the rectum. Ten ma. for ten minutes is sufficient, and is about as much as can be used with safety. The same general rules should be observed as with the other kinds of treatment given.

Still a fourth cause of constipation may be classed under the heading of "Irritable States of the Rectum"—for example, haemorrhoids, fissures and ulcers. These may all be cured by copper electrolysis, using a copper rectal electrode (No. 53), covered as before, and thoroughly wet, is placed in contact with haemorrhoidal fissure or ulcer, as the case may be, and connected with the positive pole of the galvanic current. From five to ten ma. is used according to the degree of sensitiveness of the part. A favorite method is to dip the covered electrode in a 4% cocaine solution. The cocaine and copper, both being electro positive, are carried into the tissue simultaneously, anaesthesia is quite complete. The copper, being both germicidal and astringent, effects a cure. The irritation which follows and which varies with the condition of the patient, is best relieved by hot applications. Slight haemorrhoids, which cause trouble only occasionally, are relieved by the surging, but the severer cases require the copper electrolysis.

Physicians would do well to pay attention to these scientific and reliable methods of relief by electrical treatment instead of resorting to the easy, unscientific and harmful administration of laxatives.

CHAPTER XV.

EXTERNAL TREATMENT OF THE PROSTATIC URETHRA.

There is probably no class of disease so serious and so difficult to treat owing to its localization, as affections of the prostate. On account of the lesion and anatomical structure of the organ, its sensitiveness and delicate functions, the various means all combine to render any operation on these parts extremely difficult. It seems hardly likely if the prostate was undergoing so rapid a change in the course of the disease that the glands of the prostate would be so rapidly destroyed. The writer does not believe that any of the various means of treatment will be of any service in the early stages of the disease, but that the only chance of cure is to be found in the removal of the prostate gland. The writer has seen many cases of prostatic hypertrophy, in which the prostate gland was so enlarged that it could not be removed by any of the various means of treatment, and in which the patient was obliged to resort to the operation of prostatectomy.

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The scope of this paper will have to do with

is carefully covered with chamois skin or a glove finger, then thoroughly wet and inserted into the rectum. Ten ma. for ten minutes is sufficient, and is about as much as can be used with safety. The same general rules should be observed as with the other kinds of treatment given.

Still a third cause of constipation may be traced under the heading of "Irritable States of the Rectum,"—for example, hemorrhoids, fissures and ulcers. All of these are well cured by copper electrolysis, using a copper metal electrode (No. 55), wrapped in chamois, and thoroughly wet, is placed in the rectum over hemorrhoidal fissure or ulcer, as the case may be, and connected with the positive pole of an electrical current. From five to ten ma. is appropriate, according to the degree of sensitiveness of the patient. A simple method is to dip the covered electrode in a 2 per cent. cocaine solution. The cocaine, however, and other drugs of this kind, are carried into the tissue immediately, and anesthesia is quite complete. The copper, being both germicidal and caustic, is also very sure. The irritation which follows and which varies with the condition of the patient, is best relieved by hot applications. Slight hemorrhoids, with much trouble only occasionally, are relieved by the surgery, but the severer cases require the copper electrolysis.

Physicians would do well to pay attention to these scientific and reliable methods of relief by electrical treatment instead of resorting to the easy, unscientific and harmful administration of laxatives.

CHAPTER XV.

ELECTRICAL TREATMENT OF THE PROSTATIC URETHRA.

There is probably no class of disease so serious in its nature and so difficult to treat owing to its many complications, as affections of the prostate. The site of the lesion and anatomical structure of the urethra, the sensitiveness and delicate functions of adjacent tissue all combine to render any operation on these parts extremely difficult. It seems that the Lord in His goodness was endeavoring to equalize the suffering of the sexes when He made women without a prostate. The writer does not deem it advisable at this time to discuss either the etiology or pathology of the various phases of prostatic disease mentioned in this article, because there is no lesion in which the pathology is better known than in the affection above noted.

The reporting of immature results and deductions has always been the bane of current medical literature and the most that has been said regarding the disease in question is probably no exception to the above statement, because the promises of cure or relief from most of the methods in vogue have not been fulfilled.

As the scope of this paper will have to do with

prostatic hypertrophy as well as the irritable condition preceding it, the writer believes it would be well at this point to state his views regarding the pathology of the former disease, because they differ somewhat from those laid down in the text-books upon this subject.

The term *hypertrophy* used in this connection is rather a misnomer. True hypertrophy is only an enlargement of the normal cells composing the gland, but in the case in question, however, we have not a true hypertrophy, but rather an accumulation of tissue due to an inflammatory process, which comes up between the glandular elements and by pressure *reduces* them in size. The more proper term then would be *enlargement* of the prostate.

If, as has been stated by other writers, this were a true hypertrophy, then any means tending to actually destroy tissue would be irrational because such procedure would not decrease the size of the glandular elements but destroy them. The prostate gland is a sexual organ and the effect of any interference with its function is apparent to only a casual observer.

The actual cautery as employed by my friend, Dr. Robert Newman, of New York, seems irrational, because, contrary to the statement of the doctor, the writer believes it impossible to sear any mucous surface with a red hot instrument without producing the worst kind of cicatricial tissue. This tissue not only impairs the function of the prostate by interference

with the secretion of prostatic fluid, but more often causes serious sexual disturbances by partially or wholly occluding the mouths of the ejaculatory ducts.

Dr. Wm. Newman says, the galvano-cautery does not necessarily burn or destroy and is not followed by granular tissue, then the writer believes that the operation is not different than an application to the negative pole of a galvanic battery, *with the same galvano-caustic* should have been used in the place of *galvano-cautery*.

It is hardly necessary to go into detail with respect to Minini's rapid method further than to say that the author of the operation does not even draw a free burn. It does not, however, reduce the size of the gland, but only divides it and the writer does not deny that the patient who is able to void all his urine in a short time after the operation, by this has not only repaired the treatment of the gland itself, but is eventually benefited in a much greater than simple enlargement of the prostate. The operation is not dangerous, and was performed at the New-Orleans Hospital during the year 1870-1871. Of the patients who were operated upon by this method, the report for 1871 shows 25 were cured, 25 were permanently improved, and 25 died. Dr. H. H. Young, of Johns-Hopkins is speaking of this method with reference to the cases of death are uremia, shock, cystitis, etc. thought about by the cautery blade having to

prostatic hypertrophy as well as the irritable condition preceding it, the writer believes it would be well at this point to state his views regarding the pathology of the former disease, because they differ somewhat from those laid down in the text-books upon this subject.

The term hypertrophy used in this connection is rather a misnomer. True hypertrophy is only an enlargement of the normal cells composing the gland, but in the case here referred to, we have not true hypertrophy, but rather an accumulation of cells due to an inflammatory process, which causes the gland to be generally enlarged and by *displacement* of the normal cells. The more proper term, therefore, for enlargement of the prostate, is *inflammation*.

Among the views held by other writers, this writer is decidedly opposed to any means tending to enlarge the prostate, even when it is rational because such a procedure would not diminish the size of the gland, but would only displace it. The prostate gland is a gland of the ductless type and the effect of any large amount of its secretion is apparent to only a small extent.

The actual cautery as employed by my friend, Dr. J. L. H. Jones, of New York, seems irrational, because contrary to the statement of the doctor, the cautery is not so impossible to wear any mucous membrane as he has led his instrument without producing the growth of a fibrous tissue. This tissue not only impairs the function of the prostate by interference

with the excretion of prostatic fluid, but more often causes serious sexual disturbance by partially or wholly occluding the mouths of the ejaculatory ducts.

If, as Dr. Newman says, the galvano-cautery does not necessarily burn or destroy and is not followed by cicatricial tissue, then the writer believes that his operation is not different than an application from the negative pole of a galvanic battery, and the word *galvano-caustic* should have been used in the place of *galvano-cautery*.

It seems hardly necessary to go into detail here regarding Botinni's rapid method further than to say that the author of the operation does not deny that it *does* burn. It does not, however, reduce the size of the gland, but only divides it and while the writer does not deny that the patient may be able to pass all his urine in a short time, the scar tissue left by this burn not only impairs the function of the gland itself, but is eventually followed by a worse condition than simple enlargement; besides this, the operation is not dangerless, one case operated on at the Post-Graduate Hospital dying the next day from shock. Of the patients at St. Luke's Hospital that were operated upon by Botinni's rapid method, the report for 1901 shows $33\frac{1}{3}\%$ recovered, $55\ 5-9\%$ temporarily improved and $11\ 19\%$ died. Dr. H. H. Young, of Johns Hopkins, in speaking of this method says that some of the causes of death are uremia shock, sepsis, etc., brought about by the cautery blade burning its

way into the rectum and making the incisions too long, resulting in the rupture of the urethra in front of the prostate, and sometimes fatal hemorrhage from division of perineal vessels.

If the condition *preceding* prostatic hypertrophy were properly treated much of the after trouble would be avoided and the object of this paper is more for the purpose of establishing a more rational treatment for the pathological conditions preceding than the hypertrophy itself. Chronic posterior urethritis, prostatorrhoea, hypersensitiveness of the urethra and prostatic stricture are the more important lesions which eventually lead to so-called prostatic hypertrophy.

To allay any inflammation requires the application of the positive pole of the galvanic current, but whenever a metal electrode attached to this pole is applied to a mucous surface it always sticks firmly, due no doubt to the dehydrating properties of this pole. As it would be inadvisable to make such an application to the prostatic urethra thereby disarranging the delicate mucous membrane, some means must be adopted to overcome this difficulty.

Some years ago the writer devised an electrode which largely overcame the existing difficulties and which was described in an article written at that time.*

This electrode, which will be described later, is

*"The treatment of senile hypertrophy by cataphoric applications of iodine."

is well adapted to the treatment of the condition attending prostatic hypertrophy, because the edges of the holes irritate the mucous membrane. With the assistance of my friend, Dr. Roger J. Godegn, whose mechanical genius is well known, success has been attained in making an electrode well suited to the purpose. It is constructed of a No. 8 copper wire made probe point, leaving a socket for the reception of the plug slip fastened to the proximal end and bent to a slight Van Buren curve. It is then successfully dipped into hot paraffin solution (melting point 122°F) until a coating of about 1-16 inch is deposited upon the metal. Small holes are now drilled in the paraffine coating to the metal for about $2\frac{1}{2}$ inches into the distal end and the edges carefully smoothed out so as to avoid all feeling of roughness.

The measurement formerly used for cataphoric application was made from the suprascapular capsule, but the writer has found that a normal tincture of *Spica (Santal)* is much better—the former being rendered useless by its reactionary behavior.

A diode paste is made of the best gum arabic (100g) in which 10% of the turp is thoroughly mixed. The holes in the paraffined electrode are now filled with the paste and after introduction into the prostatic urethra it is attached by the positive pole of a galvanic current, the negative being connected to a large pad placed upon the abdomen. A current strength of from 6 to 10

may pass too rectum and making the incisions too long resulting in the rupture of the urethra in front of the prostate, and sometimes fatal hemorrhage from division of perineal vessels.

In the treatment preceding prostatic hypertrophy we have already treated much of the after trouble which is caused and the object of this paper is to describe the process of establishing a more rational and efficient method of relieving the conditions present in the prostate. Chronic prostatic hypertrophy, prostaticitis, hypersensitiveness of the prostate, and other conditions are the more common causes of the disease, and usually lead to so-called prostatic hypertrophy.

The first method of treatment requires the application of a constant current of the galvanic current, the electrode is usually attached to the tip of the urethra, and it always sticks to the urethra due to the dehydrating properties of the current. It is would be inadvisable to make the electrode adhere to the urethra thereby destroying the delicate mucous membrane, some other means developed to overcome this difficulty.

Some years ago the writer devised an electrode which not only overcomes the existing difficulties and which is described in an article written at that time.

This electrode, which will be described later, is

* The writer is of course by cathartic application of the same.

not so well adapted to the treatment of the conditions preceding prostatic hypertrophy, because the edges of the holes irritate the mucous membrane. With the assistance of my friend, Dr. Edgar J. George, whose mechanical genius is well known, success has been attained in making an electrode well suited to the purpose. It is constructed of a No. 8 copper wire made probe pointed, having a socket for the reception of the cord tip fastened to the proximal end and bent to a short Van Buren curve. It is then successfully dipped into hot paraffine solution (melting point 138° F.) until a coating of about 1-16 inch is deposited upon the metal. Small holes are now drilled in the paraffine coating to the metal for about 2½ inches from the distal end and the edges carefully reamed out so as to avoid all feeling of roughness.

The medicament formerly used for cataphoric application was made from the suprarenal capsule, but the writer has found that a normal tincture of thuja (Merrell) is much better—the former being unsuited because of its reactionary behavior.

A sterile paste is made of the best gum tragacanth (ribbon) in which 10% of the thuja is intimately mixed. The holes in the paraffined electrode are now filled with the paste and after introduction into the prostatic urethra it is attached to the *positive* pole of a galvanic current, the negative being connected to a large pad placed upon the abdomen. A current strength of from 6 to 10

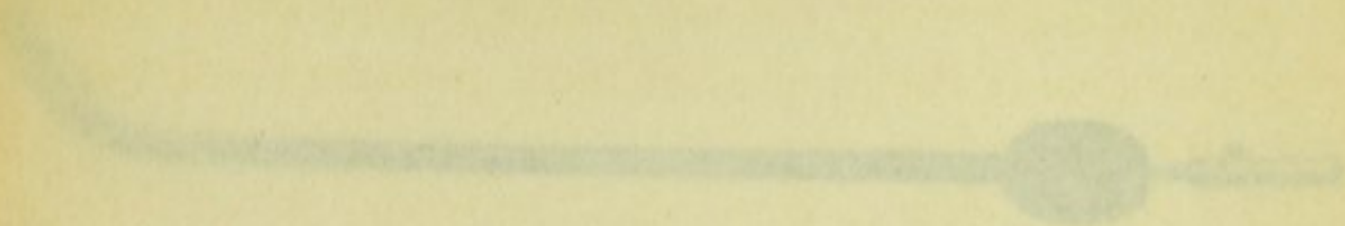
milliamperes may be maintained for about ten minutes and the operation not repeated oftener than once in four days.

After withdrawing the electrode it will be noticed that the paste in the holes has assumed a pale green color, due to a deposition of the salts of copper from the electrode. This salt (the oxychloride) is also deposited by cataphoric action in the mucous lining of the prostatic urethra and, by its strong antiseptic and healing action, accomplishes the desired result.

The majority of the cases of prostatic enlargement that come to the physician for relief are *not ready* for treatment for the reduction of the gland, and any means employed for that purpose only aggravates the trouble—the inflammation whether it be chronic or acute, must first be gotten rid of by the method just described, a marked improvement being noticeable after each treatment.

Patients who have an irritable, granular prostate that bleeds when touched, usually do not require anything more than the above mentioned treatment and will be permanently relieved, because the lesion has not become so chronic as to produce a prostatic enlargement.

We may now consider the treatment of those cases of so-called prostatic hypertrophy where the irritation has subsided and which are ready to treat for the *reduction of the gland*.



The electrode here shown and found by the author and adapted for the purpose, consists of a long rubber tube closed at the distal end by a plug of some substance and bent to a proper arc of curvature. Small holes are now drilled in the tube at a distance of two inches from the distal end. The electrode consists of a twisted copper wire to the proximal end of which is soldered a socket for the purpose of the cord tip.

Charcoal cotton is evenly wound on the apparatus for a distance of about two inches and after being dipped into a solution of potass. iod. (grs. ʒss.) it is replaced in the hard rubber receptacle. The electrode is now introduced into the prostatic urethra attached to the negative pole of a galvanic battery, the positive being placed upon the abdomen and the current gradually turned on until a dose of ten milliamperes is reached, which may be continued for ten minutes.

The purpose of this part of the treatment is to produce the softening, disintegrating and liquefying of the gland on the negative pole and also to deposit the iodine into the solution into the gland.*

*When employing electrically a solution of potass. iod. it must be remembered that the iodine is electro-negative and therefore has an affinity for the positive pole.

temperature may be maintained for about ten minutes and the operation not repeated oftener than once in four days.

After withdrawing the electrode it will be found that the paste in the holes has assumed a brown color due to a denaturation of the salts of copper from the electrode. This salt (the oxychloride) is precipitated by electrolytic action in the neighborhood of the prostatic urethra and, by its caustic, irritant and healing action, accomplishes its purpose.

The various methods of treatment of prostatic enlargement which are in vogue for relief are not being resorted to for the reduction of the gland, but only to relieve the inflammation whether acute or chronic. The first must first be gotten rid of by the means just described, a marked improvement usually follows such treatment.

Small, white, granular prostatic concretions, which usually do not cause any trouble, but the above mentioned condition will be permanently relieved, because the concretions are chronic as to produce a permanent enlargement.

We may now consider the treatment of those cases of so-called prostatic hypertrophy where the prostate has enlarged and which are ready to treat by the reduction of the gland.



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The electrode here shown and found by the writer well adapted for the purpose, consists of a hard rubber tube closed at the distal end by a plug of the same substance and bent to a proper urethral curve. Small holes are now drilled in the tube for a space of two inches from the distal end. The applicator consists of a twisted copper wire to the proximal end of which is soldered a socket for the reception of the cord tip.

Absorbent cotton is evenly wound on the applicator for a distance of about two inches and after being dipped into a solution of potass. iod. (grs. xx to $\frac{3}{4}$ i) is replaced in the hard rubber receptacle. The electrode is now introduced into the prostatic urethra attached to the *negative* pole of a galvanic battery, the positive being placed upon the abdomen and the current gradually turned on until a flow of ten milliamperes is reached, which may be maintained for ten minutes.

The purpose of this part of the treatment is to utilize the softening, disintegrating and liquefying effect of the *negative* pole and also to deposit the iodine from the solution into the gland.*

*In decomposing electrically a solution of potass. iod. it must be noted that the iodine is electro-negative and therefore has an affinity for the *positive* pole.

In treating an enlarged prostate it must be remembered that a loss of tone of the detrusor muscle of the bladder has much to do with aggravating the trouble. The office of this muscle is to raise the posterior portion of the bladder to a level of the prostatic urethra so that *all* the urine may be voided. Now, when the prostate is enlarged the floor of urethra is higher than normal and the detrusor muscle fails to do its work, allowing the back part of the bladder to sag and accumulate residual urine. This, in turn results in ammoniacal decomposition, causing much inconvenience and suffering, so that the measure of success in these cases depends as much on restoring the tone of the detrusor as in treating the enlargement.

To accomplish this, we leave the electrode in place after giving the treatment as outlined above, turn on a slowly interrupted faradic current and continue the treatment for five minutes longer. This massage not only gives tone to the detrusor but stimulates the absorbents to take up the products of decomposition set free by the first part of the operation.

The results obtained from this treatment in several cases were given in a former article on this subject, since which time the writer has treated many cases by the methods described herein, and finds the results in original cases all that could be desired, but the complete failures or those only

partially relieved were cases that had been operated upon either by the cystery or lith.

The cases showing the most marked results are those of simple enlargement of the prostate gland, not complicated with inflammation. One case is noteworthy being that of a man 56 years of age whose prostate was very much enlarged, who had not voided his urine without the aid of a catheter for more than a year. The introduction of the electrodes, however, did not cause the least pain. He was given fifteen treatments with the negative pole and cath. iod., at which time he was able to void his urine voluntarily, leaving a residual amount of about two drams.

Two cases that were previously operated upon were not benefited by the treatment.

In treating an enlarged prostate it must be remembered that a loss of tone of the detrusor muscle of the bladder has much to do with aggravating the trouble. The office of this muscle is to raise the posterior portion of the bladder to a level higher than the urethra so that all the urine may be voided. Now, when the prostate is enlarged the level of the urethra is higher than normal and the detrusor muscle has to do its work, allowing the urine to pass through the enlarged prostate and accumulate in the bladder. This results in anatomical changes, such as hypertrophy of the prostate and thickening of the bladder wall, and in cases of success in these cases the tone of the detrusor muscle is increased by the use of the galvanic current.

The electrodes are placed in the rectum and the current is continued as outlined above. The current should be continued for ten minutes longer than the time required to raise the tone of the detrusor muscle. The current is then continued to take up the products of the treatment, and is done by the first part of the treatment.

The results obtained from the treatment in the cases mentioned in a former article on this subject, and which the writer has treated by the methods described herein, and also in other original cases all that could be said are complete failures or those only

partially relieved were cases that had been operated upon either by the cautery or knife.

The cases showing the most marked results are those of simple enlargement in old men that are not complicated with inflammation. One case to illustrate being that of a man 66 years of age whose prostate was very much enlarged, who had not voided his urine without the aid of a catheter for more than a year. The introduction of the instrument, however, did not cause the least pain. He was given fifteen treatments with the negative pole and potass. iod., at which time he was able to pass his urine voluntarily, leaving a residual amount of about two drams.

Two cases that were previously operated upon were not benefited by the treatment.

CHAPTER XVI.

TREATMENT OF VARICOCELE.

After the extensive experiments of Du Bois Raymond, D'Arsonval, Duchenne and other eminent observers, no one doubts the fact that currents of electricity traverse the body in every direction; that the nerves are the carriers of these currents, etc. If the nerves carry electrical currents they have poles, and consequently, *polar effects*. Where we have a positive nerve ending we have *positive* polar effects—acidity and an underactive condition. Where the nerve ending is negative we have *negative* polar effects—alkalinity and an overactive condition.

Every battery, by overwork, is subject to what we call “polarization”—a reversal of the direction of the current. Is it a very violent supposition to say that, by disobeying some of Nature's laws we have produced this very condition within our bodies and, where it was intended that a *positive* polar effect should be present we have now the very opposite condition?

A correct knowledge of polar effects is the keynote of the application of galvanism because these poles have diametrically opposite effects. There is always indication for the use of one or

the pole, and when the current is reversed the polarity is reversed.

It is important to note that the current must be reversed at intervals of about 10 to 15 minutes.

The current should be applied to the affected area for a period of 15 to 20 minutes.

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CHAPTER XVI.

TREATMENT OF VARICOCELE.

The extensive experiments of Du Bois Reymond, of Astruc, Donders and other eminent physiologists, have shown that currents of electricity directed in every direction through the human body in these circumstances produce the same effects. When we have produced the conditions of the conditions we have seen that the effects are the same in every direction.

It is to be noted that the effects of the electric current are not the same in every direction. It is a very violent supposition to suppose that the effects of Nature's law are the same in every direction. It is to be noted that the effects of the electric current are not the same in every direction. It is a very violent supposition to suppose that the effects of Nature's law are the same in every direction.

A correct knowledge of polar effects is the basis of the application of galvanism because these poles have diametrically opposite effects. There is always indication for the use of one or

the other pole, and when one is indicated, the other will certainly aggravate the trouble.

Negative or disastrous results in the use of electricity can generally be traced to a lack of knowledge of these facts.

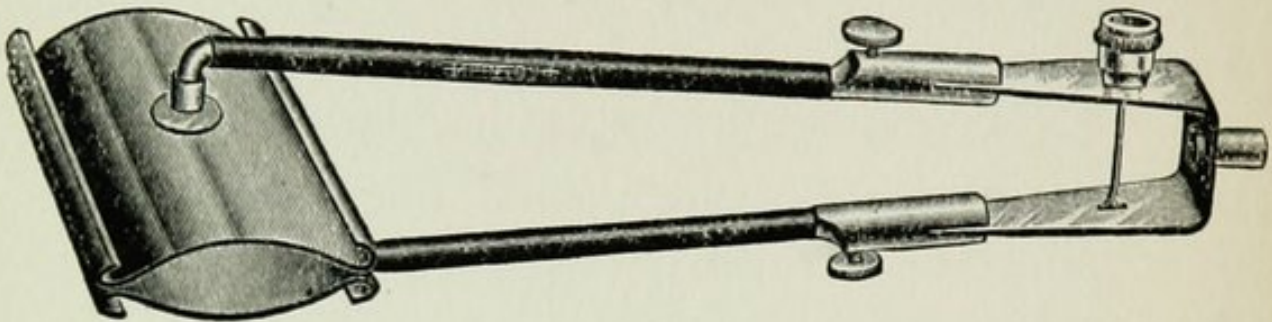
The most definite and known effect of galvanism is its action on the vasomotor nerves. The principal office of these nerves is to supply force to the involuntary muscles, and taking for our illustration of these muscles, the circular bands composing the walls of the arteries and veins, we can readily see how the blood supply and nutrition to certain parts may be influenced by an application of one or the other pole.

The positive pole acts as a powerful vaso-constrictor, lessening the lumen of the vessels and thereby causing a decreased blood supply to the part. On the other hand, the negative pole is just as powerful a vaso-dilator, rendering the walls of the vessels more patulous and increasing their caliber.

In varicocele we have an engorgement of the scrotal blood vessels, because the walls have become patulous from vasomotor disturbance, and cannot contract and expel their engorged contents. In other words, the part is in a negative condition, and it becomes evident that the positive pole must be used for the active one. What has proven a very successful technique is as follows :

The unipolar, divided current electrode de-

signed by the writer for the treatment of varicocele, is shown in the accompanying illustration.



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The proximal end or fork is of spring brass, to which is attached a receptacle for the cord tip. This end has also an adjustable screw, by the aid of which the operator can make firm contact upon any tissue included between the two small plates at the distal ends. These plates, which are semi-cylindrical in shape, and $1\frac{1}{2}$ by $2\frac{1}{2}$ centimeters in size, are made of pure tin in order to withstand the corrosive action of the positive pole. The entire length of electrode is 1.2 decimeters. A piece of absorbent cotton, well wetted, is placed upon each of the metal plates and the electrode applied to the upper part of the scrotum in such a way as to include the mass of enlarged veins between the two plates. The electrode is now attached to the positive pole of a galvanic battery, the negative being a large electrode upon the abdomen or lumbar spine.

The treatments are now given for ten minutes with a current strength of ten milliamperes, and

The applications may be made daily, if the irritation of the skin of the scrotum (which necessarily takes place) will permit.

The pains, which are the most distressing feature, commence to be relieved after the second treatment, and generally cease entirely about the sixth. The veins decrease in size as their proper tone is restored, and unless the case is a very aggravated one, fifteen to twenty sittings suffice to effect a complete cure.

The positive being the active pole used has suggested the idea of placing upon it some medicinal that might be utilized cataphorically to hasten the reduction in the size of the scrotal veins. This has been accomplished by wetting the cotton with Martell's normal solution of iodoj, which being a very powerful vaso-constrictor greatly lessens the time of treatment.

signed by the writer for the treatment of varicocele, is shown in the accompanying illustration.

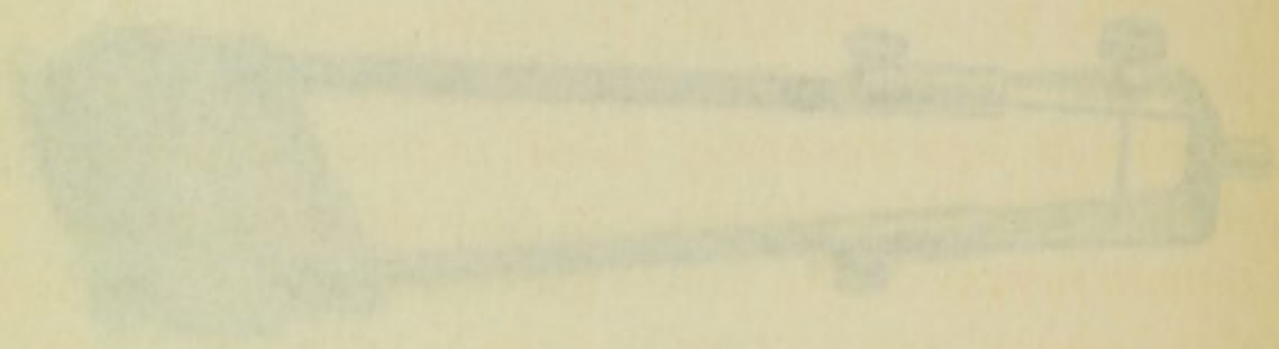


Fig. 1.

The instrument is made of spring brass, and is provided with a receptacle for the cord tip. It is provided with an adjustment screw, by the aid of which the operator can make firm contact upon the veins of the scrotum between the two small plates at the distal ends. These plates which are semi-cylindrical in shape, will be 2 1/2 centimeters in length, and 1/2 centimeter in width in order to withstand the pressure of the positive pole. The entire length of the probe is 12 centimeters. A piece of standard gauze, well soaked, is placed upon each of the metal plates and the electrode applied to the upper part of the scrotum in such a way as to include the spermatic vein between the two plates. The positive wire is attached to the positive pole of a galvanic battery, the negative being a large electrode upon the abdomen or lumbar spine.

The treatment is now given for ten minutes with a current strength of ten milliamperes, and

the applications may be made daily, if the irritation of the skin of the scrotum (which necessarily takes place) will permit.

The pains, which are the most distressing feature, commence to be relieved after the second treatment, and generally cease entirely about the sixth. The veins decrease in size as their proper tone is restored, and unless the case is a very aggravated one, fifteen to twenty sittings suffice to effect a complete cure.

The positive being the active pole used has suggested the idea of placing upon it some medication that might be utilized cataphorically to hasten the reduction in the size of the scrotal veins. This has been accomplished by wetting the cotton with Merrell's normal tincture of thuja, which being a very powerful vaso-constrictor greatly lessens the time of treatment.

CHAPTER XVII.

ELECTRICITY IN OTOLOGY.*

Success in the use of electricity in diseases of the ear, as in diseases of other parts of the body, is dependent upon three things :

1. A knowledge of certain well established facts concerning the therapeutic action of electricity.
2. An understanding of the pathologic condition to be relieved, or the progress of which is to be checked.
3. A knowledge of proper methods of applying electricity to the diseased parts.

The certain well-established facts concerning the therapeutic action of electricity, as applied to the treatment of the diseases under consideration, as already stated in the chapter, entitled "Causes of Polar Effects," are :

1. The galvanic current is capable of producing tropic changes, the character of which depends upon the strength of current used, and whether the positive or negative pole is applied to the diseased parts.
2. The positive pole of the galvanic current is astringent, antiseptic and sedative

[* Written expressly for this work by Albert H. Andrews, M. D., Professor of Otology Illinois School of Electro-Therapeutics and Post-Graduate Medical School; Associate Author "Year Book of the Ear, Nose and Throat."]

excitation, and is add to reaction. 3. The negative pole, in addition to reaction, is stimulating, but it does not increase blood supply, and has a solvent effect upon the connective tissue. 4. The faradic current, when rapidly interrupted, has a sedative or anesthetic effect upon muscle tissue. 5. The faradic current, when slowly interrupted, has a stimulating effect upon muscle tissue. The pathologic conditions and the technique of the treatment will be fully considered in the following sections:

AUDITORY CANAL.

Supra.—The cause of eczema may be either constitutional or local. Of the local causes the most frequent is the presence of an irritating discharge from the middle ear. Pathologic epitis is considered the irritating factor, but eczema cannot be regarded as more frequently found behind the ear. Treatment of eczema of the ear should be directed first toward the removal of the cause, whether constitutional or local. The local treatment consists of the application of such remedies as are recommended early in the treatment in the most delicate and delicate of mercury ointment in the early cases. The positive pole of the galvanic current applied by means of a moist cotton applicator to the diseased area has been found of value. From one to four milliamperes, depending upon the size of the electrode and the sensitiveness of the parts, will usually reach the limit of comfort for the patient.

CHAPTER XVII.

ELECTRICITY IN OTITIS.*

Electricity is the use of electricity in diseases of the ear, as well as of other parts of the body; it is employed in three things:

1. A knowledge of certain well established facts concerning the therapeutic action of electricity.
2. The understanding of the pathologic condition to be removed or the progress of which is to be changed.
3. A knowledge of proper methods of applying electricity to the diseased parts.

The certain well-established facts concerning the therapeutic action of electricity, as applied to the treatment of the diseases under consideration, are clearly stated in the chapter entitled "Causes of Pain in the Ear," etc.

1. The galvanic current is capable of producing various changes, the nature of which depends upon the strength of current used, and whether the positive or negative pole is applied to the diseased parts. A. The positive pole of the galvanic current is coagulant, antiseptic and sedative

* This chapter was first published by Albert H. Andrews, M. D., Professor of Surgery, Johns Hopkins School of Electro-Therapeutics and Post-Graduate Hospital, Baltimore, Author "Year Book of the American Medical Association."

in its action, and is acid in reaction. 3. The negative pole is alkaline in reaction, is stimulating, not antiseptic, increases blood supply, and has a solvent effect upon the connective tissue. 4. The faradic current, when rapidly interrupted, has a sedative or anesthetic effect upon muscle tissue. 5. The faradic current, when slowly interrupted, has a stimulating effect upon muscle tissue. The pathologic conditions and the technique of the treatment will be briefly considered in the following sections:

AUDITORY CANAL.

Eczema.—The cause of eczema may be either constitutional or local. Of the local causes the most frequent is the presence of an irritating discharge from the middle ear. Pediculosis capitis is sometimes the irritating factor, but eczema caused by parasites is more frequently found behind the ear. Treatment of eczema of the ear should be directed first toward the removal of the cause, whether constitutional or local. The local treatment consists of the application of such remedies as benzoinated oxide of zinc ointment in the moist cases and yellow oxide of mercury ointment in the dry or scaly cases. The positive pole of the galvanic current applied by means of a moist cotton electrode to the diseased area has been found of value. From one to four milliamperes, depending upon the size of the electrode and the sensitiveness of the parts, will usually reach the limit of comfort for the patient.

Furuncle.—Abscess of the auditory canal may be caused by an infection of one of the glands in the skin, or the infection may enter through an abrasion in the skin of the canal. Furuncles may be aborted when treatment is instituted early, but when pus begins to form the swelling should be incised. It is always desirable to prevent the formation of pus when possible, because of the tendency to recurrence after the formation of one abscess. The local application of cold tincture of iodine, nitrate of silver, or filling the canal with cotton saturated with 10% carbolic acid in glycerine, will often abort these cases when used before breaking down of the tissue begins. The positive pole of the galvanic current, as strong as the patient can endure it, may be used instead of the above remedies, or in addition to them.

MIDDLE EAR.

Acute Otitis Media.—In the treatment of acute otitis media it is important to differentiate between the purulent variety, which is caused by infection passing through the eustachian tube, and the catarrhal variety, which may originate in the ear itself or be caused by the extension of a simple naso-pharyngitis through the eustachian tube. In the purulent variety the fluid accumulating in the middle ear is pus, while in the catarrhal variety it is a clear serous fluid, free from the presence of pyogenic germs. The treatment of the former variety is early paracentesis of the membrane and

free drainage. The treatment of the latter variety when suppuration occurs should be directed toward relieving the pain, preventing a recurrence and controlling the inflammation. The need to do so is due to the pressure of fluid within the middle ear.

In the treatment of acute catarrhal otitis media when perforation occurs, rest in bed, hot applications and irrigation of the middle ear are all of value, but the most efficient remedy is the application of glycerine and carbolic acid. A pencil of cotton saturated with a 10% carbolic acid in glycerine should be pushed gently down against the tympanic membrane and left in position. The acid is antiseptic and anesthetic, while the glycerine by its osmotic property draws the excess fluid through the perforation and thus relieves the pressure, reduces the pain and promotes resolution. In severe cases the treatment should be repeated every few days, until recovery is complete, and one or two applications of the current. Especially the positive effect of the galvanic current would be indicated. In some cases it is found that the ear is too sensitive to bear a current of sufficient strength to accomplish the results desired. After the discharge ceases, whether the fluid be purulent or serous, free drainage should be maintained by keeping the ear packed full of sterile gauze. Fresh applications should be applied before the packing has become saturated.

Parotitis.—Abscess of the auditory canal may be caused by an infection of one of the glands in the skin, or the infection may enter through an abrasion in the skin of the canal. Furuncles may be started when treatment is instituted early, but when parotitis is formed the swelling should be incised. It is always desirable to prevent the formation of abscesses, because of the tendency to metastasize after the formation of one abscess. The local application of cold tincture of iodine, alcohol of ether, or filling the canal with cotton saturated with 10% carbolic acid in glycerine will often abort these cases when used before swelling begins. The positive pole of the galvanic current, as strong as the patient can stand, may be used instead of the above remedies or in addition to them.

ACUTE OTITIS MEDIA.

Acute Otitis Media.—In the treatment of acute otitis media it is important to differentiate between the purulent variety, which is caused by infection coming through the eustachian tube, and the catarrhal variety, which may originate in the ear itself or be caused by the extension of a simple catarrh through the eustachian tube. In the purulent variety the fluid accumulating in the middle ear is pus, while in the catarrhal variety it is a serous fluid, free from the presence of pyogenic germs. The treatment of the former variety is early paracentesis of the membrane and

free drainage. The treatment of the latter variety when seen before perforation occurs should be directed toward relieving the pain, preventing a perforation and controlling the inflammation. The pain is due to the pressure of fluid within the middle ear.

In the treatment of acute catarrhal otitis media before perforation occurs, rest in bed, hot applications and inflation of the middle ear are all of value, but the most efficient remedy is the application of glycerine and carbolic acid. A pencil of cotton saturated with a 10% carbolic acid in glycerine should be pushed gently down against the tympanic membrane and left in position. The acid is antiseptic and anesthetic, while the glycerine by its osmotic property draws the serous fluid through the membrane, and thus relieves the pressure, relieves the pain, and prevents perforation. In severe cases the treatment should be repeated every few hours, while in ordinary cases one or two applications will be sufficient. Theoretically the positive pole of the galvanic current would be indicated, but experience proves that the ear is too sensitive in such cases to bear a current of sufficient strength to accomplish the results desired. After the discharge begins, whether the fluid be purulent or serous, free drainage should be maintained by keeping the ear packed full of sterile gauze. Fresh gauze should be applied before the packing has become saturated.

Chronic Suppurative Otitis Media.— Whether the original cause of the suppuration was an acute purulent otitis media or a catarrhal case, which became infected after the discharge began, capillary drainage by keeping the canal filled with sterile gauze seems to bring about conditions most favorable to recovery. If the cause of the continued suppuration is dead bone, granulations or polyp, cholesteatoma, or disease of the mastoid, these conditions must receive appropriate treatment before the discharge will cease. In a number of uncomplicated cases the writer has seen the discharge cease very soon after the application of a copper electrode with positive galvanism to the mucous membrane of the middle ear. The positive pole applied to the inner wall of the middle ear invariably produces dizziness. If the current is increased gradually the patient will usually endure about one milliampere. A small coil of copper wire, covered with a thin layer of wet cotton, makes a satisfactory electrode. If the patient is in the sitting posture the cord should be brought over his head and attached to the electrode so that the head carries the weight of the cord in such a manner that it does not drag upon the ear. The shaft of the electrode should be insulated with a piece of delicate rubber tubing.

Chronic Non-Suppurative Otitis Media.— Of all the diseases causing impairment of hearing without pain or discharge chronic non-suppurative

otitis media is the most frequent. The term chronic suppurative otitis media covers a number of pathologic changes, all of which are dependent upon and consequent to occlusion of the eustachian tube. The primary cause of the trouble is chronic nasopharyngitis, which extends to the eustachian tube, and by swelling of its lining membrane more or less complete occlusion of the tube is produced. The changes following closure of the eustachian tube may be briefly stated as follows: 1. Absorption of air from the cavity of the middle ear. 2. The air pressure now being less within the ear than without the membrana tympani is pushed inward, producing the condition called retraction. 3. Another result of the lessened air pressure within the ear is congestion of the blood vessels of the mucous membrane, lining the cavity and covering the ossicles. 4. The long-continued congestion of the mucous membrane results in the formation of a permanent, or permanent, inflammation at all points, a proliferation of connective tissue, and the formation of scars. 5. The result of this permanent inflammation is the formation of a permanent scar tissue which is deposited in and around the walls of the eustachian tube, and by its contraction the tube is narrowed and begins to contract. 6. The result of this contraction is to lessen the lumen of the vessels, and consequently to lessen the blood supply. Another result of the contraction of the proliferated connective tissue is to restrict the movements of the ossicles and to impair the function of all the

Chronic Suppurative Otitis Media.—Whether the original cause of the suppuration was an acute suppurative otitis media or a catarrhal case, which became infected after the discharge began, can be ascertained by keeping the canal filled with sterile gauze wicks to bring about conditions most favorable to recovery. If the cause of the continued suppuration is distant, granulations or polypoid excrescences, or disease of the mastoid, these conditions must receive appropriate treatment before the discharge will cease. In a number of uncomplicated cases the writer has seen the discharge cease very soon after the application of a weak electric current to the middle ear. The positive pole applied to the lower wall of the middle ear usually produces the desired result. If the current is increased gradually the patient will usually receive the desired relief. A small coil of copper wire, covered with a layer of wet cotton, makes a satisfactory electrode. If the patient is in the sitting position the electrode should be brought over the ear and held so that the head is in such a position that it does not touch the ear. The head of the electrode should be isolated with a glass or rubber cap during the sitting.

Chronic Non-Suppurative Otitis Media.—The disease causing impairment of hearing without pain or discharge chronic non-suppurative

otitis media is the most frequent. The term chronic non-suppurative otitis media covers a number of pathologic changes, all of which are dependent upon and consequent to occlusion of the eustachian tube. The primary cause of the trouble is chronic naso-pharyngitis, which extends to the eustachian tube, and by swelling of its lining membrane more or less complete occlusion of the tube is produced. The changes following closure of the eustachian tube may be briefly stated as follows: 1. Absorption of air from the cavity of the middle ear. 2. The air pressure now being less within the ear than without the membrana tympani is pushed inward, producing the condition called retraction. 3. Another result of the lessened air pressing within the ear is congestion of the blood vessels of the mucous membrane, lining the cavity and covering the ossicles. 4. The long-continued congestion of the tympanic blood vessels produces the change which is characteristic of chronic inflammation at all times—i. e., proliferation of connective tissue. 5. In course of time the connective tissue which has been deposited in and around the walls of the blood vessels follows the tendency of all connective tissue and begins to contract. 6. The result of this contraction is to lessen the lumen of the vessels, and consequently to lessen the blood supply. Another result of the contraction of the proliferated connective tissue is to restrict the movements of the ossicles and to impair the function of all the

structures within the middle ear. 7. As a result of lessened blood supply there is lessened nutrition. 8. Following the lessened nutrition comes the retrograde change called "atrophy." Clinically, the pathologic process may be divided into three stages: the simple, the hypertrophic, and the atrophic stage. The line of demarkation between these stages is not sharply defined, but one passes more or less gradually into the next. The simple stage includes all the changes up to the beginning of proliferation of connective tissue. The hypertrophic stage includes proliferation and contraction until, as a result of the lessened nutrition, atrophy begins.

The symptoms of the *simple stage* are: Impairment of hearing, usually tinnitus, retraction of the membrane, congestion of the malleal plexus — i. e., slight redness of the tissues covering the handle of the malleus; marked improvement of hearing upon inflation. In the treatment of the simple stage proper attention must be given to the naso-pharyngitis. The middle ear must be repeatedly inflated either by Politzer's method or with the Eustachian catheter. The positive pole applied to the drum membrane and auditory canal is of advantage, but the mild faradic current applied in the same manner seems to do more good probably by stimulating the muscular walls of the blood vessels and helping them to regain their normal tone. The prognosis is good, providing the Eustachian occlusion can be permanently relieved.

The symptoms of the hyperplastic stage are
 ... retention as in the simple
 ... of the malleus,
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The nature of the hyperplastic stage
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 ... If the current is applied only
 ... the patient will rarely submit to
 ... half a milliamperes, while if the cur-
 ... in addition
 ... he may take from one to three
 ... After the proliferation of connective

structures within the middle ear. 7. As a result of lessened blood supply there is lessened nutrition. 8. Following the lessened nutrition comes the retrograde change called "atrophy." Clinically, the pathology process may be divided into three stages: the simple, the hypertrophic, and the atrophic stage. The lines of demarcation between these stages are not sharply defined, but one passes more or less gradually into the next. The simple stage is characterized by changes up to the beginning of proliferation of connective tissue. The hypertrophic stage, with its proliferation and contraction, is a result of the lessened nutrition, atrophy begins.

The symptoms of the simple stage are: Impairment of hearing, ringing noises, retraction of the eardrum, enlargement of the middle plezux — i. e., the space between the bones covering the handle of the malleus, loss of movement of hearing upon pressure, etc. The treatment of the simple stage consists chiefly of that given to the naso-pharynx. The middle ear must be repeatedly inflated either by Politzer's method or with the Eustachian catheter. The positive pole applied to the drum membrane and auditory canal is of advantage, but the galvanic current applied in the same manner seems to do more good probably by stimulating the muscular walls of the blood vessels and helping them to regain their normal tone. The prognosis is good, providing the Eustachian occlusion can be permanently relieved.

The symptoms of the *hypertrophic stage* are impairment, tinnitus and retraction as in the simple stage, but in this stage the handle of the malleus, as seen in the drum membrane, appears broader than normal. Inflation will improve the hearing much or little, according to the amount and condition of the proliferated connective tissue.

In the treatment of the hypertrophic stage attention to the nose and naso-pharynx is of great importance. Unless free ventilation of the middle ear can be maintained treatment of the ear itself will not give satisfactory results. Inflation of the middle ear and massage of the membrane are always indicated. Siegle's massage otoscope, or one of the various mechanical devices, should be employed. The writer has seen many cases in which good results were obtained by injecting a 3% solution of camphor and menthol in a hydrocarbon oil through the Eustachian catheter into the middle ear. After free ventilation through the Eustachian tube has been provided for, electricity will do much to improve the conditions within the middle ear. If the proliferation process is still going on, the positive pole should be applied to the canal and membrane. If the current is applied only to the membrane the patient will rarely submit to more than one-half a milliampere, while if the current is applied to the walls of the canal, in addition to the membrane, he may take from one to three milliamperes. After the proliferation of connective

tissue has been checked, the negative current applied in the same manner should be used to soften and dissolve the connective tissue already formed. The negative pole causes greater discomfort. Five to eight minutes is usually sufficient time to continue the application. The treatment should be repeated two or three times each week.

The constant symptoms of the atrophic stage are deafness, tinnitus and retraction of the membrane, as in the simple and hypertrophic stages ; but in this stage the handle of the malleus appears abnormally narrow, as seen in the drum membrane. A change in the angle, at which the handle of the malleus is seen, makes it appear shorter than normal—foreshortening of the handle. A frequent symptom during this stage is improved hearing when the patient is in a noise. Sometimes the atrophic process extends to the Eustachian tube, rendering it abnormally patent. As a rule, during this stage inflation of the middle ear causes slight, if any, improvement in hearing. In the treatment of this stage the same attention should be given to abnormal conditions in the nose and throat as have been suggested in the simple and hypertrophic stages ; especially is this true if there is any evidence of tubal occlusion. If obstruction of the Eustachian tube exists during this stage it is usually due to an old inflammatory exudate, and can only be permanently relieved by the use of the electrolytic bougie. Massage of the membrane is indi-

The infusion of 3% camphor and menthol in a
 solution of oil through the Eustachian catheter
 is advised to benefit some of these cases. The
 objective is to force the atrophied connective tis-
 sue of the eardrum and other vessels in improving the
 circulation. Frequently the remedy which excites the
 circulation in these cases is electricity. The
 galvanic current should be applied to the
 external meatus by means of a pencil of coc-
 calis and the other pencil into the canal to the
 eardrum. The current is very sensitive and
 should be used in a weak way gradually. The
 cathodes should not be too large and should be
 placed in the meatus. The pencil catheter
 should be made of coccalis or silver. The best
 results have been obtained with a weak current
 of 10 to 20 milliamperes. The current is allowed
 to flow for 10 to 15 minutes and should be
 repeated three or four times a day. The lower
 meatus should be kept dry. The later stages
 of the disease are not so favorable. An examinee
 with this treatment a few weeks and the eardrum
 will be restored and all the visible parts of the ear
 will be greatly improved. The treatment should
 be continued for a week or two, then less fre-
 quently as long as improvement seems to justify.
 The best prognosis should always be given. First
 try to replace lost parts and then try to
 restore the function when it has been long in-
 terrupted. In many of these cases the internal ear

After the tubes checked, the negative current applied in the same manner should be used to soften and dissolve the connective tissue already formed. The treatment is usually sufficient time to render the application. The treatment should be repeated at intervals of 2 or 3 weeks.

The treatment of the atrophic stage of the disease is the same as that of the hypertrophic stage, but during the atrophic stage the membrane appears shrunken and the handle of the tongue is small. The treatment is the same as that of the hypertrophic stage, but the negative current should be applied to the membrane and the tongue. A frequent complaint during this stage is impaired hearing which may result in a deafness. Sometimes the tongue passes across to the Eustachian tube, rendering it completely patent. As a rule, during this stage relief of the patient can be caused by the use of the negative current. In the treatment of this stage the patient should be given to stimulate circulation in the nose and throat as have been suggested in the atrophic and hypertrophic stages especially in the case if there is any evidence of local infection. If obstruction of the Eustachian tube occurs during this stage it is usually due to an acute inflammatory exudate, and can only be permanently relieved by the use of the electrolytic tongue. Massage of the membrane is indi-

cated. Injection of 3% camphor and menthol in a hydro-carbon oil through the Eustachian catheter has seemed to benefit some of these cases. The oil seems to soften the atrophied connective tissue and to assist other remedies in improving the circulation. Probably the remedy which exerts the greatest influence in these cases is electricity. The negative galvanic current should be applied to the canal and membrane by means of a pencil of cotton on an applicator passed into the canal to the membrane. The membrane is very sensitive and the current must be increased very gradually. The patient's feelings and not the meter should determine the amount of current. Frequently a quarter of a milliampere is all he will endure. The best results have seemed to come from a mild current applied for a considerable time—ten to fifteen minutes. The positive pole should be held in the hand or passed through the nostril to the inner meatus of the Eustachian tube. The latter position has seemed to yield the best results. An examination of the ear, after such a treatment, will show the membrane and all the visible parts of the middle ear greatly congested. The treatment should be repeated daily for a week or two, then less frequently as long as improvement seems to justify. A guarded prognosis should always be given, for it is not possible to replace lost parts nor to fully restore the function when it has been long impaired. In many of these cases the internal ear

has become involved. When this happens, while the progress may be stopped, the prognosis, as far as improvement is concerned, is still more unfavorable. While not all the cases can be helped, a large number of apparently hopeless cases have been improved by this plan of treatment.

ELECTROLYTIC DILATATION OF THE EUSTACHIAN TUBE.

The Eustachian tube sometimes becomes closed by inflammatory exudates or by annular constrictions. When such obstructions occur they do not yield to ordinary inflation of the middle ear or to treatment of the naso-pharynx. There are no easily recognized pathognomonic symptoms of these conditions, but when other plans of treatment have failed to relieve tubal occlusion, dilatation with the aid of electricity should be undertaken. The effect of purely mechanical dilatation of the Eustachian tube is not usually satisfactory, but when combined with the solvent action of the negative galvanic current, favorable results in properly selected cases will be obtained.

The special instruments required are a hard rubber Eustachian catheter, a set of olive-tipped gold wire bougies at least two inches longer than the catheter, and a measure for determining the progress of the bougie through the tube. The bougies are usually made in three sizes, with the olive tips about one, one and a half and two millimeters in diameter respectively. Before using the

boogies it is necessary to determine how much longer they are than the catheters; then the progress of the tip through the tube can be determined by measuring the end of the bougie, which has not yet passed into the catheter. In using the instruments first introduce the catheter accurately into the meatus of the Eustachian tube and test its accuracy by occluding the ear, while the auscultating tube extends from the patient's ear to the operator's ear. Then introduce the bougie and pass it into the Eustachian tube until it meets with an obstruction. Then attach the negative pole to the bougie, while the patient holds the positive electrode in his hand. Increase from one to three milliamperes and make gentle but steady pressure upon the bougie. In a few days the tip will be felt to pass by the obstruction into the clear space beyond. Now push it gradually until the tip encounters further obstruction or enters the middle ear. The length of the Eustachian tube is usually from one and a quarter to one and a half inch. Usually the patient will experience a slight bubbling sensation as the tip passes through the pain. The pain should be slight and soon is entirely absent.

Internal Ear.—The pathology of internal ear disease is not as well understood as the pathology of other portions of the ear, hence there is a considerable element of uncertainty in the treatment and also in the prognosis. In recent years, however, considerable progress has been made along

When this happens, while the patient is lying on his back, the prognosis, as far as the tube is concerned, is unfavorable. In such cases, a large quantity of mucus may be expelled, and even more, and the patient may be helped by the use of a large quantity of mucus. The prognosis is unfavorable.

THE SUBSTACHIAN TUBE

The tube becomes closed by contraction of the muscles of the pharynx or by anular contraction of the tube. When such contractions occur they do not tend to relieve any obstruction of the middle ear or to dilate the pharynx. There are no ready means to a complete dilatation of the tube, but when other plans of treatment have failed to relieve the obstruction, dilatation with the aid of electricity should be undertaken. The effect of purely mechanical dilatation of the tube is not usually satisfactory, but when combined with the internal action of the eustachian tube, the results in properly selected cases will be satisfactory.

The special instruments required are a hard rubber catheter, a set of olive-tipped catheters of various sizes, each one inch longer than the other, and a syringe for determining the position of the tube through the tube. The catheters are usually made in three sizes, with the diameters one, one and a half and two millimeters respectively. Before using the

bougies it is necessary to determine how much longer they are than the catheter; then the progress of the tip through the tube can be determined by measuring the end of the bougie, which has not yet passed into the catheter. In using the instruments first introduce the catheter accurately into the meatus of the Eustachian tube and test its accuracy by inflating the ear, while the auscultating tube extends from the patient's ear to the operator's ear. Then introduce the bougie and pass it into the Eustachian tube until it meets with an obstruction. Now attach the negative pole to the bougie, while the patient holds the positive electrode in his hand. Turn on from one to three milliamperes and make gentle but steady pressure upon the bougie. In a little time the tip will be felt to pass by the obstruction into the clear space beyond. Now push it gently on until the tip encounters further obstruction or enters the middle ear. The length of the Eustachian tube is usually from one and a quarter to one and a half inch. Usually the patient will experience a slight bubbling sensation as the tip passes through the pain. The pain should be slight, and often is entirely absent.

Internal Ear.—The pathology of internal ear diseases is not as well understood as the pathology of other portions of the ear, hence there is a considerable element of uncertainty in the treatment and also in the prognosis. In recent years, however, considerable progress has been made along

the line of diagnosis. While the discoveries have not enabled otologists to treat the internal ear more successfully, they have thrown some light on the cause of failure to improve the hearing in certain cases.

Hyperaemia.—That deviations from the normal blood supply to the internal ear produce characteristic symptoms is well understood. The symptoms of hyperæmia are tinnitus, which is increased when the patient assumes the recumbent position, and upon exertion. The hearing is more or less impaired — sometimes very slightly. This condition may be associated with diseases of the middle ear. When so complicated, the diagnosis becomes more difficult. In the treatment, internal remedies should be given to equalize the circulation and lessen blood pressure in the head. Pathologic condition in the naso-pharynx may cause changes in the blood supply to the internal ear, and hence should always be looked for and treated if found. The positive pole applied to the membrane and canal, as already described, has a tendency to lessen blood supply to all parts of the middle and internal ear. Because of its sedative effect upon the auditory nerve the positive pole will often temporarily lessen the tinnitus even when the negative pole is needed to relieve the conditions which cause the tinnitus.

Anaemia.—The usual symptoms of this condition are tinnitus and impairment of hearing. The

symptoms improve when the patient lies down and when such remedies as nitro-glycerine are administered. The general circulation should be improved in every way possible. The negative pole increases the blood supply to all parts of the middle and internal ear, and also stimulates the auditory nerve. The prognosis depends upon the length of time conditions have existed and upon the cause of the disturbance. Long continued deviations from the normal blood supply to the internal ear produces structural changes which do not readily yield to treatment.

A considerable number of diseases, in both the middle and internal ear, have been purposely omitted because electricity has seemed to have no place in their treatment.

the line of diagnosis. While the discoveries have not enabled otologists to treat the internal ear more successfully, they have thrown some light on the cause of failure to improve the hearing in some cases.

Hypertension.—The deviations from the normal blood supply to the internal ear produced by this condition are well understood. The symptoms of hypertension are transient, which is fortunate when the patient complains of vertigo, tinnitus, and deafness. The hearing is more or less impaired, but improves very slightly. This condition may be associated with disease of the internal ear. When associated, the diagnosis is more difficult. In the treatment of hypertension, attention should be given to equalize the blood flow and to keep the patient in the best possible condition. In the treatment of hypertension, attention should be given to equalize the blood flow and to keep the patient in the best possible condition. In the treatment of hypertension, attention should be given to equalize the blood flow and to keep the patient in the best possible condition.

Anemia.—The usual symptoms of anemia are weakness and impairment of hearing.

symptoms improve when the patient lies down and when such remedies as nitro-glycerine are administered. The general circulation should be improved in every way possible. The negative pole increases the blood supply to all parts of the middle and internal ear, and also stimulates the auditory nerve. The prognosis depends upon the length of time conditions have existed and upon the cause of the disturbance. Long continued deviations from the normal blood supply to the internal ear produces structural changes which do not readily yield to treatment.

A considerable number of diseases, in both the middle and internal ear, have been purposely omitted because electricity has seemed to have no place in their treatment.

Electro-Therapeutical Practice.

Abortion.

Bipolar intra-uterine electrode No. 69 introduced in uterus. Faradic secondary current, medium wire, 500 to 600 interruptions per minute. Seance 5 minutes.

(a) Unipolar method, same current, No. 21 in uterus, No. 66 on abdomen.

(b) Interrupted galvanic used same as above.

—Threatened.

Secondary faradic, fine wire, rapid interruptions, vaginal electrode No. 68 against cervix, No. 3 on lumbo-sacral region.

Abscess, Threatened.

Galvanism. No. 88 covered with wet cotton or chamois leather is attached to the positive pole and applied directly to lesion. No. 3 on negative some distance removed. Daily sittings of ten milliamperes for 10 minutes.

—Mammary, Threatened.

Galvanism. Cut a sheet of block tin after the

pieces of an ordinary breast plaster, leaving a hole in the center for the nipple; then take some terracotta clay and mix with water until it is of a consistency that can be spread; put a sheet of tin on the sheet of tin and apply to the breast. Attach to the positive pole and with a large surface electrode on the negative pole some distance removed, allow 15 to 20 milliamperes to pass for 10 minutes.

Tuberculosis.

Galvanism. Metallic electrolysis. Take a copper needle of suitable size and insulate it (see insulation), attach it to the positive pole and thrust it into the abscess. No. 3 on negative pole at some indifferent point. 5 milliamperes for 5 to 8 minutes, then reverse polarity for 2 or 3 minutes to free the needle.

Galvanism. Negative pole to lesion. 5 ma. for 10 minutes daily.

Gonorrhea, Pelvic.

Galvanism. Electrode No. 116 covered with wet cotton attached to negative pole and well up in vaginal vault. No. 66 on abdomen, 30 to 50 ma. Tri-weekly sittings.

Electro-Therapeutical Practice.

Atheroma.

Bipolar intra-arterial electrode No. 69 introduced in artery. Faradic secondary current medium wire, 300 to 400 interruptions per minute. Session 5 minutes.

(2) Unipolar method, same current, No. 91 as anode, No. 69 as cathode.

(3) Unipolar method, same as above.

Unipolar method, low wire, rapid interruptions, No. 69 as anode, No. 68 against carotid artery in subclavicular region.

Unipolar method, No. 68 covered with wet cotton wool, No. 69 is attached to the positive pole and applied directly to lesion. No. 5 on negative pole, distance removed. Daily application, 10 ampères for 10 minutes.

Unipolar method, faradic.

Unipolar method. Cut a sheet of block tin after the

design of an ordinary breast plaster, leaving a hole in the center for the nipple; then take some tenacious clay and mix with water until it is of a consistency that can be spread; put a thick coat on the sheet of tin and apply to the breast. Attach to the positive pole and with a large surface electrode on the negative pole some distance removed, allow 15 to 20 milliamperes to pass for 10 minutes.

—**Tuberculous.**

Galvanism. Metallic electrolysis. Take a copper needle of suitable size and insulate it (see Insulation), attach it to the positive pole and thrust it into the abscess. No. 3 on negative pole at some indifferent point. 5 milliamperes for 5 to 8 minutes, then reverse polarity for 2 or 3 minutes to free the needle.

Acne.

Galvanism. Negative pole to lesion. 5 ma. for 10 minutes daily.

Adhesions, Pelvic.

Galvanism. Electrode No. 116 covered with wet cotton attached to negative pole and well up in vaginal vault. No. 66 on abdomen, 30 to 50 ma. Tri-weekly seances.

Afterpains.

Secondary faradic current, fine wire coil, rapid interruptions. No. 3 electrode on each pole, one to lumbar region, the other over abdomen. 5 to 10 minutes.

Alopecia. See **Baldness.**

Amenorrhœa

Galvanism. Positive pole, No. 66, to lumbar region; negative, No. 3, above the pubes. 20 ma. for 5 minutes three times during week preceding regular period.

- (a) Galvanism, negative in vagina, No. 116. Positive, No. 66, on abdomen. 20 ma., tri-weekly.
- (b) Bipolar intra-uterine faradization.
- (c) General faradization (see Faradization).

Anæsthesia, local.

Galvanism, positive pole.

- (a) Fine wire secondary faradic rapidly interrupted.
- (b) By cataphoresis. Cocaine on positive pole, galvanism.

Aneurisms.

Galvano-puncture; No. 106 with platinum needles is used unipolar* and attached to pos-

*See foot note under "Hypertrophy."

Give pole; No. 3 on negative; 10 ma. for 15 to 20 minutes, or until clot is fully formed. Turn off current, reverse polarity and pass current on again for a few moments, or until needles can be removed easily.

Angina Pectoris.

Galvanism. No. 96 (4x3 in.) attached to positive and applied over sternum. No. 3 to negative over lower cervical vertebrae, increase current gradually to 10 ma. for 2 minutes for first few sittings, afterward prolong sitting to 5 minutes.

Arteriosclerosis. See Cardio-vascular.

Arthritis. See Paralysis.

Ascites.

Faradism. Secondary current from medium wire coil. No. 5 on positive to base of scapula. No. 1 on negative *axilla* over the motor points of the nerves supplying the affected muscles. A mild current from 5 to 15 minutes daily. Do not begin treatment until 2 or 3 weeks after the stroke.

Arteriosclerosis (Induration yet present.)

No. 96 (2x6 in.) around the joint attached to

Alzheimer's

Secondary faradic current, fine wire coil
No. 3 electrode on each
side of the head region, the other over
the chest. 5 to 10 minutes.

Alzheimer's (continued)

Alzheimer's

Galvanic - Positive pole, No. 50, to lumbar
region, negative, No. 3, above the pubis.
10 ma. for 5 minutes three times during week
providing regular periods.

(1) Tubercles, negative in vagina, No. 110.
Positive, No. 50, on abdomen. 20 ma., 10
minutes.

(2) Nodule, intracranial faradization.

(3) General faradization (see Faradization).

Alzheimer's (continued)

Galvanic, positive pole.

(1) The secondary faradic rapidly inter-
mittent.

(2) The secondary faradic on positive pole.
10 minutes.

Alzheimer's

Galvanic, No. 106 with platinum
electrode in each ear canal and attached to pos-
itive pole of battery. "Sensory."

itive pole ; No. 3 on negative ; 10 ma. for 15 to 20 minutes, or until clot is fully formed. Turn off current, reverse polarity and turn current on again for a few moments, or until needles can be removed easily.

Angina Pectoris.

Galvanism. No. 96 (4x6 in.) attached to positive and applied over sternum. No. 3 to negative over lower cervical vertebræ ; increase current gradually to 10 ma. for 2 minutes for first few sittings, afterward prolong sitting to 5 minutes.

Anthrax. See Carbuncle.

Aphasia. See Paralysis.

Apoplexy.

Faradism. Secondary current from medium wire coil. No. 3 on positive to base of brain. No. 1 on negative *labile* over the motor points of the nerves supplying the affected muscles. A mild current from 5 to 15 minutes daily. Do not begin treatment until 2 or 3 weeks after the stroke.

Arthritis. (Inflammation yet present.)

No. 96 (2x6 in.) AROUND the joint attached to

positive. No 3 on negative ; 20 ma. for 10 minutes daily.

- (a) By cataphoresis. Wet the positive electrode with solution of salts of lithium and apply as above.
- (b) Static induced current for 10 minutes daily.

NOTE.—In gouty arthritis of the fingers the positive electrode should be constructed as follows: Take a glass or porcelain dish and fill nearly full of clay about the consistence of thin mortar, and, by means of a metal strip, or otherwise, connect with the positive rheophore. The affected part of the hand is to be immersed in the clay.

Asphyxia.

Faradism. Current strong enough to produce good contractions—one electrode (No. 1) to phrenic, the other (No. 3) along the insertion of diaphragm into thorax wall. Interrupt current by raising one electrode about 20 or 30 times per minute.

Asthma.

Strong faradic current applied to opposite sides of neck for 15 to 20 minutes.

cat. Galvanism. No. 1 attached to positive at middle of outer edge of sterno-cleido-mastoid; No. 2 to negative up and down spine. 20 ma. for 10 to 15 minutes.

Galvanism. No. 96 (507 in.) attached to positive over sternum (or some indifferent point); No. 1 to negative *labile* over affected arm. 20 ma. for 10 min. every second day.

Coarse wire secondary faradic, slow induction, same manner as above, 15 minutes daily.

Galvanism. 50 ma. to head 15 minutes daily.

Galvanism. No. 3 on negative to head, positive to head 3 to 5 ma. for 10 minutes daily.

Galvanism. No. 96 (507 in.) attached to positive at middle of outer edge of sterno-cleido-mastoid; No. 1 to negative over spine. 20 ma. for 10 to 15 minutes every day.

In young girls where the above treatment is inadvisable, place one electrode over the stomach and the other over the bladder, and proceed as above.

positive. No. 3 on negative, 20 ma. for 10 minutes daily.

(2) by cataphoresis. Wet the positive electrode with solution of salts of lithium and apply as above.

(3) make indirect contact for 10 minutes daily.

Notes.—In giving cathodes of the fingers the positive electrode should be constructed as follows. Take a glass or porcelain dish and fill nearly full of jelly about the consistency of this medium, and by means of a metal strip, or otherwise, connect with the positive electrode. The affected part of the hand is to be immersed in the jelly.

Notes.—A jelly strong enough to produce cathodes—use electrode (No. 2) on positive, the other (No. 3) along the thorax or diaphragm into thorax wall. Cathodes given by using one electrode (No. 2) or 30 times per minute.

Using static current applied to opposite sides of neck for 15 to 20 minutes.

- (a) Galvanism. No. 1 attached to positive at middle of outer edge of sterno-cleido-mastoid; No. 3 to negative up and down spine. 10 ma. for 10 to 15 minutes.

Atrophy.

Galvanism. No. 96 (5x7 in.) attached to positive over sternum (or some indifferent point); No. 1 to negative *labile* over affected parts. 20 ma. for 10 min. every second day.

- (a) Coarse wire secondary faradic, slow interruptions, same manner as above, 15 minutes daily.

Baldness.

Static breeze to head 15 minutes daily.

- (a) Galvanism. No. 3 on negative to head, positive in hand, 5 to 8 ma. for 10 minutes three times a week.

Bladder, Spasm of.

Faradism. Fine wire secondary, rapid interruptions. No. 21 attached to positive in bladder, No. 66 to negative over symphysis; 5 minutes every day.

- (a) In young girls, where the above treatment is inadmissible, place one electrode over sacrum instead of in bladder, and proceed as above.

Boils, To Abort.

No. 102 or 33 covered with chamois or cotton is attached to positive pole and applied to lesion, No. 3 on negative ; 10 ma. for 10 minutes daily.

—When Pus has Formed.

Metallic electrolysis. Copper needle attached to positive in abscess ; 5 ma. for 5 minutes. (See also Abscess, Tuberculous.)

Breasts, Female, Development of.

Faradism. Current from coarse wire, secondary coil. No. 0 for active electrode *labile* is always pushed *toward* the nipple (never over it), using considerable pressure on the roller ; No. 1 in each hand on the other pole, using a bifurcated or forked cord. Commence with 5 minute sittings, to be prolonged after 8 or 10 treatments to 15 minutes. On alternate days use galvanism with same electrodes in hands attached to positive pole, No. 3 on negative *labile* to breasts ; 10 to 15 ma. for 5 to 8 minutes.

Bright's Disease.

Positive static insulation for 25 min. daily.

Bunions.

Static spark 10 minutes daily.

By cataphoresis. No. 33 covered with cotton saturated with solution of cocaine attached to positive pole, No. 8 on negative; 20 to 25 ma. for 5 to 10 minutes.

By cathexis.

By cathexis.

By cathexis. No. 33 or 33 covered with cotton or diamond well treated and attached to positive pole is applied to lesion. No. 8 on negative. 10 ma. for 10 minutes daily. If the lesion is a large one a copper needle attached to positive pole is inserted into each nodule or point for 2 minutes every 6 ma. (See also Chapter on Electrolysis.)

By cathexis.

By cathexis. Inverted patient. No. 33 attached to positive pole and No. 8 to negative. 10 to 15 platinum electrodes, varying in size of piece. The electrodes are placed on the line of growth of the lesion on each side and the current varied in strength until about 40 ma. are obtained. When the current is to be reversed by means of pole changer every 2 or 3 minutes for about 30 times, then remove needles and replace on the other two opposite sides of growth and proceed as before. (See X-ray)

1912, 1913.

No. 12 or 13 covered with charcoal or other
material to prevent heat and applied
to the area of the spine for 10 minutes
daily.

When the patient
is unable to walk, the following
method is used. A current of 10 ma.
is applied to the spine for 10 minutes
daily.

The patient is placed
in a supine position and the
electrode is applied to the spine
for 10 minutes daily.

The patient is placed
in a supine position and the
electrode is applied to the spine
for 10 minutes daily.

The patient is placed
in a supine position and the
electrode is applied to the spine
for 10 minutes daily.

The patient is placed
in a supine position and the
electrode is applied to the spine
for 10 minutes daily.

- (a) By cataphoresis. No. 33 covered with cotton saturated with solution of cocaine attached to positive pole, No. 3 on negative ; 20 to 25 ma. for 5 to 10 minutes.

Cancer, See Carcinoma.

Carbuncle, To Abort.

Galvanism. No. 102 or 33 covered with cotton or chamois well wetted and attached to positive pole is applied to lesion. No. 3 on negative. 10 ma. for 10 minutes daily. If pus has formed plunge a copper needle attached to positive pole into each nodule or head for 5 minutes, using 5 ma. (See also Abscess, Tuberculous.)

Carcinoma, Breast.

Galvanism. Anæsthetize patient. No. 105 to each pole with from 3 to 10 platinum needles according to extent of growth. The needles are plunged into the base of growth one set on each side and the current turned on rapidly until about 400 ma. are obtained when the current is to be reversed by means of pole changer every 2 or 3 seconds for about 30 times, then remove needles and replace on the other two opposite sides of growth and proceed as before. (See X-ray)

Catarrh Hypertrophic.

Metallic electrolysis. No. 99 (copper) covered with cotton wet with sol. adrenalin chlor. well back in nasal cavity. 3 ma., 5 minutes to each side.

—Atrophic.

Same as above, but with electrode attached to negative pole. Apply three times weekly until membrane exudes.

—Cervical.

Galvanism. No. 99 in cervix is attached to positive pole; No. 66 on abdomen to negative. 30 to 50 ma. twice a week.*

N. B. Do not reverse polarity to remove electrode. Use a little traction.

Central Galvanization.

No. 3 attached to both poles. Negative over epigastrium *stabile*. Positive *labile* over forehead, top of head, along inner border of sterno-cleido-mastoid, from mastoid fossa to sternum, at nape of neck and down the entire length of spine. In the former part of treatment, or where the brain is included in the

*These electrodes differ in their active surfaces; some have two and others four square centimeters. Use 25 ma. for every square centimeter of active surface. The electrodes are marked.

current, not more than 5 ma, should be used. In the latter part of the treatment the current may be increased to 10 ma. The whole of the treatment is a half hour or more.

Example. *Myocardial rheumatism.* No. 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100. The current should be applied long enough to deposit a layer of strength in deposit on the head of the neck. Apply into the tissue of the neck in accordance by the green

Example. *Myocardial rheumatism.* Moiston
No. 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100.

Example. No. 3 on both poles. Positive
to forehead, negative to nape of neck. 5 ma.
for 5 minutes. At same sitting with same

Case of chorea.

Diagnosis: chorea. No. 95 (copper) covered with saliva and with salivaria chlor. well kept in contact. 2 ms., 5 minutes to each side.

Results:

Case of chorea, 100 with circuit attached to No. 95. Apply three times weekly no ill symptoms noted.

Case of chorea.

Diagnosis: No. 95 in cervix is attached to No. 95 in abdomen to negative. 20 to 30 ms. twice a week.

Result: The case is cured polarity to remove chorea. The whole system.

Case of chorea.

Diagnosis: chorea. Negative over right side of face. Positive *left* over forehead. No. 95 along inner border of upper eyelid from mastoid fossa to forehead. 20 to 30 ms. and down the entire length of face. In former part of treatment, the brain is included in the

NOTE: The case of chorea is cured; some have two or three cases of chorea. Use 25 ms. for every square centimeter of skin. The electrodes are marked.

circuit, not more than 5 ma. should be used ; in latter part of the operation the current may be increased to 10 ma. The whole sitting may be a half hour or more.

Chancroids.

Galvanism. Metallic electrolysis. No. 37, or other suitable electrode made of copper is attached to the positive pole and applied to lesion. No. 3 on negative to some indifferent point. The current should be applied long enough and of sufficient strength to deposit the oxychloride of copper deeply into the tissues, which can be ascertained by the green color.

Chilblains.

Galvanism. Metallic electrolysis. Moisten part with salt water and apply No. 14 (made of copper) attached to positive pole. No. 3 on negative. 10 to 15 ma. for 5 minutes every second day.

Chloasma. See Liver Spots.

Chorea.

Galvanism. No. 3 on both poles. Positive to forehead, negative to nape of neck. 3 ma. for 3 minutes. At same sitting with same

electrode, negative on sternum, positive up and down spine. 10 ma. for 5 to 7 minutes three times a week.

- (a). Static head breeze for 15 minutes daily.
- (b). Galvanism. Bifurcated negative with No. 1's in hands. Bifurcated positive with No. 3's, one over each parietal region. 5 ma. for 3 minutes daily.

Cicatrix. See Scars.

Comedones.

Electrolysis. No. 107 with fine jeweler's broach is attached to negative; No. 3 to positive. Leave needle in gland about 5 seconds. Use 4 or 5 cells.

Conjunctivitis. See Trachoma.

Constipation.

Faradism. Medium secondary coil, about 600 to 1,000 interruptions per minute. No. 53 on positive in rectum. No. 1 on negative *labile* to abdomen, up the ascending colon down the descending colon. Sittings 10 to 15 minutes daily.

- (a) Galvanism. No. 53 on negative in rectum. No. 3 *labile* on abdomen. 2 ma. for 10 to 15 minutes daily.
- (c) Static Surgings. No. 53 in rectum.

Procedure. Place the foot on No. 52 covered with a wet towel or cotton and attached to the negative pole. No. 33 covered with a wet towel attached to positive over the foot for 15 minutes. If very painful the sides of positive electrode with substance.

Apply for 15 minutes daily.

Procedure. No. 31 lobed with cotton and attached to negative pole of battery. No. 32 attached to positive pole of battery. Attach to negative pole of battery. Apply for 15 minutes. If very painful the sides of positive electrode with substance.

Procedure. No. 31 covered with cotton and attached to positive pole and No. 32 attached to negative pole. Apply for 15 minutes. If very painful the sides of positive electrode with substance.

Procedure. General faradization alternated with constant current.

Positive static insulation for 30 min. daily.

electrode, negative on sternum, positive up and down spine. 10 ma. for 5 to 7 minutes three times a week.

105. *Tracheitis*.—Bilateral negative for 15 minutes daily.

106. *Esophagitis*.—Bilateral negative with No. 100 on back. Reversed positive with No. 5's on each neck parotid region. 5 ma. for 3 minutes daily.

Diagnosis.—See above.

Conductivity.

Electrolysis.—No. 107 with fine jeweler's brush is attached to negative; No. 3 to positive. Insert needle in gland about 5 seconds. Use 4 or 5 cells.

Contraindications.—See Tracheitis.

Conductivity.

Faradism.—Medium secondary coil, about 200 to 250 vibrations per minute. No. 54 in rectum. No. 1 on negative side of abdomen up the ascending colon over the descending colon. Sitzings 10 to 15 minutes daily.

107. *Colitis*.—No. 53 on negative in rectum. No. 1 ~~side~~ on abdomen. 2 ma. for 10 to 15 minutes daily.

108. *Acute Sigmoiditis*.—No. 53 in rectum.

Corns.

Galvanism. Place the foot on No. 52 covered with a wet towel or cotton and attached to the negative pole. No. 33 covered with cotton or chamois attached to positive over corn. 5 ma. for 10 minutes. If very painful wet the cotton on positive electrode with solution of cocaine.

(a). Static spark for 15 minutes daily.

Deafness, labyrinthine.

Galvanism. No. 31 loosely packed with cotton saturated with a weak solution of potassium iodide (the wet cotton protruding from the distal end of electrode). Attach to negative pole. No. 3 on positive to sternum. 3 ma. for 10 minutes three times a week.

—Nervous.

Galvanism. No. 33, covered with cotton or chamois, is attached to positive pole and placed just in front of ear to cover the tragus. No. 3 on negative to sternum. 5 ma. for 10 minutes daily.

Diabetes.

General faradization alternated with central galvanism.

(a) Positive static insulation for 25 min. daily.

Diaphragm, Spasm of. See Spasm.

Diarrhœa, Chronic.

General faradization (see Faradization) combined with frequent applications over abdomen and lumbar regions.

- (a) Galvanism. No. 53, covered with cham-
ois, attached to positive pole in rectum. No.
3 on negative over region of ileo-cœcal valve.
10 ma. for 10 minutes every second day.

Dysmenorrhœa, Congestive.

Galvanism. No. 116 with large copper bulb well packed with wet cotton and attached to positive pole is inserted well up in the posterior vaginal vault. Nos. 66 or 96 on negative to abdomen. 20 ma. for 10 minutes every second day.

—**Membranous.**

Galvanism. No. 99 in uterus, attached to negative pole. No. 66 on positive over abdomen. 30 to 50 ma. every second day for 15 minutes during the week preceding the expected period.

(See foot note under "Catarrh, Cervical".)

—**Obstructive, due to stenosis.**

Galvanism. No. 21 on negative. No. 66 on

positive to abdomen. 5 to 10 ma. for 2 minutes, or until the active electrode passes through the contraction. Repeat every third day, increasing size of olive at each sitting.

Virtual.

Galvanism. No. 96 (1x6) attached to each pole. Positive to lumbar region, negative to Epigastrium. 20 to 30 ma., tri-weekly sittings.

Stomachic Acid.

Procedure. Fine wire secondary with rapid interruptions. No. 96 (1x6) on positive pole applied to the left of the spinous processes, just at a level with the cardiac end of the stomach. No. 5 on negative table over stomach. 15 minutes daily.

Stomach.

Central galvanism. Use Central Galvanometer.

Stomachic Juice.

Procedure. Metallic electrolysis. No. 101 attached to positive in sternum, No. 56 on abdomen; 20 to 40 ma. for 10 minutes weekly. Reverse current for a few minutes to release electrode.

Distichiasis, Spasm of. See Spasm.

Dysentery, Chronic.

General faradization (see Faradization) combined with frequent applications over abdominal and lumbar regions.

18. Catarrhs. No. 53, covered with chain, attached to positive pole in rectum. No. 54 on sigmoid flexure region of ileo-caecal valve. 20 to 30 electric currents every second day.

Dyspareunia, Vaginal.

19. Dyspareunia. No. 55 with large copper bell attached to positive pole in rectum and attached to negative pole in vagina well up in the posterior fornix. No. 56 or 57 on negative electrode. 20 to 30 currents for 10 minutes every second day.

20. Dyspareunia. No. 58 in uterus, attached to positive pole. No. 59 on positive over abdominal region. 20 to 30 currents every second day for 10 to 15 minutes during the week preceding the menstrual period.

21. See also under "Catarrh, Cervical.")

22. Dyspareunia due to stenosis.

23. Dyspareunia. No. 21 on negative. No. 56 on

positive to abdomen. 5 to 10 ma. for 5 minutes, or until the active electrode passes through the contraction. Seance every third day, increasing size of olive at each sitting.

—**Virginal.**

Galvanism. No. 96 (4x6) attached to each pole. Positive to lumbar region, negative to hypogastrium. 20 to 30 ma., tri-weekly sittings.

Dyspepsia, Atonic.

Faradism. Fine wire secondary with rapid interruptions. No. 96 (4x6) on positive pole a little to the left of the spinous processes, and at a level with the cardiac end of the stomach, No. 3 on negative *labile* over stomach; 10 minutes daily.

Eczema.

Central galvanization. (See Central Galvanization).

Endometritis.

Galvanism. Metallic electrolysis, No. 101 attached to positive in uterus, No. 66 on abdomen; 25 to 40 ma. for 10 minutes tri-weekly. Reverse current for a few minutes to release electrode.

—Virginal. (See Dysmenorrhœa, Virginal).

Enuresis Nocturna.

Faradism. Fine wire secondary with rapid interruptions; No. 3 on both poles, one to lumbar spine, the other to pubes.

- (a) Same as above, with No. 53 in rectum.
- (b) Galvanism. No. 53 in rectum attached to negative, No. 3 positive over pubes; 5 to 8 ma. for 10 minutes daily.

Epilepsy.

Galvanism. No. 3 on each pole, positive to forehead, negative to nape of neck; 3 ma. for 5 minutes daily.

- (a) Central galvanism. (See Central Galvanization).
- (b) Static head breeze for 15 minutes daily.

Epistaxis.

Galvanism. Metallic electrolysis. No. 99 (made of copper) is attached to the positive pole and introduced into the nasal cavity in contact with erectile or varicose tissue that causes the trouble; No. 3 on negative to sternum or some indifferent point. The intensity of current should average from 3 to 5 milliamperes, and the length of *seance* from 5 to 8 minutes.

Encephaloma.

Electrolysis. Negative attached to No. 95 or 100 with one or more needles, according to size of growth, is inserted into base of tumor or a line with the skin. No. 3 on positive; 5 to 15 ma. until considerable sloughing has taken place. (See also chapter on X-ray.)

Encephaloma, external os.

Metallic Electrolysis. The electrode designed by John L. Fitz Hugh (Page 133) is best adapted for this purpose. Attach to positive pole. No. 60 on abdomen. 10 to 15 ma. for 10 minutes every second day.

Esophageal Tube, Stricture of.

Galvanism. No. 77 on negative is introduced into the tube until stricture is engaged. No. 3 on hand. 2 to 3 ma. about 4 minutes a day. Small end of electrode has passed the stricture.

Eye, Strabismus, External.

Galvanism. Positive (No. 3) on nucha; negative (No. 1) on frontal protuberance. 2 ma. for 3 minutes daily.

Eye, Strabismus. Positive, No. 3 on nucha; negative No. 1 on upper cervical ganglion, 5 ma. 3 minutes.

— Virginia. (See Dysmenorrhoea, Vaginitis, Haemorrhoids, Neuritis.)

Paralysis. Fine wire secondary electrode. Intercurrent. No. 3 or 4. 10-15 minutes. 1-2 times a day. The other electrode on the unaffected side. The current is continued until the patient is exhausted. The treatment is continued for 10-15 days. The current is continued until the patient is exhausted. The treatment is continued for 10-15 days.

Pharyngitis. Fine wire secondary electrode. Intercurrent. No. 3 or 4. 10-15 minutes. 1-2 times a day. The other electrode on the unaffected side. The current is continued until the patient is exhausted. The treatment is continued for 10-15 days. The current is continued until the patient is exhausted. The treatment is continued for 10-15 days.

Pneumonia. Fine wire secondary electrode. Intercurrent. No. 3 or 4. 10-15 minutes. 1-2 times a day. The other electrode on the unaffected side. The current is continued until the patient is exhausted. The treatment is continued for 10-15 days. The current is continued until the patient is exhausted. The treatment is continued for 10-15 days.

Rheumatism. Fine wire secondary electrode. Intercurrent. No. 3 or 4. 10-15 minutes. 1-2 times a day. The other electrode on the unaffected side. The current is continued until the patient is exhausted. The treatment is continued for 10-15 days. The current is continued until the patient is exhausted. The treatment is continued for 10-15 days.

Epithelioma.

Electrolysis. Negative attached to No. 92 or 105 with one or more needles, according to size of growth, is inserted into base of tumor on a line with the skin. No. 3 on positive; 5 to 15 ma. until considerable blanching has taken place. (See also chapter on X-ray.)

Erosions (of external os).

Metallic Electrolysis. The electrode designed by Julia L. Fitz Hugh (Page 132) is best adapted for this purpose. Attach to positive pole. No. 66 on abdomen. 10 to 15 ma. for 10 minutes every second day.

Eustachian Tube, Stricture of.

Galvanism. No. 77 on negative is introduced into the tube until stricture is engaged. No. 3 in hand. 1 to 2 ma. about 4 minutes or until distal end of electrode has passed the obstruction.

Eye, Atrophy of Optic.

Galvanism. Positive (No. 3) on nucha; negative (No. 1) on frontal protuberance. 5 ma. for 3 minutes daily.

(a) Galvanism. Positive No. 3 on nucha; negative No. 1 on upper cervical ganglion, 5 ma. 3 minutes.

(b) Galvanism. No. 74 on negative to closed lids; No. 1 on positive to nucha. 5 ma. for 3 minutes daily.

Eye, Trachoma.

Metallic electrolysis. No. 37 (made of copper) attached to positive pole and applied to granular surface. No. 3 negative in hand. 3 to 5 ma. for 5 minutes, or until the membrane has assumed a greenish hue. Use cocaine anæsthesia.

Facial Paralysis. See Paralysis.

—**Spasm. See Spasm.**

Faradization, General.

No. 52 covered with wet towel *stabile* to feet attached to negative. No. 3 on positive *labile* over whole body.

(a) No. 66 *stabile* over coccyx on negative. No. 3 on positive *labile* over whole body. Sitting to last a half hour or longer.

Fever, Convalescent From.

Static electric bath or breeze for 15 to 20 minutes daily.

—**Hay.**

Galvanism. No. 99 (made of copper) is attached to positive pole and applied to sensi-

five spots in nasal cavity. Negative (No. 3) is held on cheek & sittings daily commencing with 3 ma., gradually increase the current with each seance until 5 or 6 ma. is reached.

Fibroids, Uterine.

These tumors being distinctly of benign origin must be treated with a view of cutting off their nutritive supply or establishing a retrograde metamorphosis. This is nearly always better accomplished by the use of the positive pole intravaginally on account of its power of lessening the caliber of the blood vessels, besides which it will check the hæmorrhage if that be one of the symptoms.

Many operators recommend the use of the negative for the active pole, but if this pole be used it must be with the purpose of actually destroying or decomposing some of the fibrous tissue and this would require the large currents recommended by Apostoli (100 to 300 ma.) which are usually not well borne. If the negative pole was used at all it had better be on those of the sub-mucous variety where the endometrium presents a nodular appearance.

(8) Galvanism. No. 74 on negative to closed lids; No. 1 on positive to nucha. 5 ma. for 3 minutes daily.

Eye, Trachoma.

Diatyptic electrolysis. No. 87 (made of copper) attached to positive pole and applied to granular surface. No. 3 negative in hand. 5 to 10 ma. for 5 minutes, or until the membrane has received a granular hue. Use cocaine solution.

Bladder paralysis. See Paralysis.

Blindness. See Eyes.

Brachialgia. See Pain.

No. 74 on nucha, with wet towel *stabilis* to feet. No. 3 on negative. No. 3 on positive *latibis* over whole body.

No. 74 on nucha over coccyx on negative. No. 3 on positive *latibis* over whole body. Repeat every a half hour or longer.

Brain (motor) paralysis.

Hot or tepid bath or breeze for 15 to 20 minutes daily.

Chorea.

Chorea. No. 89 (made of copper) is attached to positive pole and applied to sensi-

tive spots in nasal cavity. Negative (No. 3) in hand or on cheek ; sittings daily commencing with 3 ma., gradually increase the current with each seance until 5 or 6 ma. is reached.

Fibroids, Uterine.

These tumors being distinctly of benign origin must be treated with a view of cutting off their nutritive supply or establishing a retrograde metamorphosis. This is nearly always better accomplished by the use of the positive pole intrauterine on account of its power of lessening the caliber of the blood vessels, besides which it will check the hæmorrhage if that be one of the symptoms.

Many operators recommend the use of the negative for the active pole, but if this pole be used it must be with the purpose of actually destroying or decomposing some of the fibrous tissue and this would require the large currents recommended by Apostoli (100 to 250 ma.) which are usually not well borne. If the negative pole was used at all it had better be on those of the sub-mucous variety where the endometrium presents a nodular appearance.

Anatomically all fibrous growths are decreased in size by the use of the current, but the object of such application is not so much with a view to their obliteration (very few entirely disappear) as to make a symptomatic cure and thus enable the patient to pass a comfortable existence.

Fissure, in Ano.

Galvanism. A copper wire or other suitable copper electrode attached to positive is applied to surface of fissure until characteristic green color is obtained.

—**In Nipples.**

Galvanism. A small copper wire with smooth point attached to positive pole is applied to the full extent of fissure until it turns an apple green, showing that the oxychloride of copper has been deposited. Current strength must be governed by extent of active surface on the electrode.

Fistula.

Galvanism. Insert probe-pointed copper wire to full depth of fistula, attach to positive pole. No. 3 on negative to some indifferent point. Current strength must be governed entirely by the depth and caliber of fistula.

Galvanism. If very bad, use a small electrode attached to negative pole of battery, and cathode for 2 or 3 minutes. Use the other hand in hand. Use low frequency.

Example. See Balls.

Galactorrhoea.

Galvanism. Cut a sheet of India rubber in the manner of a breast plaster, leaving a hole in the center for the nipple, and make the hole a connector for inserting a cord. Use some tenacious clay with water and it is thick enough to spread. Put a thick coat of the clay upon the block tin, attach to the positive pole of the battery and apply to the breast. No. 66 on negative between the shoulders. 20 ma. for 10 minutes daily.

Note.—If the treatments be continued the galactorrhoea will entirely cease.

Faradism. Fine wire coil rapid interrupted. No. 1 on each pole. Apply around the breasts, not through them. 10 minutes daily.

Galactorrhoea.

Faradism. Fine wire coil rapid interrupted.

Anatomically all fibrous growths are decreased in size by the use of the current, but the object of such application is not so much with a view to their obliteration (very few entirely disappear) as to make a symptomatic cure and thus enable the patient to pass a comfortable existence.

Electrolysis

Electrolysis. A copper wire or other suitable conductor attached to positive is applied to the growth of tissue until characteristic symptoms are obtained.

Electrolysis

Electrolysis. A small copper wire with smooth ends attached to positive pole is applied to the growth of tissue until it turns an apple green, showing that the oxychloride of copper has been deposited. Current strength must be governed by extent of active surface on the electrode.

Electrolysis

Electrolysis. Insert probe-pointed copper wire to full depth of fistula, attach to positive pole. Run on negative to some indifferent point. Current strength must be governed entirely by the depth and caliber of fistula.

Freckles.

Galvanism. If very black insert fine steel needle attached to negative pole just under epidermis for 2 or 3 seconds. No. 3 to positive in hand. Use four Leclanche cells.

Furuncle. See Boils.**Galactorrhœa.**

Galvanism. Cut a sheet of block tin after the manner of a breast plaster, leaving a hole in the center for the nipple, and solder onto it a connector for inserting a cord tip. Mix some tenacious clay with water until it is just thick enough to spread. Put a thick coat of this clay upon the block tin, attach to the positive pole of the battery and apply to the breast. No. 66 on negative between the shoulders. 20 ma. for 10 minutes daily.

NOTE.—If the treatments be continued lactation will entirely cease.

(a) Faradism. Fine wire coil rapid interruptions. No. 1 on each pole. Apply current *around* the breasts, not through them. 10 minutes daily.

Gastralgia.

Faradism. Fine wire coil rapid interruptions.

No. 3 on both poles, one over stomach, the other on back.

- (a) Galvanism. No. 3 on both poles. Positive over stomach, negative to back. 20 ma. for 5 minutes.

Gestation, Ectopic.

Faradism. Fine wire coil *slow* interruptions. No. 116 placed against sac per vagina or rectum. No. 66 on abdomen. Five minutes every second day until diminution in size of sac is apparent, then use galvanism, same electrodes, with negative pole to sac. 15 to 20 ma. for 5 minutes every second day.

Gleet.

Galvanism. Use a No. 100 electrode that has holes drilled throughout its entire length, with *copper* applicator.

Wind cotton loosely on the applicator and wet with normal salt solution. Use a current strength of from 5 to 8 ma. for ten minutes, repeated every fourth day.

Goitre.

Galvanism. Cataphoresis. No. 113 with pad of cotton, lint or blotting paper saturated with strong solution of potassium

electrode stretched to opposite pole. No. 1 on positive to opposite side of growth; 20 mg. for 5 minutes every third day if irritation caused by the current will permit.

Hyperostosis

Although galvanism has been used on the skull the author believes it to be harmful on account of its effect on the vagus, inhibiting the vagus's action. It is better to pay no attention to the thyroid but give the static current for 30 minutes daily, to improve the conductance of the nerves.

Paralysis.—As many cases of goitre are due to gland disease but with an entire absence of hyperostosis the author believes it safer to avoid all such electrolysis by cataphoresis, with the positive pole and not suprarenal extract.

Paralysis of the vocal cords

Paralysis. Fine wire secondary, rapid in-
tercurrents applied with suitable electrodes
over painful parts.

Galvanism. No. 95 of suitable size at-
tached to positive over seat of brain. Large

No. 8 on both poles, one over stomach, the other on back.

- (d) Galvanism. No. 8 on both poles. Positive over stomach, negative to back. 20 ma. for 2 minutes.

Uterine Cataphoresis.

Indication. Fine wire coil with interruptions. No. 100 placed against sac per vagina to the sac. No. 95 on abdomen. Five minutes every second day until diminution in size of uterus is apparent, then use galvanism, same electrodes with positive pole to sac. 10 to 15 ma. for 5 minutes every second day.

Uterus.

Indication. Fine No. 100 electrode that has been rolled throughout its entire length, with interruptions.

Application. Apply loosely on the applicator and use potassium iodine solution. Use a current strength of 5 to 8 ma. for ten minutes, or until every fourth day.

Vagina.

Indication. Cataphoresis. No. 113 with pad of cotton, lint or blotting paper saturated with strong solution of potassium

iodide attached to *negative* pole. No. 1 on positive to opposite side of growth; 20 ma. for 5 minutes every third day if irritation caused by the current will permit.

—Exophthalmic.

Although galvanism has been used on the gland the author believes it to be harmful on account of its effect on the vagus, inhibiting the heart's action. It is better to pay no attention to the thyroid but give the static breeze for 20 minutes daily, to improve the condition of the nerves.

NOTE.—As many cases of goitre are due to heart lesions but with an entire absence of exophthalmos, the author believes it safer to treat all such enlargements by cataphoresis, with the *positive* pole and sol. suprarenal ext. or thuja.

Gonorrhœa. See Gleet.

Gout.

Faradism. Fine wire secondary; rapid interruptions applied with suitable electrodes over painful parts.

(a) Galvanism. No. 96 of suitable size attached to positive over seat of lesion. Large

surface electrode to negative; 20 ma. for 10 minutes daily.

- (b) Galvanism. Cataphoresis. Use current same as above but saturate positive sponge with a solution of the salts of lithium.

Hæmatocele, Pelvic.

Galvano-puncture. No. 58 attached to positive. Make puncture through vagina. No. 66 on negative to back or abdomen; 20 ma. for 5 minutes. Reverse current to free electrode.

- (a) Galvanism. No. 94 applied to mass through vagina on positive pole. Negative No. 66 on back or abdomen so as to include the mass between the two electrodes; 25 ma. gradually increased to 50 ma. for 5 minutes every second day if the irritation caused by the negative electrode will permit.

Hæmorrhage, Cerebral.

Galvanism. Position No. 1 to the side of the lesion. Negative No. 3 to opposite side on neck. 5 ma. for 5 minutes daily.

—Post Partum.

Bipolar Faradism. Medium wire, secondary coil. 2,000 to 3,000 interruptions per minute.

No. 69 in uterus. 10 to 15 minutes, or until bleeding is checked.

- (4) Galvanism. No. 69 on positive in uterus. No. 68 on abdomen. 50 to 100 ma. for 5 minutes.

(See footnote under "Catheter Cervical.")

Florida. See Tumors.

Hemorrhoids.

Catheter. No. 57, made of copper, is introduced into the rectum and attached to the positive pole. No. 68 on negative to abdomen. 10 ma. for 10 minutes every second day.

To avoid the possibility of the electrode on the mucous surface of the rectum or metallic surface being electrically covered with discharge fluid or salt deposit as first the rectum on a catheter is irrigated with water. It is not best to use either soap or "sterilizer" are favored by the discharge of discharge. The polar effect of the current and the heat is a main factor. It is not best to discharge the electrode on the discharge fluid as this means the reason that is taken care of above treatment. Indeed the covering solution saturated with the salts of copper, and if a gauze cover is used at each session, we lose, as a great measure, the antiseptic effect of the copper salts. The operator will also find

surface electrode to negative; 20 ma. for 10 minutes daily.

- (8) Galvanism. Cataphoresis. Use current same as above but saturate positive sponge with a solution of the salts of lithium.

Stomach, Pouch.

Cathode-puncture. No. 53 attached to positive. Make puncture through vagina. No. 54 or negative to back or abdomen; 20 ma. for 5 minutes. Reverse current to free electrode.

- (9) Galvanism. No. 54 applied to mass through vagina on positive pole. Negative No. 55 on back or abdomen so as to include the mass between the two electrodes; 20 ma. gradually increased to 50 ma. for 5 minutes every second day if the irritation caused by the negative electrode will permit.

Thyroid Gland.

Galvanism. Position No. 1 to the side of the neck. Negative No. 3 to opposite side on neck. 5 ma. for 5 minutes daily.

Testicular.

Similar Faradism. Medium wire, secondary coil - 2,000 to 3,000 interruptions per minute.

No. 69 in uterus. 10 to 15 minutes, or until bleeding is checked.

(a) Galvanism. No. 99 on positive in uterus. No. 66 on abdomen. 50 to 100 ma. for 5 minutes.

(See footnote under "Catarrh Cervical.")

—**Fibroids. See Tumors.**

Hæmorrhoids.

Galvanism. No. 53, made of copper, is introduced into the rectum and attached to the positive pole. No. 66 on negative to abdomen. 15 ma. for 10 minutes every second day.

To avoid the sticking of the electrode to the mucous surface of the rectum its metallic surface must be smoothly covered with chamois leather or kid sewed on just like the cover on a ball; wet this with water only. It is not best to use either soap or vaseline; the former by its alkalinity counteracts the polar effect of the current and the latter is a non-conductor. It is not best to change the covering on the electrode for each application for the reason that it takes two to three treatments before the covering becomes saturated with the salts of copper, and if a new cover is used at each seance, we lose, in a great measure, the antiseptic effects of the copper salts. The operator will also find

relief of many reflex symptoms which puzzled him greatly that were due to rectal irritation.

Hair, Superfluous.

Galvanism. A fine, steel needle, bulbous pointed (made for this purpose), is fastened into No. 107 and attached to the negative pole. No. 3 on positive, within easy reach of the patient. Use five cells of the Leclanche form or four of the acid type. Introduce needle into follicle, following the direction of hair shaft. Have the patient complete the circuit by laying hand on sponge electrode. The hair should now be grasped with the forceps (No. 72), but *very little* traction used. When the bulb is destroyed the hair will come out *almost by itself*.

Do not use sharp pointed needle. Do not grasp hair with forceps before introducing the needle. Use magnifying glass if sight is not good.

Hay Fever. See Fever.

Hemicrania.

Galvanism. Positive (No. 1) on supraorbital arch, negative (No. 1) on the mastoid; 5 ma. for 5 to 8 minutes.

Paradise. The "electric hand" The operator holds the positive electrode in his hand while the patient holds the negative. The operator then uses his right hand as an electrode. The left hand is used as an electrode. The legs are also treated. The treatment is continued for 15 minutes.

The patient is then treated with a current of 10 to 20 mA. The treatment is continued for 15 minutes.

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relief of many reflex symptoms which puzzled him greatly that were due to rectal irritation.

Case, No. 100.

Diagnosis. A fine, steel needle, bulbous pointed (made for this purpose), is fastened into No. 197 and attached to the negative pole. No. 2 on positive, within easy reach of the patient. Use five cells of the Leclanché type or less of the acid type. Introduce needle into hair, following the direction of hair shaft. Have the patient complete the circuit by laying hand on sponge electrode. The hair should now be grasped with the forceps (No. 53), but *very little* traction used. When the hair is destroyed the hair will *soon fall out by itself*.

Use hot iron sharp pointed needle. Do not grasp hair with forceps before introducing the needle. Use magnifying glass if sight is not good.

Case No. 101.

Diagnosis.

Diagnosis. Positive (No. 1) on supraorbital arch, negative (No. 1) on the mastoid; 5 ma. for 4 to 5 minutes.

- (a) Faradism. The "electric hand." The operator holds the positive electrode in left hand while the patient holds the negative. The operator then uses his right hand as an electrode to the affected part. The hair must be moistened. Use long, fine wire, secondary current, with rapid interruptions.
- (b) Static head breeze for 15 to 20 minutes.

Herpes Zoster.

Galvanism. Negative pole over seat of lesion, positive at some indifferent point; 10 ma. for 15 minutes daily.

Hydrocele.

Galvano-puncture. No. 58 on negative pole in scrotum, No. 96 on positive to thigh or abdomen. Increase current gradually to 40 ma. and continue for 5 minutes.

- (a) Draw off the fluid from scrotum, and inject into the sac about one-half the quantity drawn off of a solution of potassium iodide (1 to 20); then introduce No. 58 attached to *positive* pole with No. 96 on thigh, and turn on current until 18 or 20 ma. is reached. Sitting 10 to 12 minutes.

Hyperæsthesia, Skin.

Galvanic baths. An ordinary bath tub may be utilized in the following manner: Attach a metallic strip to an insulated wire, place the strip in bottom of tub, which must be porcelain or porcelain lined, and cover with lattice or strips of wood to prevent contact with the patient. After the latter is placed in the bath one pole of the battery is attached to the insulated wire running to the metallic strip in tub, the other attached to No. 1 is held in patient's hand, which must be *out of the water*. In this trouble the patient must hold the positive pole in the hand, while the negative is attached to the tub.

—Of Stomach.

Faradism. Fine wire secondary with rapid interruption. One electrode (No. 3) to epigastrium, the other to spine for 5 to 10 minutes daily.

Hypertrophy, Inf. Turbinated.

Galvanism. No. 106 (used bipolar) in turbinated. 15 to 20 ma. for 5 minutes. Seance once in seven or eight days.

Avanion No. 106 (unipolar) is applied to negative by cathode. The + is attached to positive by anode to cathode. The + is attached to positive by anode to cathode. The + is attached to positive by anode to cathode.

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Hypodermic, Skin.

Galvanic baths.—An ordinary bath tub may be utilized in the following manner: Attach a metallic strip to an insulated wire, place the strip in bottom of tub, which must be porcelain or porcelain lined, and cover with lattice or strips of wood to prevent contact with the patient. When the water is placed in the tub one end of the battery is attached to the positive end of the wire to the metallic strip in the bottom of the tub. No. 1 is held in position by a clamp which must be out of the water. The other end of the battery must hold the positive end of the wire, while the negative is attached to the patient.

Electrolysis.

Electrolysis.—Start with secondary with rapid discharge. Use anode (No. 3) to epidermis, the other to spine for 5 to 10 minutes.

Electrolysis of the bladder.

Electrolysis.—No. 105 (used bipolar) in turbid urine. Use 10 to 20 ma. for 5 minutes. Sessons given every two or eight days.

- (a) Galvanism. No. 106 (unipolar)* attached to negative in turbinated. No. 3 to positive in hand. 10 ma. for 5 minutes once a week. The use of cocaine is nearly always desirable.

Hypochondriasis.

Static breeze for 15 to 20 minutes daily.

- (a) Galvanization of the spine. 10 ma. for 10 minutes daily.

Hysteria.

Static head breeze for 15 minutes followed by "static induced" for 10 minutes with roller electrode up and down spine.

- (a) Static head breeze for 15 minutes followed by general faradization for 15 minutes (See Faradization.)

Hystero-Epilepsy.

Faradism. Coarse wire coil, fifty to sixty interruptions per minute. No. 52 covered with wet towel to feet; a long sponge or spongopilin covered electrode, 2 x 24 to spine. Seance 10 minutes every second day.

- (a) Static head breeze for 15 minutes daily.

*This electrode is made unipolar by winding a few turns of bare wire around the metal connecting posts on proximal end.

Inertia, Uterine.

Faradism. Medium wire secondary with intermediate interruptions. Use bipolar vaginal electrode No. 86 in vagina. Seance 5 minutes, to be repeated every hour or two.

Infantile Paralysis. See Paralysis.**Insanity.**

Static head breeze followed by "static induced" up and down spine. Seance to last 25 minutes every other day and to be alternated with central galvanization. (See central galvanization.)

Insomnia.

Galvanism. Use a different one of the following methods at each alternate sitting:

Positive, No. 3, to forehead; negative, No. 3, to nape of neck. 2 to 3 ma. for 10 minutes.

Positive, No. 3, on cervical vertebræ; negative to epigastrium. 10 ma. for 15 minutes.

Positive, No. 3, on cervical spine; negative attached to foot bath. 15 ma. for 15 minutes.

(a). Static head breeze for 20 minutes daily. In the evening is best.

Insulation, for Needles, etc.

Take a wide-mouthed bottle and fill it nearly

full of ordinary orange shells, pour on sufficient alcohol to cover to and let stand until dissolved. It can be thinned if desirable by adding a little more alcohol. Push a camel's hair pencil into the mixture and the narrow end of a medicine brush. These can be insulated and pushed into a soft mold to the required depth and then painted with the mixture until it is on the free surface of the cork. They can be used after a few hours. Ordinary uninsulated metal electrodes of any kind can be insulated at any part desired by painting them with this mixture.

Case of the 2nd degree burn.

Condition. No. 1 is closed 50 on positive No. 2 is hand. 1 sec. for 2 or 3 minutes.

Condition. No. 1 is closed 50 on negative No. 2 is hand. 2 sec. for 2 minutes.

Results.

Condition. No. 1 covered with wet towel to keep attached to negative. No. 2 on positive 40 on whole surface of body. Sitzings 1/2 hour every second day.

(3) Static "Surgings" over liver daily.

Electric Currents

Currents. Medium wire secondary with
variable transformer. Use light
cell No. 35 in circuit. Current
to be repeated every hour at
intervals of 15 minutes.

Electrolysis of the Cervical Glands

Use 100-gram jar with 100 cc. of
distilled water. Electrodes to be
in contact with the gland to be elec-
trolyzed with surface of 100 sq. cm.
and galvanic.

Procedure.

Galvanic. Use constant current of the fol-
lowing method of electrolysis using
Parker's No. 4 as the positive, No. 3
as the negative. 4 to 10 ampere, 20 minutes.
Positive electrode attached to gland; negative
to a separate electrode for 15 minutes.
Parker's No. 3 as the positive; negative
attached to gland for 15 minutes.
(a) Place hand between the 20 minutes daily
in the evening is best.

Electrolysis of the Cervical Glands

Take a wide-mouthed bottle and fill it nearly

full of ordinary orange shellac, pour on sufficient alcohol to cover it and let stand until dissolved. It can be thinned if desirable by adding a little more alcohol. Fasten a camel's hair pencil into the stopper after the manner of a mucilage brush. The needles to be insulated are pushed into a soft cork to the required depth and then painted with the shellac varnish down to the free surface of the cork. They can be used after a few hours. Ordinary uninsulated metal electrodes of any kind can be insulated at any part desired, by painting them with this mixture.

Iritis, Pain and Congestion in.

Galvanism. No. 74 to closed lids on positive; No. 3 in hand. 1 ma. for 2 or 3 minutes.

—**Adhesions following.**

Galvanism. No. 74 to closed lids on negative. No. 3 in hand. 2 ma. for 5 minutes.

Jaundice.

Faradism. No. 52 covered with wet towel to feet attached to negative. No. 3 on positive *labile* to whole surface of body. Sittings one-half hour every second day.

(a) Static "Surgings" over liver daily.

Lactation, Excessive. See Galactorrhœa.

Lateral Sclerosis.

Galvanic Baths. The regular electric bath tub, such as shown on last page, is the one preferred. The current is turned on with the positive to head, the negative to feet, and as the patient only receives about a fifth of the total current passing, the meter should register 200 ma. The bath should continue 10 or 15 minutes and be given every day for 5 or 6 days; then every other day until 15 baths are taken.

Lead Paralysis. See Paralysis.

Leucorrhœa, Vaginal.

Galvanism. Metallic electrolysis. No. 104 with large copper olive covered with a wad of wet cotton is attached to the positive pole in vagina; No. 66 on abdomen. 25 ma. for 5 minutes every third day.

NOTE.—Electrode No. 68 if made of copper is better adapted to the treatment of this trouble. The metal portion of any electrode is, however, easily plated with copper and answers just as well as the solid metal. For process, see Plating.

Liver, Cirrhosis.

General faradization. See Faradization.

- (a) Interrupted galvanic. Positive No. 3 posteriorly over liver; negative No. 66 to epigastrium. 10 ma. Interrupted 200 times per minute.

Spots.

Galvanism. Carbon disc, No. 88, covered with cotton is attached to positive and applied over discoloration; negative in hand. 10 ma. for 5 minutes daily.

Note.—It is probable that these spots can be removed much better and quicker by the process termed "acoechment."

Lumbago Ataxia.

Galvanism. No. 88, 2x24, negative to spine. No. 63 to sacrum. Commence with a current of 5 ma. for 10 minutes, and gradually increase at each sitting until about 20 ma. is reached.

- (a) Galvanic Bath. See "Lateral sclerosis."

- (b) Static direct spark to full extent of spine for 5 minutes, followed by static head beam for 15 minutes.

Spine.

Galvanism. Metallic electrolysis. No. 14,

Lectures, Courses, São Galvão, Bahia,

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Liver, Cirrhosis.

General faradization. See Faradization.

- (a) Interrupted galvanic. Positive No. 3 posteriorly over liver, negative No. 66 to epigastrium. 10 ma. interrupted 100 times per minute.

—Spots.

Galvanism. Carbon disc, No. 88, covered with cotton is attached to positive and applied over discoloration; negative in hand. 10 ma. for 5 minutes daily.

NOTE.—It is probable that these spots can be removed much better and quicker by the process termed "ecorchement."

Locomotor Ataxia.

Galvanism. No. 96, 2x24, negative to spine. No. 66 to sternum. Commence with a current of 5 ma. for 10 minutes, and gradually increase at each sitting until about 20 ma. is reached.

- (a) Galvanic Bath. See "Lateral sclerosis."
(b) Static direct spark to full extent of spine for 5 minutes, followed by static head breeze for 15 minutes.

Lupus.

Galvanism. Metallic electrolysis. No. 14,

made of thin copper, on *positive* to lesion. No. 96 to sternum, or some indifferent part. 10 to 15 ma. for 5 minutes, or until a thorough application of the oxychloride of copper is made, which can be ascertained by the color.

N. B.—If the seat of lesion is first moistened with salt water the deposition of the salt of copper is very materially hastened.

(See also literature on X-ray).

Massage.

Faradism. No. 111 bipolar electrode is used over the parts to be influenced. Coarse wire secondary coil with medium interruptions.

(a) No. 30 attached to the arm of the operator, who then uses his hand as an electrode, the other pole being in contact with patient.

Melancholia.

Galvanism. Positive pole to footbath. Negative, No. 3, to nape of neck and up and down spine. 5 to 8 ma. for 20 minutes every second day.

(a) Static head breeze for 15 minutes, followed by "static induced" to spine. Sittings daily.

Meningitis.

Galvanism. No. 3 on positive over parietal

region, No. 3 on negative submand; 5 ma. for 6 minutes daily.

(4) Galvanism, No. 35 on negative to sur-
mun, No. 3 on positive *labile* over cervical
spot; 10 ma. for 10 minutes.

(5) Static head brace for 15 minutes daily.

Measurements

Facialia. Measure with necessary. Eye
for eyelid. No. 25 in lower 25 minutes
daily.

(6) Galvanism, No. 25 in lower 25 minutes
daily. No. 25 in lower 25 minutes
for 10 minutes daily.

(7) Galvanism, No. 25 in lower 25 minutes
daily. No. 25 in lower 25 minutes
for 10 minutes daily. No. 25 in lower
25 minutes daily. No. 25 in lower
25 minutes daily. No. 25 in lower
25 minutes daily. No. 25 in lower
25 minutes daily.

Electrolysis

Galvanism. No. 115 with silver ball is well
covered with wet cotton attached to positive
pole and placed in vault of vagina. No. 35 on
submun. 25 to 40 ma. for 10 minutes 3-
weekly.

(8) Galvanism. Metallic electrolysis. No.

made of thin copper, on positive to lesion. No. 75 to stream, or some indifferent part. 10 to 15 ma. for 5 minutes. or pain through application of the electrode of copper is made, which can be ascertained by the color.

N. 3. — Rubrospinal. A solution of potassium permanganate and water for the purpose of the salt of copper is not necessarily required.

By the use of the following

the electrode of the following electrode is used. The electrode is made of copper wire and is used in the following manner.

The electrode is used in the following manner. The electrode is used in the following manner. The electrode is used in the following manner.

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The electrode is used in the following manner. The electrode is used in the following manner. The electrode is used in the following manner.

region, No. 3 on negative subaural ; 5 ma. for 5 minutes daily.

- (a) Galvanism. No. 96 on negative to sternum, No. 3 on positive *labile* over cervical spine ; 10 ma. for 10 minutes.
- (b) Static head breeze for 15 minutes daily.

Menopause.

Faradism. Medium wire secondary. Bipolar method, No. 69 in uterus ; 10 minutes daily.

- (a) Galvanism. No. 99 attached to negative in uterus, No. 66 on abdomen ; 20 to 25 ma. for 10 minutes every second or third day.
- (b) Static insulation has an equalizing effect on the nervous forces, and is, therefore, of much benefit in the "fullness of the head" symptom which almost always accompanies this trouble.

Menorrhagia.

Galvanism. No. 116 with *copper* ball is well covered with wet cotton, attached to positive pole and placed in vault of vagina, No. 66 on abdomen, 25 to 40 ma. for 10 minutes tri-weekly.

- (a) Galvanism. Metallic electrolysis. No.

104, with zinc olive, in uterus attached to positive pole, No. 66 on abdomen; 25 to 40 ma. for 8 minutes tri-weekly.

Metritis.

Galvanism. Cupric electrolysis. No. 103 or 104 in uterus attached to positive, large electrode on abdomen; 40 ma. for 5 minutes every second day.

- (a) Galvanism. No. 116 of copper, in vagina attached to positive, No. 66 on abdomen; 25 to 40 ma. every third day.

—Peri and Para.

In the acute inflammatory stage use secondary Faradic current from long, fine wire coil with rapid interruptions. Bipolar method with No. 86 in vagina. Seances 15 to 20 minutes each day until the subacute stage is reached, when the following is to be used:

- (a) Galvanism. No. 99 attached to positive in uterus, No. 66 on abdomen. Commence with 30 ma. for 3 minutes twice a week, and gradually increase current strength and time to 75 ma. for 5 minutes.

Miscarriage. See Abortion.

Notes.

Galvanism. Steel needle fastened into No. 107 and attached to the negative pole is introduced into the mole on a line with the skin, not quite through but nearly so. No. 5 on positive within easy reach of patient, who completes the circuit by laying his hand upon it. Use six cells of the Leclanche form or four of the acid variety. Continue application for 5 minutes or until the growth is blanched to an ashy hue. In case the growth is large a holder should be used capable of holding two or three needles. Such a one is shown in Fig. 92 or 106. The needles for this work should always be insulated. (See Insulation.)

Results.

Galvanism. No. 5 over area of lesion. No. 3 on stomach; 10 ma. for 10 minutes, the current to be reversed every half minute.

(2) Galvanism. No. 3 on positive to apex of neck. No. 3 on negative to lumbar space. Sesside 10 minutes with 10 ma., the current to be reversed three times during the sitting.

104, with zinc olive, in uterus attached to positive pole, No. 60 on abdomen; 25 to 40 ma. for 5 minutes tri-weekly.

Scarcis

Carbonium. Cupric electrolysis. No. 105 or 106 in uterus attached to positive, large electrode on abdomen; 40 ma. for 5 minutes 2 times a week.

Copper. No. 110 of copper, in vagina attached to positive, No. 60 on abdomen; 25 to 40 ma. 2 times a week.

Electrolysis

At the acute inflammatory stage use second stage electrodes, instead of long, fine wire coil with large electrodes. Bipolar method with No. 10 in vagina. Sessances 15 to 20 minutes 2 or 3 times a week until the subacute stage is reached, after which the following is to be used:

Carbonium. No. 90 attached to positive in uterus, No. 60 on abdomen. Commence with 20 ma. for 5 minutes twice a week, and gradually increase current strength and time to 40 ma. for 5 minutes.

Electrolysis for Abortion.

Moles.

Galvanism. Steel needle fastened into No. 107 and attached to the negative pole is introduced into the mole on a line with the skin, not quite through but nearly so. No. 3 on positive within easy reach of patient, who completes the circuit by laying his hand upon it. Use six cells of the Leclanche form or four of the acid variety. Continue application for 5 minutes or until the growth is blanched to an ashy hue. In case the growth is large a holder should be used capable of holding two or three needles. Such a one is shown in Fig. 92 or 106. The needles for this work should always be insulated. (See Insulation.)

Myelitis.

Galvanism. No. 3 over area of lesion. No. 3 on sternum; 10 ma. for 10 minutes, the current to be reversed every half minute.

(a) Galvanism. No. 3 on positive to nape of neck. No. 3 on negative to lumbar spine. Seance 10 minutes with 10 ma., the current to be reversed three times during the sitting.

Nævus. See **Moles.**

——**Vascular.** See **Vascular Tumors.**

——**Pigmentary.** See **Wine Marks.**

Nasal, Spurs of Septum.

Galvanism. Bipolar needle holder No. 106. The needles are thrust into the growth and a current from 10 to 12 cells is used until the blanched appearance indicates that electrolysis is complete.

——**Stricture.**

Galvanism. Attach to the negative pole electrode No. 21 with an olive one or two sizes larger than the caliber of stricture. No. 3 on negative in hand or on sternum; 3 to 10 ma. until the bulb passes through stricture. Repeat operation in from five to seven days, increasing size of olive at each sitting.

Nettle Rash. See **Urticaria.**

Neuralgia.

Galvanism. Cataphoresis. No. 1 with sponge saturated with chloroform, attached to positive pole, is applied to lesion. No. 3 on negative to some indifferent point. 3 to 5 ma. for 3 to 5 minutes.

N. B. Care should be taken not to apply current too long, as vesication may result.

(a) Galvanism. Positive pole over seat of pain, with negative at some indifferent point. If the neuralgia is not about the head a current of 12 to 15 ma. may be applied for 10 minutes daily.

(b) Faradism. Secondary current from long fine wire coil, rapid interruptions. Sitzings, 10 to 15 minutes.

Hysterical.

Static head breeze for 20 minutes daily.

Trigeminal.

Galvanism. No. 1 on positive over lesion. No. 3 on negative over upper cervical vertebra. 2 ma. for 5 minutes, two or three times daily.

(a) Cataplasms. A disc of blotting paper is saturated with solution cocaine and placed over the exit of the superior maxillary branch. No. 45 attached to positive pole is applied to this. No. 3 to negative is hand. 7 to 10 ma. for 5 minutes.

Electrolysis.

Static head breeze for 20 minutes daily, followed by static induced current for 10 min.

Nervous. See Nerves.

—Tumors. See Vascular Tumors.

—Fibromatous. See Wine Marks.

Nasal, Stenosis of Septum.

Galvanic. Bipolar needle holder No. 106. The needles are thrust into the growth and a current from 10 to 12 mA is used until the bluish-gray discoloration indicates that electrolysis is complete.

—Nasal.

Faradic. Attach to the negative pole electrode No. 95 with an olive eye or two olive eyes. Attach to the positive pole electrode No. 2 with an olive eye or an olive eye and a cork. The current is passed through the nostrils. The total operation is from five to ten days, depending on the size of olive at each sitting.

—Nasal, Stenosis of Septum.

—Nasal.

Galvanic. Caseohvysis. No. 1 with sponge electrode with chloroform, attached to positive pole, is applied to lesion. No. 3 on negative to some indifferent point. 3 to 5 ma. for 3 to 5 minutes.

N. B. Care should be taken not to apply current too long, as vesication may result.

- (a) Galvanism. Positive pole over seat of pain, with negative at some indifferent point. If the neuralgia is not about the head a current of 12 to 15 ma. may be applied for 10 minutes daily.
- (b) Faradism. Secondary current from long, fine wire coil, rapid interruptions. Sitzings, 10 to 15 minutes.

—**Hysterical.**

Static head breeze for 20 minutes daily.

—**Trigeminal.**

Galvanism. No. 1 on positive over lesion. No. 3 on negative over upper cervical vertebræ. 3 ma. for 5 minutes two or three times daily.

- (a) Cataphoresis. A disc of blotting paper is saturated with solution cocaine and placed over the exit of the superior maxillary branch. No. 88 attached to positive pole is applied to this. No. 3 to negative in hand. 7 to 10 ma. for 3 minutes.

Neurasthenia.

Static head breeze for 20 minutes daily, followed by static induced current for 10 min-

utes, with one pole to feet, the other (with roller electrode) over parts affected.

—**Cerebral.**

Galvanism. No. 3 to forehead on positive. No. 3 to nape of neck on negative. 3 ma. for 3 minutes. Increase to 5 ma. for 5 minutes if tolerance is good. Sitzings daily.

Obstetrics, Uterine Inertia.

Faradism. Bipolar method. Secondary current from medium wire. No. 86 in vagina. Apply current for 5 minutes every hour.

—**Retention of Dead Fœtus.**

Faradism. Secondary current from coarse wire coil, used bipolar in uterus with electrode No. 69.

Œsophagus, Paralysis of. See Paralysis.

—**Stricture of.**

Galvanism. No. 55 is attached to the negative pole, with an olive one or two sizes larger than the caliber of the stricture. No. 3 on positive to sternum or in hands. 10 ma. until bulb passes through stricture. To be repeated in four or five days, increasing size of olive at each sitting.

Optic Nerve, Atrophy of. See Eye.

Procedure.

Galvanism. A No. 1 electrode attached to each pole is placed one on each side of the mass and the current gradually turned on until 10 ma. is reached. This should be maintained for 3 or 3 minutes, and the current turned off again gradually, when the polarity is to be reversed by the same method of current gradually turned on or off. The whole sitting should occupy about 15 minutes.

Diagnosis.

Paralysis. Involuntary contraction of the muscles will occur with direct current. The No. 1 electrode is placed on the paralyzed muscle and the current gradually turned on until 10 ma. is reached. This should be maintained for 3 or 3 minutes, and the current turned off again gradually, when the polarity is to be reversed by the same method of current gradually turned on or off.

Atrophy. The No. 1 electrode is placed on the atrophic muscle and the current gradually turned on until 10 ma. is reached. This should be maintained for 3 or 3 minutes, and the current turned off again gradually, when the polarity is to be reversed by the same method of current gradually turned on or off. The whole sitting should occupy about 15 minutes.

Precautions.

The positive pole of galvanic current.

Orchitis.

Galvanism. A No. 1 electrode attached to each pole is placed one on each side of the mass and the current gradually turned on until 10 ma. is reached. This should be maintained for 2 or 3 minutes, and the current turned off again gradually, when the polarity is to be reversed and the same amount of current gradually turned on as before. The entire sitting should occupy about 10 minutes.

Ovaritis.

Faradism. Secondary current from long, fine wire coil applied with bipolar vaginal electrode No. 86 for 15 to 20 minutes each day until sensitiveness to pressure has been overcome; then use:

- (a) Galvanism. No. 116 in vagina against the ovary on positive pole. No. 66 on negative to abdomen. 20 ma. for 8 to 10 minutes every second day. Gradually increase current with each sitting until 35 to 40 ma. is reached.

Pain, Relief of.

The positive pole of galvanic current.

- (a) Faradic current from long, fine wire secondary coil rapidly interrupted.
- (b) Cataphoresis. Galvanism. Use solution of cocaine on positive pole.

Paralysis.

Galvanism. Positive pole with large electrode *stabile* over sternum or some indifferent point. No. 1 on negative *labile* over affected nerves and muscles, with current strength easily borne by the patient.

—Agitans.

Static insulation followed by sparks along the course of spine. 15 to 20 minutes.

- (a). Galvanism. Positive to forehead, negative to nape of neck. 3 to 5 ma. for 5 minutes daily.
- (b). Galvanism. Positive pole with large electrode over sternum. Negative, No. 3, *labile* over spine. 10 ma. for 10 minutes daily.

—Aphasia.

Galvanism. Positive pole over the third frontal convolution; negative on opposite side of neck. 3 to 5 ma. for 5 minutes daily.

- (a). Static head breeze for 15 to 20 minutes daily.

Diphtheritis.

Faradism. Coarse wire secondary coil, slow interruptions. No. 28 applied to pharynx. No. 1 low down on front part of neck. Sittings 3 to 10 minutes daily.

Note.—If electrode No. 28 causes the patient discomfort, such as gagging, etc., use No. 14 instead on tongue.

Facial, Cerebral Origin.

Galvanism. No. 1 on negative over exit of facial nerve just in front of ear. No. 3 on positive to nape of neck. 3 to 5 ma. for 5 minutes daily.

Hemiplegia.

Galvanism. No. 3 on positive to nape of neck. No. 3 on negative over inferior fronto-parietal region. 3 to 5 ma. for 3 minutes; then change the negative to a subaural position, the positive as before. Same time, same current strength. Next use faradism, coarse wire, secondary coil, slow interruptions for 10 minutes over paralyzed muscles.

Hysterical.

Static head breeze for 20 minutes daily followed by static induced current applied with roller over affected parts.

- (a) Faradic current from long, fine wire secondary coil rapidly interrupted.
- (b) Cataphoresis, Galvanism. Use solution of cocaine on positive pole.

Tracheitis

Catharsis. Positive pole with large electrode *apex* over sternum or some indifferent point. No. 1 on negative *labile* over affected larynx and muscles, with current strength easily borne by the patient.

Tracheitis

Stagnation followed by sparks along the course of spine. 15 to 20 minutes.

- (a) *Catharsis.* Positive to forehead, negative on back of neck. 3 to 5 ma. for 5 minutes daily.

- (b) *Galvanism.* Positive pole with large electrode over *apex*. Negative, No. 3, *labile* over spine. 10 ma. for 10 minutes daily.

Tracheitis

Catharsis. Positive pole over the third dorsal vertebra; negative on opposite side of neck. 3 to 5 ma. for 5 minutes daily.

- (c) Still head breeze for 15 to 30 minutes daily.

—Diphtheritic.

Faradism. Coarse wire secondary coil, medium interruptions. No. 28 applied to pharynx. No. 1 low down on front part of neck. Sittings 5 to 10 minutes daily.

NOTE.—If electrode No. 28 causes the patient discomfort, such as gagging, etc., use No. 14 instead on tongue.

—Facial, Cerebral Origin.

Galvanism. No. 1 on negative over exit of facial nerve just in front of ear. No. 3 on positive to nape of neck. 3 to 5 ma. for 5 minutes daily.

—Hemiplegia.

Galvanism. No. 3 on positive to nape of neck. No. 3 on negative over inferior fronto-parietal region. 3 to 5 ma. for 3 minutes; then change the negative to a subaural position, the positive as before. Same time, same current strength. Next use faradism, coarse wire, secondary coil, slow interruptions for 10 minutes over paralyzed muscles.

—Hysterical.

Static head breeze for 20 minutes daily followed by static induced current applied with roller over affected parts.

—**Infantile.**

Faradism. One pole (with bifurcated cord) in hands; the other *labile* ever affected parts.

(a) Galvanism. Large surface electrode on positive over diseased focus; negative to spine. 5 to 10 ma. for 10 minutes daily.

(b). Central galvanization (see central galvanization).

—**Intestinal.**

Galvanism. No. 85 attached to negative in rectum; No. 3 on positive *labile* over abdomen; 3 ma. for 10 minutes every second day.

(a) Faradism. Coarse wire secondary coil, medium interruptions. No. 85 on positive in rectum; No. 3 *labile* on negative over abdomen, lumbar and dorsal regions of the back.

—**Lead.**

Galvanic baths after the manner given under "Hyperæsthesia." In this trouble the metal strip in tub is connected with positive pole while the patient holds the negative out of the water.

—**Ocular Muscles.**

Galvanism. No. 74 attached to negative

over closed lids. No. 3 on positive below
output; 2 to 3 mA for 5 minutes daily.

67. Same electrode in same position with
output; 2 to 3 mA for five minutes.

68. It is best to alternate these two
treatments.

Chloropia

69. Same wire secondary coil with
about 100 turns per minute. No. 13
attached to the upper edge of sclerum,
output 2 to 3 mA daily.

Strabismus

70. Same as "Lagophthalmos." No. 13

attached to the upper edge of sclerum.

Parosmia

71. No. 1 on negative over exit of
facial nerve just in front of ear, or at the
zygomatic process. No. 2 on positive below
output 2 to 3 mA for 5 minutes daily.

72. Same induced current with one electrode
in hand, the other at the zygomatic process.
Output 2 to 3 mA daily.

Uterus, Infertility, Endometritis and Adenosis

73. Galvanism. No. 1 is attached to positive and
up in the vaginal vault. No. 65 on negative

Labialis.

Galvanism. One pole (with bifurcated cord) in hand; the other *labialis* over affected parts.

(a) *Galvanism.* Large surface electrode on positive over diseased focus; negative to hand. 4 to 20 ma. for 10 minutes daily.

(b) *Course galvanisation* (see central galvanisation).

Abdomen.

Galvanism. No. 85 attached to negative in rectum; No. 3 on positive *labialis* over abdomen; 2 ma. for 10 minutes every second day.

(a) *Frischman.* Coarse wire secondary coil, medium interruptions. No. 85 on positive in rectum; No. 3 *labialis* on negative over abdomen, lateral and dorsal regions of the back.

Rectum.

Galvanism. Apply after the manner given under "Hypodermic." In this trouble the metal may if left be connected with positive pole while the patient holds the negative out of the rectum.

Recto-Vaginales.

Galvanism. No. 14 attached to negative

over closed lids. No. 3 on positive below occiput; 3 to 5 ma. for 5 minutes daily.

- (a) Same electrodes in same position with mild faradic current for five minutes.

NOTE.—It is best to alternate these two treatments.

—**Œsophagus.**

Faradism. Coarse wire secondary coil with about 600 interruptions per minute. No. 14 on tongue. No. 3 to upper edge of sternum. Sittings five minutes daily.

—**Paraplegia.**

Galvanism. See “Locomotor Ataxia.”

- (a) Galvanic Baths. See “Lateral Sclerosis.”

—**Peripheral, facial.**

Galvanism. No. 1 on negative over exit of facial nerve just in front of ear, or at the styloid process. No. 3 on positive below occiput; 3 to 5 ma. for 5 minutes daily.

- (a) Static induced current with one electrode in hand, the other at the styloid process. Sittings 5 minutes daily.

Pelvis, Inflammatory Exudates and Adhesions.

Galvanism. No. 116 attached to positive well up in the vaginal vault. No. 66 on negative

to abdomen; 20 to 40 ma. for 5 to 8 minutes every second day until all inflammation and tenderness has disappeared, then reverse the polarity in all subsequent sittings and use No. 68 covered with cotton or chamois on the negative pole; same dosage as before.

Piles. See Hæmorrhoids.

Plating, Copper, for Electrodes.

Put into a suitable glass vessel a saturated solution of copper sulphate and immerse in it a strip of copper long enough to bend over the outer edge of the jar; to this strip, by means of a suitable connector, attach the positive pole of a battery of two or more cells. Connect the electrode to be plated to the negative terminal and immerse in the fluid until sufficiently plated, which will be in about 10 minutes.

NOTE.—This does not make an *elegant* job of plating, but I have found it to answer the purpose when a copper electrode is wanted for immediate use and there is none at hand. The metal to be plated should be first thoroughly cleansed. This is best done by scouring with a solution of potassium cyanide.

Myositis. See Myelitis.

Post-Purpura Hemorrhage. See Hemorrhage.

Proctitis, Extraintestinal. See Constipation.

Rectum. See

Proctum. For use with secondary coil, and interruptor. No. 3 of cathode over cathode. No. 2 of anode to tank. Charge to 100 microfarads capacity.

Rectum. For use with a 2 inch diameter cathode of No. 3 and an anode of No. 2. Charge to 100 microfarads capacity. No. 3 of cathode to tank. No. 2 of anode to tank. Charge to 100 microfarads capacity.

Rectum. See

Proctum. For use with a 2 inch diameter cathode of No. 3 and an anode of No. 2. Charge to 100 microfarads capacity. No. 3 of cathode to tank. No. 2 of anode to tank. Charge to 100 microfarads capacity. For further information the reader is referred to Chapter X.

Galvanocautery. The galvanocautery used in this operation is devised for the purpose, the best one being after the style

to abdomen: 20 to 40 ma. for 5 to 8 minutes every second day until all inflammation and tenderness has disappeared, then reverse the polarity in all subsequent sittings. Use No. 88 covered with cotton or shadix on the negative pole; same on the positive.

Electrolysis of the Gallbladder.

Electrolysis of the Gallbladder.

The gallbladder is a pear-shaped sac-like structure, situated in the right hypochondrium, and is about 4 inches long and 1 1/2 inches wide. It is covered by a peritoneum, and is attached to the greater curvature of the stomach by the cystic duct. The gallbladder is situated in the right hypochondrium, and is about 4 inches long and 1 1/2 inches wide. It is covered by a peritoneum, and is attached to the greater curvature of the stomach by the cystic duct. The gallbladder is situated in the right hypochondrium, and is about 4 inches long and 1 1/2 inches wide. It is covered by a peritoneum, and is attached to the greater curvature of the stomach by the cystic duct.

Notes.—This does not make an elegant job of plating, but I have found it to answer the purpose when a copper electrode is wanted for immediate use and there is none at hand. The metal to be plated should be first thoroughly cleaned. This is best done by scouring with a solution of potassium cyanide.

Poliomyelitis. See Myelitis.

Post-Partum Hæmorrhage. See Hæmorrhage.

Pregnancy, Extrauterine. See Gestation.

—Vomiting of

Faradism. Long, fine wire secondary coil, rapid interruptions. No. 3 on positive over epigastrium; No. 3 on negative to back. Sittings 5 to 10 minutes each morning.

- (a) Galvanism. No. 88, covered with a thin layer of cotton or lint, attached to positive pole is applied above the clavicle, between the two branches of the sterno-mastoid. No. 3 on negative over the epigastrium. 8 to 10 ma. for 15 to 30 minutes.

Prostate Gland, Hypertrophy.

Galvanism. Use electrode No. 100. Wind cotton loosely on applicator for three inches and dip into sol. potas. iod. (20 grs. to 1 oz.) Attach to *negative* pole, introduce into prostatic urethra and use 10 ma. for 10 minutes. Repeat in 4 or 5 days. For further information the reader is referred to Chapter X.

- (a) Galvano-cautery. The galvano-cautery sound used in this operation is devised for the purpose, the best one being after the style

invented by Dr. Newman. It is catheter-shaped, the stem being a hard rubber or metal tube terminating in a hollow olive which holds the platinum burner; a fenestrum in the olive permits the application of the burner to the tissues. An accumulator or storage battery is best adapted for this work.

—**Granular.**

Galvanism. Metallic electrolysis. A suitable copper olive is attached to No. 104 on positive pole and introduced into the prostatic urethra. No. 3 on negative to lumbar region or on abdomen. 5 ma. for 5 to 8 minutes. To be repeated in 4 or 5 days.

(See also Chapter X.)

Pruritus.

Faradism. Long, fine wire secondary coil with rapid interruptions. No. 3 in hand; No. 1 over seat of lesion. 5 to 10 minutes daily.

(a) Galvanism. Same electrodes. Positive pole to lesion; negative in hand. 5 ma. for 10 minutes daily.

Rectum, Stricture of.

Galvanism. No. 21 with metal olive one or

two sizes larger than caliber of stricture is
affixed to the negative pole and introduced
into the rectum against stricture. The 20 cc
solution or further saline. It is 10 cc
acid bath passes through. Repeat the
course every 4 days using large catheter
each day.

Prostate

Prostate. Urethra. Prostate. A suitable
catheter is introduced into the urethra
and the solution is introduced into the
prostate gland. The solution is
introduced into the prostate gland
by the urethra. The solution is
introduced into the prostate gland
by the urethra.

Prostate. Urethra. Prostate.

The solution is introduced into the
prostate gland by the urethra.

Prostate

Prostate. Urethra. Prostate. A suitable
catheter is introduced into the urethra
and the solution is introduced into the
prostate gland. The solution is
introduced into the prostate gland
by the urethra. The solution is
introduced into the prostate gland
by the urethra.

Take point for the electrode via from No. 10 to 15 cm. from

presented by Mr. Newton. It is
 stated that the report contains a
 full and complete account of the
 work done during the year, and
 is a valuable contribution to the
 knowledge of the subject.

The report is divided into
 several parts, and contains
 a large amount of statistical
 information. It is well
 illustrated with diagrams and
 tables, and is a most
 interesting and valuable
 work.

two sizes larger than caliber of stricture* is attached to the negative pole and introduced into the rectum against stricture. No. 66 on abdomen or lumbar spine. 10 to 15 ma. until bulb passes through. Repeat operation every 4 days using larger olive at each sitting.

—**Ulceration of.**

Galvanism. Metallic electrolysis. An insulated stem with a copper or zinc olive is applied attached to the positive pole, the negative being at some indifferent point. 5 ma. for 10 minutes, repeated every third or fourth day.

Rheumatism, Acute Muscular.

Static induced current applied for 15 minutes daily.

—**Articular.**

Galvanism. Cataphoresis. A suitable flexible, sponge covered electrode, arranged so as to envelop the joint, is saturated with a solution of some of the salts of lithium and attached to the positive pole, the negative (a

*Olive points for this electrode run from No. 10 to 40 French scale.

large electrode) being at some indifferent point. 20 ma. for 10 minutes.

Ringworm.

Galvanism. Metallic electrolysis. Attach to the positive pole a suitable electrode made of copper, No. 14 or 37, and having moistened the spot to be treated with salt water apply the copper electrode directly to the lesion. No. 3, or even a larger electrode is attached to the negative pole and placed at some convenient indifferent point. If the seat of lesion is about the head a very large current cannot be employed, but a smaller current for a longer time will do just as well. On other portions of the body a current of 15 ma. can be tolerated for 5 minutes.

N. B. As the object of the treatment is to deposit the oxychloride of copper deeply into the tissues, the current must be applied long enough and of sufficient strength to give the tissues a greenish appearance.

Salpingitis, Acute.

Faradism. Bipolar electrode No. 86 in vagina. Long, fine wire secondary coil, rapid interruptions. Seance 20 to 25 minutes.

subacute.

Galvanism. No. 116 attached to the positive pole well up in the vagina; No. 66 to lumbar region but negative; 20 to 30 ma. for 15 minutes every second day until three improvements are given, then use negative pole to rectify.

Chronic.

Galvanism. No. 99 intrauterine attached to positive pole, No. 66 on abdomen; 20 to 30 ma. for 15 minutes tri-weekly.

Chronic. A fine steel needle is fastened upon the end of the electrode with the negative pole. The needle is inserted just below the superficial layer of skin, and the current continued long enough to separate it from the superficial tissue. The needle should be removed at other points until the whole surface of the scar has been acted upon. Six cells are sufficient for the work.

Galvanism. No. 96 or No. 66 is attached to the negative pole and placed upon the lumbar spine. No. 8 on positive is used *laterally* along

large electrode) being at some indifferent point. 20 min. for 10 minutes.

Diagnosis

Condition. Metallic electrolysis. Attach to the positive pole a soluble electrode (electrode No. 14 or 21, and having gotten out of the battery at the negative pole) and immerse the negative electrode directly in the wound. If the wound is very large a larger electrode may be used at the negative pole and placed at some indifferent point. If the wound is very small a very large electrode may be used at the negative pole, but a smaller electrode may be used at the positive pole. It is just as well to immerse a third electrode in the body a current of 5 to 10 milliamperes for 5 minutes.

The object of the treatment is to deposit a quantity of copper deeply into the wound. The current must be applied at a strength sufficient to give the wound a grayish appearance.

Apparatus

Electrode. Bipolar electrode No. 36 in use with a low wire secondary coil, rapid induction. Source 20 to 25 minutes.

—Subacute.

Galvanism. No. 116 attached to the positive pole well up in the vagina; No. 66 to lumbar region on negative; 20 to 30 ma. for 10 minutes every second day until three treatments are given, then use negative pole in vagina.

—Suppurative.

Galvanism. No. 99 intrauterine attached to negative pole, No. 66 on abdomen; 20 to 50 ma. for 5 to 8 minutes tri-weekly.

Scars.

Galvanism. A fine steel needle is fastened into No. 107 and connected with the negative pole. The needle is introduced just below the superficial layer of skin, and the current continued long enough to separate it from the underlying tissue. The needle should be reinserted at other points until the whole surface of the scar has been acted upon. Six cells are sufficient for the work.

Sciatica.

Galvanism. No. 96 or No. 66 is attached to the negative pole and placed upon the lumbar spine. No. 3 on positive is used *labile* along

the course of the nerve ; 15 to 20 ma. for 10 minutes daily.

- (a) Static induced current used in same manner as above.

Scirrhus. See Cancer.

Sclerosis. See Lateral Sclerosis.

Shingles. See Herpes Zoster.

Spasm, Facial.

Galvanism. No. 3 on positive is placed about 2 inches above the ear, No. 3 on negative to nape of neck ; 5 ma. for 5 to 8 minutes.

- (a) Galvanism. No 1 on positive is placed just in front of the ear, No. 3 on negative to nape of neck ; same current, same time.

Spasm, Diaphragm.

Galvanism. No. 3 on positive pole to epigastrium. No. 3 on negative to back of neck. 10 ma. for 5 minutes, twice daily.

- (a). Faradism. Long, fine wire, secondary coil, rapid interruptions. No. 17 labile over epigastrium. No. 3 to back of neck. 5 minutes 2 or 3 times daily.

—**Sterno-Cleido-Mastoid. See Torticollis.**

Spasmodic Dysuria.

Galvanism: In this lesion the ejaculatory ducts and seminal vesicles are in a relaxed condition and need having an artificial erection given them by means of weak and brief shocks. This can best be accomplished by using the positive in rectum and the negative in abdomen, and exactly the same technique may be employed as that given under "Hemorrhoids," which see.

Stricture, Urethra.

Galvanism: No. 8 attached to positive pole in rectum. No. 8 on negative *labia* to fall over *urethra* & *penis*. 5 to 8 ma. for 10 minutes daily.

Stricture, Urethra.

Static sparks drawn from region over spine.
(1) **Static electrical current.** One electrode over spine, the other on back directly opposite.

(2) **Galvanism:** No. 8 on positive over *penis*. No. 8 on negative to back. 10 to 15 ma. for 10 minutes daily.

Stricture, Uterus.

Galvanism: No. 8 with an olive of suitable size is attached to the negative pole and is

the coating of the nerve; 15 to 20 ma. for 10 minutes daily.

(2) Static reduced current used in same manner as above.

Electrolysis. See Chapter

Electrolysis. See Chapter

Electrolysis. See Chapter

Electrolysis. See

Electrolysis. No. 2 or positive is placed along front of face, No. 3 on opposite side of face; 5 ma. for 5 to 6 minutes.

Electrolysis. No. 2 or positive is placed along front of face, No. 3 on opposite side of face; 5 ma. for 5 to 6 minutes.

Electrolysis. See

Electrolysis. No. 2 as positive pole to episternum, No. 3 or negative to back of head; 10 ma. for 5 minutes, twice daily.

Electrolysis. Long, fine wire, secondary with fused interruptions. No. 17 table over episternum. No. 3 to back of neck. 5 minutes 2 or 3 times daily.

Electrolysis. See Chapter.

Spermatorrhœa.

Galvanism. In this lesion the ejaculatory ducts and seminal vesicles are in a relaxed condition and need the toning that can be given them by the positive pole. This can best be accomplished by using the positive in rectum and negative on abdomen, and exactly the same technique may be employed as that given under "Hæmorrhoids," which see.

Spinal Meningitis.

Galvanism. No. 3 attached to positive pole to occiput. No. 3 on negative *labile* to full extent of spine. 5 to 8 ma. for 10 minutes daily.

Spleen, Enlarged.

Static sparks drawn from region over spleen.

(a). Static induced current. One electrode over spleen, the other on back directly opposite.

(b). Galvanism. No. 3 on positive over lesion. No. 3 on negative to back. 10 to 15 ma. for 10 minutes daily.

Stenosis, Uterine.

Galvanism. No. 21 with an olive of suitable size is attached to the negative pole and in-

troduced into the uterus. No. 66 on abdomen to positive. A current strength of 8 to 10 ma. will generally carry the olive point through the stenosed canal in about 5 minutes.

Repeat every third day, using larger olive at each sitting.

Sterility. Due to nondevelopment of Uterus.

Faradism. Coarse wire, secondary coil, slow interruptions. No. 69 in uterus, bipolar method. Sitzings daily for 5 to 8 minutes.

NOTE.—If the canal is not patulous enough to admit the No. 69, use No. 21 with small olive in uterus and No. 3 on abdomen.

Stricture, Lachrymal Duct.

Galvanism. Take a small olive-pointed probe and insulate it all except about $\frac{1}{8}$ inch at the distal end (see insulating). Fasten it into a "D" connector (see cut) and attach to the negative pole. No. 3 on positive in hands. Introduce the probe into the duct until the stricture is engaged and gradually turn on current until 2 or 3 ma. is reached. The point of probe will pass through stricture in a few moments.

Nasal. See Nasal.

Oesophagus. See Oesophagus.

Rectum. See Rectum.

Urethral.

Galvanism. Use a Newman's sound, shown on next to last page, about three sizes larger than caliber of stricture. Attach to the negative pole. No. 3 or 66 is attached to positive and placed on the abdomen or back. The stricture is then engaged with the sound and the current gradually turned on until 5 ma. is reached. Use very little or no pressure, the cleaning action of the negative pole will carry the bulb through in about 5 minutes. Before the current is turned off the bulb is drawn back through the stricture. Repeat in 3 to 7 days with an electrode having larger bulb.

Vagina. See Vagina.

Vulvovaginitis of Uterus.

Faradism. Coarse wire secondary coil, 500 to 600 interruptions per minute. Bipolar method with No. 69 in uterus. 10 minutes daily.

(2) Galvanism. No. 39 attached to positive

introduced into the uterus. No. 86 on abdomen to positive. A current strength of 8 to 10 ma. will generally carry the olive point through the stenosed canal in about 5 minutes.

Repeat every third day, using larger olive as work permits.

Method. For the treatment of Uterus.

Material. Galvanic wire, secondary coil, slow interruptor. No. 28 in uterus, bipolar method. 10 days daily for 5 to 8 minutes.

Notes. If the canal is not patulous enough, use No. 28; use No. 21 with small olive if necessary and No. 3 on abdomen.

Method. For the treatment of Uterus.

Material. Take a small olive-pointed probe and insulate it all except about $\frac{1}{4}$ inch at the distal end (see insulating). Fasten it to a "D" connector (see cut) and attach to the negative pole. No. 3 on positive in hand. Introduce the probe into the duct and the wire is engaged and gradually carry current until 2 or 3 ma. is reached. The point of probe will pass through stricture in a few moments.

—**Nasal.** See **Nasal.**

—**Œsophagus.** See **Œsophagus.**

—**Rectum.** See **Rectum.**

—**Urethral.**

Galvanism. Use a Newman's sound, shown on next to last page, about three sizes larger than caliber of stricture. Attach to the negative pole. No. 3 or 66 is attached to positive and placed on the abdomen or back. The stricture is then engaged with the sound and the current gradually turned on until 5 ma. is reached. Use very little or no pressure, the alkaline action of the negative pole will carry the bulb through in about 5 minutes. Before the current is turned off the bulb is drawn back through the stricture. Repeat in 5 to 7 days with an electrode having larger bulb.

—**Uterine.** See **Stenosis.**

Subinvolution of Uterus.

Faradism. Coarse wire secondary coil, 500 to 600 interruptions per minute. Bipolar method with No. 69 in uterus. 10 minutes daily.

(a) Galvanism. No. 99 attached to positive

pole in uterus. No. 66 on abdomen. 25 ma. for 5 to 8 minutes every second day.

Syphilis, Chancre. See Chancroids.

Toothache.

Galvanism. Take a short piece of platinum wire and fasten it into an ordinary needle holder (No. 107) and attach to positive pole. Upon this twist a piece of absorbent cotton suitable to the size of the cavity; dip the cotton into a strong solution of cocaine and insert into cavity. No. 3 to negative in the hand. The current strength may be governed by the limit of tolerance of patient.

Tonsils, Hypertrophy of.

Galvanism. No. 106 used after the bipolar method is plunged into the tonsil. 15 to 20 ma. for 5 minutes every third day. Cocaine anæsthesia is always desirable in these cases.

(a) Galvanism. No. 106 is attached to the negative pole and plunged into the tonsil. No. 3 in hand or on sternum. 10 ma. for 5 minutes every second day.

Torticollis.

Stimulate the sterno-cleido-mastoid and trapezius on the *opposite* side from the lesion,

using a faradic current from the coil of wire secondary coil with slow interruptions for 10 minutes every second day for a course of 10 days and galvanism on the affected area. Positive pole leads over lesion. Negative pole leads at some distance from lesion. 10 to 15 amp. for 5 to 10 minutes.

For the treatment of the eye, the patient is placed in a supine position and the head is supported. The eye is washed with sterile water and the eyelids are everted. The positive pole is applied to the cornea and the negative pole is applied to the sclera. The current is gradually increased to 10 to 15 amp. and maintained for 5 to 10 minutes. The treatment is repeated every second day for a course of 10 days.

Electrolysis of the Eye
Electrolysis of the Eye

Galvanism. Use No. 185 with from one to ten needles (according to size of eye) always attached to the negative pole, and a large surface electrode on positive. Use

pole in situ. No. 46 on the other

for 2 to 3 inches every second

system shown. See Chapter 10

Footnote

Chapter 10. This is a short story

and is not to be taken too

seriously. The subject is not

very important. See also

the notes on the subject of

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using a faradic current from the coarse wire secondary coil with slow interruptions for 10 minutes every second day. On alternate days use galvanism on the affected muscles. Positive pole *labile* over lesion. Negative, large electrode at some different point. 15 to 20 ma. for 5 to 8 minutes.

NOTE.—As this trouble seems to be dependent upon an overactive condition of the spinal accessory nerve, the more rational treatment (and one in which the writer has had some very good results) seems to be to produce sedation of that nerve by the use of the positive pole over its motor point. (See Duchenne's chart). With No. 1 electrode attached to the positive pole covering the motor point and the negative in the hands. A current strength of 15 to 20 ma. could be tolerated for 5 minutes.

Trachoma. See Eye.

Tumors, Benign.

Galvanism. Use No. 105 with from one to ten needles (according to size of growth), *always* attached to the negative pole; use a large surface electrode on positive. Intro-

duce the needles into the base of the tumor on a line with the skin and continue the application until considerable blanching has taken place. In these tumors it is generally only necessary to establish a retrograde metamorphosis. Six to ten cells are sufficient for the work.

—**Malignant.** See **Carcinoma.**

—**Vascular.** See **Vascular Tumors.**

Ulcers, Exuberant or Fungous.

Galvanism. Metallic electrolysis. No. 14, 37, or other suitable electrode (made of zinc) is attached to the positive pole and applied directly to the lesion. No. 3 on negative to some indifferent part; 8 to 10 ma. for 5 minutes. To be repeated in about three days if a healthy granulation has not been established. Where not contraindicated, cocaine anæsthesia should be produced locally before operating.

—**Indolent, Phagedenic, Sloughing, Etc.**

Galvanism. Metallic electrolysis. Used in the same manner as above except that a copper electrode is used instead of a zinc one.

Case, Incontinence of.

Paradise. Medium wire secondary, medium intensity. No. 14 in urethra up to the prostate, No. 3 about pubes. Mild current for three sittings, to be followed by saline irrigations. Treatment with galvanism as follows: No. 3 connected to positive pole is placed at top of neck; No. 3 on negative pole, opposite pubes; current 15 ma. At the first of these treatments the time may be prolonged to 4 minutes, and at the fifth to 5 minutes.

Case, Incontinence of.

Paradise. Medium wire secondary, medium intensity. No. 104 in urethra up to the prostate, No. 14 about pubes. Mild current for three sittings, to be followed by saline irrigations. Treatment with galvanism as follows: No. 104 connected to positive pole is placed at top of neck; No. 14 on negative pole, opposite pubes; current 15 ma. At the first of these treatments the time may be prolonged to 4 minutes, and at the fifth to 5 minutes.

Remarks.

Paradise and galvanism should be used at each sitting, and as the technique is identical

duce the needles into the base of the tumor on a line with the skin and continue the application until considerable blanching has taken place. In these tumors it is generally only necessary to establish a retrograde metamorphosis. Six to ten cells are sufficient for the work.

Indications: See Carcinoma.

Caution: See Carcinoma Tumors.

Contra-Indications: See Diagnosis.

Technique: Metallic electrolysis. No. 14, No. 20, or other suitable electrode (made of zinc) is attached to the positive pole and applied directly to the tumor. No. 3 on negative to same indifferent part; 8 to 10 ma. for 5 minutes. To be repeated in about three days. A healthy granulation has not been obtained. Where not contraindicated, coagulation and chrosis should be produced locally before operating.

Results: Regressive, Sloughing, Etc.

Caution: Metallic electrolysis. Used in the same manner as above except that a copper electrode is used instead of a zinc one.

Urine, Incontinence of.

Faradism. Medium wire secondary, medium interruptions. No. 21 in urethra up to the prostate. No. 3 above pubes. Mild current for three minutes; to be followed by a three minute treatment with galvanism as follows: No. 3 attached to positive pole is placed at nape of neck; No. 3 on negative above symphysis pubis; current, 15 ma. At the third of these treatments the time may be lengthened to 4 minutes; and at the fifth to 5 minutes.

Urethra (Female, Polypus.)

Galvano-cautery snare.

—**Stricture of.** See Stricture.

—**Urethritis, Granular.**

Galvanism. Metallic Electrolysis. No. 104 with copper bulb of suitable thickness and $1\frac{1}{2}$ inches in length is attached to the positive pole and introduced into the urethra. No. 66 on abdomen. 5 ma. for 5 minutes every third day.

Urticaria.

Faradism and galvanism should be used at each sitting, and as the technique is identical

with that used for *pruritus*, the reader is referred to it.

Uterine inertia. See **Obstetrics.**

Uterus, Cancer of. See **Carcinoma.**

—**Displacements of.**

Always reposit the organ as nearly as possible in normal position and use a slowly interrupted secondary faradic current from the coarse wire coil in order to stimulate the muscular fiber of the uterine attachments. This current may be used with No. 99 intra-uterine and No. 3 on abdomen, or No. 68 in vagina well up in the vault and No. 3 on abdomen. Should the organ be bound down with adhesions, due to inflammatory deposits, it will first be necessary to break them up before proceeding with other treatment. See "Adhesions."

—**Subinvolution.** See **Subinvolution.**

Vaginal Leucorrhœa. See **Leucorrhœa.**

Varicose Veins.

Galvano-puncture. Insulate a platinum needle to within $\frac{1}{8}$ inch of the point (See insulating), fasten into No. 107 and attach

The positive pole of the battery was connected to the anode and the negative pole to the cathode. The electrolyte was a solution of aluminum chloride in hydrochloric acid. The current was passed through the cell for a period of 24 hours. The results of the experiment are given in the following table.

Time (hours)	Current (amperes)	Volume of gas evolved (liters)	Weight of aluminum deposited (grams)
0	0	0	0
1	1.5	0.1	0.2
2	1.5	0.2	0.4
3	1.5	0.3	0.6
4	1.5	0.4	0.8
5	1.5	0.5	1.0
6	1.5	0.6	1.2
7	1.5	0.7	1.4
8	1.5	0.8	1.6
9	1.5	0.9	1.8
10	1.5	1.0	2.0
11	1.5	1.1	2.2
12	1.5	1.2	2.4
13	1.5	1.3	2.6
14	1.5	1.4	2.8
15	1.5	1.5	3.0
16	1.5	1.6	3.2
17	1.5	1.7	3.4
18	1.5	1.8	3.6
19	1.5	1.9	3.8
20	1.5	2.0	4.0
21	1.5	2.1	4.2
22	1.5	2.2	4.4
23	1.5	2.3	4.6
24	1.5	2.4	4.8

The results of the experiment show that the current is passed through the cell for a period of 24 hours. The volume of gas evolved is 2.4 liters and the weight of aluminum deposited is 4.8 grams. The current is 1.5 amperes. The results of the experiment are given in the following table.

and that used for *pruritus*, the reader is referred to it.

Uterine inertia. See Obstetrics.

Uvula, Cancer of. See Carcinoma.

— Treatment of.

Always remove the organ as nearly as possible to normal position and use a slowly increasing electrolytic faradic current from the source which will go over to stimulate the muscular fibers of the uterine attachments.

For catheter use No. 99 intra-uterine and for dilatation of No. 65 in vagina and of the neck and No. 8 on abdomen. Should the organ be bound down by adhesions or inflammatory deposits, it will be necessary to break them up before beginning with other treatment. See *Uterus*.

Uvulitis. See Inflammation.

Vagina, Cancer of. See Carcinoma.

Vagina, Prolapse.

Electrolytic procedure. Insulate a platinum needle so within 1/2 inch of the point (See *insulating*), fasten into No. 107 and attach

to the positive pole. No. 3 on negative to some indifferent part. 15 ma. for 10 minutes or until clot is formed, See also Aneurisms.
(a) Static sparks for 15 minutes daily.

Verruca. See **Warts.**

Vomiting, of Pregnancy. See **Pregnancy.**

Warts.

Galvanism. A No. 1 surgeon's needle being fastened into 107 and attached to the negative pole is introduced into the growth at its base on a line with the skin. No. 3 on positive is applied near the seat of operation. A current from 4 to 6 cells for 5 minutes is generally sufficient for a wart of ordinary size. This class of tumor is very easily removed, as the vitality is very low and it is only necessary to establish a retrograde metamorphosis.

— **Venereal (Thread Warts).**

Galvano-cautery snare.

Wine Marks.

Galvanism. No. 108 is attached to the negative pole and pushed through the skin deep enough to reach the congested mass of capillaries; No. 3 on positive near the seat of operation or in hand. Current from 6 to 8 cells long enough to cause considerable blanching around the electrode.

- (a) A fine jewelers' broach fastened into No. 107 and attached to the negative pole is introduced just under the epidermis and parallel with the skin to its full depth; a current from 5 cells is gradually turned on for a few moments, when there will be considerable blanching on either side of the needle, which can now be withdrawn and inserted in another place.

It may not be out of place here to state that the writer has had better success in removing small pigmentary marks by using a plaster composed of :

Antimony tartrate.....one part.

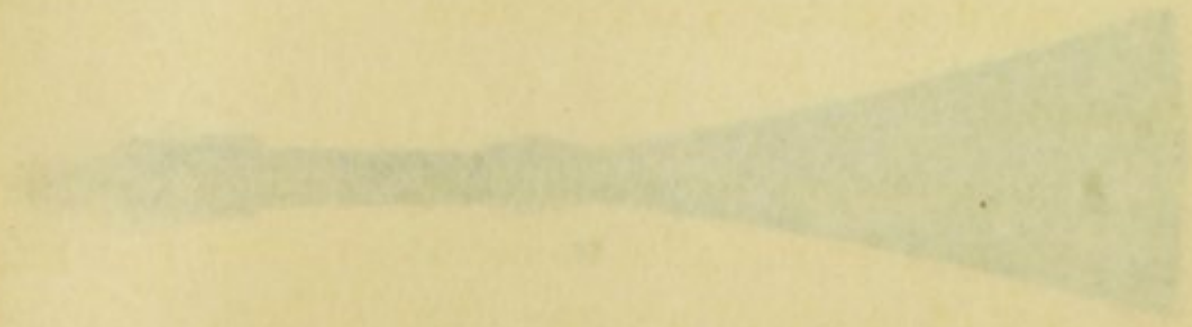
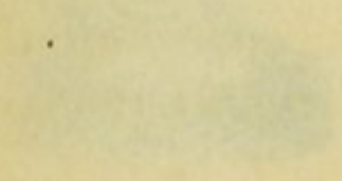
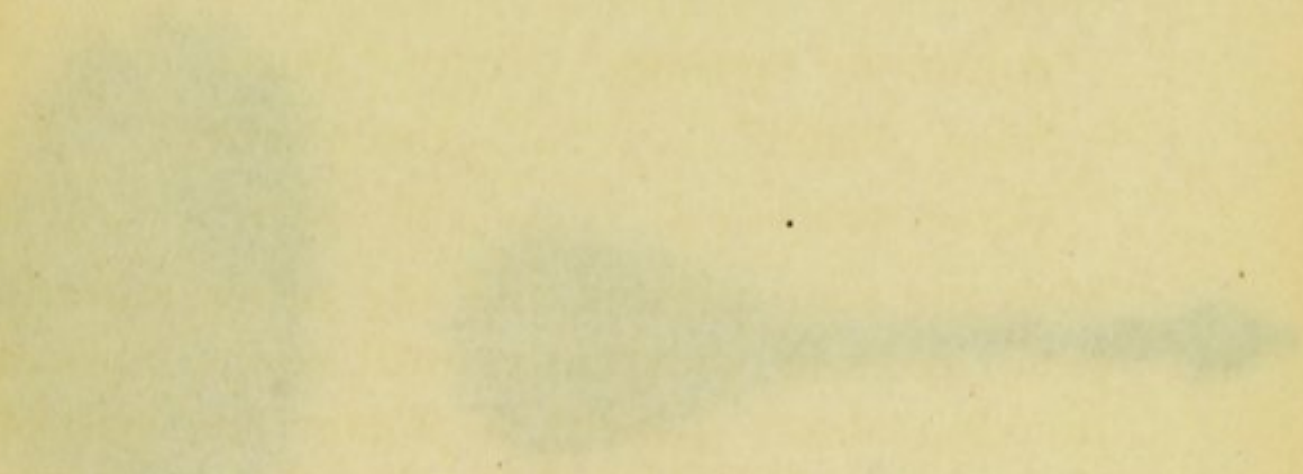
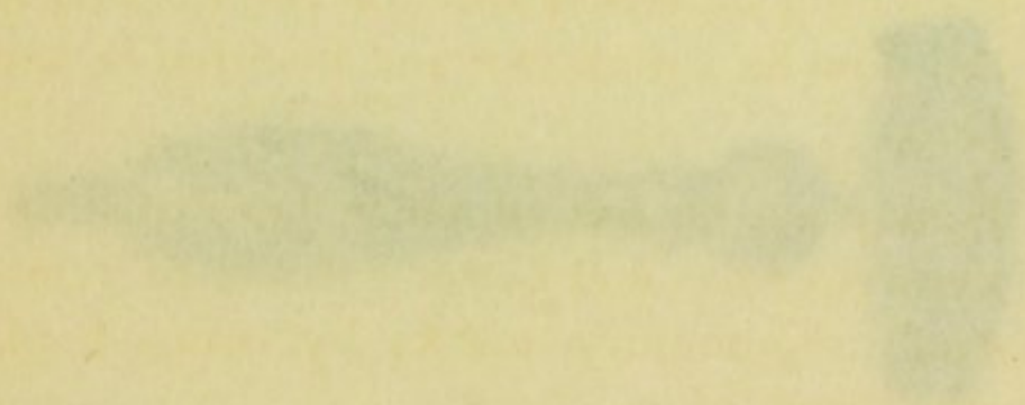
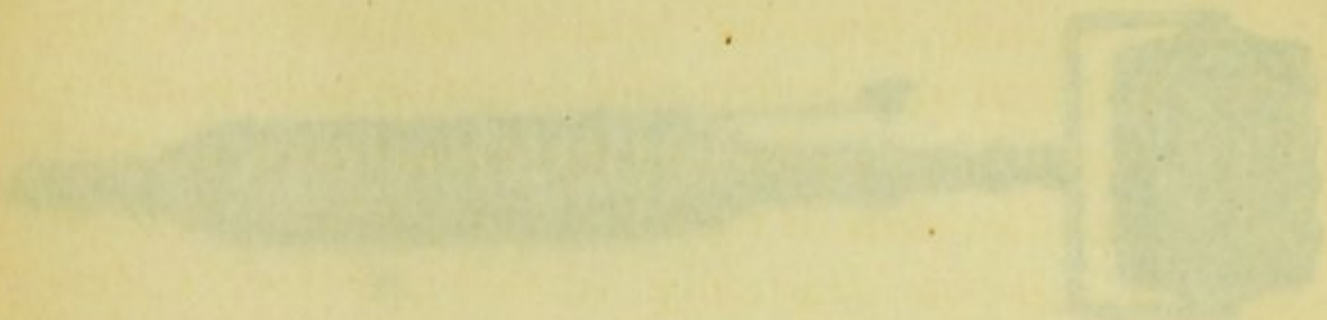
Soap plaster.....three parts.

Green soap.....one part.

Melt the soap plaster, add the other ingredients, and stir constantly until cool. Spread thickly, (about $\frac{1}{12}$ inch), a plaster the size of the mark and apply. After 3 or 4 days active suppuration will have commenced, when the plaster can be removed and the sore dressed in the usual manner. In most instances the mark is entirely obliterated.

Wounds.

Suppurating or nonhealing wounds are best treated by metallic electrolysis after the manner of indolent ulcers. See Ulcers.



187. A fine jewelry brooch fastened into No. 187 and attached to the negative pole is introduced just under the epidermis and parallel with the skin to its full depth; a current from a cell is gradually turned on for a few moments, when there will be considerable blanching on either side of the needle, which can now be withdrawn and inserted in another place.

It is to be noted here to state that the blanching is not due to the current but to the mechanical action of the needle. In removing the needle, a gauze pad soaked with a solution of potassium permanganate should be applied.

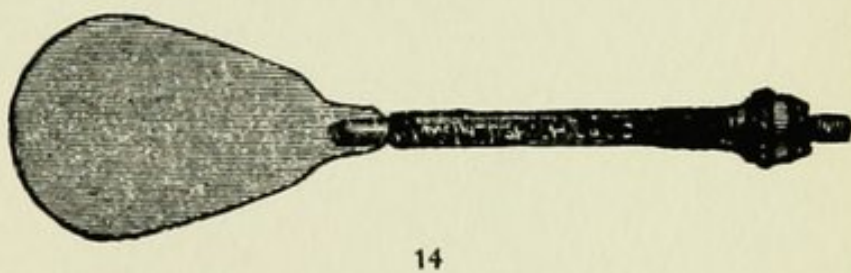
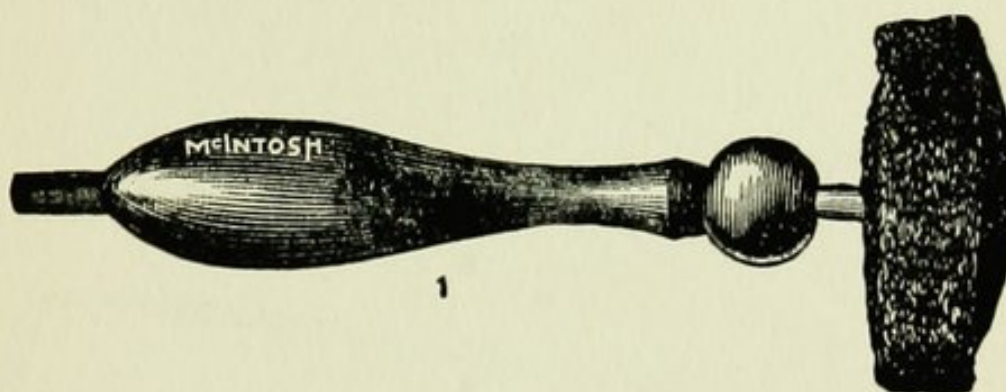
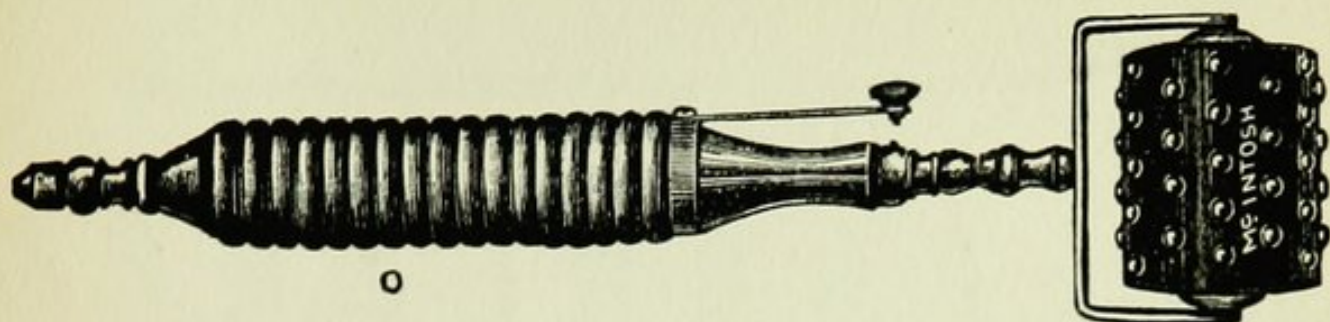
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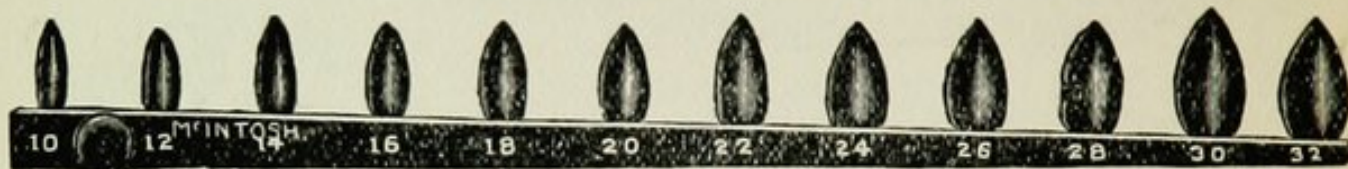
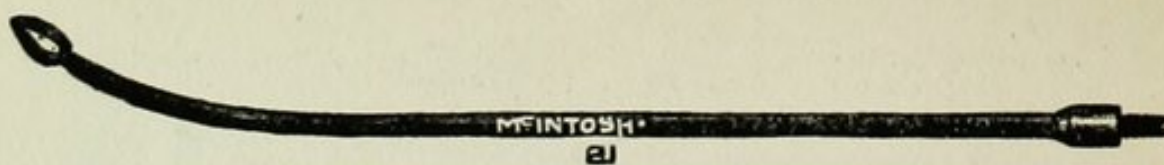
. three parts

. one part

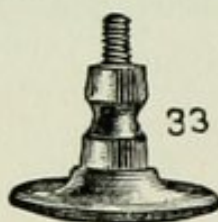
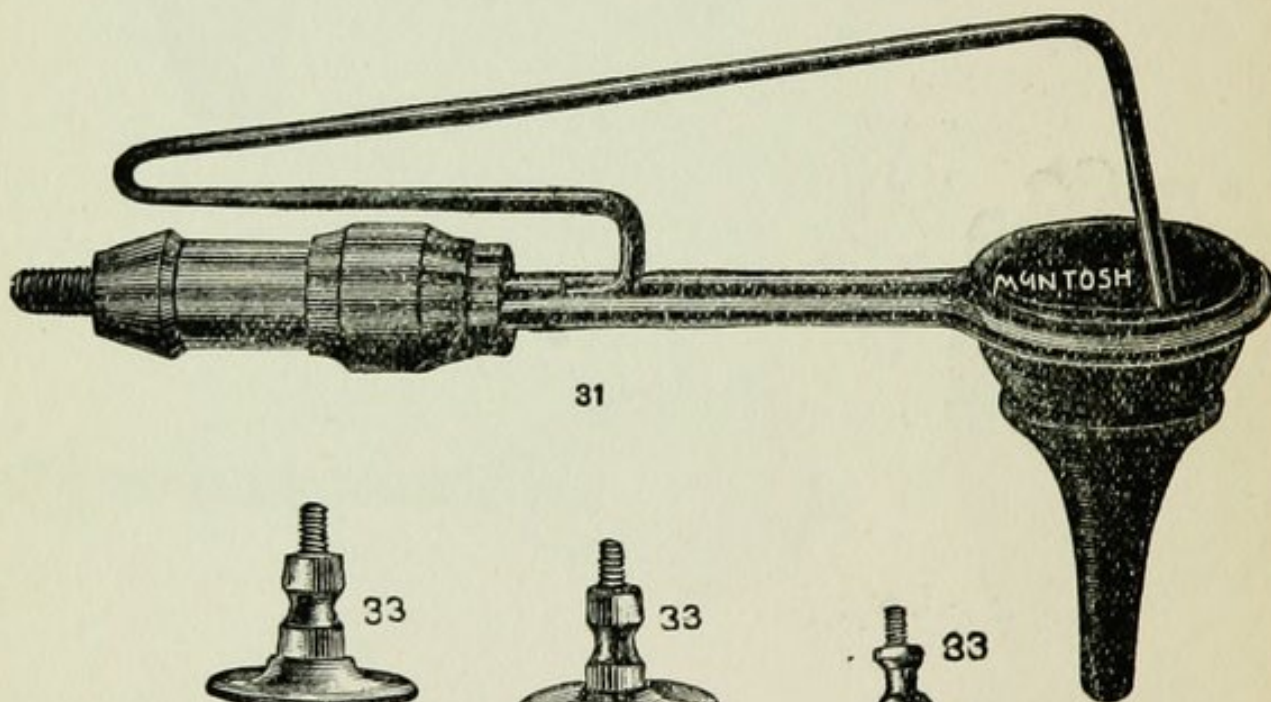
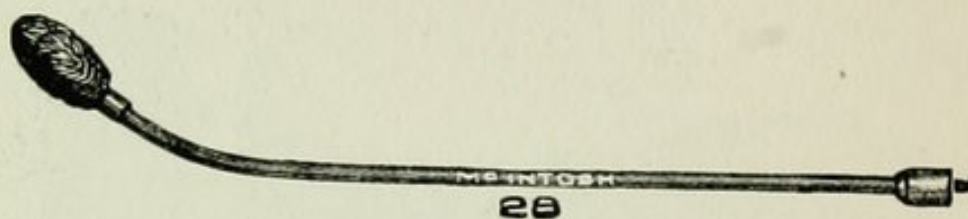
When the plaster is dry, add the other ingredients and mix thoroughly until cool. Spread about 1/8 inch thick, a plaster the size of the wound and apply. After 3 or 4 days a cure is apparent. If it has commenced when the plaster can be removed and the sore dressed in the usual manner. In most instances the wound is entirely obliterated.

Suppurating or nonhealing wounds are best treated by metallic electrolysis after the manner of indolent ulcers. See Ulcers.

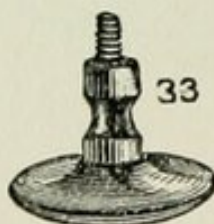




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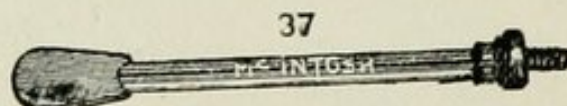
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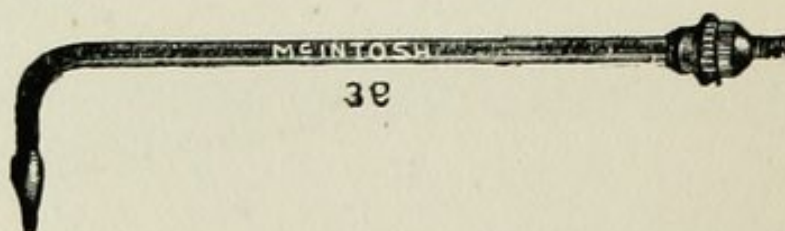
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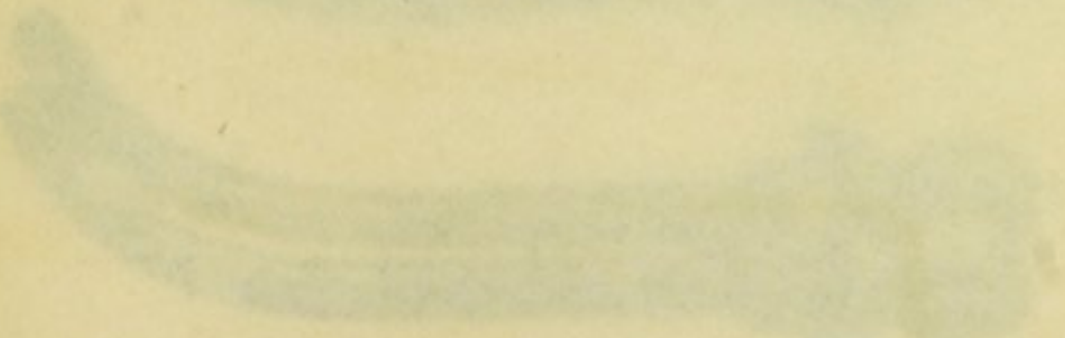
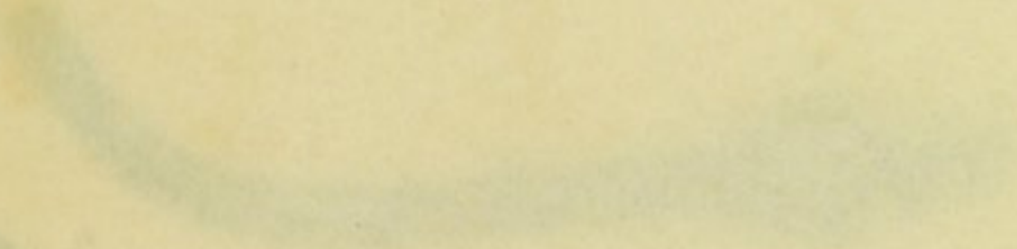
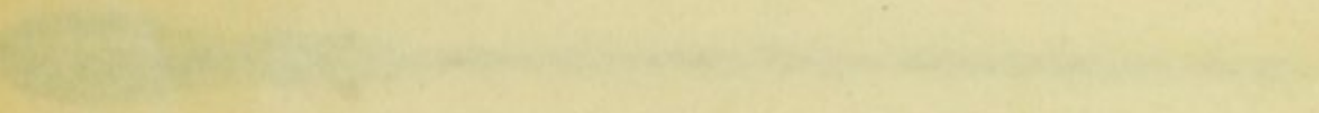
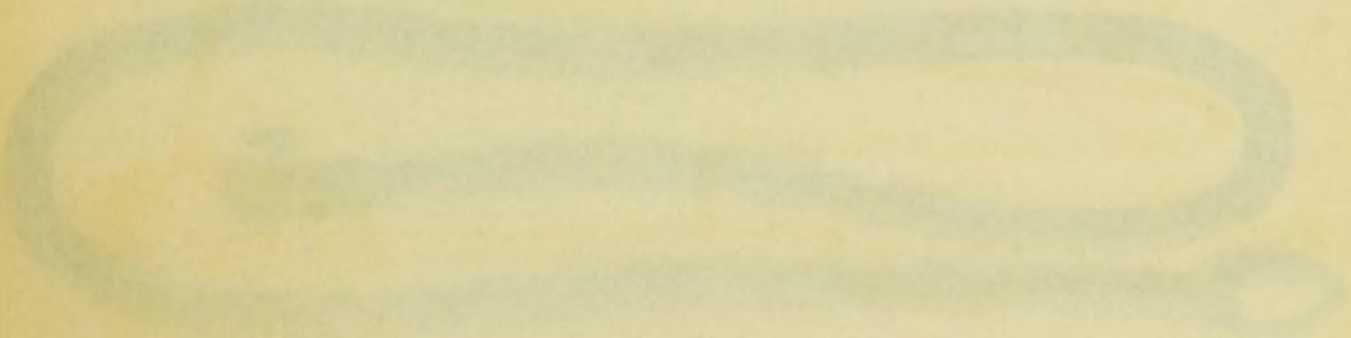
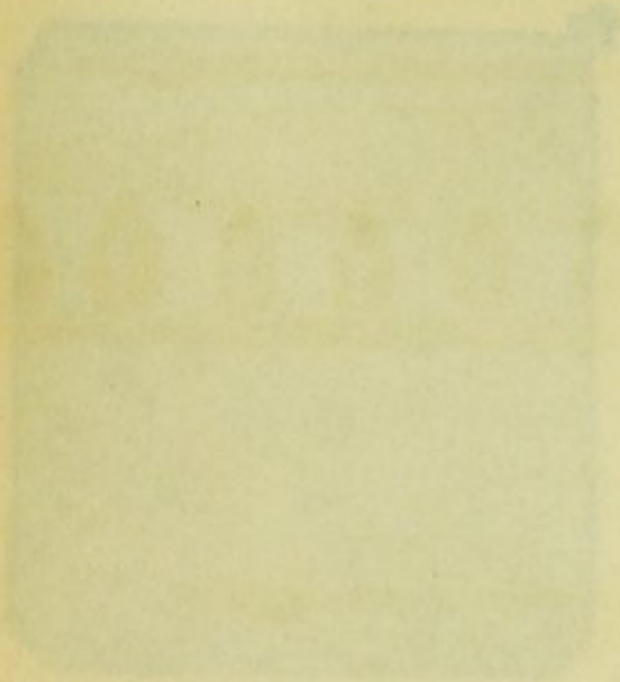
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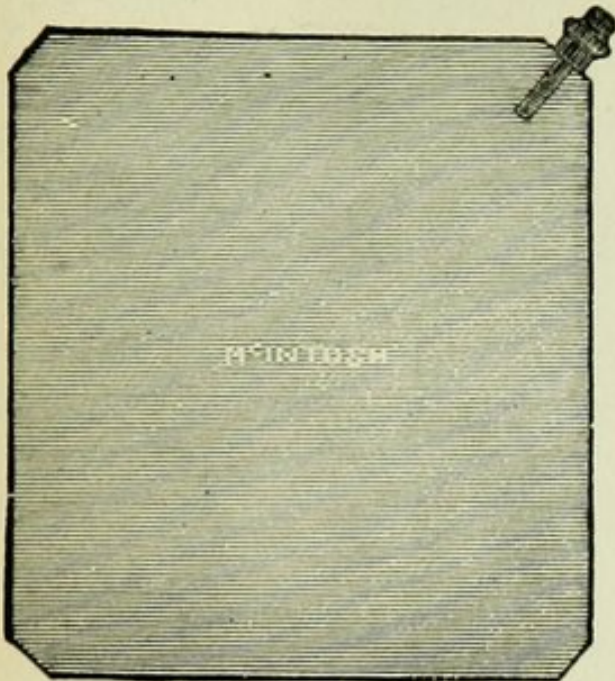
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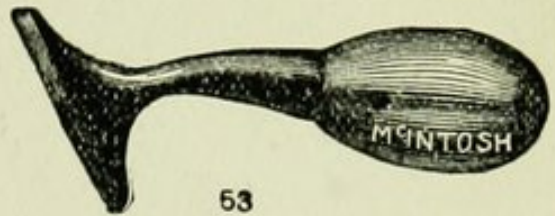
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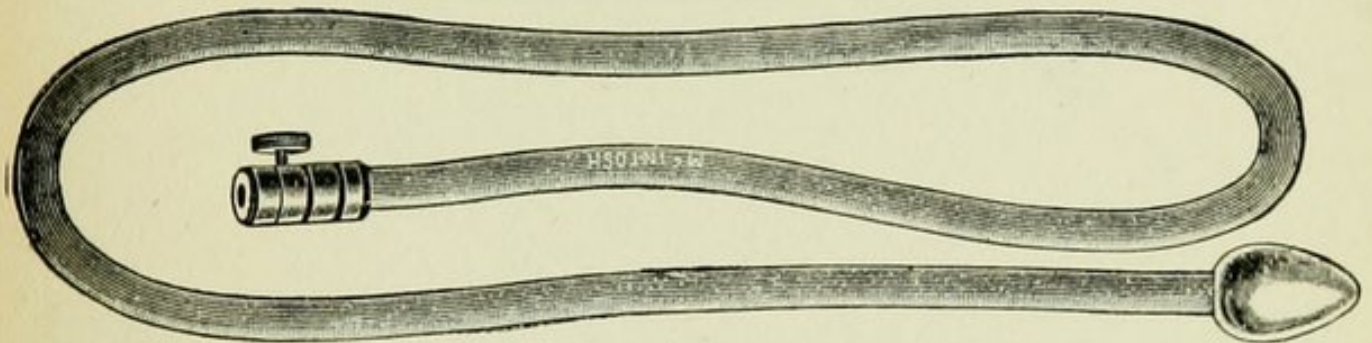
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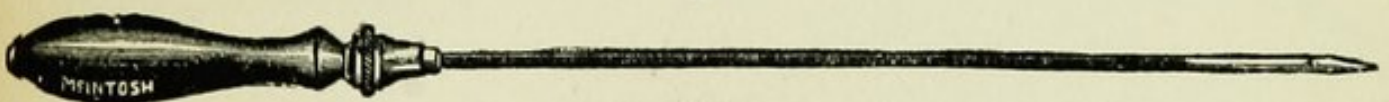
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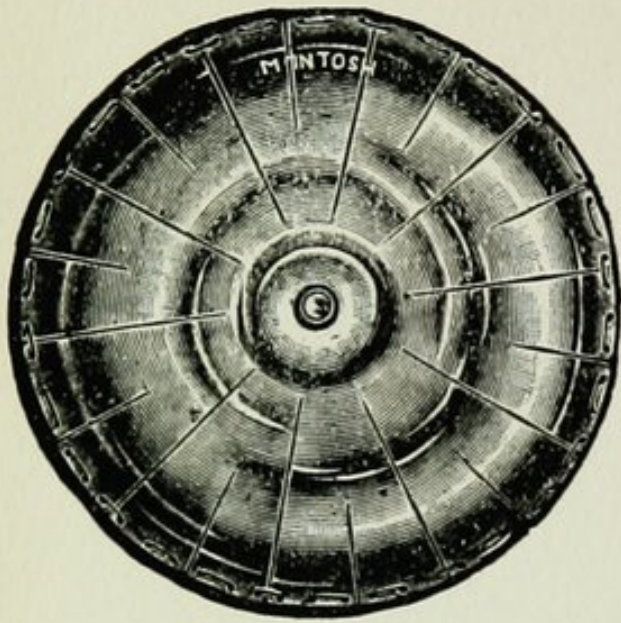
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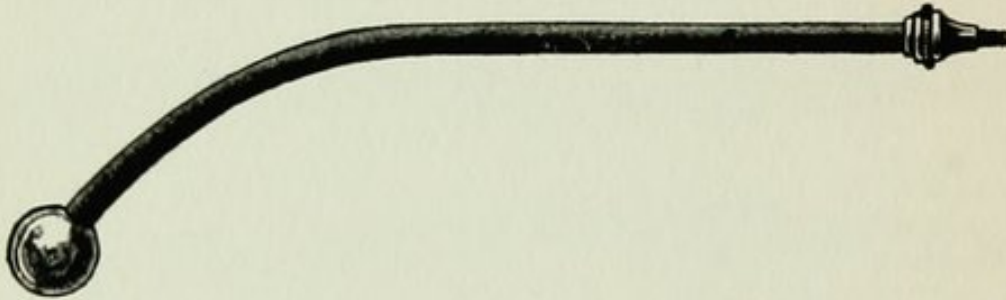
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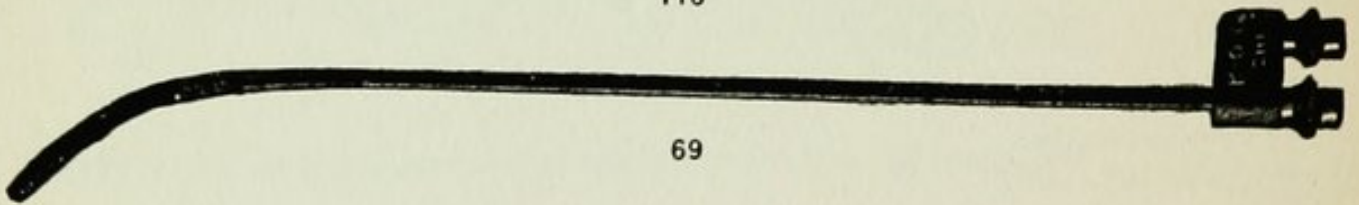
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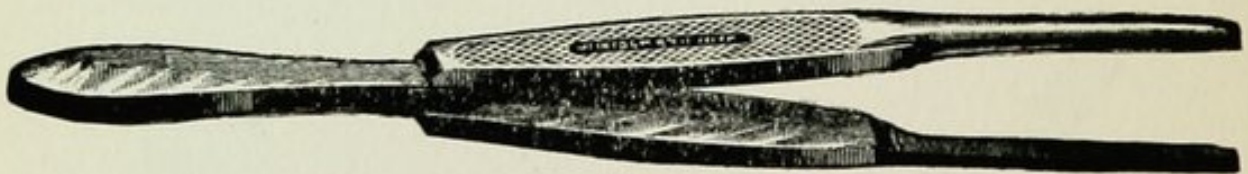
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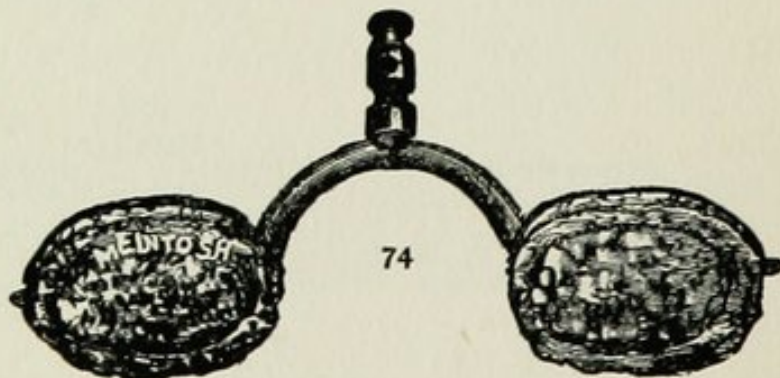
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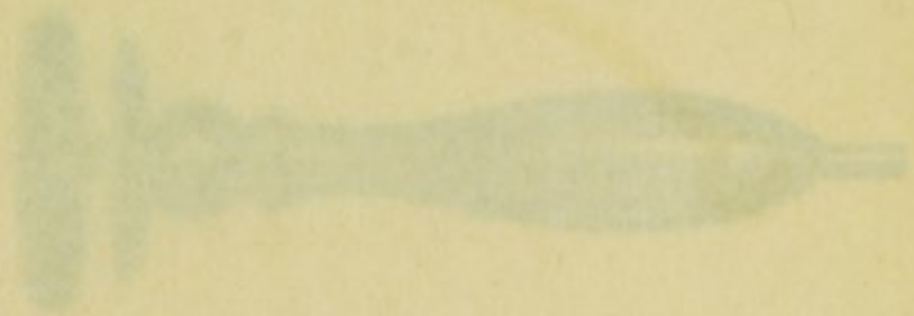
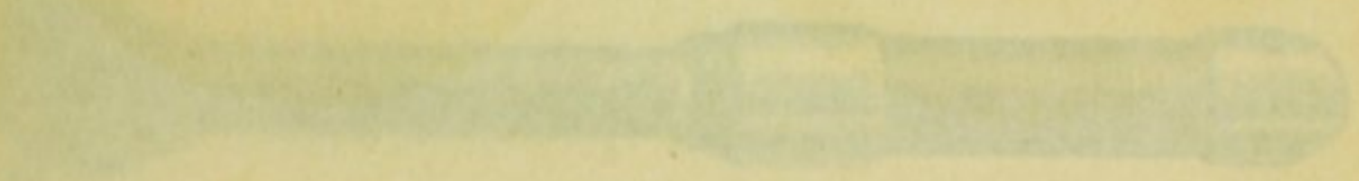
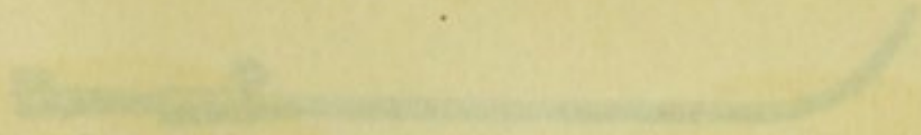
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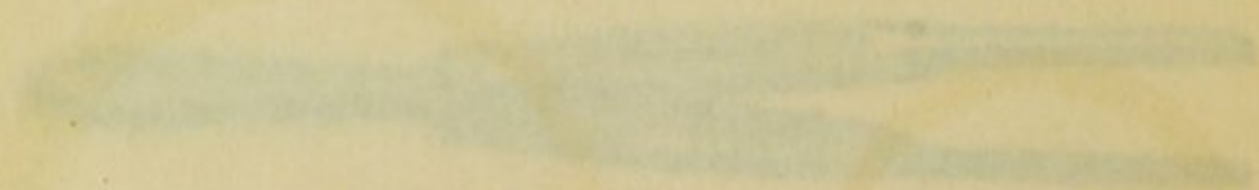
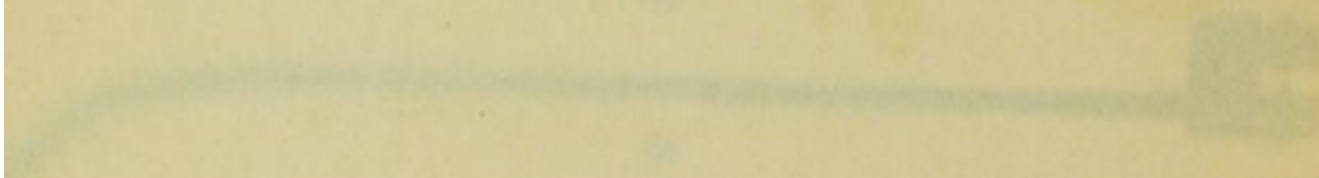
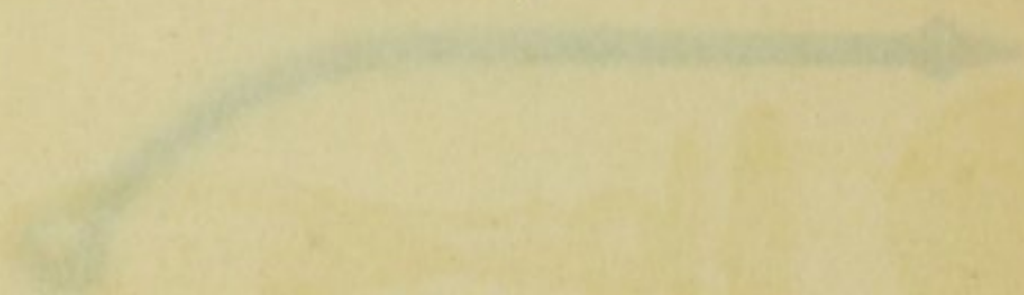
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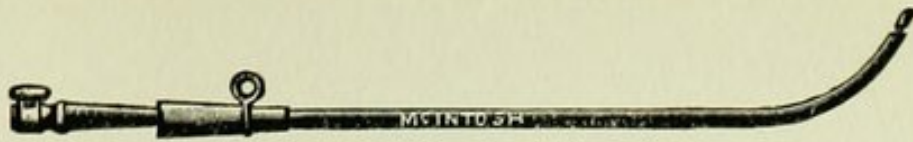


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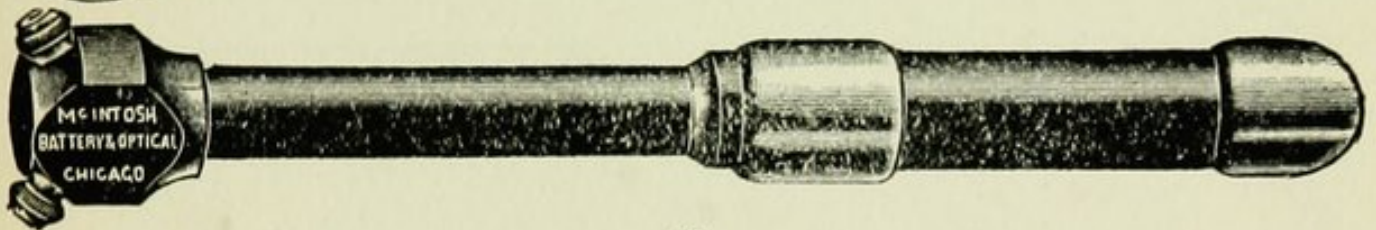




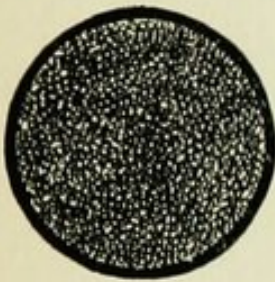
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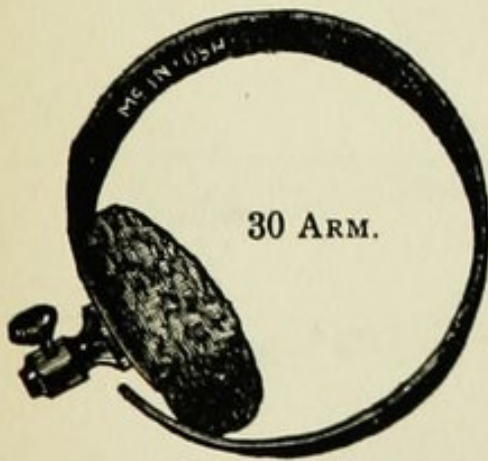
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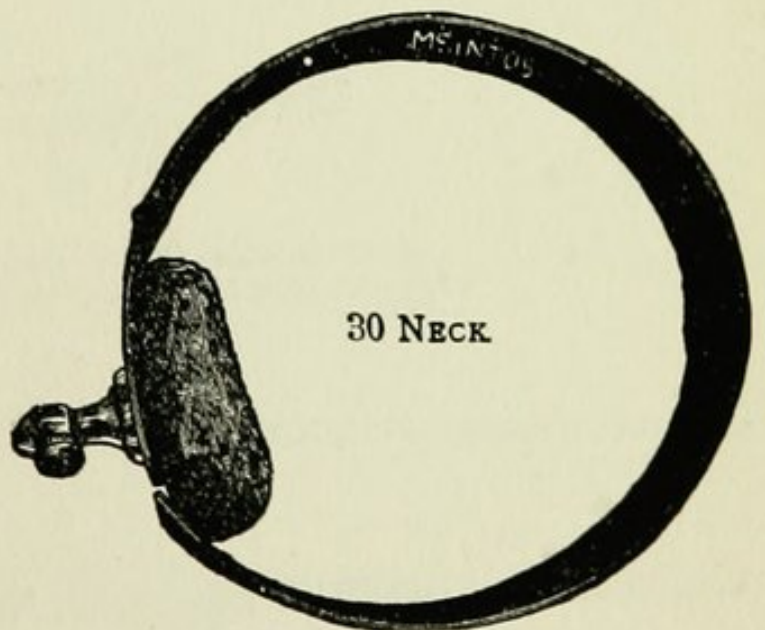
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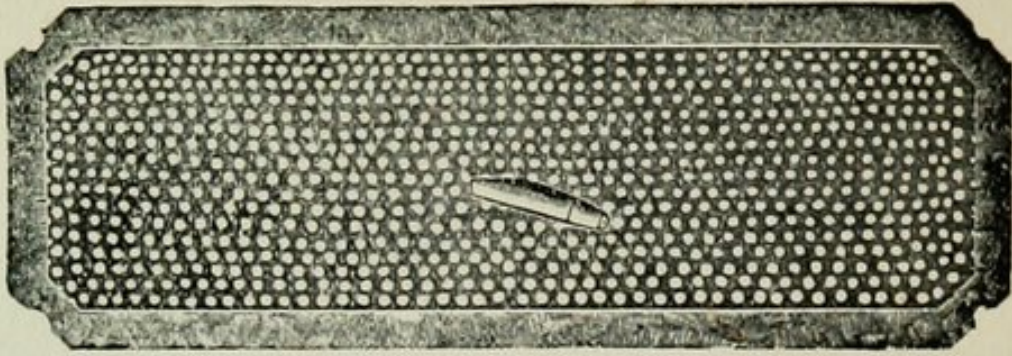
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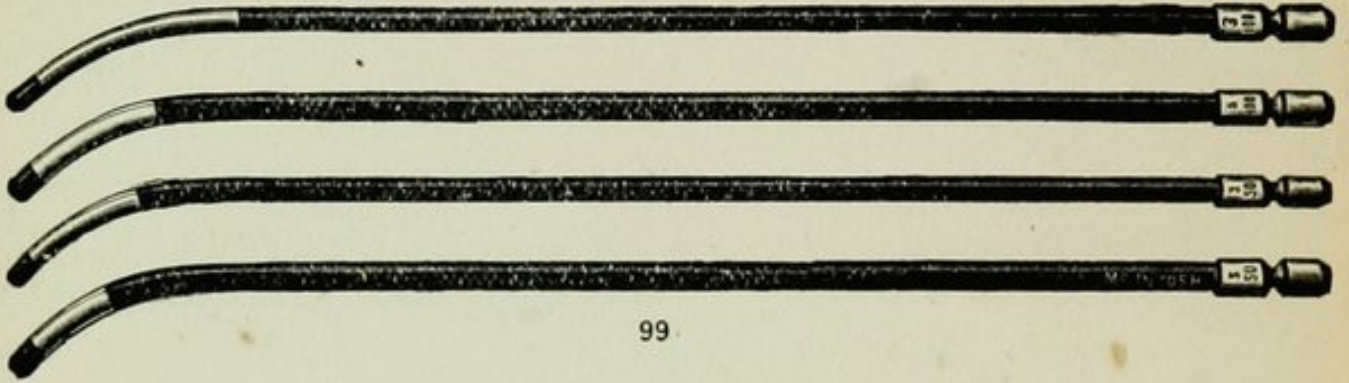
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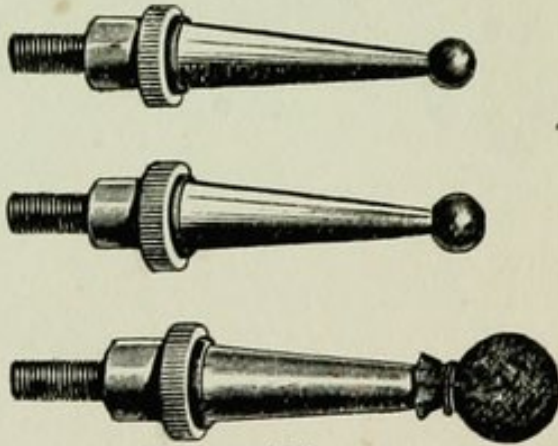
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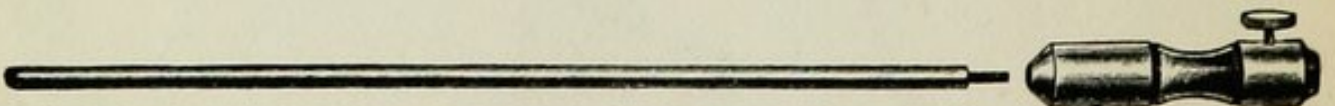
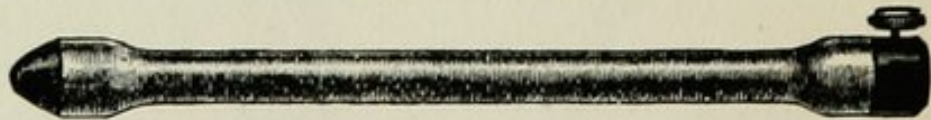
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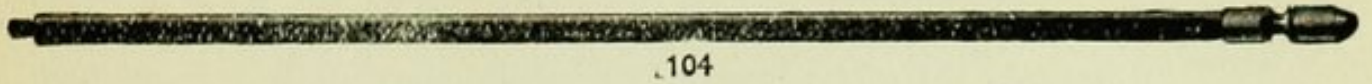
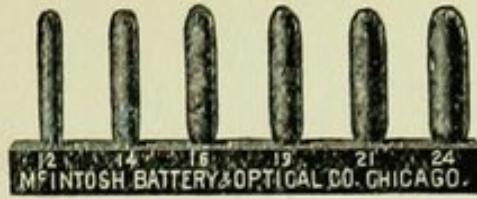
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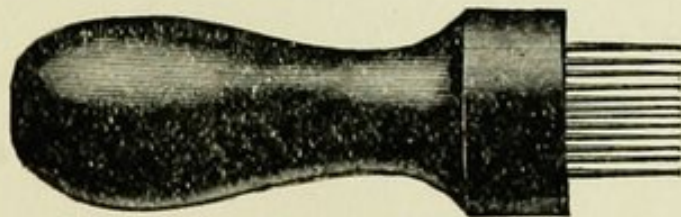
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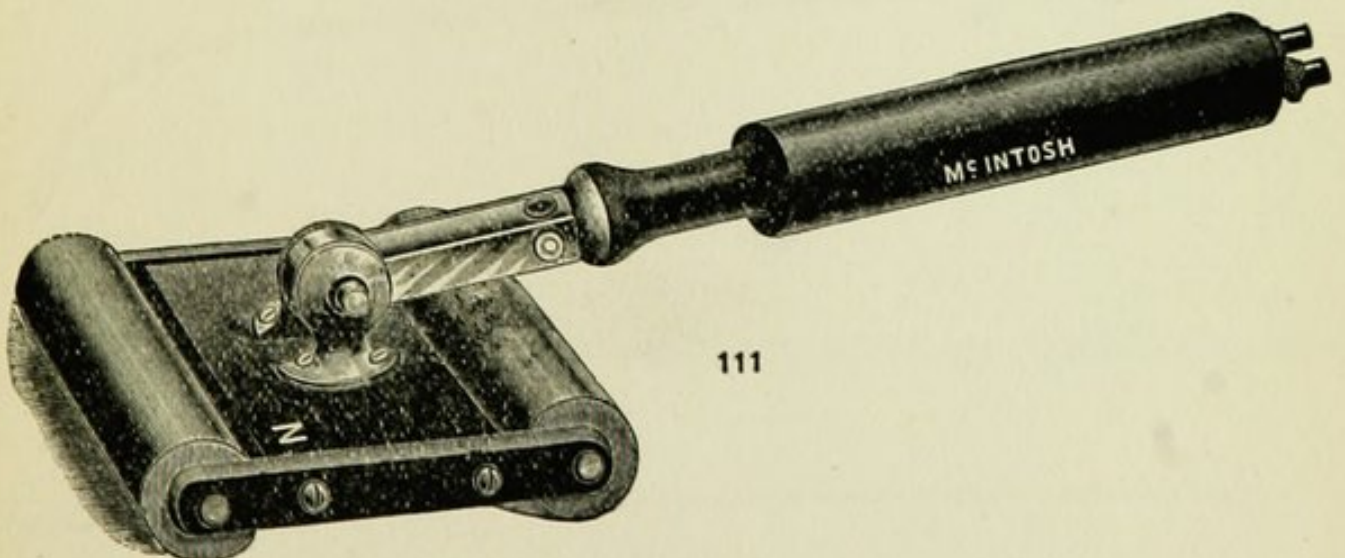
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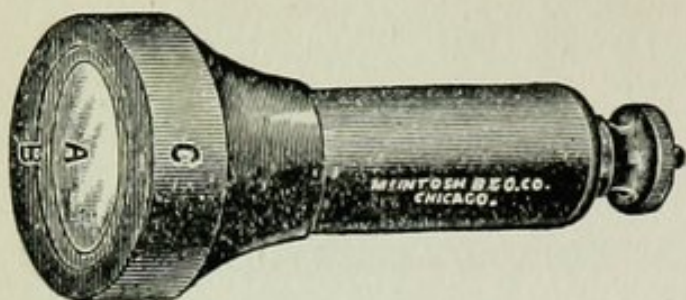
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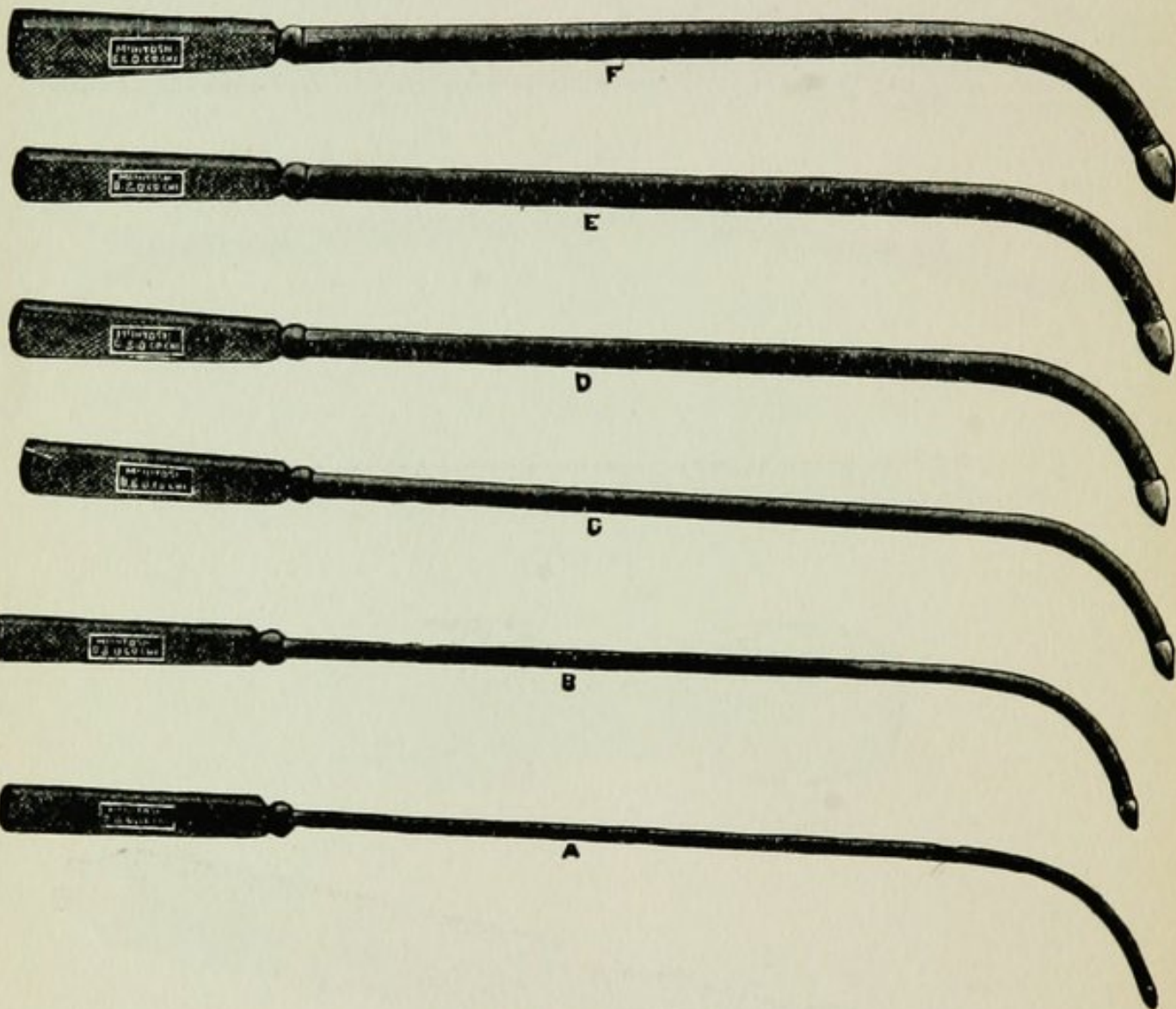
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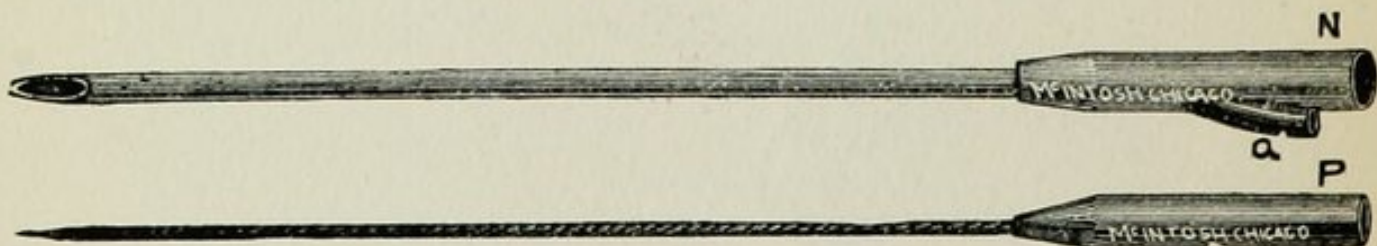
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D CONNECTOR.



NEWMAN'S SOUNDS



EXPLORING NEEDLE.

ELECTROLYTIC DEPOSITION

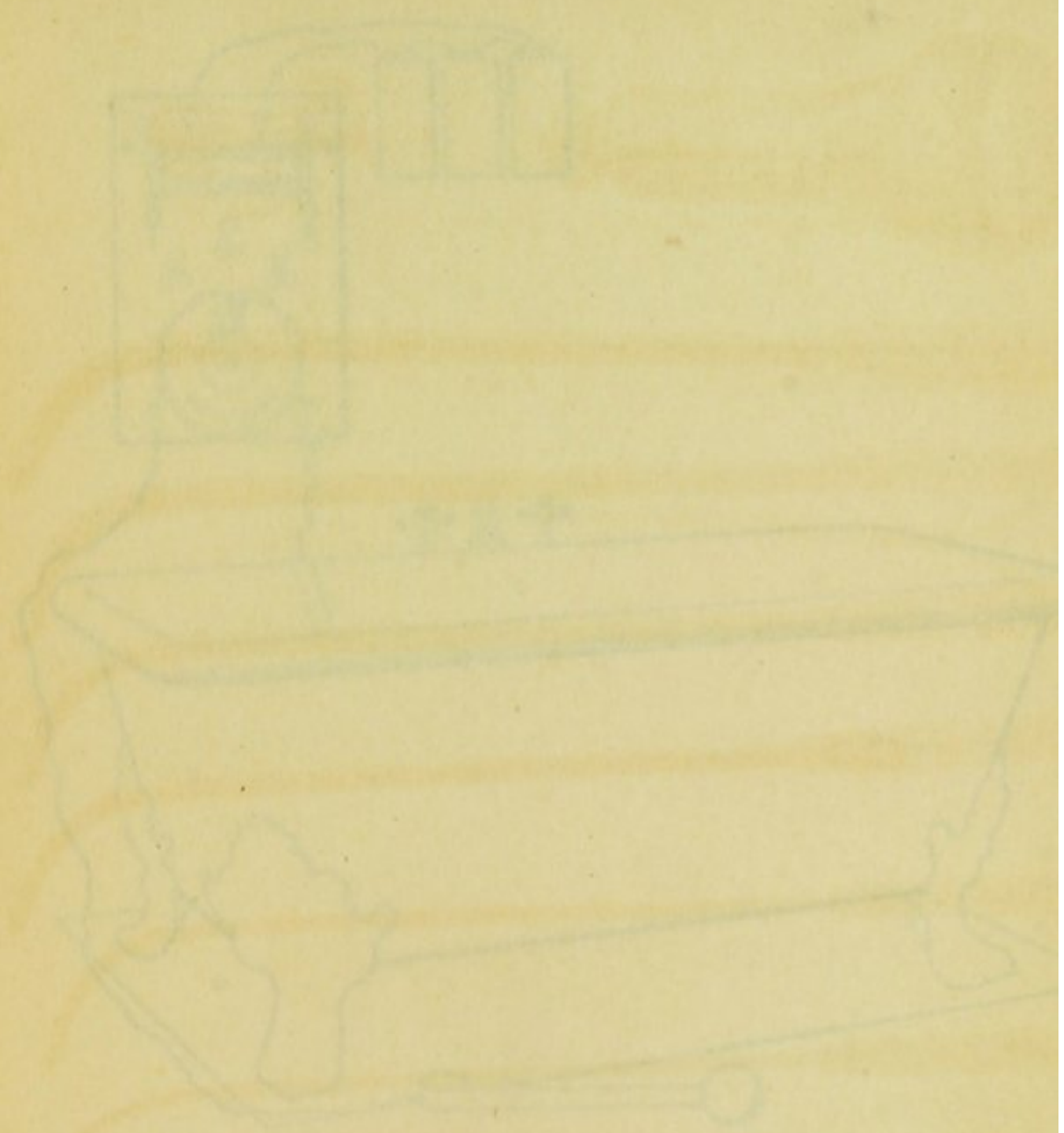


Diagram showing the apparatus for the electrolytic deposition of metal on a cathode.

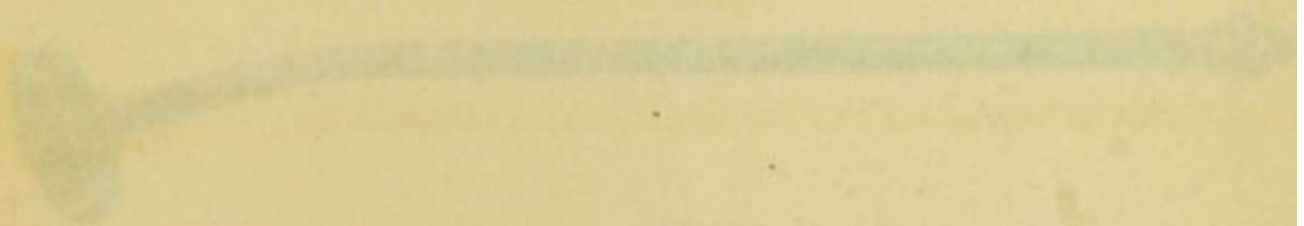


Diagram showing the apparatus for the electrolytic deposition of metal on a cathode.

PHYSIO-THERAPEUTICAL PRACTICE

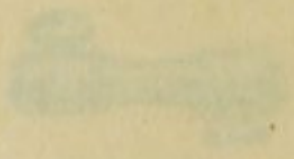


FIG. 1

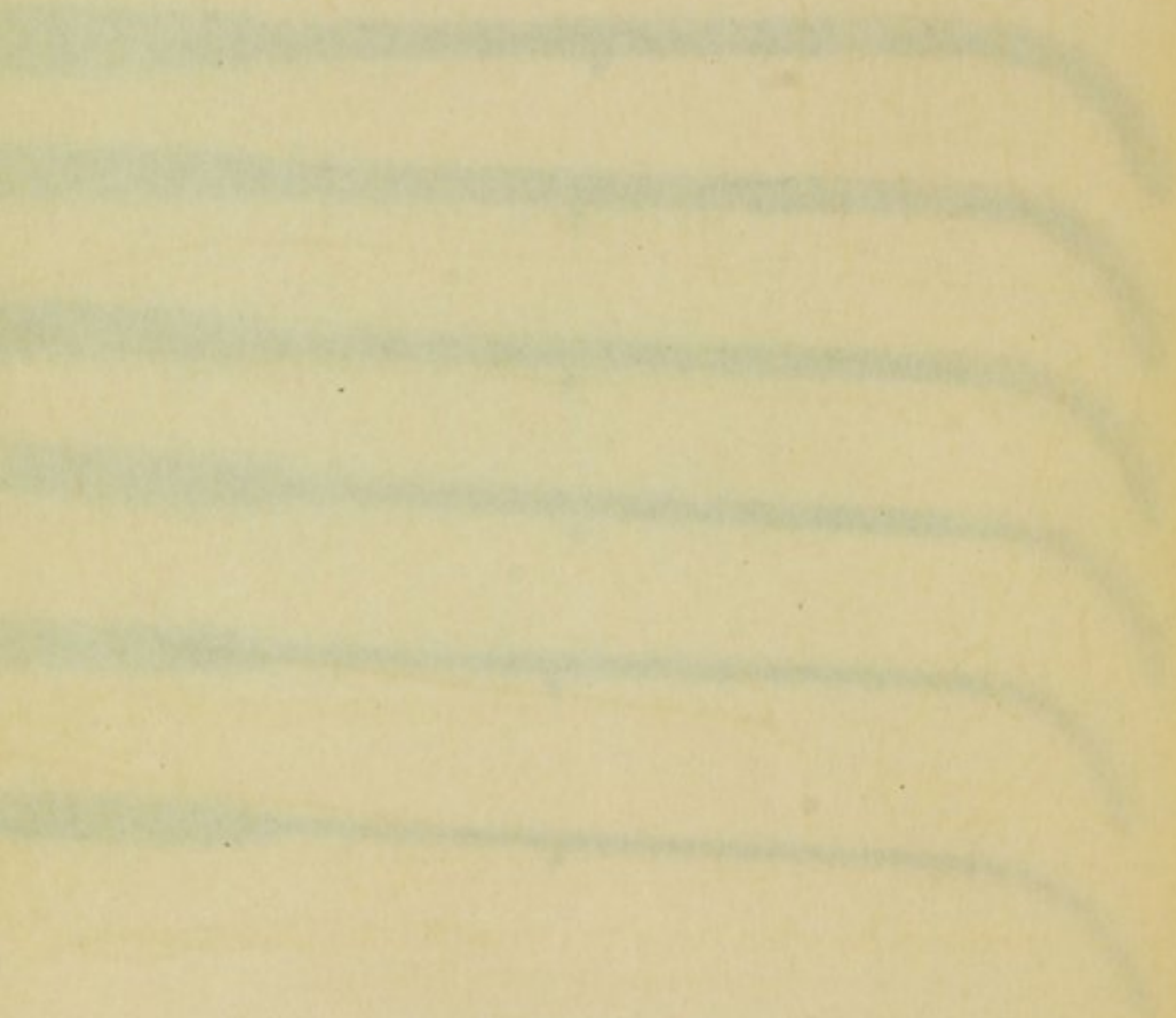


FIG. 2

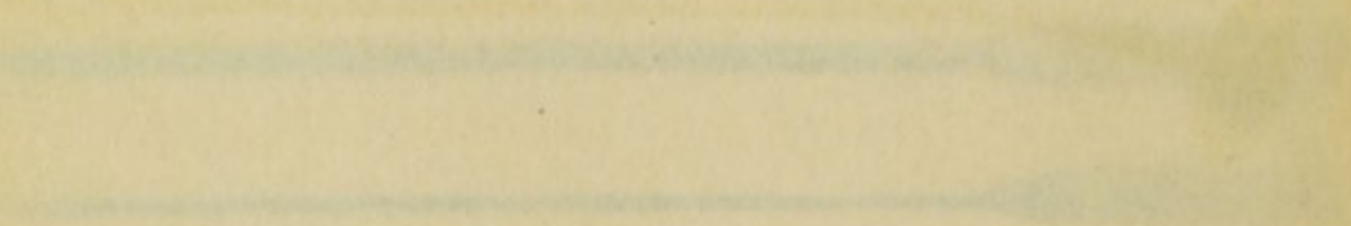


FIG. 3

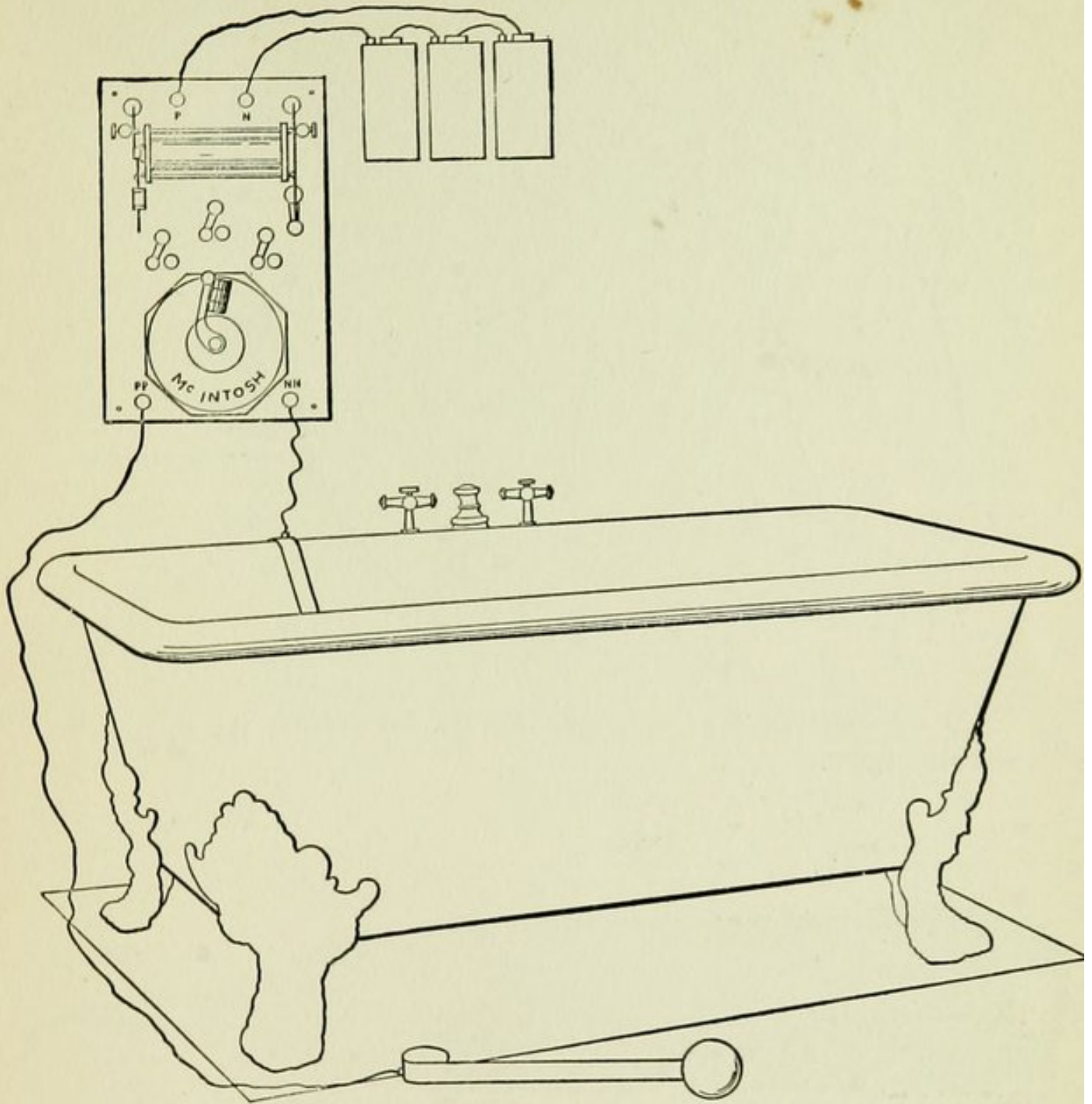
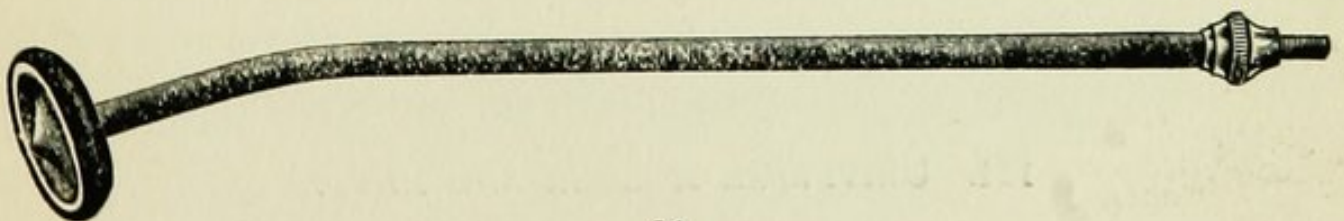
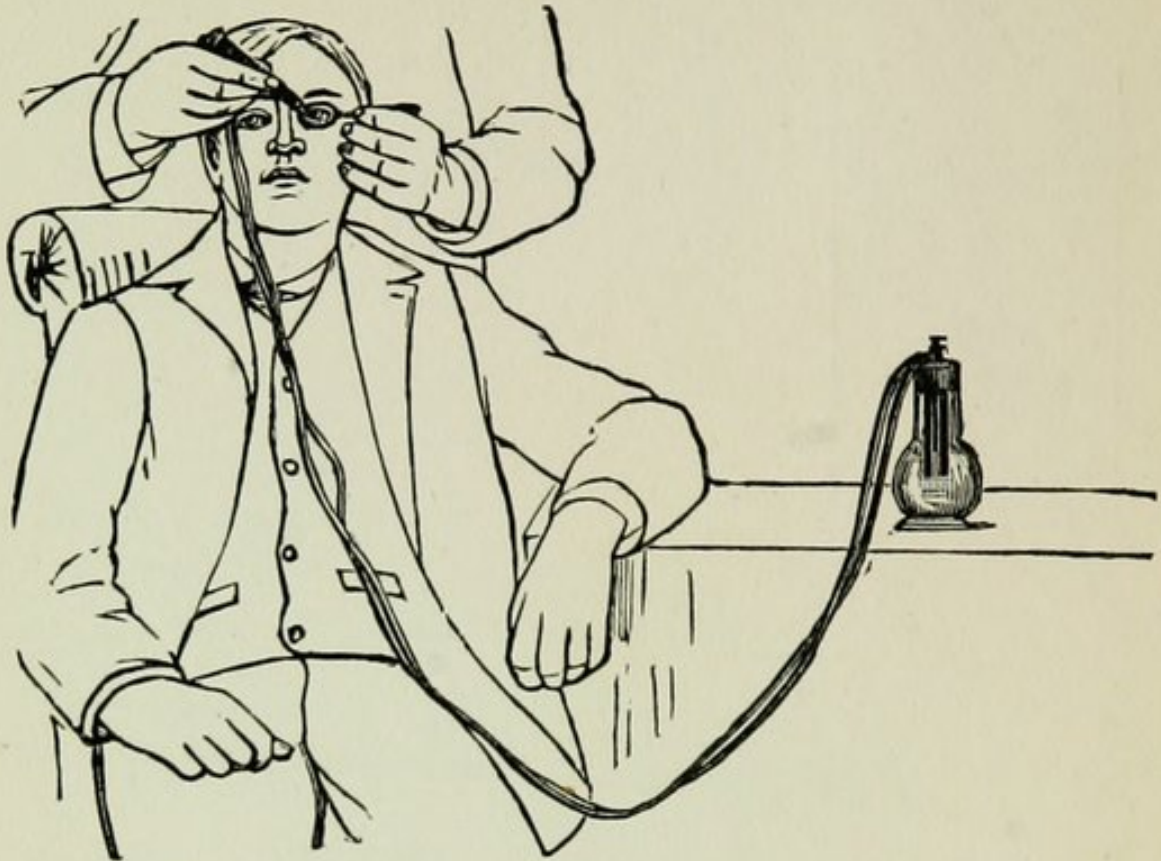


DIAGRAM SHOWING BATH TUB WITH MOVABLE ELECTRODES
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EXTERNAL OS BY METALLIC ELECTROLYSIS.



Showing method of removing foreign body from the eye with electro-magnet.



130. ELECTRO EYE MAGNET.



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BY A. HUTTON PARSONS, M. D.

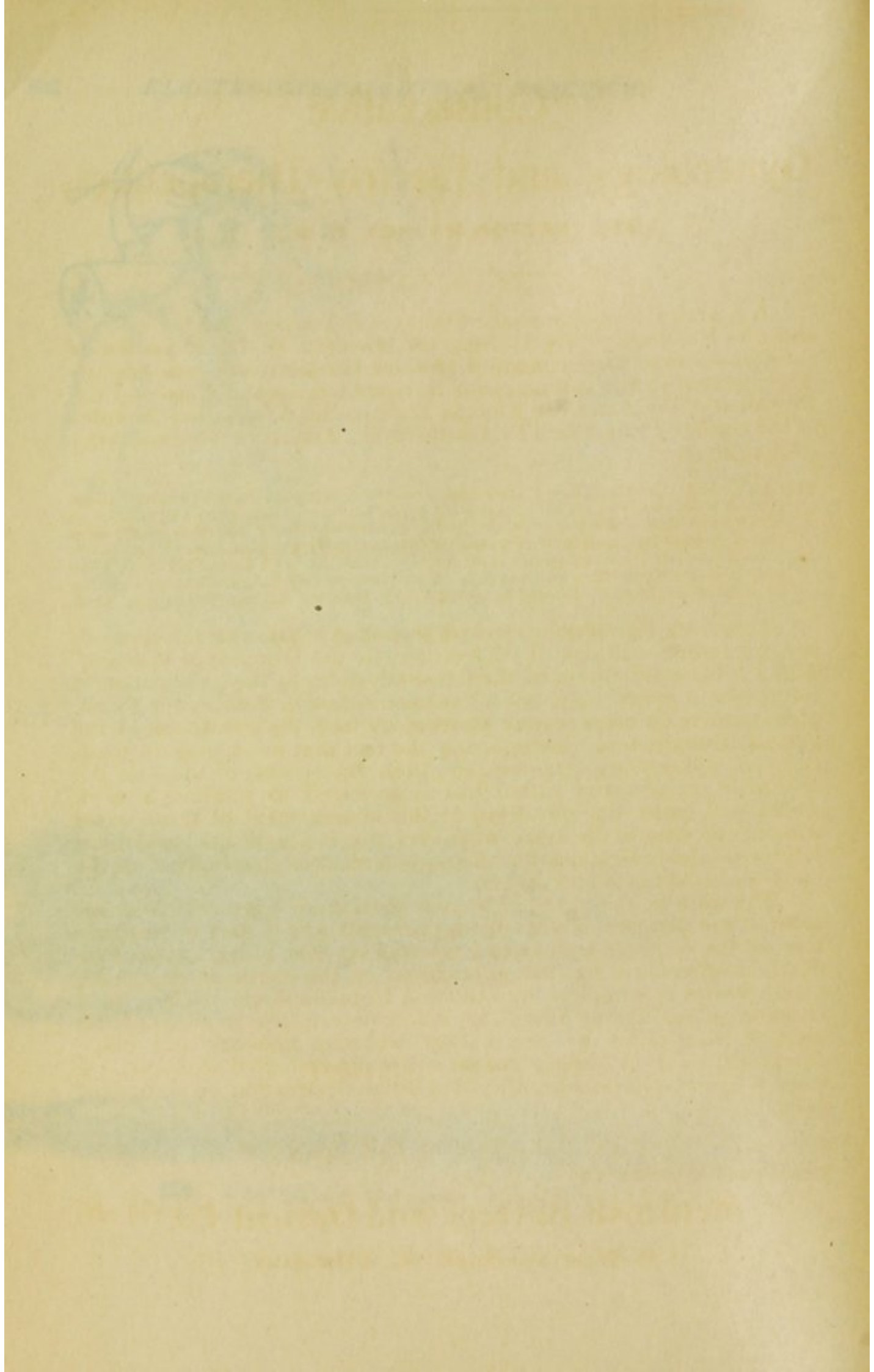
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This work is not only a revision and expansion of the author's two preceding volumes, "Electricity in the Diseases of Women," with a full consideration of the latest advances in the application of electricity in gynecology, but it has been revised in the light of a complete treatise on conservative gynecology from the standpoint of the general practitioner. Throughout the text and most modern treatment in gynecology are written from the point of view of the conservative physician, and the author has endeavored to produce a work which will assist the physician in the management of these cases without recourse to the knife. It is a practical and complete guide to the treatment of all the diseases of women, and is a volume of a high and useful character.

The work is complete, and is a volume of a high and useful character. It is a practical and complete guide to the treatment of all the diseases of women, and is a volume of a high and useful character. It is a practical and complete guide to the treatment of all the diseases of women, and is a volume of a high and useful character.

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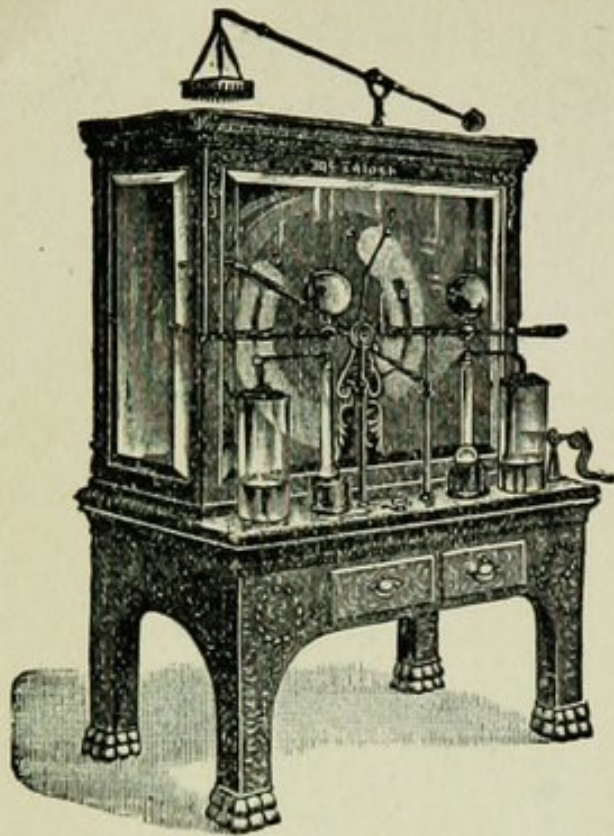
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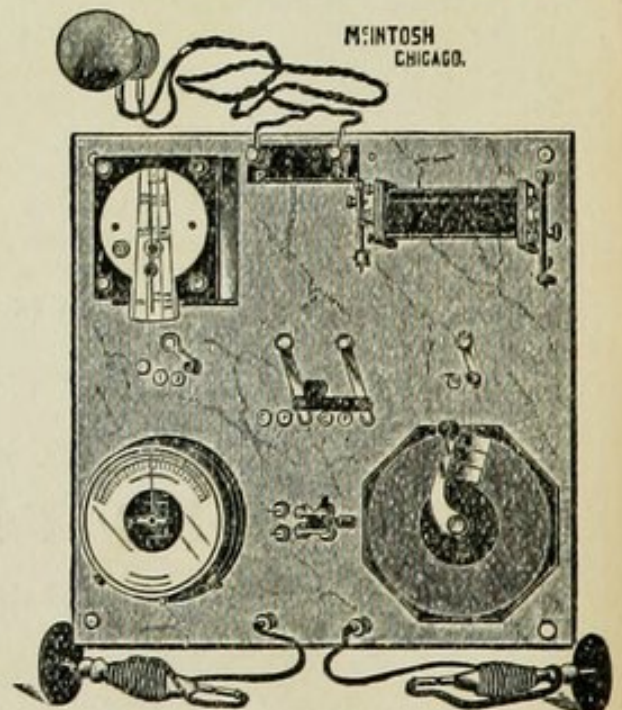
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