Electricity in the diseases of women : with special reference to the application of strong currents / by G. Betton Massey.

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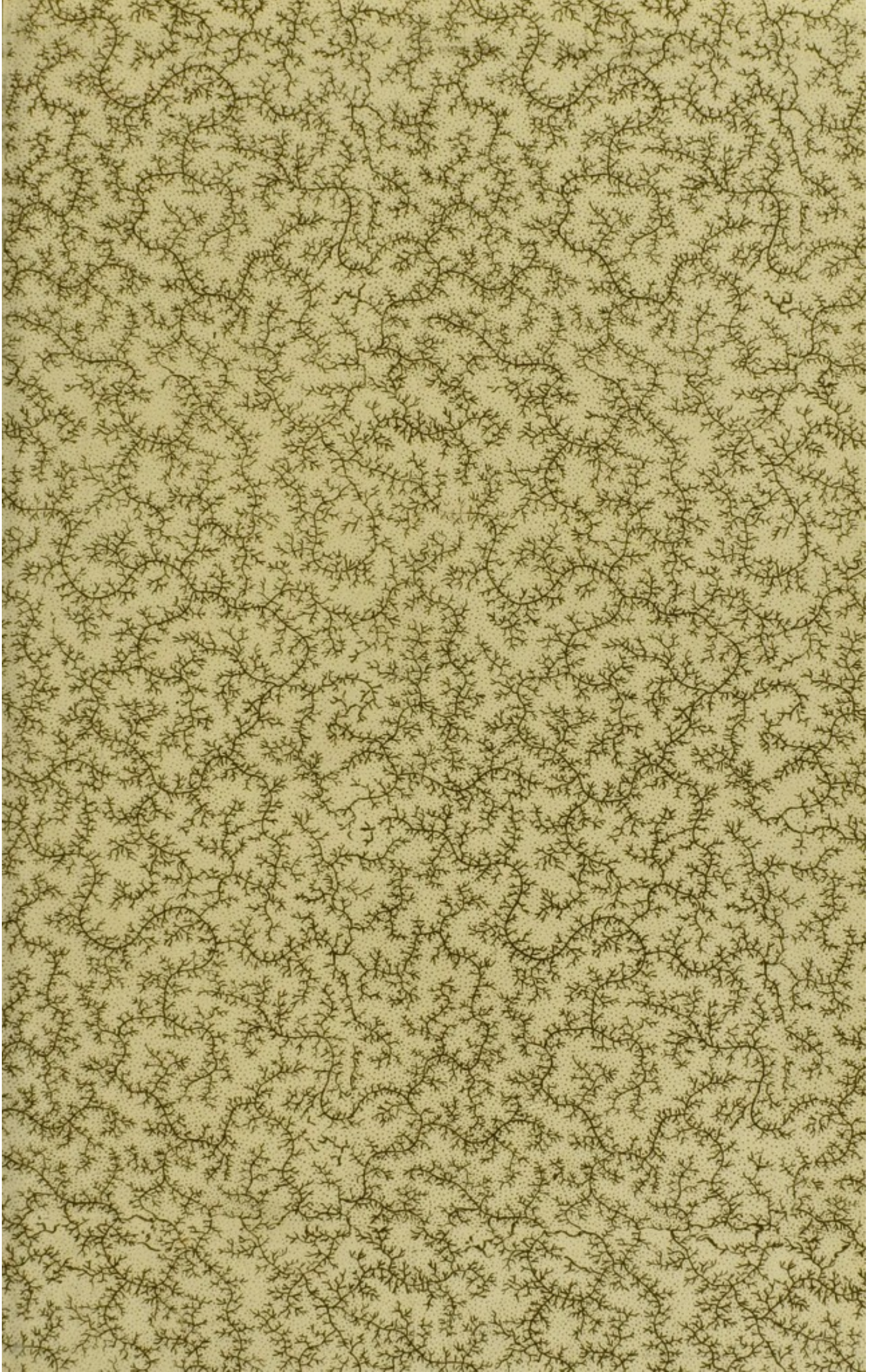

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ELECTRICITY

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DISEASES OF WOMEN,

WITH SPECIAL REFERENCE TO THE APPLICATION OF STRONG CURRENTS.

BY

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PREFACE.

In presenting to the profession what is believed to be the first attempt at a complete treatise on the electrical treatment of the diseases of women, the author deprecates in advance any misapprehension of its scope and claims. Only such conditions receive notice in the treatment of which electricity has recently been urged upon professional favor; and this portion of the work partakes, therefore, more of the nature of a mirror of the author's daily work than of a classical research into the literature of the subject. While the experience of others, particularly of Apostoli, Engelmann, and Laphthorn Smith, has been utilized as a guide and mentor, it is not forgotten that a scientific investigation takes nothing upon hearsay evidence, and that the profession demands proofs rather than theories. It should be stated, also, that the author does not wish to assume the position of recommending the routine use of any one agent or procedure, to the exclusion of other rational remedies, in the medical or surgical treatment of any single class of diseases. It was merely in the interest of

clearness and accuracy that many of the cases mentioned in these pages were confined to electrical applications alone after beginning treatment with this remedy.

In the introductory part of the work, a portion of which has been published in the shape of papers contributed to the *Philadelphia Medical Times*, the author has aimed to briefly present the laws of electricity, as applied to this branch of medicine and surgery, in so concrete and practical a shape that the conscientious student is insensibly made to comprehend current proportions as he would after prolonged mathematical study; the aim being to make the medical user of electricity as intelligently familiar with this physical force as is now required of so many practical workers in its industrial applications. It will be noticed that some electrical words peculiar to physicians are not found in the body of the work. This is particularly true of words terminating in "ism," such as galvanism and faradism—words that, besides possessing an objectionable termination, fail to convey a distinct idea of the particular procedures that they are intended to describe.

1706 WALNUT ST., PHILADELPHIA,
December, 1888.

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ELECTRICITY

IN THE

DISEASES OF WOMEN,

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CHAPTER I.

INTRODUCTORY.

A DAWNING reaction from the ultra-mechanical methods of the followers of the late J. Marion Sims was probably instrumental in first attracting earnest attention to electricity as a therapeutic agent in gynecology. It was readily seen that in it lay the possibility of a wide range of direct applications, generally of a harmless nature, and better calculated than any other to touch whatever neurotic element might lurk in a case. Of late, however, a more serious use of the remedy has been added to these milder therapeutic applications, constituting indeed a truly surgical use of electric force. I do not allude to the galvano-cautery, in which the remedial agent is merely caustic heat which happens to be generated by electricity, but to the chemical action of a strong current brought to a focus on the bared surface of a single pole, which has been placed directly at the seat of local disease. The

possibility of using currents of the chemical energy wielded by one hundred, two hundred, and three hundred milliampères, in this perfectly safe and almost painless manner, was first pointed out by Apostoli in descriptions of his method of treating fibroid tumors of the uterus. More recently the same powerful but easily-controlled surgical agency has been employed for the direct treatment of metrorrhagia, chronic metritis and endometritis, stenosis of the os and cervical canal, subinvolution, chronic pelvic indurations, etc., and a conservative view of the results gained is that a most important addition has been made to surgical gynecology.

At the present time, therefore, an unusual degree of professional attention is being directed toward two essentially different means of rendering electrical applications useful in the diseases peculiar to women, the one consisting of a therapeutic use of faradic and weak galvanic currents applied percutaneously or directly to the vagina, uterus and bladder, mainly for the relief of *pain*,—a symptom that prompts most of the plastic and resectional operations, and yet so sadly persists after many of them,—and the other, a surgical disintegration of diseased tissues and neoplasms by strong but accurately-measured currents, the disintegration being so controlled as to cause a mere surface cauterization at a circumscribed spot on the mucous membrane, or to produce an extensive, wholly internal destruction within the body of a tumor.

While it cannot be said that the first-mentioned method of using electric currents in gynecology has not already been extensively tried, it is yet true that circumstances were against anything like an adequate

determination of its value until a very recent date, as the want of reliable means of measurement and dosage made intelligent experiment impossible. Since the general adoption of the milliampère meter (although it can hardly be said to be in sufficiently general use yet), a great stimulus has been given to such applications, and their true field will doubtless be speedily outlined. The scientific use of strong currents, on the other hand, is admittedly in its infancy, and owes its professional favor to the very recent writings of Apostoli and others abroad, and of numerous enthusiastic gynecologists in this country.

It is in the use of galvanic currents especially, whether weak or strong, that recent progress has been attained, and its key-note has been the use of *a single pole for treatment*, the circuit being completed by a non-active pole on the surface. Definite results can thus be secured and accurately predicted beforehand, for the basis of the work has been shifted from theory to observed fact. We know much of the effect of each pole upon tissues in immediate contact with it,—the polar effect,—and but little of the more distant interpolar effects. Gynecological applications of electric currents have, therefore, a distinct advantage over neurological applications,—at least until such time as neurologists shall practice the same boldness in local treatment.

This surgical use of strong currents within the pelvis has already been found to be a desirable substitute for a number of both major and minor gynecological operations,—such, for instance as laparotomy for fibroid tumors and for hydrosalpinx, curetting, trachelorraphy, application of styptics, caustics or caustic solutions to

the endometrium, etc., the current application being in each case either less fraught with peril to the patient, more quickly curative, or more easily applied and controlled. It is an absolute substitute for sharp curetting in all cases, and, where it can be conveniently performed, this operation is unjustifiable in the future. As compared with caustics and caustic solutions, it possesses the advantages of being easily and absolutely controllable, permitting either an alkaline or an acid caustic action to begin gradually and be terminated at any desired instant, accompanied at the same time by a distant action of a salutary nature. The caustic effect, moreover, may be confined to the interior of the uterine cavity, leaving the cervical mucous membrane untouched, or *vice versâ*, by the use of a form of intra-uterine electrode devised by the author. As a means of controlling hemorrhage from the uterine cavity, whether due to malignant disease or not, powerful positive cauterization is unequalled.

It is true that a full test of the practical utility of electricity in the diseases peculiar to the female sex must show that it is an agent capable of being properly applied without the need of a very great amount of technical skill. The main purpose of this little book is to show that the necessary skill can be readily gained by any one, even the busy general practitioner, if he will but consent to study the remedy in a practical way, and use reasonable care and circumspection in performing the operations. Unfortunately, such a student must also consent to abstain from reading any but the most recent works upon electro-therapeutics, as a certain result of a perusal of many of them is a failure to comprehend the present position of electrical science.

To the gynecologist it is by no means a fault of these works that they are written from the stand-point of the neurologist, for there is no essential difference in the two kinds of work. The real difficulty is a lack of clearness and simplicity that of necessity attended all electrotherapeutic writings before the introduction of the meter. Since its adoption the most intricate laws of electrical science are capable of demonstration to the senses without calculation or figuring, and one may handle a current properly without being an accomplished theoretical electrician.

But, while making light of the necessity of much theoretical knowledge, I do not wish to be understood as implying that an intelligent comprehension of currents and their behavior is not essential to any one who would subject a woman to the influence of the heavy doses now in vogue. They are, unfortunately, too often given at the present time by persons in ignorance of their laws and powers, and I have more than once been simply astounded at the lack of acquaintance with elementary physics on the part of graduates of our best medical schools. Fortunately, this lack may be overcome by a little earnest work under proper direction, and it is for this purpose that an experimental part of this book has been arranged.

Practical experimentation with currents not only insures their easy control in subsequent work, but furnishes the best means of comparing the three medical currents,—the galvanic, the faradic, and the franklinic; and but little handling of this sort is needed to convince any one that each is an essentially different article of the materia medica.

CHAPTER II.

APPARATUS REQUIRED IN GYNECOLOGICAL APPLICATIONS OF THE GALVANIC CURRENT.

THE preliminary handling and study of the galvanic current that is so essential to intelligent work begins, of course, in a selection of the proper apparatus. This may be somewhat less imposingly complicated than usually supposed. The articles considered necessary by the writer for both experimental and therapeutic work are both inexpensive and simple. The list may be given as follows:—

1. A battery, or the supply terminals of an incandescent electric light circuit. 2. A current controller of proper make. 3. A meter indicating from one to at least five hundred milliampères. 4. For mere experimental work, at least three sizes of cutaneous electrodes, with a sufficient number of conducting cords. A few words may be profitably devoted to each of these articles.

The Battery.—The best stationary battery for all-around medical galvanic work is made up of a suitable number of a kind of cell known among electricians as an "open-circuit" cell,—that is, a cell that will not deteriorate during periods of idleness, that is ever ready to work well, and that possesses the single disadvantage that it requires rest for recuperation after its full power has been taxed. As the full power can never be used in medical work, this one objection has no significance.

The Leclanché (prism or Gonda pattern) is one of the best of this type in general use, and one cannot make a mistake in its purchase. The cell used by Apostoli, as made by Gaiffe, and also in this country by Otto Flemming, is an open-circuit variety, in which the internal resistance is lessened in order to reduce the number required to furnish heavy currents through the slight

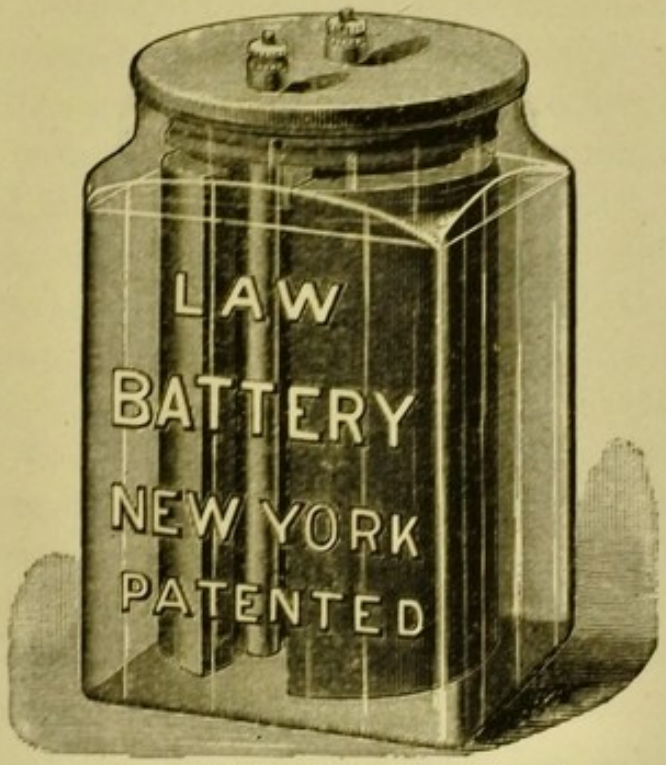

FIG. 1.—LAW CELL (New Form).

resistances encountered in tumor work. It has no special advantage over the Leclanché when the skin has to be traversed twice by the current. Neither of these cells require any attention whatever beyond a very rare supply of water and chloride of ammonium, and a still rarer renewal of the cheap zinc rod employed as the negative element. I have recently placed in my private hospital a permanent battery, consisting of seventy cells

of the Law telephone variety (Fig. 1). The makers claim that the new form of carbon element shown in Fig. 2, which they have but lately adopted, is practically everlasting, and not possessed of a definite though long existence, as is the case with the Leclanché and other peroxide of manganese arrangements. This cell has the further advantage to the physician of being hermetically

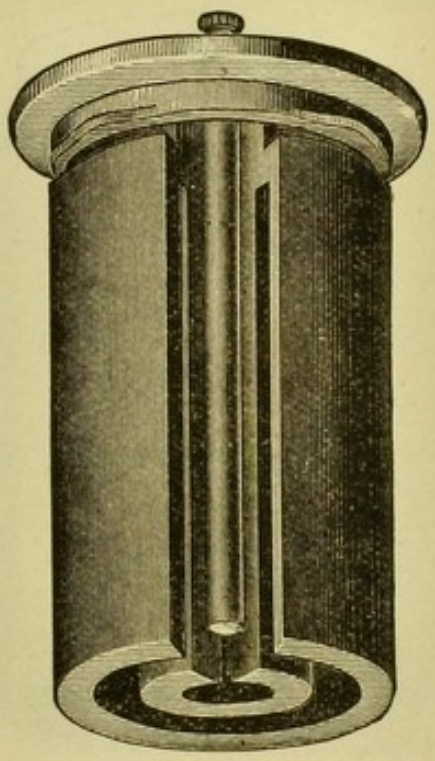

FIG. 2.—ELEMENTS OF THE LAW CELL.

sealed to prevent evaporation, and is not an unsightly addition to the office furniture.*

*After several months' hard usage of my own battery and of one recently placed in the Pennsylvania Hospital, I am convinced that the Law cell is unquestionably the best for medical purposes, as its air-tight seal disposes of the only disadvantage encountered in the best type of other forms. If short circuiting and splashing are avoided, it requires no attention whatever, and should last the physician indefinitely.

The number of either of these cells required by a physician varies from thirty to seventy or more, according to the scope of the work to be performed. Thirty cells give but little current through the skin of most parts of the body, and the number is mentioned here merely because some physicians seem to be content with very weak galvanic batteries. Forty-five cells give a reasonably strong current for percutaneous or permucous work, but for the heavy currents of electro-cauterization and electro-puncture from fifty to seventy give the best results through the meter and controller, when used in the way described in this work. They are to be set up according to directions accompanying them, on shelves in some permanently secluded place, connected "in series,"—that is, the zinc of the first to the carbon of the second, the zinc of the second to the carbon of the third, and so on until all are connected.* It will then be found that the first carbon and last zinc are unconnected with anything else; to each of these attach a wire and carry the circuit to two binding posts conveniently placed to receive the cords of the electrodes. The post connected with the first carbon will be the positive pole (anode) and the one connected with the last zinc will be the negative pole (kathode) of the battery.

My experience with the gravity cell has convinced me that it is entirely out of place in a physician's battery,

* Although the connecting together of the cells of a permanent battery is so simple a thing if the exact order outlined in the text is observed, cells are frequently ruined by carelessness in this particular. When they are all to be used at once with a current controller in circuit, as advised by the writer, their proper arrangement "in series" is exceedingly simple.

being exceedingly dirty from the constant accumulation of creeping zinc sulphate, and unreliable owing to the rapidity with which evaporation breaks the circuit by depressing the water surface below the horizontally-hung zinc. In each of the other cells the perpendicular arrangement of the elements permits the circuit to remain good as long as any water is left in the jar. The gravity cell is really designed only for continuous "closed-circuit" work, and is only economical when engaged in constant action, under constant supervision, as in telegraph-offices.

What are known as current selectors—that is, devices to select one or any number of cells for use—should be utterly rejected in any kind of medical battery when it is possible to obtain a current controller such as will be described directly, by means of which the current can be varied at will, without shock of any kind. Two wires only are needed when the controller is used, doing away with the great number and intricate arrangement of wires necessitated with the selector.

But, instead of the bulky office battery described, many physicians will doubtless wish a portable one, making battery work possible at the bedside as well as in the office. A first purchase is apt to take this direction, and very properly so, since cases are constantly met with that cannot come to the office. Of the portable batteries, I have been compelled to return again and again to Flemming's zinc-carbon-bichromate battery, as one after the other promising substitute failed to bear the test of time and work. These batteries are made with a selector on the face-board, consisting of a plug-socket over each cell; but where shock is to be avoided

the careful operator will use the whole battery at once, with a controller and meter in circuit, as recommended for the stationary battery. They are usually supplied with a commutator (pole changer) also; but this means of changing the polarity of the electrodes is only essential in electro-diagnosis, and is a positive disadvantage in gynecological applications, as leading to confusion between the poles, and even accidental breaks in the circuit while at work.*

A thirty-cell portable Flemming battery, *freshly charged*, can be made to maintain from one hundred to one hundred and fifty milliampères through a circuit consisting of the patient (from embedded needle to large dispersing electrode) and a meter and controller such as are described in this paper. Two such batteries will give from two hundred to three hundred milliampères under similar circumstances.

The cleaning, re-amalgamating, and refilling that all acid batteries demand every month, and especially when about to be used after a period of inaction, is an obstacle to their comfortable use; but no little satisfaction is given by them after being put or kept in order, as they give a powerful current, considering their small bulk, and the simplicity of their repair makes it possible for the physician to keep them in order himself, without the trouble and expense of sending to the manufacturers. I have one of thirty cells that has been used by me constantly for bedside work for nine years, with but

* The wheel shape of some of these commutators has actually led some physicians to think that the proper way to administer a galvanic current is to place the poles *in situ* and rapidly reverse the current by turning the crank.

two renewals of zincs, and it is yet as good as a new one.

It is probably best to state distinctly in this place that the portable batteries, consisting of small chloride of silver or chloride of ammonium cells, while useful and convenient in administering from five to twenty milliampères at the bedside, are totally inadequate to produce the heavier or even medium currents required in direct intra-pelvic work.

The Current Controller.—This instrument I consider indispensable in the use of heavy currents, and of great value in all forms of galvanic work where shock is to be avoided. Its function is to vary the current at will, by rapidly increasing or decreasing the resistance of the circuit. The older forms were called rheostats, and consisted of coils of wire of known resistance or of glass tubes containing water and a sliding rod. The coils have been entirely discarded for this purpose, for reasons that I will not now enter into, and the tube, while largely in use, has too small a range for heavy currents. The same objection may be urged against the original form of a circular pencil-mark controller devised by the writer about two years ago, and exhibited before the Philadelphia County Medical Society. Its range of resistance adapted it to all percutaneous currents up to fifty milliampères, but not above that point. I have recently succeeded, with Mr. Flemming's assistance, in so improving it as to remove this objection, and it will now vary a current from a fraction of a milliampère to the full strength of the battery, without shock (Fig. 3).

It consists of a ground-glass plate provided with a tapering area of soft pencil-mark, broadening into thick

graphite embedded in the glass, which is joined to lead. These act as resisting materials, over which a brass contact attached to a crank can be made to pass. When the crank (1, Fig. 3) is placed to the right of the hard-rubber button, 2, the contact rests entirely on the glass and the

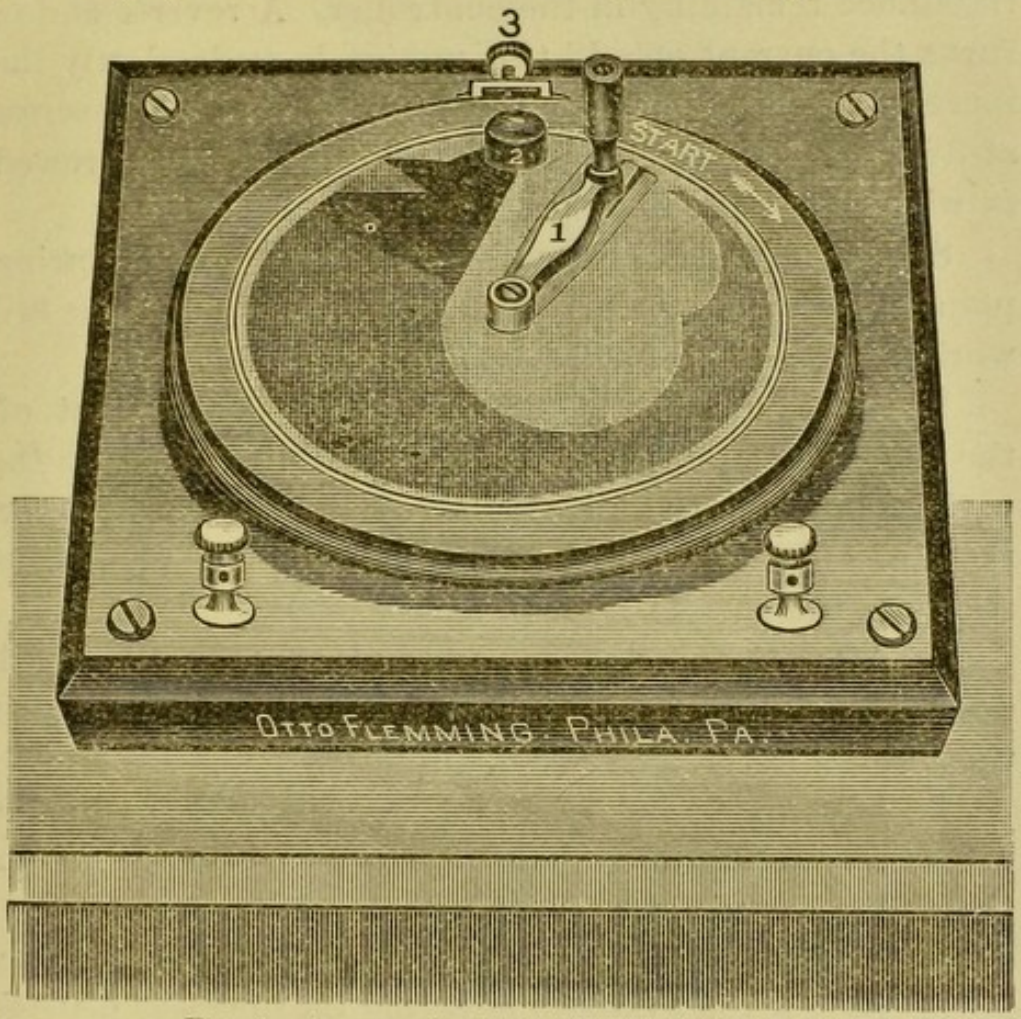

FIG. 3.—AUTHOR'S CURRENT CONTROLLER.

circuit is broken. Moving it slightly in the direction of the arrow, it soon touches the graphite mark and permits the least amount of current to pass through, since the current must pass through the whole length of the graphite,—a poorly-conducting medium. As the crank

is slowly brought down from the point of rest and up the other side, there is a progressive, gradual increase of current, until, finally, the thick graphite and the lead at the left of the rubber button is reached, when the whole power of the battery is turned on, there being no resistance remaining in the controller. A reverse action turns the current off. If this motion is made slowly the increase and decrease is exceedingly gradual. The screw at 3 is for breaking the circuit, and should be screwed *in* when using the instrument.

Special attention should be paid to the following points in order to prevent mishaps and to retain the full working capacity of the controller :—

1. Always place the turning crank to the right of the rubber button before applying the electrodes to the patient, so as to be sure that the full resistance is interposed; otherwise an unpleasant or even dangerous shock to the patient might result.

2. After the electrodes are in place, turn the crank down and toward the left *slowly* until the meter shows the desired current strength.

3. If using an incandescent current, never bring the metallic part of the cords or electrodes together unless the crank is well over to the *right.*

4. Prevent all dust from settling on the glass plate.

5. Renew the graphite covering on the glass plate as often as marks of wear are visible by rubbing graphite over the circumscribed area from a *very soft pencil.*

This instrument is chiefly valuable in enabling us to use an incandescent electric light current for all strengths of medical galvanic work. The principal advantages in using it with a battery of cells, instead

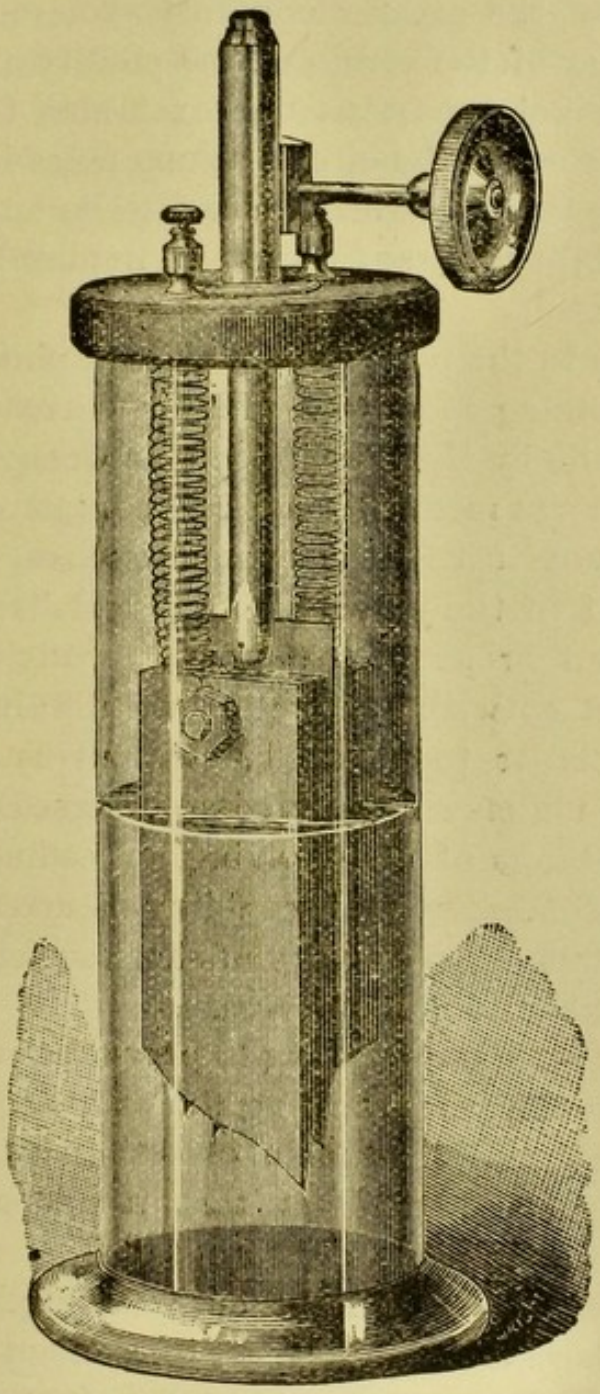

FIG. 4.—BAILEY CURRENT CONTROLLER.

of the older cell selector still advised by Apostoli, are: its simplicity, the greater certainty of avoiding shock, the even wear of the cells, and the possibility of mounting the terminal apparatus on a movable table, which may be attached to the circuit at any point in a room or house where two wires may be carried to binding posts. This movability of apparatus is impossible when a selector is used.

Previous to the perfection of this graphite controller there was nothing equal to the Bailey Current Controller (Fig. 4), made by the Law Telephone Company, of New York. This was made originally to control the strength of the currents used in telephone exchanges, and is a development of the water tube and rod, the rod being replaced by four broad carbon plates, giving immense surface contact with the water when fully immersed. The plates taper to points below, and by means of a ratchet and pinion may be gradually immersed into the water or raised out of it, giving an exceedingly wide range of resistances, and enabling the current to be varied without the possibility of shock from zero to any desired number of milliampères.

In use it requires watching to prevent the mechanism becoming too loose, permitting the plates to descend of their own weight. The main objection to it is its unwieldy shape, and the fact that it leaves a certain amount of resistance in the circuit.

The Meter.—With light currents applied to skin surfaces, where the sensitiveness of the patient is added to the watchfulness of the operator, there may be ample excuse for occasionally neglecting to use a meter and depending on the number of cells in circuit; but when

we have an insensitive mucous membrane, as in the vaginal, uterine and urethral tracts, situated so as to make it impossible to watch effects, it is simply criminal to use a galvanic current without adequate means of knowing the amount actually passing through the patient. Such neglect cannot be too strongly condemned. Milliampère meters are at present quite cheap, and

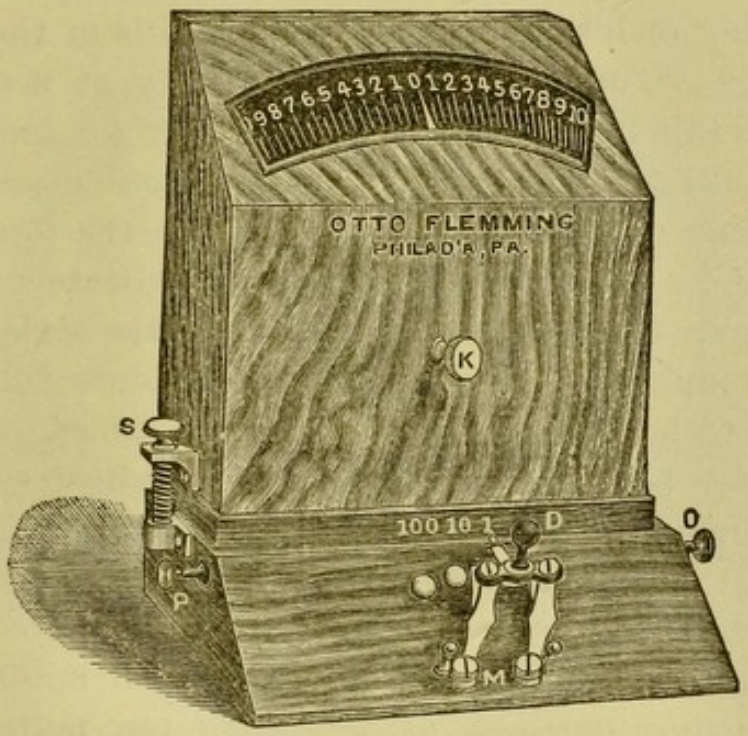

FIG. 5.—FLEMMING'S MILLIAMPÈRE METER.

should be ordered with every battery. They should register from one milliampère to six or eight hundred. Those made in this country by Flemming, Barrett, and McIntosh make it unnecessary to send abroad for foreign instruments; in fact, the American instruments have proven superior to the imported ones in the author's experience.

The directions for using Flemming's meter (Fig. 5)

are as follow: When the meter is being transported the needle should be arrested by turning the knob, K, until it no longer moves. When about to use it, release the needle by a reverse movement of the knob, when it will be seen to swing freely on its pivots. If the needle does not settle at the 0 of the scale when it comes to rest, it is evidence of the displacing power of the earth's magnetism at that particular spot, and should be remedied by raising or lowering the case by means of the adjusting screw, S, until the index is exactly at zero. The scale on this instrument is divided into ten units from zero in either direction. When the double switch, M, at the base of the instrument points to the figure 1 in front of it, the figures of the scale indicate a milliampère each. If this switch points to 10 the scale reading is to be multiplied ten times. If it points to 100 the scale is to be multiplied one hundred times. Thus, if the switch points to 1 and the needle indicates 3 on the scale, there is a current of three milliampères in the circuit; if the switch points to 10 and the needle to 3 there are thirty milliampères; if the switch points to 100 and the needle to 3 there are three hundred milliampères. When using currents of less than ten milliampères, therefore, the switch, M, should point to 1; when less than one hundred are to be used it should point to 10, and when over one hundred it should point to 100. Before turning on the current always be sure that the needle is free.

Directions for using the McIntosh meter (Fig. 6):—

1. Release the indicator by sliding the button, D, to the right.

2. Turn the instrument so that the indicator points

due east and west; when it rests at 0 adjust the leveling screws until it is perfectly horizontal.

3. *To Use the Long Scale.*—Connect the positive pole of the battery with binding post C and the patient with post A by means of a conducting cord and electrode. The patient is also connected directly with the negative pole of the battery, as usual.

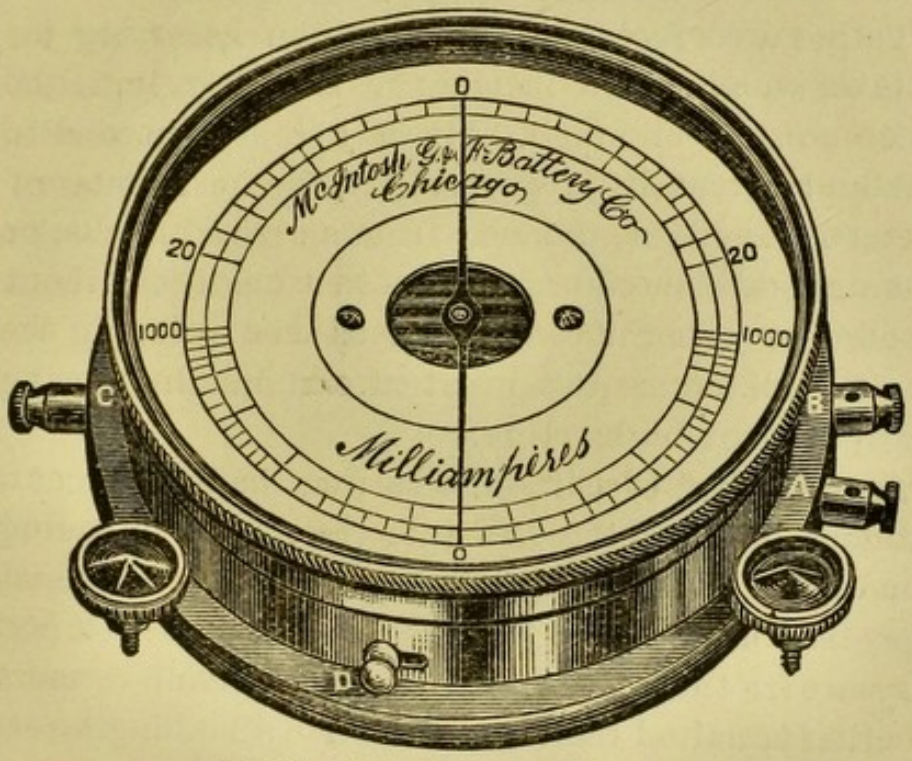

FIG 6.—THE MCINTOSH METER.

4. *To Use the Short Scale.*—Connect the positive pole of the battery with binding post C, and connect the patient with post B; also with the battery as before.

Scales.—The *longer scale* is graduated from 0 to 1000 milliampères; each division to 30 marking 5 milliampères, and increasing in the number indicated, according to space, up to 1000 milliampères. The *shorter*

scale marks from 0 to 20 milliampères, the spaces from 0 to 5 being divided to indicate half-milliampères.

This milliampère meter must not be placed within two feet of magnetic bodies—pieces of iron or steel—or inductive influence when in use.

The electrodes should not be allowed to touch while the instrument is in circuit, for the violent agitation of the indicator is liable to damage the bearing.

To get a correct reading it is often necessary to jar the table on which the instrument rests lightly, until the needle comes to a stand. Great care is also needed to level and orientate it properly. As the resistance of this meter is slight, the current from a series of cells, or even a single cell, should not be sent through it without a controller or other means of resistance being in the circuit. All meters require great care in handling, being readily injured by hard usage.

Arrangement of Circuit.—In use, the meter and current controller are inserted into the circuit by including them one after the other, between the last carbon and its respective binding post, as follows: From the last carbon carry a wire to one terminal on the controller; connect the other terminal on the controller with a binding screw on the meter; and, finally, carry a wire from the other binding screw on the meter to the positive binding post. The two instruments may be arranged on a single base-board, or on a table, as shown in Fig. 7, which is an illustration of a movable ward galvanic table, designed by the author for bedside use in the Infirmary for Nervous Diseases and in his private hospital. Fig. 8 illustrates a more elaborate stationary arrangement of the same switch-board elements combined with a faradic

apparatus, as constructed by Otto Flemming for the operating-room of the author's private hospital.

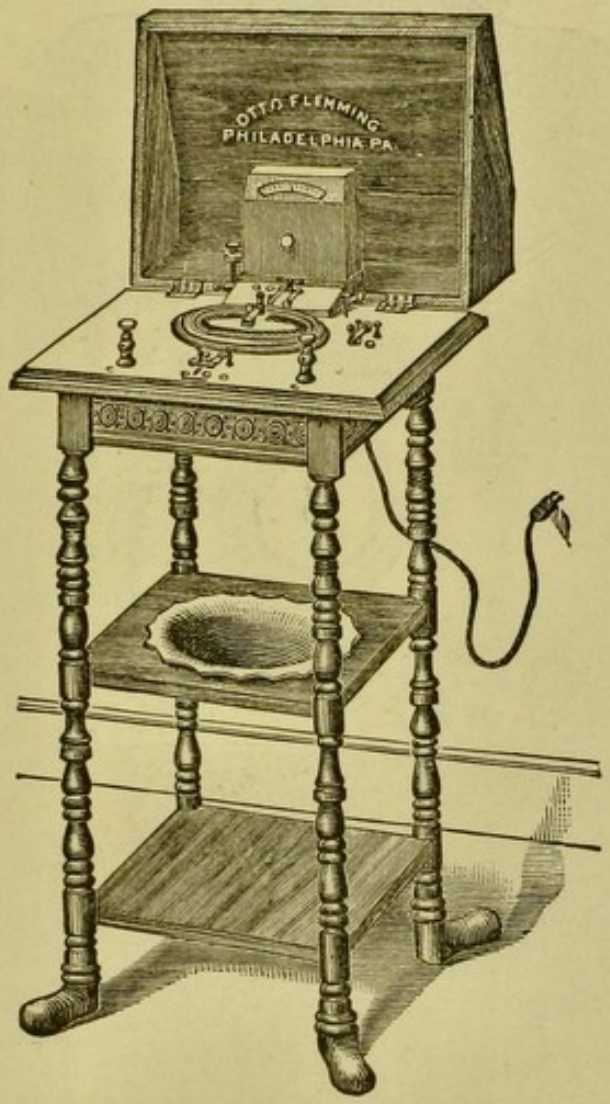

FIG. 7.—BEDSIDE GALVANIC TABLE.—For use with supply wires from an incandescent plant or permanent battery. Connection with the supply wires is made by a double plug and socket, or by two binding posts.

Use of the Incandescent Electric Light Current in Medical Work.—This current will be found in every way well adapted for medical use, and should be preferred to that furnished by the ordinary battery of cells

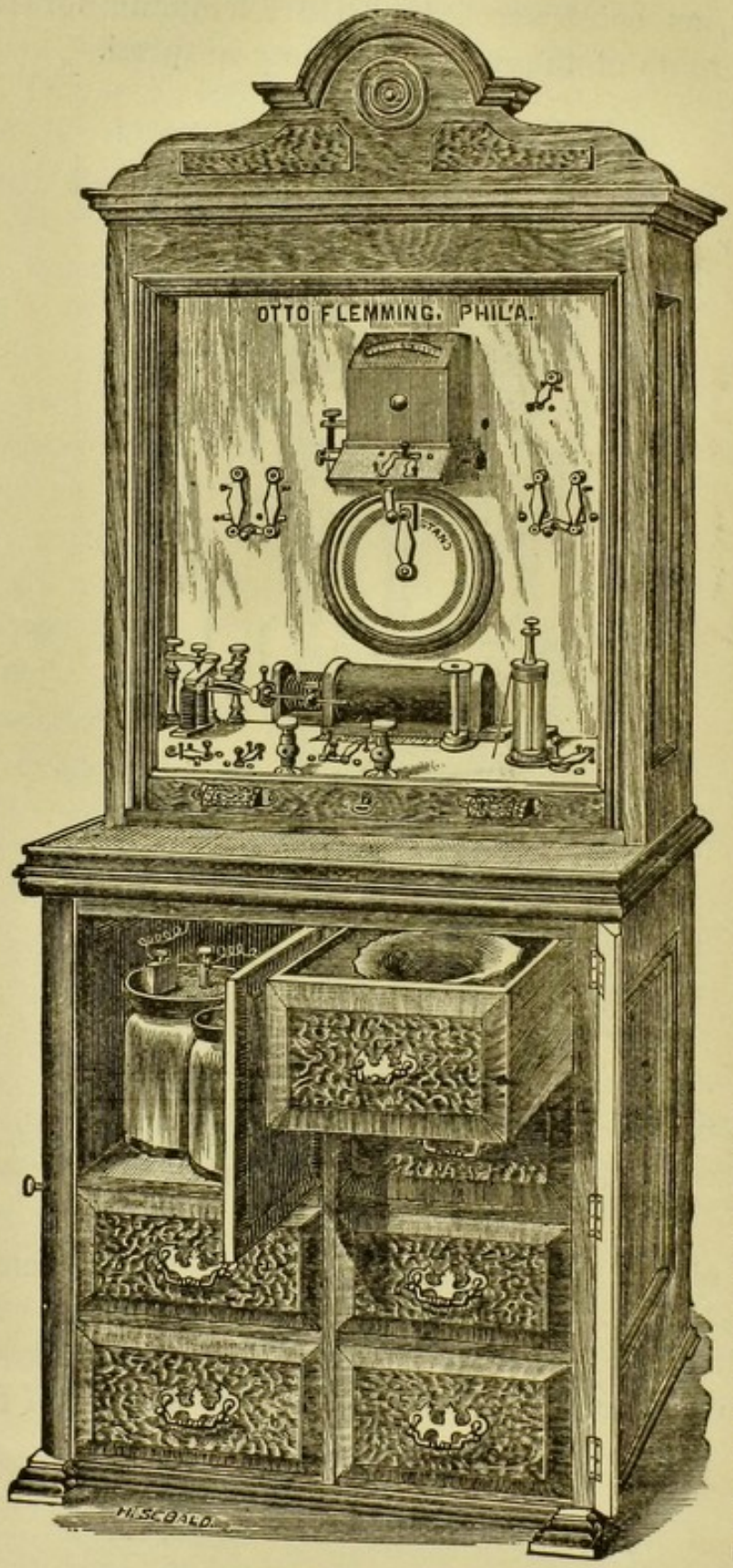

FIG. 8.—THE AUTHOR'S OFFICE CABINET.—This cabinet furnishes both currents, separate or combined. Permanent cells may be placed on shelves attached to the rear of the cabinet, and the whole mounted on rollers; but usually the larger size of cells are to be preferred, kept in a separate compartment. The original form of the graphite or pencil-mark controller is shown in the centre of the switch-board.

whenever it is possible to obtain it during the hours convenient for work. By its use the possible annoyances and inconveniences of a battery are entirely avoided, and a current capable of variation to any strength from a fraction of a milliampère to a thousand milliampères is ever at hand. The whole strength of the current is supplied by the two supply wires, and its medical use demands, of course, some means to diminish it at will. This is thoroughly accomplished by the controller and meter described in these pages, their use rendering it just as safe as the current from any kind of battery. They are inserted in the circuit as follows: Connect one supply wire directly with one of the binding posts for electrodes; the other wire is connected with one binding screw on the controller; from the other binding screw on the controller a wire is led to one binding screw on the meter; and from the other binding screw on the meter a wire is led to the remaining electrode binding post. All that is to be done now is to test the polarity of each binding post and mark it accordingly. For method of testing, see page 26. The controller and meter should be kept permanently in the circuit in this way,—especially the former,—more as a precaution against injury to the instruments by "short circuiting" than from fear of injuring the patient, as the full strength of this circuit can force no more current *through the body* than can the full strength of any ordinary medical battery of sixty or seventy cells. To avoid accidentally burning out the meter, the controller should always be kept with the crank to the right of the button when not in actual use, and the brass parts of the electrodes should never otherwise be brought together.

The Edison circuit, direct from the dynamo, which the author uses daily in office practice, has a usual electro-motive force of about one hundred and ten volts, and is therefore equal in force to about seventy-three good Law or Leclanché cells. The internal resistance is practically *nil*, rendering it equally available for use with the galvano-cautery knife as in medical work, provided proper resistances are inserted in each case.* The only disadvantage is the necessity of *keeping* some resistance in circuit to prevent "short circuiting" and consequent injury to the meter. The current from the storage-battery of the Electrical Accumulator Company is also available for medical work, although weaker than the Edison current, possessing usually from fifty-one to sixty volts. No incandescent current of these volt powers is in any way dangerous when transmitted through the body. Arc-light currents, on the other hand, are highly dangerous, and should never be used.

Cutaneous Electrodes.—The essentials for either experimental or therapeutic work are now complete, if to the above list be added appropriate electrodes and conducting cords. For the experimental work we should be supplied with at least one each of the two sizes of cutaneous electrodes required as dispersing poles in therapeutic work, as well as a pair of the ordinary disks with handles usually supplied with faradic batteries, and a fine-pointed electrode (the latter readily improvised from a stiff wire). The larger dispersing electrode must be of a size to completely cover the abdomen,—viz.,

* The graphite controller should not be used to control galvano-cautery currents.

about nine by ten inches,—made of thin sheet-lead in order that it may be made to take any shape to fit the abdominal contour. The smaller one is most convenient when not larger than five by six inches, and may be made of either thin brass or lead. It is best covered with a layer or two of absorbent cotton,* the latter being unrolled and cut about an inch larger than the plate, and kept in place by fine spool-cotton loosely wrapped. The method of applying the absorbent cotton to the larger electrode is described in Chapter V. The disks and point are readily wrapped with cotton at each using in the same way that an applicator is covered.

For therapeutic and surgical work a series of special electrodes and needles are required for use as active poles, in addition to this list of dispersing plates. They will be found described in the chapters devoted to each operation.

I have been particular to specify that a meter and current controller should accompany the battery, for the regular and invariable use of this combination not only permits of scientific and accurate work, but really simplifies the whole subject to the beginner. They may be said to be devices for relieving an operator from the burden of knowing anything of Ohm's law, or of making calculations of resistances and current strengths, although, of course, their practical value is far greater than this.

*It is gratifying to note the widespread and general adoption of absorbent cotton as an electrode covering in place of what a writer has called "the filthy, current-absorbing sponge," since its use was first recommended by the author in communications to the *Medical News*, February 7 and December 26, 1885.

CHAPTER III.

EXPERIMENTS ILLUSTRATING THE PHYSICAL QUALITIES OF GALVANIC CURRENTS.

HAVING set up the battery or put it into operation, and connected the meter and controller in circuit, the conducting cords and electrodes may be attached to their binding posts in readiness for the first experiment.

To Test for Current.—(*Experiment 1.*) Set the controller for least current (in the graphite controller with the crank on the beginning of the pencil-mark to the right of the rubber button, and in the Bailey controller with the sponge-tips merely touching the water), and bring the brass parts of the electrodes together. The meter will show a deflection of more or less extent. If there is no deflection a break exists in some part of the circuit.

To Test the Power of the Battery and the Range of the Controller.—(*Experiment 2.*) Unite the poles directly by means of a conducting cord or wire, and note the gradual increase in the current as the crank is brought down and to the right, or the carbon plates are slowly immersed into the water. This procedure is wasteful of battery power, but will show the total capacity of the battery through these resistances, if the meter registers high enough. Anything like this experiment should be carefully avoided when using the incandescent current.

To Test the Polarity of the Electrodes.—(*Experiment 3.*) If in doubt as to which is the negative

pole and which the positive pole of a galvanic battery, place the tips of the cords in a solution of potassium iodide. The compound will be electrolyzed, iodine appearing at the positive pole as a brownish cloud, and potassium at the negative pole. If the potassium iodide be dissolved in starch-water, the discoloration at the positive pole is blue instead of brown, the nascent iodine immediately uniting with the starch. A more quickly performed test than this is to ascertain which moist electrode produces greatest pain on suddenly making contact; that one will be the kathode, or miscalled negative pole.

Comparison of Metallic Contact with Moist Cotton to Cotton Conduction.—(*Experiment 4.*) *Having set the controller for a weak current*, note the number of milliampères in circuit when the brass surfaces of the two electrodes are brought together, and the number when the two wet surfaces of cotton or sponge are pressed together.

This will show the immensely greater conductivity of brass. As the current is not intended to go right back to the battery in this manner during ordinary work, it is called "short circuiting," and is wasteful of the battery power and dangerous to the delicacy of the meter.

Application of Dry Metallic Electrodes to Skin compared with that of Wet Electrodes.—(*Experiment 5.*) Experiment now with the dry metallic surfaces of the electrodes pressed down upon dry-skin surfaces. Little or no current will be shown by the meter if the skin is free from moisture, even with the controller set for full strength. Substitute wet cotton-covered electrodes for

the dry ones, and a current will be shown both by the sensations and the meter.

The current passes with exceeding ease from metal to metal when in contact, either dry or wet; but passes from dry metal to the body with difficulty. This is because the cuticle is practically a non-conductor; not until the air-spaces of its horny layers are filled with water, which is a reasonably good conductor, will it permit the current to penetrate to the moister tissues below, and even then the bulk of the current passes through the sweat-ducts and any congested or abraded spots. Electrode coverings are therefore designed merely to hold a layer of water between the metallic surface and the skin, acting as a conducting joint.

In making the experiment just detailed with dry metallic points instead of a flat surface, an intense burning sensation will soon develop if the full number of cells are used and the points well pressed down. This burning coincides with the appearance of some current in the circuit, as shown by the meter; but the number of milliampères by no means corresponds with the intensity of the burning; very little current passes, in fact, when the pain is greatest. This pain of the "galvanic brush" is usually described as due to the concentrated action of the minute current quantities upon the most superficial and sensitive nerve filaments; but doubtless the real reason is the microscopic spark-leaps through the cuticle incidental to this mode of current transmission.

Effect Produced on the Current Volume by Salt Water on the Electrodes.—(*Experiment 6.*) Set the controller at a given place and leave it there (or use

the full strength of a certain number of cells), and note the number of milliampères passing through the hand when both wet electrodes are pressed upon opposite sides; leaving the battery strength undisturbed, remove the electrodes and saturate them with salt water. When they are replaced, a considerable increase in the number of milliampères passing through the hand will be found. The sensations will be still more acutely increased.

Saturated salt water is about three thousand times a better conductor than distilled water; hence the use of salted water on electrodes increases the current by lessening the resistance offered by the "conducting joint" at the points of entrance into and egress from the body. It is of great service when the battery power is deficient or accidentally low; but its constant use is inadvisable, owing to the disproportionate increase of pain produced by it and the bad effect upon the electrodes, which are quickly oxidized. The excess of pain is doubtless due to the irritant effects of the products of the decomposed chloride of sodium.

Effect upon the Current of Different-sized Electrodes.—(*Experiment 7.*) Note the number of milliampères passing through a part of the body from the full strength of fifteen cells,—(1) when two small electrodes are used; (2) when two medium ones are used; (3) when two large ones are used,—care being observed to place them in the same spots and press their whole surface in contact.

If it is more convenient to use all the cells in the way advised generally in this work, instead of using the full strength of only fifteen, it may be done by simply setting the controller for a comfortable current with the small

electrodes, and leaving it untouched in the subsequent steps of the experiment.

The increase of current when the larger electrodes are used is exceedingly striking. The cuticle, as has been explained, is the chief obstacle to the current; and from a given number of cells but a certain quantity can be forced through each square inch of its surface. The more square inches are included in the conducting surface, therefore, the more current will go through from the given number of cells; but there will be no increase in (and possibly a slight diminution of) the number of milliampères passing through the original square inch of skin, unless the number of cells is increased or the resistance of the controller lessened. The use of broad electrodes is indicated, therefore, whenever we wish to introduce a large current into the body with a minimum of pain, and without a special concentration at the points of entry. It is the only way to affect deep structures by percutaneous transmission without excessive pain, and for such purposes both electrodes are large. In gynecological work, where the effect of a single "active" pole is alone desired, the other "indifferent" pole is made sufficiently large to secure easy penetration without such local action.

Comparison of the Effect of the Same Current Strength when Concentrated and Diffused.—(*Experiment 8.*) Connect the body with the positive pole of the battery by means of a large moistened electrode on its surface. This will form the indifferent pole. Select (1) an equally large moistened electrode for the active pole; place it on another part of the body; connect it with the negative terminal of the battery, and bring

the current up to, say, eight milliampères, as shown in the meter. Note the slight pain produced. (2) Exchange the large active pole for a medium-sized one, moistened of course, and bring the current up to the eight milliampères. The pain will be increased, owing to the concentrated action of the same number of milliampères. (3) Use next a fine point as active pole, well covered with moist cotton, and again bring up the current to eight milliampères. The pain is quite decided.

As the size of the active pole is diminished, the current being kept the same by adjusting the controller, there is an increase in the intensity of the pain corresponding to the increased density at this spot. The indifferent pole is left large in this experiment, as in so many gynecological operations, because it combines a slight resistance to the current with the least local pain. The experiment illustrates admirably the axiom that more force is required to get the same sized current through a small place than through a large one,—a principle that applies self-evidently to most things.

Increase of pain accompanies with great certainty an increasing concentration of a given number of milliampères on the skin surface; but it should not be forgotten that this is because of the peculiar sensibility with which the body-sheath is endowed. Beneath it and in the interior of less sensitive cavities there is no such admonition to guide us; hence the use of a meter becomes more imperative in the latter situations, for the current is just as active whether pain is felt or not. It is only at and near the junction of mucous membrane with the skin surface, such as the lips, vulva, etc., that great sensitiveness to currents exists; and here it is even more

sensitive than on the skin surface, in accordance with a fuller endowment of sensitive nerve-filaments.

Differing Resistances of Skin Surfaces.—(*Experiment 9.*) The differences in the resistance offered by the skin of various parts of the body, and of different persons, is readily shown by the effect on the meter at each position, the battery and controller being left undisturbed. The face, inner surface of the limbs, etc., will show more current (presenting less resistance); while the back and outer surfaces of the limbs will show less current (presenting more resistance), etc.

That these differences depend almost entirely on varying thicknesses of cuticle is proven by the showing of more current with the poles on distant but thin spots than when alongside of each other on thicker cuticle. The difference between corresponding parts of the skin of different individuals is also at times considerable, especially when a clear-skinned blonde and pallid brunette are compared.

Comparison of the Resistance of Skin and Mucous Membrane.—(*Experiment 10.*) Connect but a small number of cells, say fifteen, with the meter and controller, in order that the full strength of that number of cells may be used. Having put the indifferent pole on the abdomen or back, cover an insulated-stemmed vaginal electrode with absorbent cotton, wet it, and direct the subject of the experiment to hold it between the bare arm and chest in such a manner that the whole conducting surface is in contact, as it would be in the vagina. Turn the current on gradually now to its full extent by means of the controller, and note the number of milliampères. Reverse the controller until there is

no current, and introduce the electrode into the vagina. The current may then be again increased by the controller to its full capacity, and the number of milliampères noted in this situation.

A marked increase in the milliampères will be noted in the vagino-abdominal circuit over the merely percutaneous one, on account of the lessened resistance encountered at the active pole when placed in contact with mucous membrane.

The actual performance of these and similar experiments is unequalled in its teaching power. Besides familiarizing one with many details essential to successful work with the continuous current,—such as the necessity for always using a meter; the possibility of avoiding shock, even with powerful currents; the advantage of ample battery force held in easy check by a controller; and the wisdom of using large or small electrodes as we wish non-local or local effects,—it will show that the practice of electro-therapeutics, while relieved of many unnecessary and obsolete physical theories, may still remain free from the formidable task imposed by at least one recent writer, Engelmann,* who recommends that the resistance of the tissues be calculated and recorded in the history of each case. As well might he say that we should measure the darkness in a room rather than the light produced in the effort to dispel it; and the measurement of darkness under the circumstances would be even more useful, for we can readily assume that any two closed rooms are equally dark;

* "The Use of Electricity in Gynecological Practice" (reprint from "Gynecological Transactions"), page 146.

while no two human bodies present exactly the same resistance, nor can electrodes be put on or within them twice under exactly similar conditions. Exactness of record is amply attained if the number of milliampères is given, together with the name and dimensions of the active pole and the duration of the application.

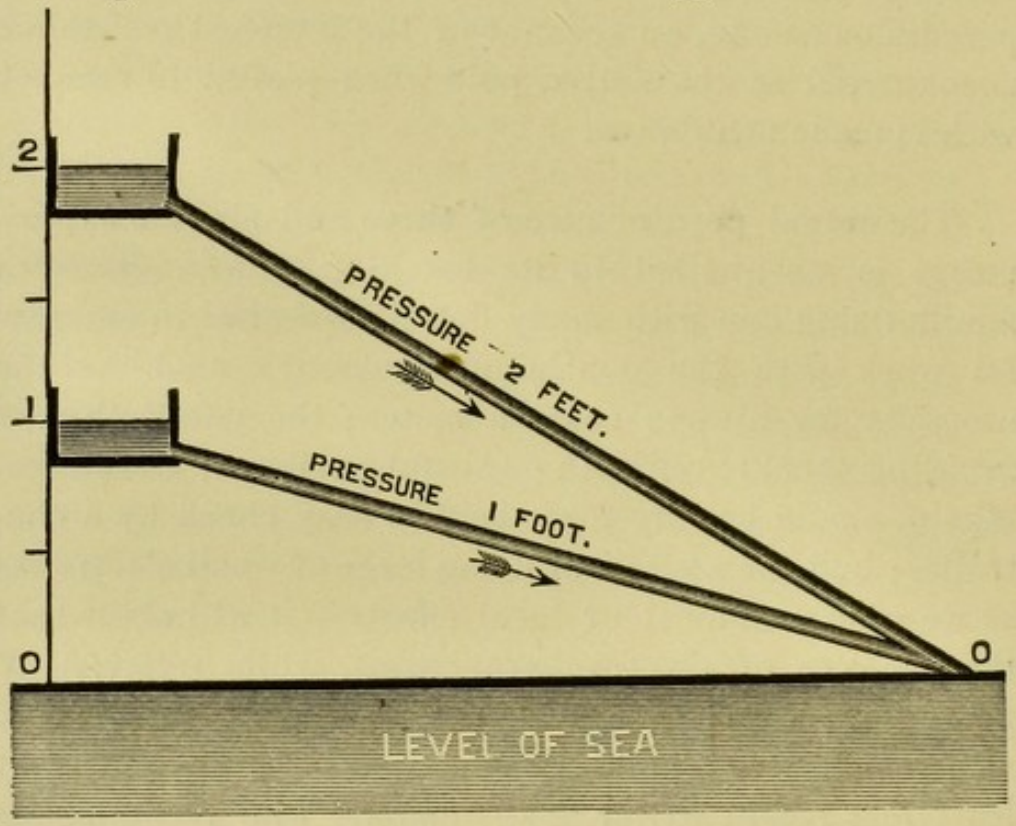

FIG. 9.—DIAGRAMMATIC REPRESENTATION OF THE CAUSE OF FLOW IN HYDRAULIC CURRENTS.—The pressure, measured by a vertical scale of feet, is due to the elevation of the source or reservoir. The amount of water delivered will depend on the calibre of the pipe as well as on the height of this pressure.

Such experiments will also show the thoughtful student that a galvanic battery, or any other source of ampères or milliampères of current, is a reservoir of this peculiar form of energy, and in giving it out obeys laws singularly analogous to those of the force stored in a reservoir of water. If we examine a stream of water issuing

from a reservoir (Fig. 9), we will find two qualities in it which it will be somewhat difficult to separate in the mind,—pressure and volume. The former is the force by which water transports itself, and depends on the height of the water in the reservoir. It is the same in all pipes issuing from it, whether large or small. The volume of water carried by a pipe, on the other hand, depends on the size and length as well as on the pressure.

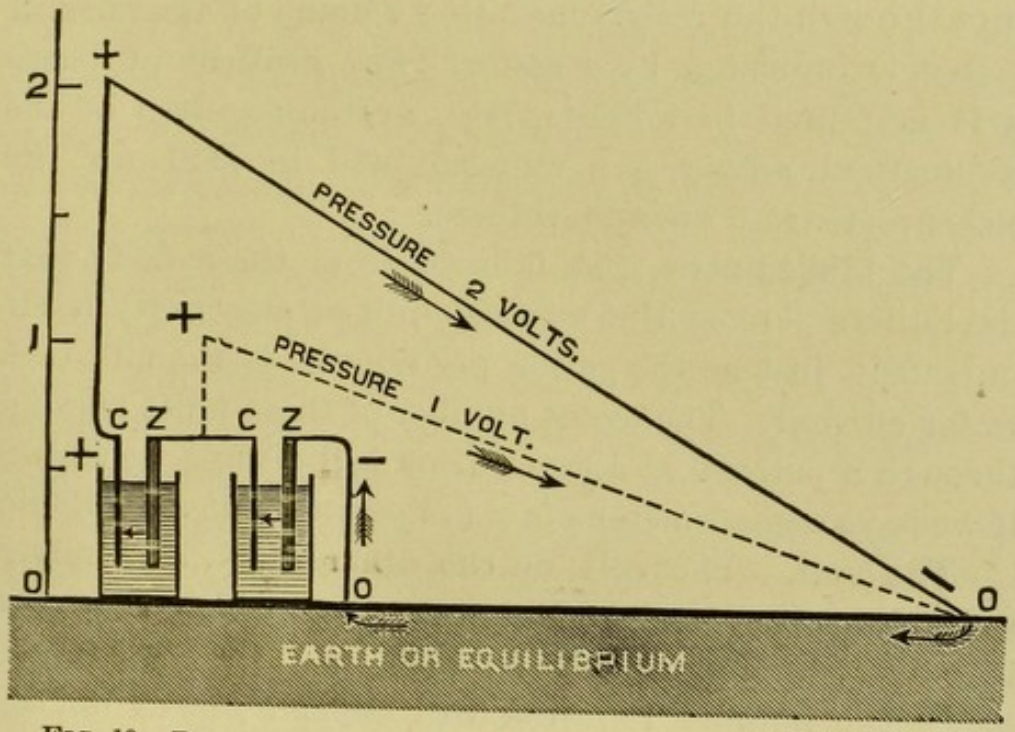

FIG. 10.—DIAGRAMMATIC REPRESENTATION OF THE CAUSE OF FLOW IN ELECTRIC CURRENTS.—The pressure (or electro-motive force), measured by a scale of volts, is due to the elevation of the electric level of the positive end of the conductor by the particular generator in use. The amount of current delivered will depend on the size and conductivity of the wire as well as on the height of this pressure.

In electricity (Fig. 10), the peculiar force by which it transports itself is called electro-motive force; and it likewise is independent of the size of the wire or excellence of the conductor. It is measured in volts. In galvanic batteries, the number of volts of this "pressure"

depends on the number and volt power of the cells when serially arranged (placed one after another).

The "volume" of the electric current is equally analogous to that of the water current, for it depends jointly on the height of the pressure (the number of the volts) and the size of the conductor (the diameter and length of a wire if a metal, and the conductivity, breadth, etc., if a living compound). It is this result of the pressure through the resistance—this volume of the current—that is indicated by a meter. For medical purposes it is measured in milliampères, or thousandths of the commercial ampère,—a unit adopted in 1881 for the measurement of current volume.

The Milliampère.—It follows from these facts that the milliampère is the medical unit of electricity itself in transit, just as the gallon per minute is the unit of a water current. The exact number of these units passing through a patient at a given time will always be shown if we have a good meter *placed in circuit with the patient.*

The Volt.—The volt, on the other hand, is merely a unit of measurement of the pressure at which a current is delivered. Its use is to overcome the resistance, hence the number required will depend jointly on the heaviness of the current required and the resistance to be overcome. The number of these units possessed by a current has no medical value unless the interruption action of the current is desired.

The Ohm.—The ohm is the unit of measurement of the resistance that a current meets in a circuit. In the medical use of electricity it is an important factor, since there is so much resistance to be overcome; but it is, after all, but the measure of a negation, so far as actual working results go.

CHAPTER IV.

ACTION OF CONCENTRATED MILLIAMPÈRE CURRENTS ON ORGANIZED TISSUES.

GYNECOLOGICAL applications of electricity consist so largely in the continuous, concentrated action of one or the other pole of a current strong enough to produce more or less destruction of tissue, that the exact nature of this destructive process invites close attention. A careful naked-eye observation of the phenomena when a strong current is flowing is certainly both instructive and impressive, as well as decidedly conducive to the future welfare of the observer's patients. An experiment with fresh butchers' meat will give a very good illustration of the chemical part of these phenomena as they occur within the living body.

Chemical Effects at Each Pole.—(*Experiment 11.*) Procure a half-pound of beef-muscle; insert into it two ordinary steel needles, one connected with the positive pole and the other with the negative pole of a good battery, and pass through the meat from one hundred to two hundred milliampères for two minutes.

A sort of hissing or frying noise will be heard. This is seen to be caused by the rapid production and escape of small bubbles (of hydrogen gas) from the track of the negative needle. The positive needle will cause no appreciable production of gas, but will immediately be found to be so firmly fixed in the tissues as to be withdrawable with difficulty.

On cutting down alongside the negative needle it is

found to be practically surrounded by a cavity containing liquids and bubbles of hydrogen gas. The muscular tissue has been destroyed wherever in contact with the needle, the edges of the cavity showing it softened, infiltrated, and of a darker color. The needle remains as bright as ever.

The positive needle, if left in place and cut down upon, shows itself greatly rusted and corroded, inclosed firmly in a grayish eschar, colored darker in places by the dissolved iron of the needle.

If the positive needle be of brass, copper, nickel, aluminum, or any of the other baser metals, it is corroded with equal rapidity, the tissues being stained by the particular metallic salts formed for some distance from the needle. On using a gold or platinum needle for the positive pole, on the contrary, it is found to be practically unattacked by the nascent oxygen and acids. The tissues about the needle show now the uncomplicated picture of a positive electrolysis, viz., the characteristic hardening and searing of an acid application. A slight cavity forms about the needle, though not so large as that about the negative needle, filled with bubbles of oxygen gas which has failed to unite with the gold, and the non-corrodible positive needle is therefore not firmly fixed in the tissues, as would happen with a baser metal. It is evident, therefore, that *whenever the active pole of a strong, concentrated current is positive, it should consist of either gold or platinum*, as otherwise the electrode surface is destroyed and the tissues infiltrated with a foreign metallic oxide.

The negative needle remains clean, whatever the metal of which it is composed or the strength of the current.

According to Inglis Parsons,* after the passage of two hundred milliampères through a recently-removed fibroid for one and a half hours, "that portion of it acted on by the current cut quite hard and gristly as compared with the rest. This change was also perfectly apparent to the touch. On making some fresh sections and examining them under the microscope, I found that of the portion in immediate contiguity to the needle everything had disappeared except the fibrous tissue, and this result was obtained at both the negative and positive poles."

Reverting again to the disintegrated cavities in the meat, produced by the negative and positive poles of a strong current (the positive pole having been non-corrodible), we can easily prove that the froth at the negative is alkaline, and that at the positive acid, by placing a drop of litmus solution upon each and allowing the current to continue a few moments. The blue color of the solution is unchanged at the negative pole, but is quickly reddened at the positive. By changing the character of the pole back and forth while still *in situ*, several such changes of color can be produced. The peculiarities of the disintegrating action of each pole are clearly due to the nascent alkalies of one and the nascent acids of the other. At the negative pole we have the soft liquefaction and infiltrated edges of an alkaline caustic; at the positive pole the hardened, coagulated eschar of an acid caustic.

Electro-Chemical Reasons for Using the Negative Pole.—It is evident from these appearances that whenever destruction of tissue is desired the negative pole

* *British Gyn. Journ.*, May, 1888, p. 78.

and its soft liquefaction is indicated, and therapeutic experience seems to confirm the view that the secondary effect of destructive electrolysis—absorption—is more extensive after the negative application.

Electro-Chemical Reasons for Using the Positive Pole.—From similar considerations, the use of the concentrated positive pole with strong currents is almost entirely limited to two objects in gynecological work, namely, the control of intra-uterine hemorrhage, which it accomplishes by sealing up the bleeding orifices by its characteristic coagulation, and the production of a patulous canal, as for the relief of stenosis of the os or cervix.

Extent of Destruction at the Poles.—As to the extent of the destruction produced by a current,—a question of great interest in the electrolysis of tumors and other structures beyond the range of vision,—I have made the rough estimate that two hundred milliampères, concentrated at the half-inch exposed end of a negative needle, will destroy an area of this length and a quarter of an inch in diameter in the muscular tissue of the cadaver, if passed through for two minutes. It is more than probable that living muscle is acted upon to exactly the same extent, an equal destruction occurring in either case with the same number of milliampères, duration and concentration of the application; although more force is required to get the same current through the drier, dead muscle. This difference of resistance does not need to be considered, of course, when a current controller is used, as it matters nothing what the cell power may be if the milliampère readings are made to correspond. The amount of destruction produced by

the same number of milliampères in different tissues varies, though, and it may be said to depend largely on the aqueous contents of the tissue, for the cavities produced in the experiments on meat were caused to a large extent by the destruction of water. Less decomposition will be attained by the same current in a fibroma than in a striated muscle for this reason, and the disintegration depends more largely on the cauterizing effects of the liberated chemicals.*

Surgical Electro-Puncture.—The practical work of electrolysis in gynecology differs from the experiments just described, in that but one pole is permitted to be sufficiently concentrated to produce such results; the other pole, consisting of a large dispersing electrode, being placed, as properly advised by Apostoli and Engelmann, on the nearest convenient surface. This active pole, in the shape of a strong, spear-headed needle, generally has its conducting surface still further contracted by being insulated to within a half-inch of the point, enabling the operator to confine the work strictly to the neoplasm itself. The details of this operation are given in Chapter VI.

Galvano-Chemical Cauterization.—If electrolytic destruction of tissue has been produced by an active pole merely placed in contact with a mucous surface, it is called by Apostoli a *cauterization*, and this designation will not readily confound it with the entirely different cauterization produced by the heat of a galvano-cautery

*In a recent experiment on a fibroid, kindly placed at my disposal by Prof. H. A. Kelly, the cavities produced by two hundred milliampères in two minutes were fully as great as those described in meat.

knife, if the polar nature of the application is always stated as it should be,—whether a positive or a negative cauterization. This electrolytic cauterization with a single pole does not differ in any respect from that of electro-puncture, being found only when a strong current is concentrated in its passage through a mucous membrane by the small area of the conducting surface of an electrode, or when a weaker current is unduly prolonged. It is illustrated by slightly varying experiment 11. Instead of needles use two blunt metallic surfaces merely pressed into good contact with the meat. The same phenomena will be observed with similar current strengths as in the puncture experiments, with the sole difference that the energy of the disintegration of surface will be lessened owing to greater electrode size, and consequently lessened concentration.

The need of a moist covering for the electrode, that is so important when we wish a current to penetrate through the skin, does not exist in a permucous application, for the mucous surface is always sufficiently moist to furnish a perfect conducting joint between the metallic surface and itself. Several recent writers have been led astray on this point, teaching that a cotton-covered electrode favored easy transmission of current to deeper structures in permucous as well as in percutaneous work, and that the bare metal alone was liable to produce cauterization of the mucous surface. In truth, there is no difference between either the local or distant action of a covered and an uncovered negative electrode in contact with moist mucous membrane *when the current strength and the extreme area of the conducting surface of the electrodes* remain the same.

The wrapping of a bare electrode of course increases its size, and hence lessens the concentration of a given number of milliampères; but if the experiment be tried of passing the same number of milliampères through a piece of meat in two different situations—once with bare poles and again with wire ends wrapped firmly with cotton until their total size is the same as the bare poles—it will be found that the electrolysis is exactly the same, except that the cotton about the positive pole will save the meat some staining if the pole is of baser metal. The electrolysis produced in either case is a mere matter of strength and concentration of current, and one can cauterize a surface just as effectively with a cotton-covered electrode as with a bare one of the same size. The only way to avoid local action when using a strong current is to disperse its force by increasing the surface of the active electrode; and in vaginal applications, at any rate, this is quite possible with moderately strong currents by the use of large oval or cylindrical conducting surfaces.

Polar and Interpolar Regions.—In performing experiments, and in all surgical punctures and cauterizations, it will be noticed that no visible change occurs in the meat or tissues except directly at each pole. This is because an electrolytic disintegration of animal tissue consists in a resolution of the organized compounds of which it is formed into their chemical constituents,—acids and bases,—the two classes of bodies being separated and conveyed to one or the other pole. The acids, oxygen, etc., appear at the positive pole, and the bases and hydrogen at the negative pole. An actual transfer of particles in both directions takes place through the

whole distance of tissue between the poles,* but the freed particles, singularly enough, appear only in the immediate neighborhood of the latter. These freed particles, being in the active condition known to chemists as *nascent*, immediately attack the tissues at the poles, and, if in overwhelming abundance, cause the peculiar destructive appearances described in the preceding paragraphs.

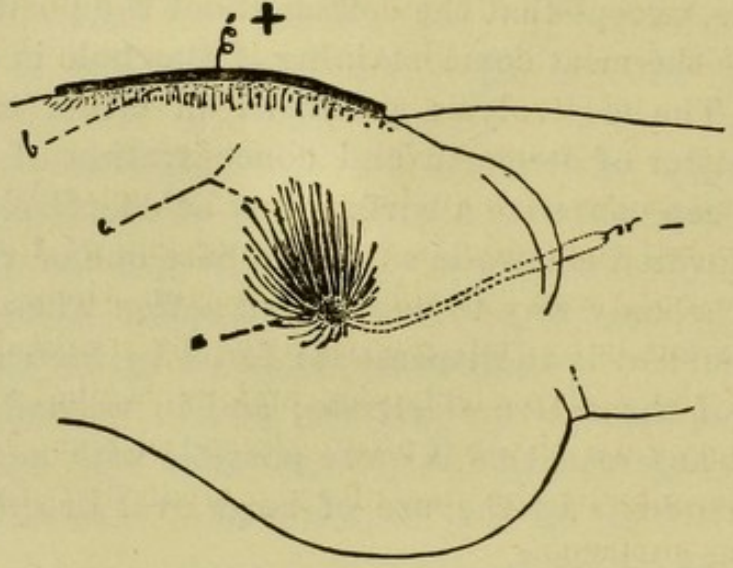

FIG. 11.—DIAGRAM OF THE POLAR AND INTERPOLAR REGIONS OF A CURRENT.—*a*, active polar region (negative in diagram); *b*, indifferent polar region (positive in diagram); *c*, interpolar region. The radiating curved lines in the interpolar region show the situations in this region where the current density is greatest; with the indifferent electrode on the back instead of the abdomen the denser area is more posterior.

The passage of a current of appreciable milliampère strength through the body presents, therefore, three distinct regions for therapeutic possibilities (Fig. 11),—two, restricted to the immediate vicinity of the electrodes, and called the "polar regions," and the third

* This may be experimentally proven by wetting the kathode with a solution of potassium iodide: after a varying period of application and strength of current, the free iodine will appear at the anode, having passed through the intervening part of the body.

extending along the lines of least resistance between the first two, and called the "interpolar region." Within the interpolar region the interstitial and cellular irritation incidental to the transmission of the current and of the particles that appear naked at the poles (cataphoresis) is the chief basis for therapeutic results, while in the polar regions the chemical action of these particles, as described above, is supplemented by another set of phenomena due to the behavior of nerves when under the influence of concentrated current at either pole. It is in the immediate vicinity of the poles, therefore, that the most direct therapeutic results are obtained, and the readiness with which electrodes may be brought in contact with diseased conditions within the pelvis is a most promising fact for the electro-therapeutics of gynecology; although, even in this class of diseases, the interpolar action of the current must frequently be depended upon.

It is hardly necessary to mention here that no attention is paid to the direction of the current, as such, by modern therapeutists, who look only to the polarity of the active electrode. The older terms "ascending" and "descending" were incorrect in view of the fact that a current spreads in all directions beneath each pole; and the reactions formerly attributed to one or the other direction are now known to be due to the polarity. Even within the interpolar region the direction of the current has no known significance at present.

Alteration of Nerve Irritability within each Polar Region.—(*Experiment 12.*) Attach two medium-sized electrodes of the same dimensions to the binding posts, place them (well wetted) on the skin over each peroneal

nerve just back of the head of the fibula, and increase the current to five or ten milliampères.

The burning pain under the negative electrode is in distinct contrast to the numb sensation under the positive. While pain is produced near the positive pole also, if the current be greatly increased in volume, it has been demonstrated by careful experiments that a nerve lying within the negative polar region has its normal excitability increased, and one lying within the positive polar region has its normal excitability diminished. These physiological facts were very early applied to the treatment of neuralgic conditions and the rule laid down that the positive pole was the best adapted for the relief of pain. I, myself, believe that this rule has been too hastily adopted. The polar modifications of a nerve are beyond dispute, but it is more than questionable whether the production of either anelectrotonus (positive polarization) or katelectrotonus (negative polarization) within a nerve can exert any influence upon the pathological conditions giving rise to pain; at any rate, my experience has been that the negative pole is even more effective for this purpose than the positive, for it has been so satisfactory as to make it useless to resort to the positive pole with the incorrodible electrode then necessary. The efficiency of the negative pole in the relief of pain might be ascribed by some to the after-effects of electrotonus, as ascertained by Waller and De Watteville,* who showed that sedation followed the excitement of negative polarization after the discontinuance of the current, and *vice versâ* with positive polarization; but, to my mind, the relief of pain is due rather to the influence of

*"Philosophical Transactions," 1882, p. 961.

the current of either pole on the physical molecular conditions of the nerve-trunk and on its circulation, as well as reflex impressions made on the centre, whence the pain so frequently emanates.

A practical matter to be considered when using a current to impress the sensory nerves of the pelvis is the wisdom of using as large a conducting surface for the vaginal electrode (when the application is vaginal) as convenient, in order that as much current—ten to thirty milliampères—may be used as is possible, without unnecessary cauterization of the mucous membrane. It should also be understood that the region of nerve polarization about an active pole is somewhat larger than the region of chemical decomposition, and that we can readily include within it any nerve or nerves within, say, three-quarters of an inch of the electrode, when using currents of twenty or thirty milliampères.

Current Action within the Interpolar Region.—Since it follows from the facts touched upon in the foregoing paragraphs that the chemically destructive action of a continuous current is limited to the close neighborhood of the electrodes, and the direct nerve-modifying action is also limited to a somewhat larger region in the same situation, the natural question arises: What can be therapeutically accomplished when the seat of disease is necessarily situated beyond the direct reach of the electrode? An answer drawn from both neurological and gynecological experience is that much can be accomplished; and this is doubtless due, in the first place, to the influence upon nutrition of the chemical interchanges that occur throughout the circuit, in the onward progress of the particles that appear free finally at the poles

(catalysis and cataphoresis), to the influence upon nutrition of the circulatory changes that result from vasomotor stimulation, and to the contractions produced in unstriated muscular tissue by heavy currents, even at a distance. These results of quiet current transmission are governed in magnitude at a given spot by the *density* of the current at that situation and by the *duration* of the application. The difficulty of carrying an effective density to a tumor, extravasation, or other morbid spot, situated at some distance from the active electrode, is indicated by a glance at Fig. 11, in which the spread of current is well represented by the direction and shading of the lines shown in the interpolar region. To accomplish much in the more distant parts of this region considerable milliampère strength must be employed; hence a delicate judgment is demanded in the selection of the size of the active pole to avoid cauterization on the one hand and too great a diffusion on the other.

Interrupted Galvanic Currents in Gynecology.—Galvanic interruptions, either rapidly or slowly produced, are rarely if ever used in direct pelvic applications, for the reason that they are far more productive of pain and shock than faradic currents and are in no wise more effective than the latter.* The avoidance of current variation, indeed, is a most important detail in the majority of applications of this sort, and it is for this reason that the author has insisted on the gradually increasing and decreasing method in this work.

A sudden current variation, either accidentally or

* This statement by no means applies to the neurological applications of electric currents.

intentionally produced in a galvanic current (or as naturally occurs at the beginning of each induction in the series of currents constituting the faradic current), should be understood as productive of effects that are essentially different from those of the continuous current. So far as we know at present the perturbation produced by it is limited entirely to an artificial stimulation of the functions of a nerve or muscle. No chemical changes whatever result from the variation as such, but merely the local stimulation, together with the centripetal and possible reflex effects of the sensory stimulus. The differing effects produced by a continuous current and by a current variation on a nerve may be studied by a slight addition to the details of experiment.

The Effect on Nerves of a Slowly Varied or Continuous Current Compared with that of a Sudden Current Variation.—(*Experiment 13.*) Proceed as in Exp. 12, noting that no pain or motion is produced in the distant parts of the nerve if the five or ten milliampères have been attained by a *gradual* increase from zero. With the current at this height remove now one of the electrodes and reapply it (or break and make the circuit by an interrupter),—a contraction will be produced in the muscles supplied by the motor fibres, and a sudden sensation in the areas supplied by the sensory fibres of the nerve.*

* If the nerves subjected to this experiment are not too deeply embedded in muscular or adipose tissue they exhibit very readily the normal polar reactions of motor nerves, so important in connection with the electro-diagnosis of paralytic conditions. It is readily seen that the greatest action is produced at the cathode at the closure of the circuit and at the anode at its opening; hence the formula: K. Cl. C''''., A. O. C'''., A. Cl. C''., K. O. C'.

Although exceedingly important in neurological work, such stimulations are generally to be avoided in gynecological applications, in which, if the current in use be heavy, they may be accompanied by exceedingly unpleasant shock, or even syncope.

CHAPTER V.

INTRA-UTERINE GALVANO-CHEMICAL CAUTERIZATION. (APOSTOLI'S OPERATION.)

THIS operation is the one most largely employed for the disintegration and reduction of fibroid tumors of the uterus, and it was while engaged in this work that Apostoli discovered its value in a number of other conditions associated with local alterations and hypertrophy of the uterine tissues. It is particularly valuable in the treatment of subacute and chronic endometritis, as elaborately pointed out by this author in a recent monograph.* Of its value in both classes of affections the author can bear the highest testimony, based upon results detailed elsewhere in this work. It consists essentially in a concentrated cauterization of the interior of the uterus by one pole of a heavy current (fifty to three hundred milliampères), administered from the bare surface of a sound-shaped intra-uterine electrode, and dispersed by a broad, indifferent electrode on the abdominal surface. The battery, meter, and current-controller used are described in Chapter II. Of the active and dispersing electrodes some special remarks are demanded.

The Intra-Uterine Electrode.—Apostoli and some operators in this country use a sound capable of being covered at will by a sheath, made of either glass or hard rubber, or, as specially commended by the former, of

*"On a New Treatment of Chronic Metritis," by Georges Apostoli. Translated by A. Laphthorn Smith.

celluloid, which is said to be less absorbent than the rubber (Fig. 12). These sheaths are extended backward into handles, through the whole of which the sound slides, and to which it may be rigidly connected at will by a screw. In my own practice I have found that this arrangement presented certain disadvantages. It is difficult to render the interior of the tube aseptic, and the best antiseptic—the flame of an alcohol lamp—cannot be applied to the exterior of the rubber and celluloid sheaths, owing to their inflammable nature. In most cases, moreover, the insulating cover should be extended beyond the bend of the sound, in order that the cervix may be protected from unnecessary cauterization and the current action confined to the interior of the corpus alone. This is impossible if the sheath is made of a rigid material, and, were it possible, the abrupt increase of calibre at the end of the cover would render the proper introduction of the sound impossible in many cases.

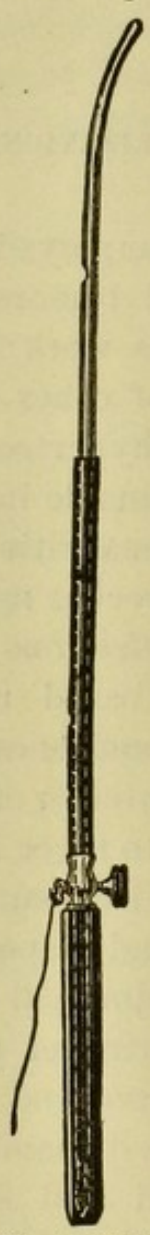

FIG. 12.—APOSTOLI'S INTRA-UTERINE ELECTRODE.

An exceedingly handy way to insulate a sound to any extent found desirable in a given case, after the proper curve has been given to it, and at the same time to thoroughly sterilize it, is to heat it to a considerable

temperature in the flame of an alcohol lamp, and melt upon it a sufficient coating of pure gum-shellac. This forms a smooth, highly-insulating covering that adheres tightly to the sound and shades off in thickness at the bare end so gradually as to readily admit a passage wherever desired. The fusibility of the shellac without burning is its greatest advantage over the best quality of sealing-wax, but the latter may, however, be substituted for it if the shellac is not readily obtained. In covering the hot sound at first the coating retained by it is too thin for safe reliance, and it should be made heavier after cooling by attaching additional quantities of melted gum-shellac to it, the whole being then reduced to a uniform thickness by gentle fusing.

This procedure is only adapted to an electrode closely following the form of a Simpson, or other rigid-shanked sound; and after the parts are once covered there should be no danger of the covered portion bending, as the material breaks easily, giving rise to leaks when in use. This disadvantage is, however, more apparent than real; for nothing is more trying in this work than an attempt to employ one of the flexible-shanked electrodes made by some manufacturers, who erroneously insist upon making the curved portion rigid and the shank flexible.

Fig. 13 represents the electrode usually employed by the author, for whom it was made by Flemming. It bears a general resemblance to the Simpson sound, with a hard-rubber handle of the usual flat shape for indicating its position *in uteri*, and the addition of a socket for the attachment of the conducting cord. The two and a half inches which may be left bare at the extremity

are made of platinum, to adapt it for use as a positive pole. The covering should be made to reach the platinum always, and it is generally best to protect the os and cervix by carrying it much farther up.

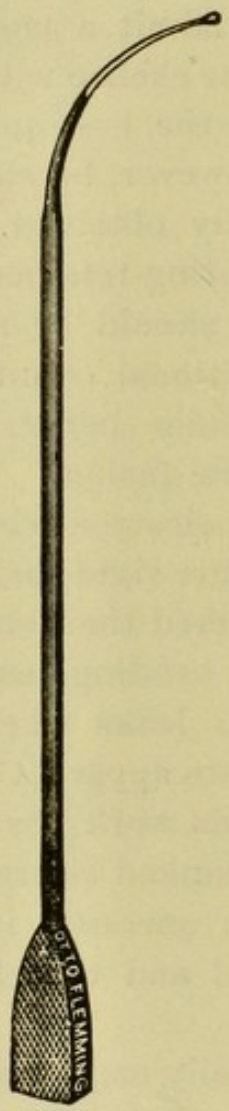

FIG. 13. — AUTHOR'S INTRA-UTERINE ELECTRODE.

Before each operation, and after the desired curve has been imparted to the end, this electrode should be sterilized and any accidental breaks closed by a thorough heating of the bare part and fusing of the first two or three inches of the covering.

The Cutaneous or Dispersing Electrode. — The passage of heavy currents through the body in such a manner that all painful or truly destructive actions shall be confined to the one electrode was first achieved by Apostoli by an adherence to and extension of scientific rules already well known. The importance of a large surface in minimizing the local action on the skin at the indifferent electrode has been urged by German writers for years. Apostoli wisely made this indifferent electrode unusually large, in keeping with his increased currents, and placed it on the abdomen, where both least resistance and least skin sensitiveness are found. For a means of making a perfect contact between the metal of the electrode and the skin he has introduced the use of moistened potters' clay, specially worked over for

each operation and spread upon a piece of tarlatan in a cake a third of an inch thick and about eight by ten inches in size. This is laid on the abdomen, tarlatan down, and on the top of it a metal disk (three by four inches), which is connected by a conducting cord with one pole of the battery, is placed and gently pressed into good contact.

The objection to this form of dispersing electrode is the trouble and dirtiness of the clay, and the fact that the cold surface gives an unpleasant shock when first applied. It is evident that the water contained in the clay is the part of the compound that conducts the current, and that its only advantages are its size and the tendency to adhere closely to the skin. This quality of stickiness is, nevertheless, an important advantage when we are using strong currents (over one hundred milliampères), and I have found by experience that such currents may be passed through the clay with less danger of irritating the skin and causing an interference with the frequency of the operations than when any other form of conducting medium is used. For the easy preparation of the clay a wooden frame or trough of the size desired for the electrode (eight by ten inches) is used, having edges one-third of an inch high. Over this a piece of wet tarlatan is laid. The clay is then thoroughly incorporated with sufficient water, worked into proper consistence, and spread upon the tarlatan with a spatula or trowel, sufficient being placed on it to fill the space within the frame. By grasping the edges of the tarlatan the cake is now lifted from the frame and lowered, tarlatan down, on the abdominal surface, after which the trowel is passed over the surface, gently

pressing it into good contact with the skin. On the top of the clay a plate is now laid, to which one conducting cord of the battery is securely attached. I have found an advantage in having this plate consist of the thinnest commercial sheet-lead, and of a size only somewhat smaller than the clay cake. To make it adapt itself the more readily to the clay surface it is split from the periphery to near the centre in eight equidistant places. This large plate adheres so well to the clay and abdomen as to lessen greatly all risk of breaking contact by slight movements.

After one thorough moistening and working the clay may be kept ready for use by covering it up in a stone crock, such as is used by housekeepers for butter.

For currents less than one hundred milliampères, and even with stronger currents when the patient's skin is non-irritable, we may use instead of the clay a pad of absorbent cotton of the same size, made of at least three layers of the cotton, thoroughly wet with warm water. The lead plate is laid on the top of this cotton in the same way as on the clay.

Dr. F. H. Martin, of Chicago, has recommended a dispersing electrode shaped somewhat like an inverted metallic basin. An animal membrane is stretched over the brim and the interior filled with warm water. It is laid with the membrane in contact with the abdomen when in use.

Precautionary Details.—There are certain things which should be methodically attended to before each separate operation, to avoid the possibility of either a failure of its technical smoothness or a painful mishap to the patient.

Examination and Arrangement of Apparatus.—The operator should, first of all, be sure of the perfect working of his battery. If he has an incandescent circuit at command, or a well-connected Law or Leclanché battery, he need not trouble himself on this score. With a less perfect battery the strength and perfect working should be tested by joining the terminal poles directly, gradually turning the controller and noting the effect on the meter. If an acid battery be used, all the cells should be put into action and tested in this way.

2. While testing the battery the freedom of motion of the meter-needle should be noted, and if it does not come back exactly to zero, the instrument should be leveled accordingly.

3. The test being satisfactory, *the controller should be reversed until the circuit is entirely broken*, in readiness for the operation.

4. Examine the conducting cords to see if there is not a break somewhere. The one attached to the lead plate requires particular attention.

5. Determine upon the proper curve required in the sound and the extent of surface to be left uncovered at its end.* Then heat the end of the sound in the flame of an alcohol-lamp and gently fuse the shellac over the distal third of the insulated part, noting that there is a sufficiency of the materal to repair all breaks and weak

*The cases of atresia reported by Apostoli as occasionally consequent upon the operation were probably due to leaving too much of the sound uncovered, as it appears from his published directions that he never insulates beyond the os. The cervical canal should always be protected unless the operation is for endocervicitis, leaving the cavity of the body only exposed to the cauterization.

spots. After it has cooled, examine it critically in a good light to see if the covering is perfect.

6. Arrange the gynecological table or couch so that it will be convenient to hold the sound in place with the left hand, leaving the right hand to manage the current controller.

Preparation of Patient.—The patient should be assured that the operation will not give her excessive pain, and may even give her no sensation beyond a slight burning. She should be warned of the necessity of keeping absolutely still to avoid shock by disarranging the electrodes or wires. Enjoin her to notify you if she feels pain, and assure her that you will instantly lessen the current if the pain causes suffering. A free evacuation of the bowels previously assists the introduction of the sound. As a rule, the flushing of the vagina with a permanganate solution, on arising in the morning, will be a sufficient antiseptic precaution.

She should remove the corsets and loosen all bands about the waist.

If there are any pimples or abrasions on the abdominal surface they should be covered with pieces of paper, smeared with vaseline or lard on the side in contact with the skin.

The Operation.—Besides the operative preparations just detailed, on the exact disposition of which successful results largely depend, Apostoli has divided the operation itself into three stages,—the initial stage, the middle stage, and the end. As it is an excessively technical procedure, and abounds in positions that demand an exact adherence to rule as the price of immunity from accidents, the distinct separation of these stages

should be freely conceded, and an additional stage also recognized as part of the operation,—that of placing the electrodes. The following description of these several stages is intended to apply to the apparatus and instruments recommended in this work :—

Placing the Electrodes.—1. Apply the clay as already described, being sure that it is soft enough to exude beyond the meshes of the tarlatan, and lay the lead plate upon it. Attach the cord or wire of the plate to the binding post of the pole that is desired to be indifferent. If an absorbent-cotton pad is to be used in place of the clay, it is applied in a similar manner, an abundance of moisture being used.

2. Attach a disconnected conducting cord firmly to the intra-uterine electrode and insert it as any other sound is inserted, using all the precautions recommended in the passage of this instrument. *Forcing of any kind is to be absolutely avoided.* If the calibre is too small for an electrode of the ordinary size, a smaller one is to be used. In some cases of intra-mural fibroids it is extremely difficult to find the os, owing to the extensive alterations of the uterus ; in others, the sharp flexures produced in the canal by the presence of the growth render repeated attempts necessary before gaining entrance. Gentleness and patience are essential, and if entrance has once been gained by the most filiform instrument a positive cauterization will make subsequent introductions easy.

As a rule, the sound is to be passed by touch, and without the aid of a speculum. No one who has become expert at this method will readily return to the use of the speculum, as the sound guided by the finger becomes

to a certain extent an elongation of that member, conveying intelligence with great readiness and certainty. In cases of difficult introduction it may be necessary to use a speculum and tenaculum, but both should be removed after placement has been secured, leaving the electrode to be grasped firmly by the hand during the passage of the current.

3. Glance at all the switches and connections, noting that they are tight and in order, and noting particularly that the controller contact is at the right of the button and does not touch the graphite mark.

4. Attach the cord of the intra-uterine electrode to the pole that is to be active, and grasp the electrode with the left hand, the index finger being within the vagina.

Initial Stage.—Turn the current on slowly at the controller, with the right hand, until a slight sensation has been felt by the patient or until forty or fifty milliampères are shown by the meter. A pause may now be made for a moment, followed by another gradual increase of ten or twenty units. As a rule, sixty or eighty milliampères will suffice for the first treatment, or even less if the patient is nervous. The increase is always productive of more sensation than the steady action of the current; hence it should be exceedingly gradual. The eye, meantime, as advised by Apostoli, is alternately fixed upon the meter and the patient's countenance, to detect the first sign of intolerance of the pain, as well as follow the current increase. From the moment the current has been turned on, the apparatus and patient should be kept immovable, with the exception that the active electrode may be slowly moved in such a manner that all parts of the endometrium are brought under its

action. These slight movements are always productive of some pain. No pressure should be used for fear of puncturing the uterus,—an accident that the current action facilitates.

The Middle Stage.—Having reached the current strength desired in the case, or the lesser amount that seems to be the limit of easy tolerance, the controller is held at its position for a period varying from two to ten minutes. The average of five minutes, adopted by Apostoli, agrees in the main with the author's practice. In some cases we are compelled to retire after four minutes' and even three minutes' duration, when two hundred and fifty and three hundred milliampères have been attained; in others, continued tolerance permits an extension of the time beyond five minutes, but it is never wise to produce so much local destruction of tissue in any but the more intractable cases.

The End.—The period during which it is desirable to continue the current having expired, the action of the controller is slowly reversed, bringing the needle of the meter back to zero. The decrease of current must be almost as gradual as the increase, as suddenness in either change gives rise to shock. After the needle of the meter has come to zero the circuit is broken at some point, and the sound gently removed by carrying the handle up over the pubes in the ordinary manner. The lead plate and the clay are now removed, and, after the abdomen has been cleaned, the patient is ready to rearrange her clothing.

After the Operation.—It is usually best to have the patient rest awhile before going home, if the operation has been performed in the office and a strong current

used; but if a means of conveyance home without walking is handy, this precaution is frequently unnecessary. *In every case, however, where at least a hundred milliampères have been used, she should lie down immediately on reaching home, and remain inactive during the remainder of the day.* It is well to tell her plainly that a neglect of this precaution may cause a serious inflammation, entailing much discomfort upon her. As a necessary consequence of the operation she must look for a more or less slight sanguineous discharge during the day and evening, becoming the next day in some cases sero-purulent. I have, however, frequently given as high as two hundred and fifty milliampères without causing a discharge to persist longer than the first day, and the method detailed in these pages for the protection of the cervix renders the discharge less likely to become purulent. The patient should be warned also that colicky pains may be felt during the day or evening, as otherwise their advent might cause uneasiness. Rest will prevent or diminish these, as a rule; but if persistent, the application of dry or wet heat to the abdomen should be advised.

In all cases an antiseptic vaginal injection should be directed once or twice a day, and if the patient is married the cessation of marital intercourse should be especially enjoined. Apostoli inserts an antiseptic vaginal tampon after the operation, but I have found this precaution unnecessary.

The Current Strength and Duration.—As the conditions in which intra-uterine galvano-chemical cauterizations are advisable vary from a slight but persistent endometritis of an otherwise normal uterus to the most

extreme case of uterine hypertrophy, hemorrhage, or abnormal growths, so the efficient dosage varies through an even greater gamut of change, additionally influenced as it is by the individual idiosyncrasy as to pain. Where the hypertrophy is great, and especially where the uterus participates in the growth and abnormities of an intramural tumor, the strength is to be limited only by the easy endurance of the woman, as it is pretty clearly established that the total effect depends more on the number of milliampères in circuit than upon the duration of the application. It is true, of course, that the actual amount of electrolysis produced by, say, two hundred milliampères in five minutes can be secured by fifty milliampères in twenty minutes; but the effect in the latter case would differ nevertheless, for it would be entirely lacking in a powerful action within the interpolar region, which is depended on to influence the contractile tissue not directly influenced by the cauterization. It should be remembered also that mere electrolysis does not describe the action obtained, and that the *caustic* effect of slowly-liberated chemicals does not compare with that of a liberation *en masse*. Two hundred, two hundred and fifty, and three hundred milliampères are, however, to be reached only after the tentative use of weaker currents.

On the other hand, slight cases of subacute or chronic endometritis, unaccompanied by hyperplasia, may be effectively treated and quickly cured by applications of twenty or thirty milliampères for five minutes, and, such being the case, it is manifestly improper to subject the patient to a more heroic treatment. In cases of hysterical or neuralgic pain, in which it is thought wise to

use intra-uterine galvanic applications, an even greater circumspection should be used, for cauterizations should be gauged primarily to the amount of organic disease present. I have already shown in a previous chapter that there is no way in which currents of more than twenty to thirty milliampères can be applied to the inner surface of the uterus without local action, the fancied protective virtues of a cotton-covered intra-uterine electrode being delusive.

It is a safe rule, therefore, to gauge the dose to the amount of organic change within the uterus or in tumors closely attached to it, subject to modification at any moment on the appearance of pain.

As to the duration of an application not interrupted by the appearance of pain, I have every reason to commend Apostoli's rule of five to ten minutes as an average for the whole operation, rarely prolonging the middle stage beyond three minutes. Given a large hypertrophy or tumor and easy tolerance of the current, it is better to extend the current increase rather than its duration, as there is less risk of producing breaks in the cuticle of the abdomen and the resultant burns.

The Question of Pain.—With an even, unbroken current, flowing from a good battery through a controller and through tightly-screwed cords and binding posts, as much as three hundred milliampères may be given without actual pain of any kind. The broad abdominal electrode rendering that pole non-painful, the only seat of painful concentration is at the active pole, and the uterus is fortunately analgesic as a natural trait. The patient should, nevertheless, be told to expect some pain, for there is likely to be an unpleasant excitation of

the sacral plexus by the current-spread, besides the sensation of warmth on the abdominal surface. Some women complain of the sacral excitation very decidedly, especially if the uterus is situated at one side of a morbid growth.

The appearance of real pain should always be accepted as a sign for current reduction, and should lead to an immediate cessation of the treatment by a gradual reversal of the controller, for the following reasons: (1) If the pain is distinctly uterine in seat it is indicative of the presence of a perimetritis or an acute metritis, in the presence of either of which the operation is contra-indicated. It is sometimes difficult for the patient to distinguish this periuterine pain from the intestinal colics occasionally provoked, and its recognition must depend somewhat upon the objective evidences gained in the preliminary examinations. (2) If the pain consists of a sharp burning concentrated at some spot on the abdominal surface, it is indicative of a break in the cuticle, and a continuance of the current would only develop an ulcer that would interfere with subsequent operations. This accident is particularly liable if the cotton or clay is too thin or has been permitted to become too dry. (3) Pain at the vulva or within the vagina indicates a leakiness or insufficiency of the insulating cover,—an accident that previous inspection of the active electrode should guard against.

Frequency of Operation.—Three times a week is as often as this operation can be performed with advantage. If undertaken daily the progress is likely to be checked and unfavorable symptoms arise, such as continued tenderness and augmented discharge. In many cases the

local irritation within the uterus has quite subsided by the second day. If, however, time be not an important consideration, twice or once a week gives excellent results.

Contra-Indications.—These operations are contra-indicated under the following circumstances:—

1. During the menstrual flow.
2. If there is an acute metritis or perimetritis.
3. If the woman is pregnant.

A performance of the operation during the existence of an unsuspected pregnancy would be particularly unfortunate, as abortion would certainly result. To guard against this, careful questioning, as well as an examination to detect softening of the os, should be made.

CHAPTER VI.

OPERATIVE DETAILS OF PELVIC ELECTRO-PUNCTURE.

THE details of this operation are an exact duplicate of those of an intra-uterine galvano-chemical cauterization (see preceding chapter), with the exception of the nature of the active electrode and its method of placement. Instead of an insulated sound introduced within the uterine cavity, an insulated spear or needle is thrust through the cervix or vagina into the body of the tumor itself, confining the destruction entirely to its tissue. The best operators at present condemn any attempts at puncture through the abdominal walls.

The Fibroid Spear.—This instrument is far better described as a spear than as a needle, for stoutness is an important characteristic of it, and a cutting edge at the extremity is equally essential in enabling it to pierce the dense tissue of a fibroma. At the beginning of my work in electro-puncture I was much hampered by the impossibility of obtaining an efficient "needle" for this purpose. Those made in this country were found to be defective in one or more of the following particulars: They were either not rigid enough, too dull, lacking in a proper insulating cover that would follow the needle into the tissues, or covered with insulating material that ran the risk of chipping during the process of insertion. Some were also too short for use. Apostoli's needles, as supplied by Gaiffe, are mere trocars without covering of any kind, the portion not penetrating the uterus or vagina being covered when in use by movable

glass or celluloid covers. In use, these trocars cauterize healthy tissue through which they are plunged as well as the growth itself, doing useless damage and leaving an open track for possible suppuration (Fig. 14).

The very evident importance of confining the destructive action of a powerful current to the tumor itself, after we have taken the trouble to pierce it, impelled me to have an entirely new form of needle made for this purpose. The desiderata were: a stout, slender shank, with a cutting extremity and a bared surface extending back from the point not more than a half-inch. From the termination of the bared surface to the butt end a continuous insulating sheath is required, which, as far as the handle, should be of a total calibre less than the openings to be made by the cutting edge, permitting the whole to be readily inserted into the tissues. This sheath must, if possible, form a homogeneous whole with the needle axis, and especially be adherent to the metal at the extremity next the spear-head.

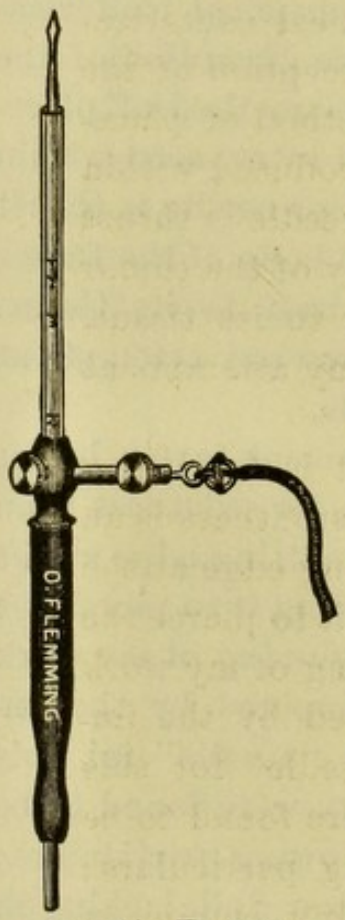

FIG. 14.—FIBROID SPEAR, WITH MOVABLE SHEATH.

The material to cover the needle in this manner was for a time a puzzle, as it was absolutely unsafe to use shellac or wax for this purpose with the risk of chips being left within the tumor. The end was finally gained by vulcanizing rubber on the spear after the manner in use by dentists (Fig. 15), a small

shoulder being made at the extremity of the bare metallic surface for the point of junction. For assistance in carrying out the design I am indebted to Howard E. Roberts, D.D.S., of this city.

FIG. 15. — THE AUTHOR'S FIBROID SPEAR.

Since the pole selected for electro-puncture is usually negative, we may avail ourselves of the ordinary advantages of steel as the metal for the spear; if so, great care is, of course, to be observed not to use it as a positive pole. The point of my own instrument, which is made of gold, is shaped like a spear-head with three cutting edges, as this shape makes a wound of but small size compared with the calibre of the instrument that it will admit.

Insertion of the Spear.—A most accurate diagnosis of the position of the tumor in relation to the important organs surrounding it is first made, the patient being always placed on a table rather than on a more yielding base. The proper spot and direction having been decided upon, the needle is carried into the vagina without a speculum, the point pressing against the pulp of the finger. The most prominent part of the tumor is selected for puncture, which is done while an assistant makes counter-pressure upon the abdomen. If possible,

the spear is always made to traverse the uterine tissue to reach the tumor, as this method gives least pain. If the tumor, however, is large, and cannot be reached in this way because of its slight connection with the uterus, no scruples should prevent a piercing of the vaginal wall and traversing of the peritoneum, if the instrument and vagina have both been sterilized as much as possible, and the important pelvic organs are avoided. I have been compelled to adopt this latter path a number of times, and have not as yet met with accident of any kind. The spear should be forced in far enough to bring the exposed end completely within the morbid tissue; it need not be inserted any deeper than this. Some recent remarks of Apostoli on this subject are quoted in the chapter on the treatment of fibroid tumors.

Precautions Necessary After Puncture.—Pelvic electro-puncture should be only performed under surroundings that permit the patient to be immediately put to bed, where she must remain at least twenty-four hours. All of my own operations have been performed in my private hospital, and, although slight febrile reaction supervened more than once, no serious inflammatory symptoms ever arose.

Frequency of the Operation.—Twice a week is advisable in large tumors, the punctures being made in different spots, but in smaller growths once a week gives excellent results.

CHAPTER VII.

THE FARADIC CURRENT IN GYNECOLOGY.

THIS easily-produced current has been quite extensively used in direct pelvic applications, especially during the embryonic period of electro-therapeutic work, when the average operator considered one form of electricity about as good as another. Of late its employment has been much circumscribed as compared with the galvanic current, based on a more general recognition of its limited physical capabilities; but the same scientific considerations have also indicated certain conditions in which it is pre-eminently useful. These physical qualities and peculiarities are best studied in much the same way as advised for galvanic currents, occasion being taken for a comparison of the two at the same time.

Faradic Apparatus.—The choice of a faradic apparatus for gynecological use is by no means so important as that of a galvanic apparatus, and it is somewhat unfortunate that a number of writers and manufacturers have been led to perplex the minds of average readers with speculative differences in the currents produced by different coils. In view of the vast divergence between galvanic and faradic currents, these mystical peculiarities sink into utter insignificance, and their recognition only serves to obscure facts of real importance. As the result of a long personal study of the subject, it is my deliberate conviction that all usable strengths and qualities of a faradic current are obtainable from a

single secondary coil of sufficient power by using the ordinary means of graduation forming a part of the battery. There is even, in my opinion, no therapeutic difference between the primary and secondary currents of a faradic coil beyond the fact that the latter gives a far higher range of current strengths.*

In the selection of a faradic apparatus, therefore, such questions may be safely left to the judgment of the manufacturer. Of the more mechanical parts, certain features require to be looked into, and this is especially true of the spring interrupter. A clear note from the apparatus is important in gynecological applications, as this indicates a regular succession of currents of even strengh and duration. An irregular, jarring, discordant note emitted by a spring shows an unfitness for therapeutic work, as the irregular currents produced give unnecessary pain and fail to excite the tonic muscular action aimed at. The Du Bois Reymond method of

*The reasons given by Tripier, Apostoli, and a number of recent writers in favor of using a secondary bobbin of short, thick wire for muscular stimulation, and one of long, fine wire for sensory stimulation, are based upon theoretical considerations that embrace only a part of the facts. A short, thick wire gives less internal resistance, of course, but it also gives less volt force than a long, thin wire. Whether we get more current from the one or the other is governed solely by the ratio between this volt force produced and the total resistance of the circuit; and since we always have from a hundred to several thousand ohms to overcome outside the bobbin, a few ohms more or less within it make no appreciable difference. There is no doubt that a long wire, giving many volts of pressure, will produce greatest action on the external muscles of the body, and in the absence of exact measurements of the pressure and volume of currents from these arbitrarily-constructed coils, why not accept so tangible a test as this?

graduating the strength of the current, by sliding the secondary coil over the primary, is especially well adapted to gynecological applications when Flemming's excellent cog-wheel mechanism for moving the outer coil is added. This apparatus (Fig. 16), is too bulky for portable batteries, but furnishes the most even method of gradually increasing and decreasing the current without shock,—a desideratum in pelvic applications. The "swelling" currents advised for unstriated muscular stimulation are also most easily applied by it.

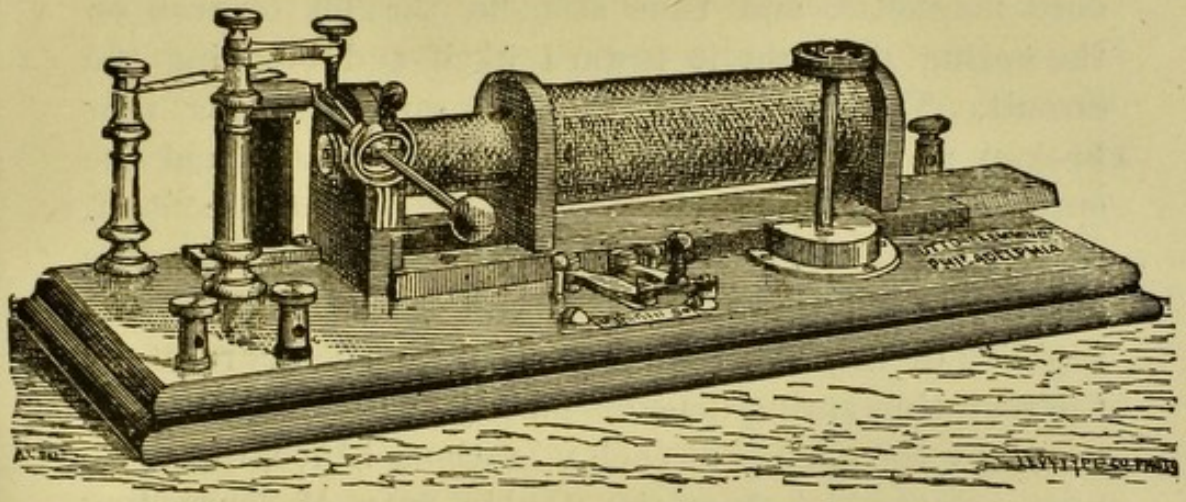

FIG. 16.—DU BOIS REYMOND COIL.

Principles Involved in the Production of Faradic Currents.—As a help to understanding the peculiarities of this current, a brief statement may be given of its mode of production.

If a faradic battery, as received from the manufacturer, be critically examined, it will be seen to consist of three parts,—a cell; an arrangement of two coils, one placed over the other, with an iron core in the centre; and one or more devices for automatic current interruption. The cell in the portable battery is usually

of the Grenét pattern, with a removable zinc and electro-poion fluid, but in stationary batteries two Law or Leclanché cells give much greater satisfaction, and save the watching and renewals demanded by the acid cell. The current from the cell does not reach the patient in any way, but is merely used to animate the coil in the following manner: From the cell it circulates through the inner coil of coarse wire, passing thence to the interrupter and back to the cell. During its passage through the coil the current makes the iron core magnetic, and thus attracts the bit of iron on the spring, drawing it toward itself and breaking the circuit. The circuit of the cell current being now broken, all magnetism in the iron core ceases, and the spring returns by its elasticity to its platinum contact, restoring the cell current and causing the same series of phenomena to be repeated. It is evident that the rapidity of this make and break of the cell current by the vibrating spring depends mainly on the distance traversed by the spring at each vibration; hence, the platinum point, which does the double duty of controlling the spring and conducting the cell current, is attached to a screw, by which this distance may be regulated with great nicety.

About the electro-magnet, formed by the iron core and the inner coil, the long, fine wire of the secondary coil is wound. It is not connected in any way with the circuit carrying the cell current, but is merely close to it. In it the currents conveyed to the patient arise by induction at the moments when the cell current is broken by the interrupter. Each current thus produced in the secondary coil is of almost infinitesimal duration (four

one-thousandths of a second, according to Blaserna). What is called the faradic current is consequently a series of remarkably short current productions, following each other rapidly or slowly as a fine spring, a coarse spring, or a pendulum is used to interrupt the cell current. The faradic current is therefore essentially a broken current, and is never continuous.*

Management of the Apparatus and Method of Controlling the Strength of Faradic Currents.—To put the battery in action, insert the zinc and make the proper connection tight if an acid cell is used; if a Law or Leclanché cell, close the cell circuit by a switch. If the interrupter does not begin action immediately, tap the screw-head over the platinum point lightly. Adjust the screw to as clear a note as possible, if it is not already adjusted. If an experiment or application be contemplated the battery should now be set for its weakest current and the secondary circuit left open somewhere, —a precaution against unwittingly shocking a patient that should be invariably followed. In gynecological applications the indifferent electrode is next adjusted in contact with the body surface, and the active electrode carried to its proper situation before the secondary circuit is closed, and the current is then gradually increased from zero to the strength desired.

Flemming's portable faradic battery is set for its weakest current when the switch rests on the button marked 1, with the tube covering the iron core *pushed in* as far as it will go. The current is increased most

* A slowly run dynamo also produces disconnected currents, but when running at full speed the inductions follow each other so rapidly as to become blended together into a truly continuous current.

gradually by *withdrawing* the tube slowly to the extent desired; the increase by moving the switch from 1 to 2, and so on, is much more abrupt, and is best done when the circuit is broken and the tube pushed in.

The Du Bois Reymond apparatus is set for its weakest secondary current when the outer coil is slid *as far away from the inner coil* as the space admits. A reverse action, *i.e.*, the sliding of the outer coil back over the inner, increases the current in the secondary coil in a very gradual manner. As the position for weakest secondary current corresponds to that for strongest primary inductions (a current, by the way, that I never use), a preliminary glance to see that the switches are right may save the patient an unpleasant surprise.

Indications for the Use of Covered and Bare Electrodes with Faradic Currents.—The use of a moist conductor to convey the faradic current through the skin to nerves and muscles beneath it is fully as important as in the case of the galvanic current; for, although the former current leaps from a dry metallic disk to the skin with great facility, and is therefore best adapted to the dry-brush method of stimulation, it expends its action at such times almost entirely on the dermic surface and nerve-ends, the polar region being extremly superficial. The moist covering permits a greater penetration and extension of this region; hence, a deeper action with less surface pain. Within moist cavities, however, the use of a moistened covering on the exposed conducting surface of the electrode is totally unnecessary, as the moisture of the cavity itself readily favors this distribution of the current. The bare electrode is,

moreover, introduced into such cavities with greater ease. The handles of such electrodes should, of course, be properly insulated, to protect the vulva and other parts not designed to be affected.

Experimental Comparison of the Electro-Motive Force or "Pressure" of the Faradic Current with that of the Galvanic Current.—(*Experiment 14.*) This may be roughly done by touching simultaneously, with dry fingers, the bare terminal wires of a full-strength galvanic battery. No current is felt, since the sixty to ninety volts of pressure in such a galvanic current are not sufficient to make the current jump through the minute layer of air between the finger and the wire; moist fingers permit a little to get through. If, now, the dry fingers be simultaneously brought in contact with the bare terminals of a faradic current of merely medium strength considerable tingling will result; its pressure is amply sufficient to cause it to leap through this air-space.

There are two practical applications of this fact besides its demonstration of the main quality of electro-motive pressure: one indicates the need of a more careful insulation of the faradic current to prevent accidental shocks; and the other, the greater adaptability of this current for the electric-brush application to the body surface. It should not be understood that the greater penetrating power of the faradic current applies to good conductors, such as the moist tissues of the body, for here the galvanic current is most efficient, as the penetration is by conduction, not disruption. It is only in the disruptive penetration of poor conductors, such as dry cuticle and air, that the

faradic current shows greater power. Exact measurement of this volt force of faradic currents is, unfortunately wanting, but they probably vary from several hundred to several thousand volts.

Experimental Proof of the Inappreciable Volume of Faradic Currents. — (*Experiment 15.*) Place a milliampère meter in circuit with the secondary coil by including it directly between the poles of the battery, and turn on the full strength of the current: the meter will not show even the fraction of a milliampère. The minuteness of its volume is also shown in its failure to decompose water, salts, or organic compounds, and in the practical absence of all tissue irritation, congestion, or cauterization when it is passed through the body.

Action of the Faradic Current on Sensory Nerves and Muscles.—Notwithstanding the exceeding weakness of this current in "bulk" or "volume," the great requisite for usefulness in the mechanic arts and in the chemical destruction and metamorphosis of tissue, a slight acquaintance with its action on any part of the body is apt to impart an exaggerated idea of its physiological powers. Being essentially a series of exceedingly abrupt current creations, its power to excite the functions of nerves and muscles is unique, and the manifest phenomena of pain and muscular contraction conceal its total inability to produce profounder impressions on the body. A nerve or muscle, brought within either polar region, is thrown into action as each induction arises, just as an abrupt variation of the galvanic current, whether a rise or fall, produces a similar phenomenon. Each induction produces a separate stimulus, therefore, and it is only when they

follow each other very rapidly, as when a rapid interrupter is used, that the separate stimulations seem to blend together, producing a continuous contraction or sensation. Even then the impressions on the nerve are those of distinctly-separated though rapidly-successive currents.

The faradic susceptibility of the sensory nerves of the limbs and trunk is fully shared by those of the pelvis, although the lessened sensibility of the normal uterine and ovarian nerves permits the employment of current strengths not bearable on the skin surface. The vulva, on the contrary, like other muco-epidermic junctions, is exquisitely sensitive to this stimulus, and should be protected from it in all ordinary applications by well-insulated electrode stems. The sensibility of the vagina is about midway between the two.

Therapeutic Uses.—This current acts only on nerves and muscles, stimulating each into action, and its use is therefore limited strictly to such conditions as exhibit nervous or muscular laxity. But is this limitation a very narrow one? How many of the commoner cases met in daily practice present just these shortcomings, especially those encountered in a public clinic? The case after case of displaced and prolapsed uteri that present themselves, with or without rectocele or vesicocele, and with intact perinei, teach the paramount importance of muscular tone of the vaginal walls and uterine ligaments in the maintenance of a normal condition. When this tone has been lost, it is evidently the part of rational medicine to endeavor to restore it, if possible,—not to prolong and intensify it by erecting a false skeleton of a pessary or tampon within the vagina. Whether

this can be done by repeated applications of the faradic current is now a living question that should reach a speedy solution. Each individual application will undoubtedly provoke temporary contractions and tonicity, and, so far as known, it is the only means we have at command that will accomplish this much. The question of the permanence of this tonicity after repeated applications will be discussed in another place. For this muscular stimulation the negative pole is most efficient.

In the relief of neuralgic conditions of the pelvis gentle faradic currents are often most effective, and for this purpose I have found the positive pole (using an electrode of any kind of metal) decidedly preferable.

Beyond this neuro-muscular stimulation, with its therapeutic possibilities of direct and reflex effects, the faradic current is powerless for either good or harm in gynecology.

Electrodes and Dosage.—As a rule, the active electrodes required for galvanic applications may be used for this current, and a similar dispersion of current at the indifferent pole is advisable when used after the monopolar method. The absorbent-cotton pad will, of course, be more convenient than the clay.

The selection of the dose is purely empirical, as we have at present no means to measure this current beyond the individual scale of each instrument. The best guide to the strength required in a given case is gained from the sensations of the patient, the current having been brought up from zero to the point of easy tolerance, after placing the electrodes in position, in the same gradual manner as advised for galvanic applications. If we do not shock by a sudden turning on or off, there is

no possible way in which the patient can be harmed; so that our main point in muscular applications is to use as much current as the patient will bear, and it is astonishing how much can be given in this way with one pole in the vagina or uterus and a large dispersion on the abdomen. Weaker currents are better for neuralgic conditions, as a rule. The milliampère meter is, of course, useless with this current.

CHAPTER VIII.

THE FRANKLINIC CURRENT IN GYNECOLOGY.

THE possibilities of electrical treatment in gynecology, in the broadest sense of the latter term, are not exhausted with the use of galvanic and faradic currents. Although totally unadapted to local use, the so-called static electricity* is an agent of unique value in at least three of the conditions that are liable to present themselves to the specialist in the diseases of women, besides being useful in some other, more strictly neurological affections. These three conditions are: the *backache of nervous women*, unassociated with definite pelvic disease; *hysterical pains;* and *amenorrhœa.* In my experience, its relative value in these conditions is in the order of their mention here. In amenorrhœa I rarely use it, finding galvanic applications to the back more generally useful. In the dissipation of obscure aches and weaknesses of the back its use is sometimes truly magical, and it has the advantage of not requiring any disturbance of the clothing whatever, as in the most active mode of using it thick clothing is rather a help than a hindrance.

* The currents produced by static machines are generally, but improperly, called by the same name in this country. Such a designation involves a contradiction in terms, as the product of the battery, being a current, can no longer be *static*, or in a state of rest, although produced by static induction. Franklinic, a term honored more abroad than in Franklin's own country, offers no such objection, and is in keeping with the names of the other two currents.

The Tœpler-Holtz Machine. — The Tœpler-Holtz machine (Fig. 17) is a self-charging plate rotation multi-

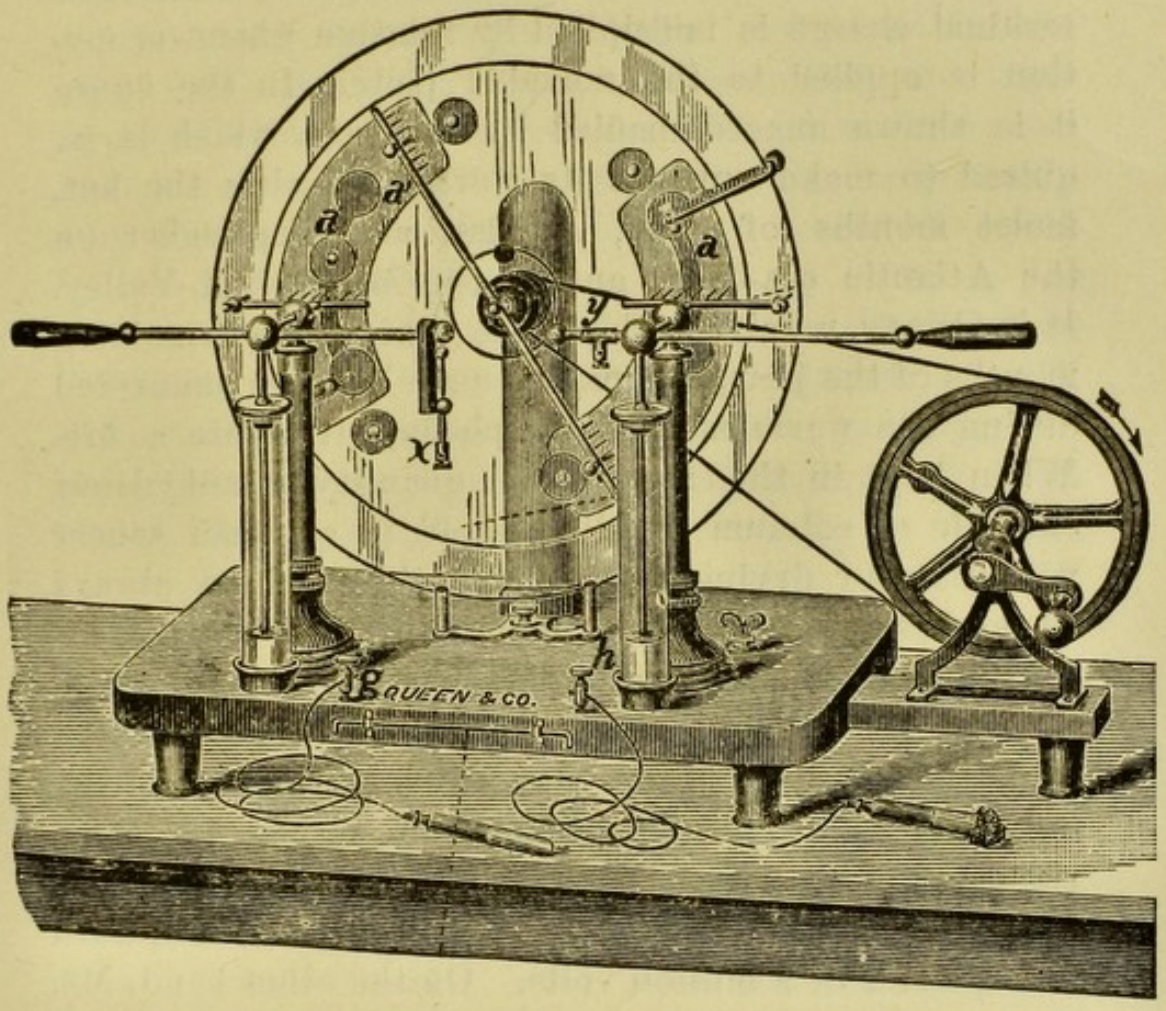

FIG. 17.—TŒPLER-HOLTZ MACHINE.—For the application of franklinic sparks and the electric spray the electrode chains are attached directly to the discharging rods, which are then to be separated. The sparks may be passed through moist electrodes placed on the body by connecting the wires attached to the binding posts, x and y, separating the rods, and gauging the sparks by the small sliding rod at x. The alternating current from the exterior coatings of the condensers may be similarly applied from the binding posts g and h. To connect these binding posts directly by means of the rod brings the condensers into action.

plier that in principle of construction and action bears a striking resemblance to the essential features of that

triumph of electrical invention in another field,—the dynamo,—although to the superficial observer no two things could be more unlike. Like it, an infinitesimal residual charge is multiplied by rotation whenever motion is applied to the movable plate. In the figure it is shown unaccompanied by the case, which is required to make sure of its working during the hot, moist months of July, August, and September on the Atlantic sea-board and in the Mississippi Valley. It is always reliable without the case in the remaining months of the year, and may be made to work uncovered during the warm months by placing it before a fire. When kept in the case, a small quantity of anhydrous chloride of calcium should be kept in an open saucer within it for drying the air, and the machine always works best when it is kept in the sunlight.

Physical and Clinical Characteristics.—Each spark of this current has an enormous voltage, depending directly upon its length. According to some exact calculations by Sir William Thomson, it has fifty-three thousand volts per centimeter. A spark of five inches in length would have a "pressure," therefore, of upward of a quarter of a million volts. On the other hand, Mr. Sprague found that, by actual measurement, a quarter-inch spark carried but .000005 ampère (five thousandths of a milliampère) of volume.

Notwithstanding this extremely minute quantity of electricity conveyed by the sparks, the enormous pressure at which they are delivered renders them capable of stimulating superficial nerve-terminations very acutely, especially when the spark breaks through the dry cuticle. The superficial bundles of muscle are apt to be excited

by this disruptive penetration also, but the muscular excitation is much increased if wet electrodes are used as recommended by Dr. A. W. Morton, of New York. On account both of its high potential and small volume this current tends to reside entirely in the outer layer of moist tissue, and it cannot therefore be made to penetrate a reasonably good conductor like the human body very deeply. In whatever way administered it is essentially a surface excitant.

The dry penetration of the spark through the air to the skin produces a most acute needle-thrust stimulation of the nerves of common sensation, rendering it a powerful physiological stimulant of centric and reflex areas. Each spark, besides stimulating the nerve-ends, causes a contraction of the elastic fibres of the skin, producing "goose-flesh" and blanching at the spot. After a half-hour or so, this local anæmia of the skin gives place to an acne-like irritation that may last for hours. When this current is administered by means of moist electrodes placed on the skin (the necessary metallic break and air-space to produce a spark being inserted elsewhere in the circuit) the sensory stimulation is lessened and the action on superficial muscles increased. By some it was recently claimed that this latter use of franklinic currents would supersede faradic applications to muscles, but my experience has convinced me that it is too unhandy and difficult of insulation to be adopted, unless we particularly wish to reach superficial muscles.

Mode of Application.—In administering the franklinic current for the conditions mentioned in this chapter, the form of *franklinic sparks* should be chosen.

These are administered as follows: The patient stands upon an insulated platform (for lighter stimulation the floor will do) connected with one pole of the machine by means of a chain held in the bare hand, and with the back to the operator. The other pole is connected to a chain attached to a ball-electrode (Fig. 18) held in the operator's left hand. The poles to be selected for the attachment of the chains are the discharging rods themselves, and not the attachments below for connecting the outer surfaces of the condensers. These latter should always be disconnected unless we wish to administer a heavy charge. The attachments *x* and *y* (Fig. 17) may be removed by unscrewing the balls from the rods. The rods being in contact, the crank of the machine is turned in the direction of the arrow with the right hand, and when the current is well going the rods are separated and the ball-electrode passed up and down the back and over painful parts.

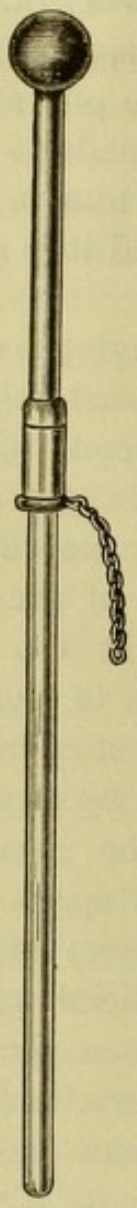

FIG. 18.—BALL-ELECTRODE FOR ADMINISTERING FRANKLINIC SPARKS.

The sparks will penetrate all clothing when dry, but the best material is loosely-woven woolen cloth. Linen as an outer covering is difficult to penetrate, the current going to the material itself, as it is a reasonably good conductor. Cotton mixed with wool makes a particularly bad insulator, as

the current refuses to pass in sparks, but does so in a hissing, continuous discharge. Whenever any of these conditions of dress exist they are readily remedied by throwing over the patient, clothing and all, a dry woolen shawl or blanket; the whole will then be readily pierced by the sparks.

When the condensers are connected by the mechanism below, the sparks are much more severe. In either case the severity of the spark between the electrode and the body surface is governed by its length.

CHAPTER IX.

NON-CAUSTIC VAGINAL, URETHRAL, AND RECTAL APPLICATIONS.

THE general plan of what might be called therapeutic applications of faradic and weak galvanic currents to the female genitalia do not differ greatly from those of the more powerful surgical cauterizations described in preceding chapters. The best results are generally obtained by an adherence to the same monopolar rule, carrying the active pole as near as possible to the seat of disease, and relegating the large dispersing pole to a contiguous dermic surface. As a rule, the same kind of active and indifferent electrodes may be used with both currents, being merely careful not to use a corrodible galvano-positive pole.

In applying a galvanic current to the vagina, either for its local stimulating action on the mucous membrane, or for the purpose of bringing various portions of the pelvic contents within the interpolar region, we must be careful to avoid the caustic action aimed at in the surgical operations, which is, to say the least, undesirable when not needed. There is but one way to do this with currents over fifteen to twenty milliampères, and that is to have as large a conducting surface as practicable on the active intra-vaginal electrode. The shape shown in Fig. 19 is by far the most desirable for all vaginal applications, giving as large a conducting surface as is compatible with an easy insertion within

the average vulva. The stem is covered with hard rubber, insuring a complete insulation of the sensitive parts of the vulva during the flow of the current,—a precaution to be observed alike with both galvanic and faradic currents. Caruncles or pruritus may necessitate a direct vulvar application of the bared extremity of the electrode with either strong or weak currents, but such applications are liable to be painful with far weaker currents than are well borne within the cavities of any of the mucous tracts. To lessen the risk of cauterization, already reduced by the considerable conducting surface of this electrode, we should keep the active pole in motion when using strong currents, applying it alternately

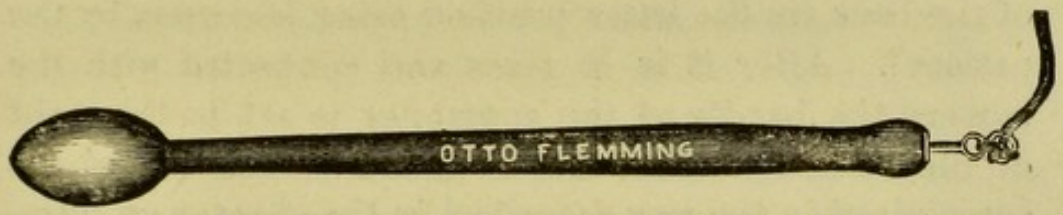

FIG. 19.—THE AUTHOR'S MONOPOLAR-VAGINAL ELECTRODE.

to different aspects of the vaginal walls. No cotton or other moist covering is required on its surface, as the moisture of the cavity is sufficient for the intermediate conduction between electrode and vaginal wall, and its use is only troublesome. When we desire to use a really strong current (thirty to fifty milliampères), we may increase the conducting surface by enveloping it in evenly-wrapped absorbent cotton, wetting it and inserting the whole into the vagina through a speculum. The speculum should, of course, be withdrawn before the current is turned on. The large conducting surface of this electrode is of service also in faradic applications, as it enables us to give stronger currents with less local pain.

For either pole of a faradic current, and as the negative pole of the galvanic, a nickel-plated vaginal electrode surface is quite sufficient, but when the positive pole of a galvanic current is used on a mucous membrane it should be heavily gold-plated at least. The erosion of nickel or copper when used as the positive pole of even a weak current is quite remarkable, and I am not aware of any justification for such an unwarrantable staining of the tissues.

The middle-sized dispersing electrode (five by six inches) described at page 25 is the most convenient for use with these currents. It is thoroughly wetted and placed in position, either on the abdomen or at the small of the back (in the latter position being laid upon by the patient). After it is in place and connected with the battery the handle of the controller is set to the right of the rubber button, the meter and switch-board are scrutinized in the way described in the chapter on intra-uterine cauterizations, and the open condition of the circuit ascertained before inserting the active electrode. This is now introduced into the vagina, and the current, whether galvanic or faradic, is turned on gradually until the desired strength is attained, and at the end of the application the same gradual reduction and complete break are made before withdrawing the vaginal electrode.

The details of urethral and rectal applications are the same as those of the vaginal, with the substitution of active electrodes adapted to the calibre of these canals.

CHAPTER X.

GENERAL PERCUTANEOUS APPLICATIONS IN THE TREATMENT OF NERVOUS WOMEN.

In spite of the frequent causal association of organic disease of the pelvic organs with nervous symptoms in this region and in other parts of the body, cases occur in which such symptoms persist after all local corrections have been made, or even where no abnormalities can be found. The lesson taught by such occurrences has been forced upon an increasing number of gynecologists of late, emphasizing the need of looking beyond these organs at times for an explanation of their perturbed functions. This change of front is especially true of many cases of dysmenorrhœa, ovaralgia, and moderate conditions of anteflexion, when these are associated with evidences of neurasthenia or hysteria. The dilatation of small cervical canals, the wearing of a pessary, or the removal of the ovaries, alike fail to alleviate the distress which prompted the operative interference. Without indulging in this place in a discussion of the probable nature of these cases, whether due to local organic changes or to plexal or parenchimal neuralgias, hysteria, or neurasthenia, certain procedures may be described that are at times singularly happy in their relief or amelioration.

Simultaneous Administration of Galvanic and Faradic Currents.—In some of these procedures both currents are useful. They may be given simultaneously with a

saving of time and effort by simply including the secondary coil of the faradic battery in the galvanic circuit. The two currents should, of course, be made to circulate in the same direction, else one will more or less neu-

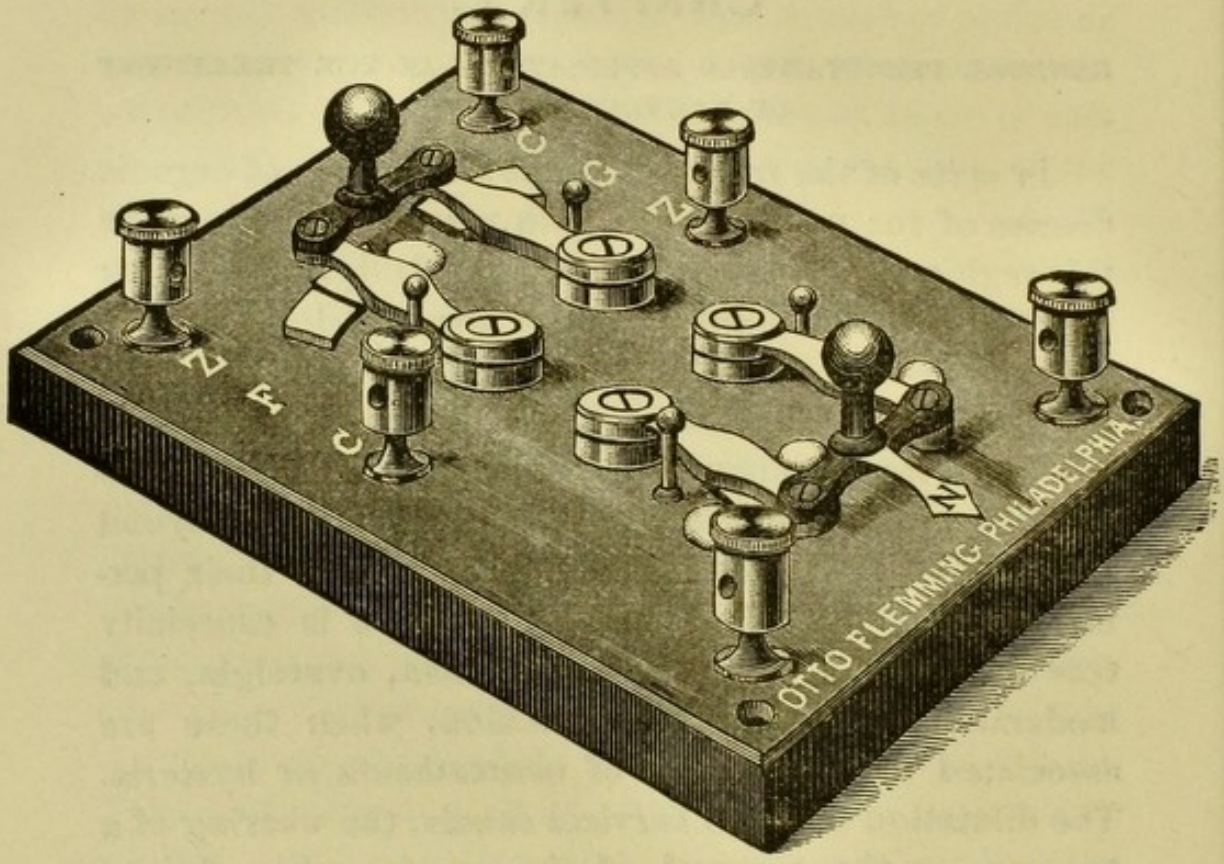

FIG. 20.—CURRENT COMBINER.—The galvanic wires are permanently attached to the upper right-hand binding posts marked with the letter G between them, that from the carbon to C, and the one from the zinc to Z. The faradic wires are also permanently attached to the binding posts designated by F, the negative to Z and the positive to C. The upper switch (to the left in the figure) is shown in the position for combining the two currents. When it is turned toward F, the current at the electrode binding posts shown at the right of the figure is faradic; when toward G it is galvanic. The lower switch is a pole changer, the index pointing to the negative, whether of the simple or combined currents.

tralize the other. A convenient arrangement of switches for combining the two currents with ease, and also for selecting either one or the other, is shown in Fig. 20. In the absence of this arrangement the two currents

may be combined by connecting the negative pole of the galvanic battery with the positive pole of the faradic battery. The positive pole of the galvanic battery will then be the combined positive pole of the two currents and the negative pole of the faradic the combined negative. The two currents are controlled by the contoller, with the assistance of the graduating apparatus of the faradic current.

De Watteville has claimed decided advantages from this double application, and my own experience has indicated its special value as a general stimulant of the abdominal functions.

Abdomino-Dorsal Applications.—The patient lies upon the back with a large (about five by six inches) dispersing electrode of wet absorbent cotton beneath the lumbar region, the clothing being protected from wetting by a folded towel or piece of mackintosh. Making sure that all current is turned off at the controller, the active electrode is next placed on the abdominal surface. This electrode should be about half the size of the dispersing pole and covered also with absorbent cotton, well wetted. The current, whether galvanic, rapidly-successive faradic, or galvano-faradic, is now turned on until the desired strength is obtained, after maintaining which for half a minute it is reduced, the active electrode changed to another spot, and the procedure repeated. To move the active electrode when the current is at its height is somewhat painful, and it is only necessary as a remedy for atonic constipation.

The large poles used in this procedure enable a considerable density of current to be carried deeply into the abdomen, and it is not only an effective way of

impressing the nerve-structures of the upper pelvis and abdomen in unmarried or modest women, but by a slight upward extension of it we are enabled to act favorably on the liver and intestines. From fifteen to sixty milliampères may be used *pro re nata.*

Spinal Applications.—The transmission of continuous currents through the spinal cord, so useful in many neuroses in which symptoms referred to the spinal region exist, is also of signal value in the amenorrhœa and dysmenorrhœa of young girls, requiring no concurrent medication if anæmia does not co-exist. The patient sits sideways in a chair with the clothing loosened at the back, and two spinal electrodes are used (about two and a half by five inches), the positive being placed immovably on the lumbar region, and the negative held in contact with the cervical and various parts of the median and dorsal regions in turn, giving a *stabile* or stationary current in each situation of a minute's duration. From ten to twenty milliampères may be used in accordance with the patient's endurance. The faradic current is not used in this manner, as it would doubtless fail to act on the cord or deep-seated nerve-roots.

General Faradic Stimulation.—This procedure, so largely used by Dr. S. Weir Mitchell as a part of his renowned "rest-cure" treatment of neurasthenia, hysteria, etc., consists in a systematic bipolar stimulation of all the accessible muscles of the body, except the face, after the manner of Duchenne; wet electrodes of medium size being used, with the current carefully graduated to produce the greatest motion with the least pain. Both rapidly successive and isolated currents are used, —the former only with the small muscles of the fore-

arm, as it is likely to give more pain. The least amount of current should be used consistent with tolerable results, especially at first. The details of the procedure, as practiced by the author, are as follow :—

If the application is made in the office, the patient removes the tighter articles of underclothing and lies on a couch; if at home or in hospital, he or she is entirely undressed and laid in a blanket, the sides of which are lapped over in front. This last method permits the freest access to all parts of the body with least chilling or exposure, as but a single part need be uncovered at a time. With the battery conveniently at hand, the first applications are made to the nearest forearm, beginning with the extensors, which are caused to contract by applying both poles to their surface, taking care to include the motor points as shown in the cut (Fig. 21). A gentle current must always be used at first in a new case, especially in nervous or apprehensive individuals, its strength being gradually increased until satisfactory contractions are produced with a minimum of pain. The electrodes are best held in one hand when treating the smaller muscles, the handle of one protruding between the index and middle fingers and pressing against the thumb, and that of the other between the ring and little fingers and grasped in the palm; with a little practice this gives easy control of both electrodes, leaving one hand free to regulate the battery or support the limb. Slowly isolated currents are preferable with delicate, non-muscular persons, the pendulum being set to vibrate at a rate that will permit relaxation of the muscles between each contraction. By the use of electrodes at least one and a half inches in diameter, each

group of muscles, *with physiologically associated action*, may be stimulated simultaneously with but slight pain, the considerable size of the electrodes permitting several

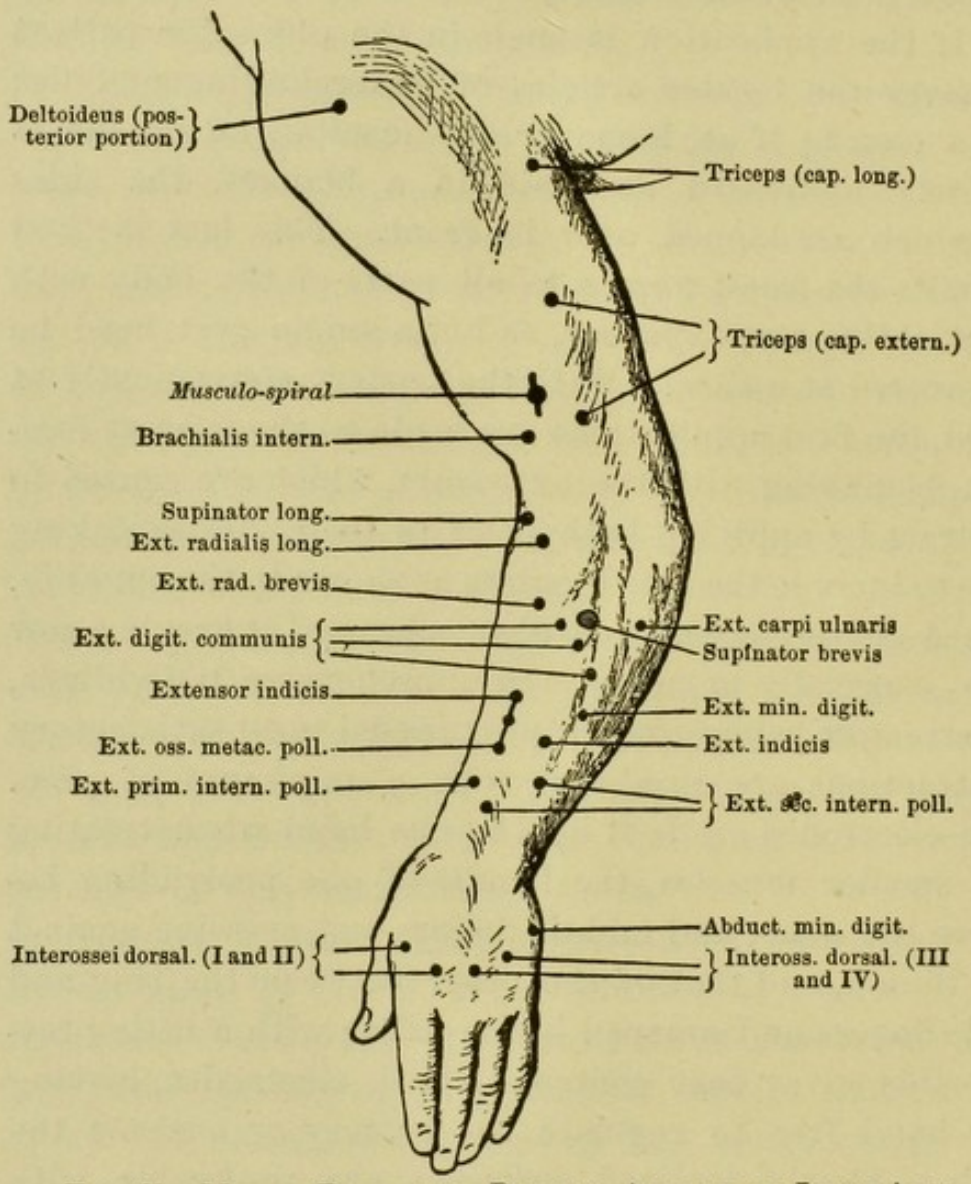

FIG. 21.—MOTOR POINTS OF DORSAL ASPECT OF LEFT ARM.

motor points to be acted on at once. After six or eight full contractions of the extensor group of the forearm, made comprehensive by slight shifting of the poles, the

anterior surface of the forearm (Fig. 22) is similarly stim-

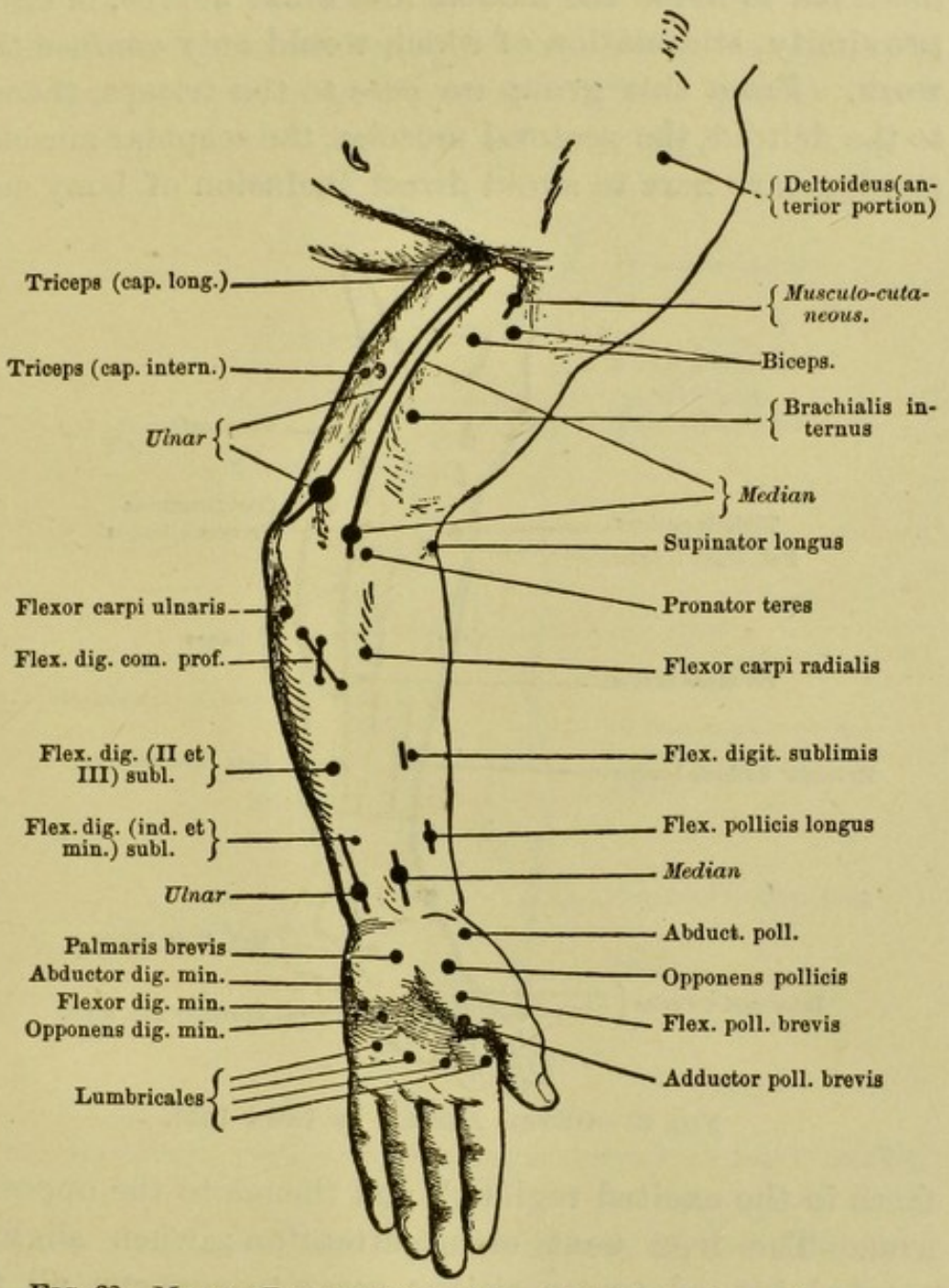

FIG. 22.—MOTOR POINTS OF INNER ASPECT OF LEFT ARM.

ulated with a weakened current, the skin here being thinner and the nerves more superficial. The next muscle

is the biceps, both motor points being covered, and care observed to avoid the median and ulnar nerves, in close proximity, stimulation of which would only confuse the work. From this group we pass to the triceps, thence to the deltoid, the pectoral muscles, the scapular muscles (taking care here to avoid direct inclusion of bony sur-

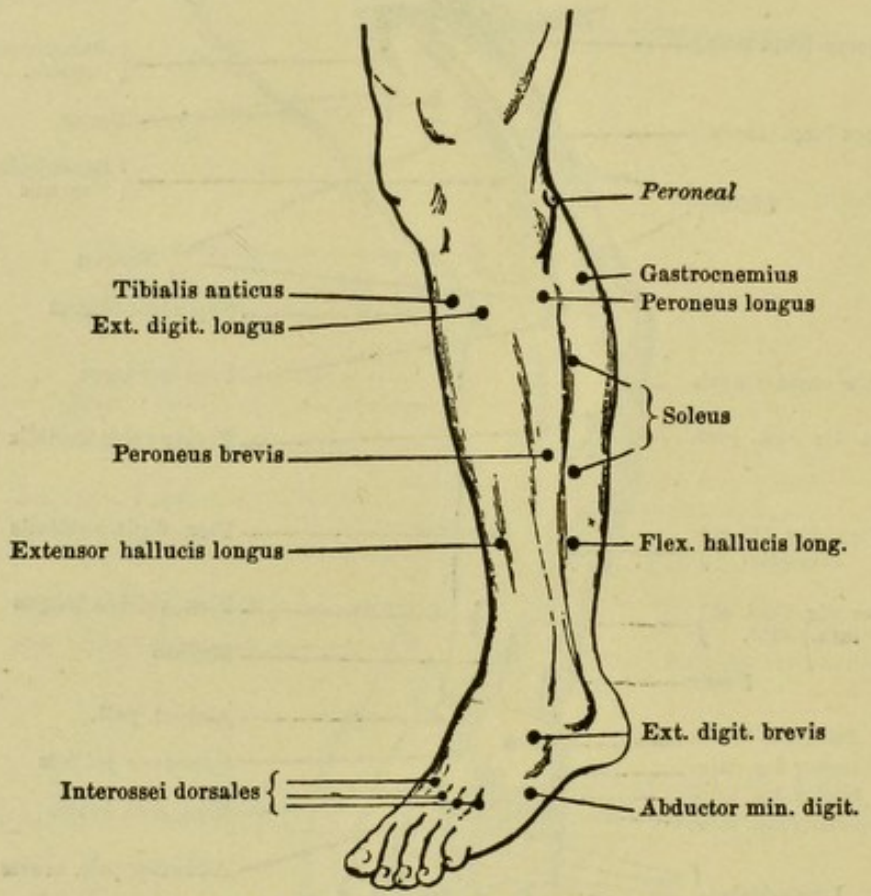

FIG. 23.—OUTER ASPECT OF LEFT LEG.

faces in the excited regions), and thence to the opposite arm. The legs next claim attention; when slightly rotated inward two positions serve to contract all the muscles below the knee,—in one the negative pole is placed on the peroneal nerve just behind the head of the fibula (Fig. 23), and the positive is moved about over

the peroneal and anterior tibial groups; in the other the negative is slid back about an inch into the popliteal space to the motor point of the posterior tibial nerve (Fig. 24), and the positive placed upon the several points below.

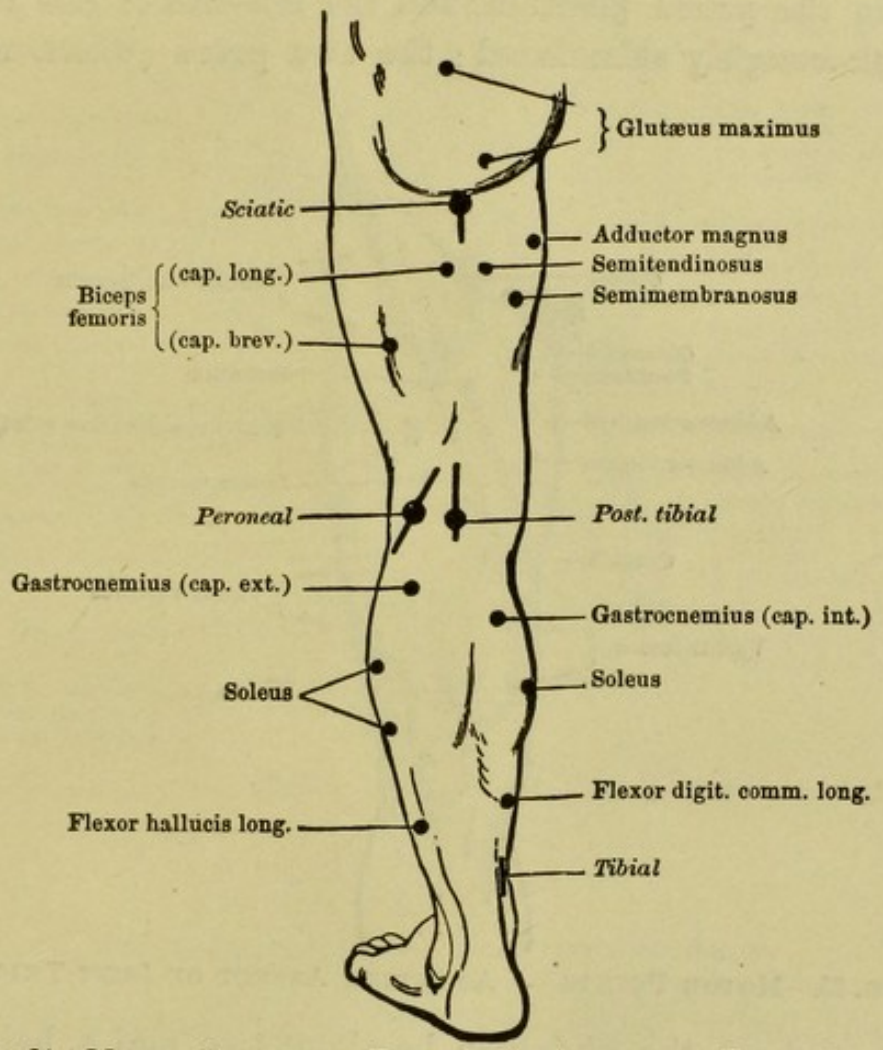

FIG. 24.—MOTOR POINTS OF POSTERIOR ASPECT OF LEFT THIGH AND LEG.

All the muscles on the anterior aspect of the thigh may be contracted by placing the negative over the external branch of the anterior crural nerve just after it emerges from beneath Poupart's ligament (Fig. 25), and the positive about the middle of thigh. The muscular planes of

the belly are now excited, and this is best done by placing the negative in different spots near and below the short ribs, with the positive swept along over the bodies of the abdominal muscles of that side. The patient now assumes the prone position, and the muscles of the back are thoroughly stimulated; the two poles (which may

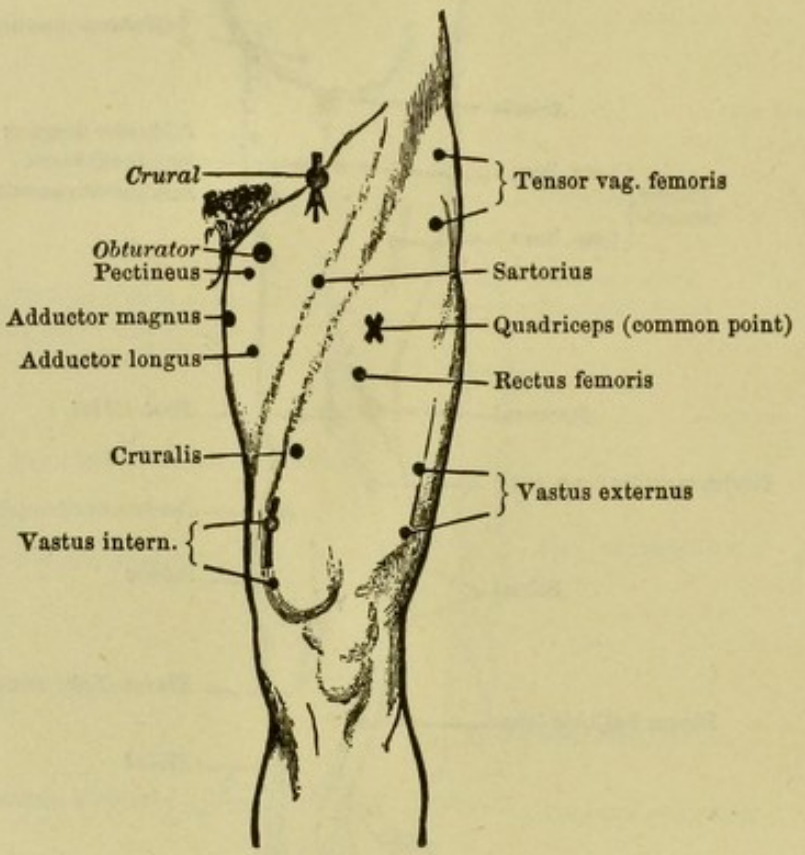

FIG. 25.—MOTOR POINTS OF ANTERIOR ASPECT OF LEFT THIGH.

here and on the abdomen be about two and a half by five inches in size with advantage) are kept on the same side of the spinous processes about five inches apart. A similar stimulation of the buttocks and backs of the thighs completes the application. Dr. Mitchell usually directs that it be followed by a sedative application of the rapidly successive current for ten minutes,

the positive pole at the nape of the neck and the negative at the heels.

Rest after treatment assists the action of the

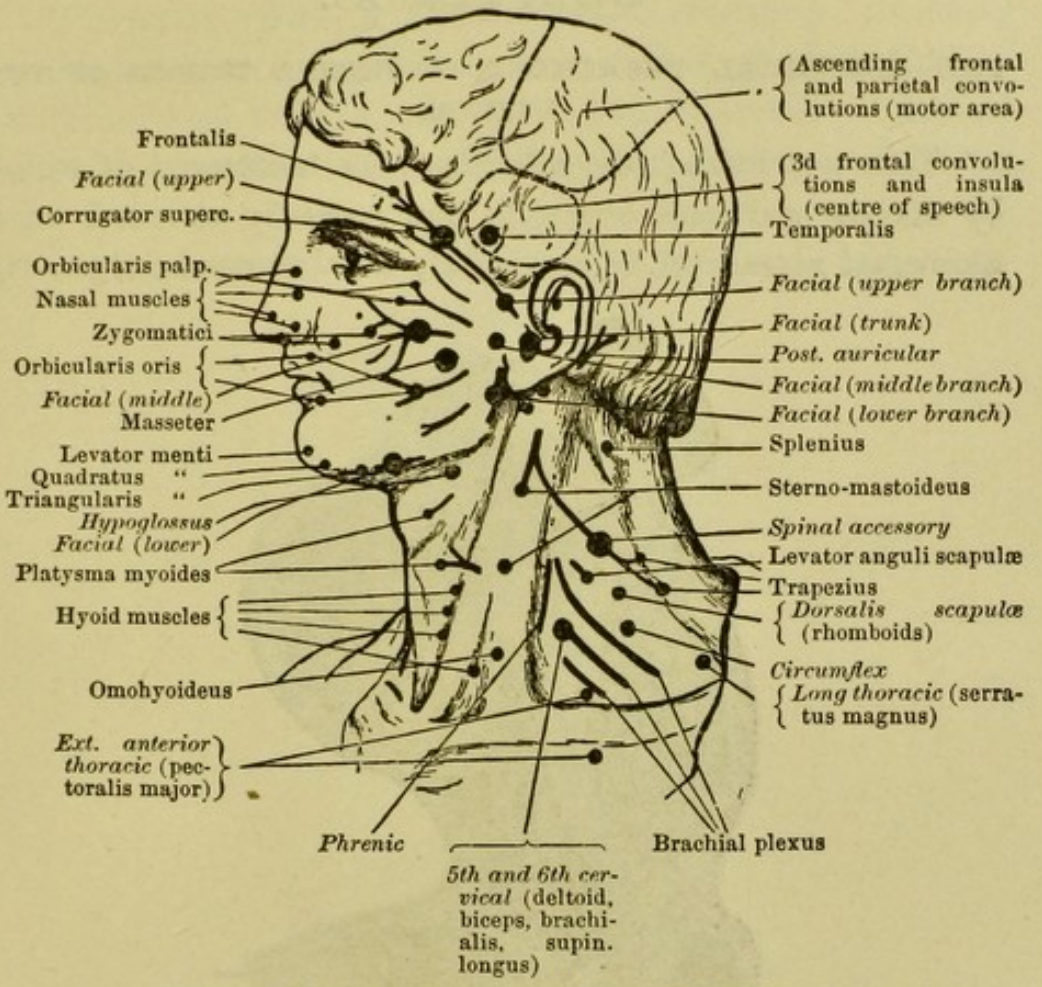

FIG. 26.—MOTOR POINTS OF FACE AND NECK.

remedy, and the patient should, if treated in bed, remain there for an hour after the termination of the application.

CHAPTER XI.

THE ELECTRICAL TREATMENT OF FIBROID TUMORS OF THE UTERUS.

THIS not infrequent affection, the treatment of which by strong galvanic currents has recently aroused such universal attention, is essentially an abnormal outgrowth

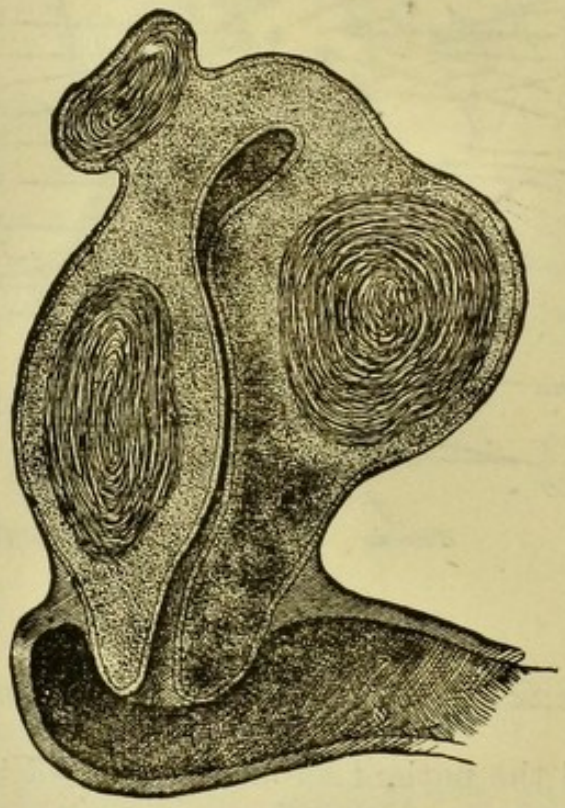

FIG. 27.—INTRA-MURAL AND SUBPERITONEAL FIBROIDS CO-EXISTING. (*Emmett.*)

from the parenchyma of the uterus, varying in size from a small nodule to a mass nearly filling both pelvic and abdominal cavities. The tumors thus formed may be firm and tough when the true fibrous or connective tissue predominates, or soft and yielding when the muscular

fibres are most numerous. The firm, fibrous variety are properly called fibromas and the muscular growths myomas, the designation *fibroid* being a general one.

Varieties Due to Situation.—According to their situation with reference to the uterus, fibroid tumors are known as submucous, intra-mural, or subperitoneal (Fig. 27). According to Winckel, 10 per cent. of living

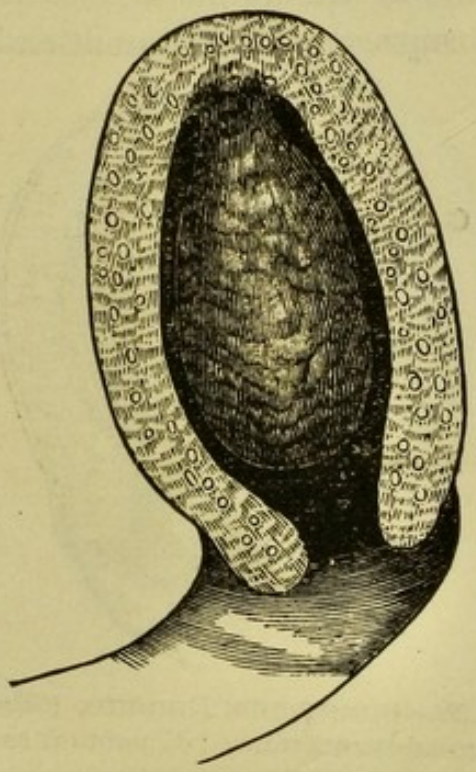

FIG. 28.—FIBROID POLYPUS. (*Byford.*)

cases are submucous, 65 per cent. intra-mural, and 25 per cent. subperitoneal.

All fibroid tumors have their origin in the uterine wall, and fall into either of these divisions according to whether the point of development is near the mucous membrane, in the centre of the uterine wall, or near the peritoneal covering. Those that arise immediately beneath the mucous membrane, pressing toward the point

of least resistance, soon become pediculated and polypoid in shape. In this form the uterine enlargement is most equal, taking on the form and shape of pregnancy, especially when the tumor is soft or filled with trabecular cavities containing liquid (fibro-cystic). The structure of such an enlarged uterus is, however, unlikely to be so muscular and contractile as in a pregnancy, seeming rather to partake of the connective-tissue degeneration. Figs. 28 and 29 represent diagrammatically a true fibroid

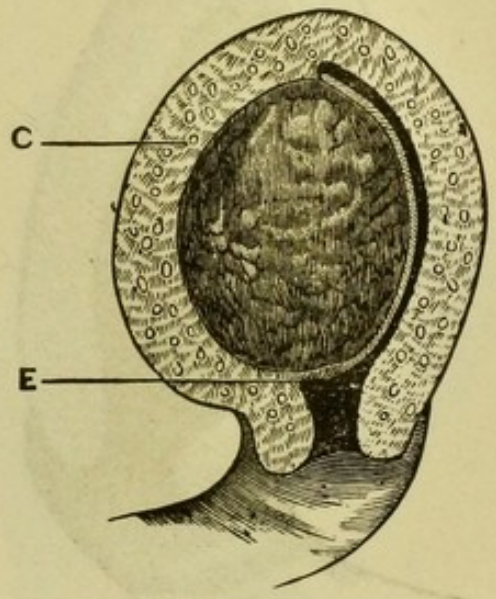

FIG. 29.—SUBMUCOUS FIBROID. (*Byford.*)
C, point of greatest resistance; E, point of least resistance.

polypus and a submucous fibroid rapidly becoming pediculated and polypoid from the influence of lines of pressure. In Fig. 30 a small intra-mural growth is shown which will continue to remain within the uterine wall and cause an exceedingly unequal hypertrophy of the organ. Subperitoneal tumors are frequently accompanied by but little change in the uterus itself, being at times merely attached by slender pedicles, but as a rule they are associated with other foci of abnormal growth in the uterine walls.

It should be remembered that in actual practice we rarely meet with a typical example of either of these varieties.

Varieties Dependent on the Consistence of the Mass.—Fibroid tumors may be still further divided into the hard and soft tumors on the one hand, and the fibro-cystic on the other, and this distinction is exceedingly important in connection with the question of the indica-

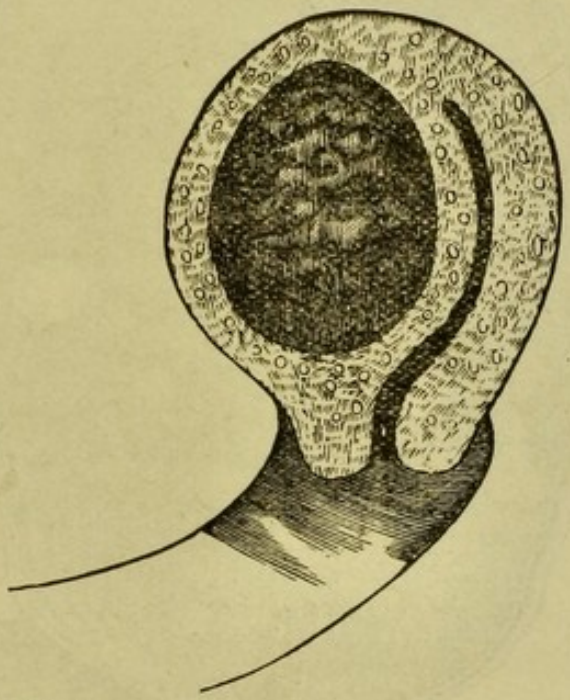

FIG. 30.—INTRA-MURAL FIBROID. (*Byford.*)

tions and contra-indications for electrical treatment. The simple fibroid appears to be prone to either of two changes when the vascular and nervous supply becomes limited by the growth of the tumor without a corresponding growth of its blood-vessels and nerves. It may become almost cartilaginous by the deposit of calcareous material (Fig. 31), or may be softened by the appearance of cysts in its substance. These cysts are usually

multiple, without any connection between their cavities, consisting of mere spaces between the fibres of the tumor filled with a watery, mucoid, or blood-stained fluid. They seem at times to be due to localized inflammatory processes, and have been reported as resulting

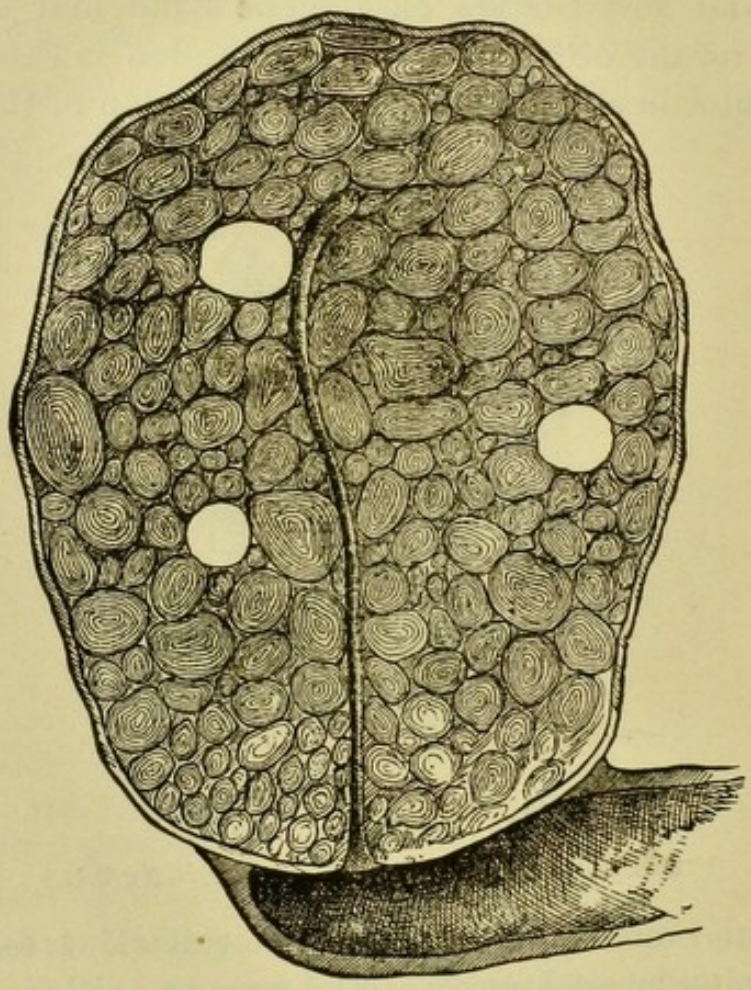

FIG. 31.—FIBROID UTERUS WITH MULTIPLE FOCI.—Several nodules have undergone calcareous degeneration. (*Emmett.*)

from electro-puncture. The red, fleshy, myomatous tumor is more likely to degenerate in this way than the dense, white fibroid.

Their Nature and Cause.—It is thought by many at the present day that fibroid tumors are in some way

related to continuous hyperæmia of the uterus, whether as cause or effect is not yet very clear. The early occurrence of hemorrhages in many would seem to make the former likely, especially since a small tumor frequently gives rise to greater loss of blood than those of the largest size. They are inclosed within a layer of compressed tissue, often resembling a capsule, but not really possessed of the reproducing power of such a covering. When once destroyed, therefore, the chance of a reproduction is by no means so great as in ovarian tumors. The fibrous tumors are supplied with nutrient nerves and blood-vessels very sparingly, generally by small filaments and vessels only at their periphery. They are, therefore, poorly endowed with vitality, giving greater scope to the depressant action of electro-chemical cauterization. This readiness of sphacelation of the tumor as a whole or in parts is a source of danger also in connection with electro-puncture, on account of the possibility of septic infection. Spontaneous inflammation of the morbid growth, or eremacausis, is not infrequent. Martin, of Berlin, in two hundred and five specimens obtained by operation, found evidences of retrograde processes, suppuration, fatty degeneration, etc., in seventy.

General Considerations as to Electrical Treatment.—Apostoli, whose experience with his own operation still remains the largest, thus summarizes certain points in the course of a detailed reply to objections in an address delivered at the Congress of the British Medical Association, at Glasgow, August 8, 1888. In reply to the objection that the method is dangerous, *A, from the intra-uterine application; B, from the making of galvano-punctures; C, from the use of heavy currents*, he proceeds:—

"I have been reproached on account of several recent deaths said to be directly attributable to my treatment. To this indefinite assertion I again give the most positive denial, as I did last year in publishing my complete statistics. I prove, too, by figures relating to nearly seven thousand galvanic applications, the innocuousness of my method, provided the operative conditions are appropriate, that it be used rationally, and with antiseptic scrupulousness. I will say a word on each of the three sources of danger specified:—

"*A.* The intra-uterine cauterization, which is nothing more than a therapeutical hysterometry, might have appeared formidable before the common adoption of the practice of intra-uterine raclage. As that which I do is only a sort of galvano-chemical raclage, there is every reason to regard it as equally beneficent in its action, and my experience more than fully justifies its *à priori* sanction.

"*B.* I put entirely out of the question all abdominal or supra-pubic punctures. Any one who is not both gynecologist and electrician might be expected to set down the vaginal galvano-punctures as hazardous. In making them we certainly do come within the risk of doing mischief, which must be guarded against, and which my experience enables me to disclose with exactness.

"*a.* It has been urged as a point against my treatment that after a number of punctures, when there is free suppuration, or a quantity of necrosed matter in the womb or in the centre of the tumor, there must be difficulty in keeping off septicæmia. This objection would have some force if there were neglect in following the rules which I have framed, viz.:—

"1st. To observe a constant and perfect antiseptic practice.

"2d. To make the punctures only every eight or fifteen days, so as to avoid accumulations of fetid matter, with temporary suspension of the sittings as soon as there are any threatenings of fever.

"3d. To make, without exception, only superficial punctures, not more than half, or, at most, one, centimeter deep, so as not to cause any central gangrene, and to admit of an incessant antiseptic treatment.

"*b.* Perforation of the bladder or rectum, followed by fistula and the wounding of some great blood-vessel, are accidents to be apprehended. I admit that a misfortune of this nature happened in one of my early operations. I now point out the way in which it may be avoided.

"1st. Never make a puncture in the anterior *cul-de-sac.*

"2d. Confine the punctures to a lateral, or to the posterior, *cul-de-sac.*

"3d. Make use of a very fine trocar.

"4th. Never introduce a speculum through which to make a puncture; and before proceeding to puncture make a minute and scrupulous examination of the part chosen for puncture.

"5th. Puncture as near as possible to the body of the uterus, from without inward, making the axis of the instrument correspond with the axis of the organ.

"6th. Choose for the seat of puncture the most prominent point of the tumor found in the vagina, making it project more, if necessary, by directing an assistant to press it downward with his hands upon the body above the pubes.

"7th. First pass the insulating celluloid sheath through the vagina, and fix it at the spot to be punctured, on the point of the index finger. Then slide the trocar up the sheath and make the puncture.

"*c.* The high intensities, which I have been falsely represented as using exclusively and abusively, are denounced as sources of danger; and the less tolerance shown by the rabbit's than the human uterus under a galvanic current has been made the base of an objection. As regards the animal, it affords no ground for comparison. As regards woman, clinical observation has more than sufficiently proved the perfect impunity with which high intensities can be supported; and more than that, it has demonstrated their utility by establishing the fact of the progressive rapidity with which improvement takes place in proportion as the ascending force of the current increases, if it be well applied and well tolerated. I ought, however, to add that there is a limit to this increase of intensity; and it must be regulated by the therapeutical effect obtained. For the present, I disclaim all participation in recommending what I regard as the abuse of those intensities—such as the administration, said to have been made, of currents of more than five hundred milliampères. Moreover, I feel some difficulty in believing that men who daily put women under the perils of castration or hysterectomy are speaking seriously when they denounce my procedures by recounting a series of hypothetical dangers."

In reply to the objection that his method is not efficient, he continues:—

"This objection is presented in a variety of forms:—

"*A.* For some, it is useless in the greater number of cases.

"*B.* Others say that the current has no action on fibrous tissue; that its effect is only shown on the uterine tissue.

"*C.* Others, again, if they admit any action, say that it is only temporary and ephemeral; that the tumor against which we direct it remains just as it was, and that relapses are sure to come. I answer:—

"*A.* The faults committed in the application of the treatment when it is done badly or incompletely ought in no way to bring disparagement upon the method itself. Further, I affirm again, as I have already written, that the method properly used has effected, ninety-five times out of one hundred, not, as I have been erroneously made to say, the absolute removal of the tumor, but—

"1st. An anatomical diminution which does not advance so far as the complete dispersal.

"2d. The quick and lasting cessation of hemorrhages.

"3d. The disappearance of all the symptoms of compression.

"4th. The symptomatic restoration of the patient.

"If these four clinical results are not witnessed regularly and in the same order in all subjects, the fact may be explained in many ways. I will mention some of the chief:—

"1st. The anatomical regression generally varies, first, according to the character of the tumor, whether soft or hard, being more rapid in the case of soft tumors than in the hard ones. Then, again, a difference is made by the situation of the tumor, the localization of the electric action. The more distinctly this is subperito-

neal, the weaker will be the influence of the current. But, without doubt, the general tendency of all fibroids, when skillfully treated with high doses of electricity, is toward spontaneous enucleation, by their disengagement from amidst the uterine stroma. This curative process, which consists in their liberation either through the mucous membrane or the peritoneum, is seen to take place with some interstitial fibroids.

"I ought, also, to note here what I have almost constantly observed as the treatment advanced, namely, the occurrence of an accumulation of adipose tissue under the abdominal tegument. This new condition ought always to be borne in mind when estimating the size, or changes of size, in fibroids, by measurement of the circumference of the abdomen. The external measurement, even with a collapsing fibroid, may remain the same simply on account of the recent, and often abundant, quantity of fat developed in front of the tumor. I therefore recommend that, at the commencement of every course of electrical treatment, three measurements of the body should be registered, which may serve for future reference; 1st, the circumference of the abdomen at several points: 2d, the exact thickness of the layers of skin and fat, above, below, to the right and to the left of the umbilicus, taken by means of a graduated compass; 3d, the weight of the patient. I cannot deny that I have in some rare cases been disappointed and failed, the same as happens in all human undertakings. The future may enlighten us about these difficulties, for they all relate either to ascitic fibroids or to fibro-cystic, or to abnormally vascular fibroid tumors. I may add, that while certain fibroids shrink without

any sphacelation, or any appreciable sero-purulent discharge, others only undergo this change as the result of a more or less extensive necrosis.

"2d. The arrest of hemorrhage has also been disputed. Many who hold this opinion do so without ever having made, or seen, an experiment on some tissue to convince themselves of the hæmostatic power of the condensed action of the positive pole, when applied to a cut and bleeding surface. Then, I am asked to explain how it is that results are not constant. I can only say that this depends upon different conditions, clinical, anatomical, and physical. Clinically, hemorrhages are more difficult to suppress in the cases of interstitial and submucous fibroids. Anatomically, the arrest of hemorrhage will be more speedy and certain as the uterine cavity is more narrow and less deep. Physically, the hæmostasis becomes more decided as we augment the intensity of the electrical current, and insure the perfect coaptation of the electrode with the entire extent of the bleeding surface.

"To resume: the arrest of hemorrhage by electricity is arrived at in three different ways, either associated or independent of each other. The action of the current, which is a vehicle of force and of chemical action, may be studied either as it is manifested at the poles, or in the interpolar circuit.

"*a.* The polar action of the positive pole is hæmostatic, either at once, or some time afterward: immediately, if the bleeding surface is totally cauterized by the application of a sufficient intensity; subsequently, after some interval from the commencement of the treatment, if the hæmostatic action has not been powerful

enough in the first instance by the appearance of an atresia, more or less pronounced, of the uterine canal. This atresia, which some gynecologists will not admit, I have the opportunity of seeing almost every day in some one or more of my former patients, although they have not yet arrived at the menopause. In certain women, with a large uterus and expanded cavity, in which the ordinary sound had moved with great freedom, I have discovered, one, two, or three years afterward, that it could not then be introduced, and that the canal only permitted the entrance of a sound of the most diminutive size. Now, this cicatricial atresia (which, however marked it may be, and, as a new observation, it is interesting to notice this, is not accompanied with dysmenorrhœa) is the physical reason of the postponed electrical hæmostasis and of the permanence of the results established.

"*b.* The interpolar action is equally hæmostatic in a tardy manner, and in an entirely different way, without the polar action being in any degree implicated. Indeed, there is reason to believe that we may stop hemorrhage, though it must be confessed more slowly, without at all cauterizing the mucous membrane, and by restricting the treatment to galvano-punctures made in the tissues of the tumor itself. The denutrition of the substance of the fibroid will, after a certain time, bring about a progressive stoppage of the hemorrhage, without the mucous membrane having been touched. Either pole may be used for this purpose, though I incline to prefer the negative. It is more to be relied upon because it is more denutritive than the positive. I have, as a matter of experiment, given clinical demonstration of this sepa-

rate interpolar hæmostatic action by treating several hemorrhagic fibroids by galvano-punctures only, without any intra-uterine cauterization. I am convinced, however, that the combined use of the two methods will be found more certain in producing the hæmostatic action in cases where the simple intra-uterine cauterization has shown itself ineffectual.

"3d. The cessation of pain and of the effects of compression will vary among patients as much as the causes which produce them. Generally, this takes place coincidently with the retrogression of the tumor. In other instances, on the contrary, it is the initial phenomenon which precedes all others. This may be accounted for either by the relief of the uterine congestion, which is early realized, or by the mitigation of the ovarian neuralgia. There are cases, however, in which this amelioration comes on but very slowly. I have remarked that in these inveterate cases we can generally recognize some ovarian or tubal complication, some inflammatory or suppurative condition of these parts, which is less disposed to yield to electrical treatment.

"4th. The symptomatic restoration of the patient is the most striking result of the treatment, the most rapid, and that which most surprises both the subjects of it and their medical attendants. One of the few adversaries of the method has thus expressed himself: 'I have been able to assure myself that all the women under treatment have experienced a stimulating influence very favorable to general nutrition and the recuperation of their forces. They feel more cheerful, more buoyant, more alert—in a word, seem to have more life. Whether it be that the innervation, sensibility, and mobility of the abdomen

and pelvis are more happily excited, the patients keep about without difficulty, and walk freely, in a way which was impossible before anything was done for them. The movements are unembarrassed. The tumor no longer distresses by its weight or contact with the sensitive viscera. With the trunk and the pelvis disengaged from an overpowering constraint, the limbs do their office with freedom.' They acknowledge, too, that the digestive functions are well performed, that sleep is natural, that the miseries of bladder pressure have ceased, that constipation is less annoying, and that there is a restoration of active life in all its integrity and intensity.

"*B.* The second reproach of inefficacy is made on the supposition that the current can act only on fibrous tissue, and that it has no effect upon the uterine tissue. There is falsity in this limitation of the effect of the current; and the proof is that an action, combined or isolated, may be observed in both one and the other of these tissues. We see cases, in fact, where the uterus itself undergoes no contraction, as may be ascertained by the sound, while examination above the pubes enables us to decide positively as to a diminution of the sub-peritoneal part of the fibroid tumor. On the other hand, in the simple hypertrophies which follow chronic metritis, or in the non-fibroid hypertrophies of the uterine tissues, there is always a lessening of the uterine cavity under treatment. The action, then, is here only on the uterine tissue, as in the other case it was upon the fibrous tissue; and the process of disintegration set up by the passage of the current results in promoting a general retrograde metamorphosis of the muscular, connective, and fibrous hyperplasias.

"*C.* The third reproach, in reference to inefficiency, which consists in a declaration that the effect of the treatment is only temporary and ephemeral, can be no better sustained. It is now six years since I began the practice of this method, and I have regularly and carefully kept an account of the condition of my patients. I can affirm that relapses have been truly exceptional. The very infrequent cases where I have had to administer secondary treatment were those of women who had unadvisedly discontinued their attendance. There has been no difficulty in bringing this secondary treatment to a satisfactory end."

This exceedingly interesting statement is undoubtedly the most authoritative presentation of the subject that is possible at the present time, yet I think it is entirely too conservative on one point. In disclaiming the possibility of a complete anatomical dispersal of the tumor Apostoli overlooks the probabilities presented by two conditions favorable to this termination: first, the probability of a partial sphacelation of a submucous growth, and the powerful uterine contractions excited by the current, ending in a complete extrusion of the tumor from the cavity of the uterus; second, the peculiar energy of this treatment upon a tumor when it is both small and submucous. An instance of complete extrusion of an intra-mural fibroid, the dimensions of which are not given, but which was probably quite large, is reported by Dr. Mary Putnam Jacobi in the *American Journal of Obstetrics* for August, 1888. The patient, æt. 36, had suffered from a uterine fibroid for at least six years, which, at the beginning of the electrical treatment, was situated in the uterine wall posteriorly and to the left.

Thirty-eight galvano-chemical cauterizations were administered during the space of six months, followed by a presentation of the tumor at the dilated os and delivery through the vulva by the operator. A menorrhagic tendency was corrected early by the applications, some of which were positive and some negative, with a usual strength of two hundred milliampères and ten minutes' duration.

Another case reported by Dr. E. Holland (*Brit. Med. Jour.*, January 7, 1888, page 20) adds confirmatory evidence of the same nature. Dr. Holland's report of this case is as follows:—

Mrs. C., aged 38, having seven children, was admitted to the Woman's Hospital, Soho Square, London, July 4th, severely blanched and flooding. The uterus was involved in a hard, multiform, fibroid enlargement, whose measurements were as follow: Upper limit, level with the middle of umbilicus; right lateral limit, five inches to right of middle line; left limit, three and a half inches from middle line; transit of sound, six and a half inches to seven inches. The hemorrhage resisted all ordinary resources, and, as there was no cervix available for a stump, electrolysis was considered a legitimate procedure, and was accordingly begun on July 22d, as follows: The negative electrode, insulated to four and a half inches from its extremity, was placed in the uterine cavity, whilst the positive electrode was connected with the zinc and potters' clay distributor of Apostoli and applied externally over the tumor. A current of fifty milliampères was gradually produced and allowed to flow for ten minutes. On the 25th the application was increased to eighty milliampères, on the 29th

to one hundred and fifty milliampères. After this there was pain for an hour and the tumor was perceptibly diminished in area. On August 2d there was again free hemorrhage and clots passed for several days. On August 9th, the hemorrhage still continuing, positive cauterization to two hundred and fifty milliampères was maintained for twelve minutes, with the result that the hemorrhage was arrested and never recurred. August 12th, negative cauterization two hundred and fifty milliampères.

On this and subsequent occasions the patient appeared less tolerant—August 15th, to two hundred and fifty; 18th, to three hundred; 22d, two hundred and thirty-five. After the application on August 22d the patient suffered chilly feelings; thought she had taken cold, and had raised temperature and vaginal discharge, which became more and more fetid. August 27th, much pelvic pain was noted. August 29th, fetor increasing; cavity of uterus well douched, after which the temperature shot up to 103°. Between the last date and September 4th a large, sloughing mass was bloodlessly enucleated and extruded into the vagina. September 5th, mass removed by two applications of the écraseur and other small enucleations by fingers and scissors from a base which was found to be the left lateral wall of the uterus inverted. After the operation the inverted left lateral wall was manually replaced. Between the date of this operation and the 8th a second bloodless enucleation and extrusion was accomplished, and of a much larger mass, which tightly distended the vagina and was removed by three applications of the écraseur and one or two twisting processes. On the second evening after

this operation the temperature rose to 104°, but this was quickly subdued by quinine. The douches were most thoroughly used every three or four hours, chlorine water being the usual one, whilst quinine was freely given at each rise of temperature.

On September 15th the patient was quite convalescent, the discharges scanty and without fetor, the sound passing two and three-quarter inches in and no tumor being perceptible. From the commencement of the electrical treatment to the date of convalescence was exactly fifty-five days. Dr. Holland adds: "It is also well to observe that the tetanoid condition into which the uterus was thrown by the electrical application led us to anticipate necrosis and enucleation as possible and probable contingencies, and, in doing so, to draw attention to the extreme importance of the galvanic current as a diagnostic agent in all solid uterine tumors."

The result in both cases was clearly due in great part to a stimulation of the uterine muscle, and it is reasonable to hope that the cramp-like pains usually complained of by patients undergoing an application will always tend to have this happy result in appropriate cases. That these cramps, which usually require at least one hundred milliampères for their production, are attendant upon real contractions of the muscular tissue, is proven by the appearance of identical pains during the use of much weaker currents in cases of recent subinvolution, where the muscular fibres are much better developed. In one such case a distinct grasping of the electrode was detected by the author while using eighty milliampères, the patient declaring that she felt as if she were in the throes of parturition.

It is possible that these contractile effects play a greater part in the cure of fibroids than the actual destruction of tissue by cauterization or electrolysis. That a continuous current will provoke contractions in uterine tissue is well known, the contraction being of a slow, tonic character, supervening at times only after the cessation of the current. It is, however, the act of turning on a heavy current, or turning it off, that is most effective in producing contractions, and this fact has led me to adopt a plan of prolonging the current increase in some cases to the point of apparent endurance, and then immediately reversing the controller with a slow movement, thus extending the initial stage at the expense of the middle. By this "swelling" method we obtain the maximum contractile effect, while the electrolytic effect is the same as that from a current with a less number of milliampères and greater duration.

In beginning the treatment of a case of fibroid tumor with the galvanic current, the form of intra-uterine cauterization should be given a fair trial first, if the uterine cavity can possibly be reached by a sound. This method may be slower than puncture at times, but it offers the advantage of absolute freedom from risk when properly performed.

If, on the other hand, electro-puncture be decided upon, the question arises, Shall the puncture be made through the abdominal walls or per vaginam? Apostoli invariably prefers the latter, and I have not as yet punctured in any other way than through the vagina. Ephraim Cutter, of New York, on the contrary, has made the greater number of his punctures directly through the abdominal walls into the most prominent

portion of the growth, the patients being etherized. This operator, who deserves the credit of being one of the earliest, if not the very first experimenter on the electrolytic treatment of uterine fibroids, has recently published a full report of fifty cases treated by his method, the operators being himself and Gilman Kimball.* His summary of these cases is as follows: Cured, 11 cases; relieved, 3; arrested, 25; non-arrested, 7; fatal, 4. Unfortunately for the value of this report as bearing upon the galvanic treatment of fibroids, it is by no means certain that these operators used any current to speak of in connection with their punctures. Beginning their work in 1870, before the perfection of convenient instruments for measuring currents, they naturally remained unaware of the actual current strength used; but they were additionally oblivious to the effect of Ohm's law, which had been well understood many years previously, or they would not have adopted and continued to use a battery consisting of a single cell, no matter how large the cell might be. The resistance of the tumor between the two electrodes is too great to be materially overcome by a current with a pressure of but one and a half volts; but a small number of milliampères could therefore get through, and the actual number at each operation would depend on the nearness of the electrodes to each other. That the current actually used was trifling is evidenced by the fact that they were able to withdraw the steel needle used as a positive pole almost as easily as the negative needle. A hun-

* Contributions to Gynecology. "The Galvanic Treatment of Fibroids."

dred milliampères would have attached it firmly to the tissue of the fibroid.

While lacking in value as testimony to the efficiency of electricity in large doses, these cases are nevertheless exceedingly interesting, as showing the small danger attending the thrusting of an instrument into a solid tumor through the abdominal walls and the good effects that may at times result. That the vagina should be the preferable point of departure is pretty well settled, though, and the principal reason, besides the avoidance of the peritoneal cavity and the intestines, is the ease of drainage afforded in this situation.

Apostoli reported to the British Medical Association, in 1887,* a list of two hundred and seventy-eight patients "with fibromata, or hypertrophy of the uterus in some manifest degree." For these he had applied three hundred and eighty-nine vaginal negative galvano-punctures, thirteen hundred and thirty-nine negative intra-uterine cauterizations, and two thousand five hundred and eighteen positive intra-uterine cauterizations. He claims but two deaths as resulting from the treatment: in one, a suppurating ovarian cyst ended in death from peritonitis; in the other case, a too deep puncture resulted in death from intra-peritoneal gangrene. Ninety-five cases in a hundred were permanently benefited.

Diminishing bulk, checked hemorrhage, easy menstrual periods, relief of pressure symptoms, and general restoration of the patient has been the usual result in all cases so far operated upon by the author; and this is invariably the verdict of all who have used currents

* *Brit. Med. Jour.*, October 1, 1887, p. 699.

intelligently for this condition. The history of the treatment is too recent for any statistics of value, yet there are certain facts relating to the curability of the several varieties that may be stated, as follows:—

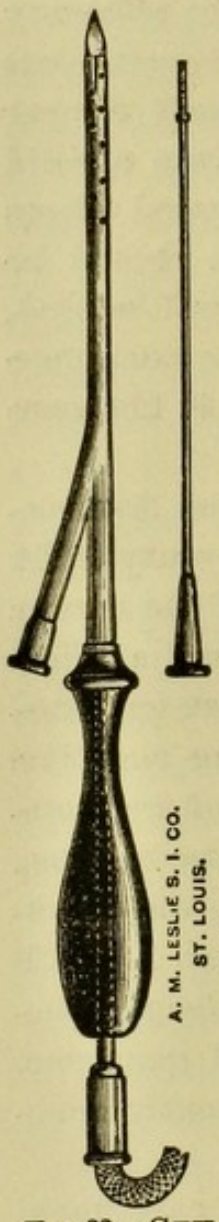

FIG. 32.—GEHRUNG'S ELECTROLYTIC TROCAR AND CANULA.

Soft, Varying to Firm, Fibroids are the best adapted to electrical treatment. Very hard tumors respond more slowly. In one of the author's cases mentioned under the head of subperitoneal fibroids, there was, nevertheless, considerable shrinkage in spite of the cartilaginous condition of certain parts of the growth.

Fibro-Cystic Tumors are not regarded at present as favorable cases for electrical treatment. Cases have been reported in which the cysts degenerated into abscesses, ending at times fatally. Whether such a termination would have occurred if the cavities had been aspirated and drained is at least open to question. Dr. Gehrung, of St. Louis, has recently suggested a method and devised an instrument, made by the Leslie Instrument Company of that city, by the use of which it seems possible that these cases may be treated by electro-puncture without danger.* He gives the following description of the instrument (Fig. 32) and directions for its use:—

The trocar, including the handle of two and three-fourths inches, measures seven and one-half

* *American Journal of Obstetrics*, August, 1888, p. 820.

inches. The steel of the trocar reaches through the handle and terminates below in an expansion or bell to receive the tip of the conducting cord. Its stem is four and three-fourths inches long, and rests, with the exception of the point, in the canula. Just behind the point the stem is thinner than elsewhere, so that the canula, by means of spring-power produced by a slit in its distal extremity, will be prevented from causing any unevenness that might impede its introduction. The canula measures four and three-fourths inches in length, and being arranged on the principle of a double canula, it has, inserted at an acute angle, an arm or canula one and one-half inches in length, almost parallel to the straight tube, while the distal end of the tube is provided with a number of perforations, or holes, like those in other drainage-tubes. Lastly, there is an inner tube, which can easily be inserted and withdrawn, as it is fastened merely by a conical friction joint. Near the further end, this tube carries a nut or septum, which, when inserted into the outer canula, divides the perforated region into two nearly equal parts. A probe-point may be attached to the inner canula, so as to close the front openings of both canulæ, therefore the inner one of these has a few holes in the side beyond the septum.

All that is necessary beyond what is here described consists in two or three pieces of India-rubber tubing, provided at the ends with perforated metallic tips for the easy attachment to the canula, and an aspirator of some kind—one piece of tubing to connect a vessel or bottle with the outer or influx canula containing the fluids to be used, a short one to connect the aspirator to the inner or outlet canula, and a third piece to lead

to a vessel to receive the waste. The calibre of the canula may vary from No. 6, American scale (No. 9, French), to any size to suit the taste of the operator or the conditions of the case.

Before beginning the operation the portion of the canula that is to be insulated is covered with a thick layer of shellac (heating the canula slightly will favor its adhesion). In deciding how much surface to leave bare at the extremity, the operator has two methods to choose from; that recommended by Dr. Gehrung is to leave all parts bare that actually penetrate into the tissues, with a view of leaving a fistulous opening extending through the sound tissues from the vagina into the tumor. This cauterization of the tract is said to favor matting together of contiguous parts and the production of continuous walls to the opening. I have adopted the opposite course of insulating all parts of the needle not embedded in the tumor, and it would seem that this would be preferable when drainage is already secured by the use of this apparently excellent device.

The trocar and canula being plunged to the requisite depth into the tumor or cyst, the conducting cord of the *negative* pole should be attached to the handle of the trocar and the current turned on as described elsewhere.* This done, the trocar is withdrawn, and the fluid, if any be present, allowed or made to flow away through the canula, which is left in position.

The cyst being drained, the next step is to introduce

* The escape of hydrogen gas and the liquids produced during the operation will be assisted if the trocar is removed before turning the current on.

the inner canula into the space previously occupied by the trocar. After attaching the rubber tubes and aspirator as described, the cyst can be washed by antiseptics and alterants, as carbolic ($\frac{2}{100}$ to $\frac{4}{100}$), mercuric bichloride solutions ($\frac{1}{1000}$ to $\frac{1}{2000}$), iodoform oil (twenty grains to one ounce), tincture of iodine even to full strength, etc. By means of this apparatus these medicaments can be applied by aspiration or irrigation, as the operator may desire.

When the cyst is cleansed and treated to satisfaction, the inner canula can be withdrawn, while the outer remains as a permanent drainage-tube; one of the two arms of the canula should now be closed by a cork of wood or metal, and the other should be closed by a perforated metallic tip, to which is attached a very soft rubber bag (a child's rubber balloon will do), for the purpose of collecting for inspection and examination all fluids that may pass through the canula between visits. In this way the cyst or wound is hermetically sealed, without arresting the constantly secreted fluids within.

The washing, etc., should be repeated about once a day.

After the removal of the aspirating apparatus nothing can be seen except the little rubber bag, as the whole drainage-tube is safely ensconced within the vagina, just reaching to within the labia majora, enabling the patient not only to lie down with comfort, but to sit up, walk about, and to micturate and defecate with ease.

If there is no fluid present, of course, the trocar and canula may, after the use of electrolysis, be removed simultaneously, unless it be desired to leave the canula

for future applications of this agent without the necessity of a repeated puncture. For the application of the current, either the trocar may be reintroduced through the canula and the cord attached, or the latter may be attached to the canula itself. A silver canula seems to be sufficient, as only the negative pole is to be used. In Dr. Gehrung's case it came out but a little tarnished after sojourning twenty days in an abscess cavity. Twenty-four hours after its removal no sign of the wound could be traced.

In the article alluded to, Dr. Gehrung reports a case of exudation tumor of fifteen years' standing, developed around a subserous fibroid, in which four or five electro-punctures with a solid needle had been made. Shortly after the last puncture, evidences of pus formation set in, and the tumor was found to be enlarging. At this juncture the cyst was punctured through the vagina with an aspirator needle, and a large quantity of serous fluid and about an ounce of pus drained away. This was followed by a fall of temperature. The opening was enlarged, and a double, uterine, aspirating canula introduced. Failing to keep this in place, the instrument described above was introduced into the tumor, which had meanwhile developed symptoms of a re-formation of the abscess. It was kept in place until the flow was completely arrested. During this time the cavity was washed out daily with 2 per cent. carbolized water, followed by iodoform oil and pure tincture of iodine. Occasionally, electrolysis was repeated, in the hope of securing further modification of the cyst-walls. The patient made a good recovery.

Electro-puncture and drainage with this instrument

seem to be particularly promising in cysts situated in close proximity to the vagina, whether located in solid tumors or the tubes. It is possible, also, that it may bring ovarian cysts within the province of electro-puncture, as the results with the solid needle have not been encouraging.

Fibroid Polypus.—When in the shape of polypi, an electrical treatment should be declined, unless the polypus is small and hard; for the surgical treatment of intra-uterine polypi is clearly feasible and reasonably free from danger, under which circumstances it should always have the preference. After the heavy mortality suffered by the last generation from the practice then in vogue among surgeons of slow strangulation of these growths (*vide* Barnes' "Diseases of Women"), we should be chary of repeating a similar invitation to septicæmia. This is especially true of all soft, fibro-cystic, or vascular polypi of large size. The disintegrating power of heavy currents is so great in these soft tumors, so largely cut off from trophic influences, that an exceedingly ready necrosis occurs, with the consequent danger of septic infection. If the polypus be of the harder variety, cauterizations, negative in non-hemorrhagic and positive in the hemorrhagic variety, are far less likely to be attended by this risk, and may speedily end in spontaneous contractions and expulsion. Under these circumstances the currents should be of short duration (one to two minutes), but carried to the full strength tolerated by the patient.

Submucous Fibroids.—Where the tumor merely projects into the uterine cavity, its treatmeut by properly regulated galvano-chemical cauterizations offers the best

hope of either an entire disappearance by absorption or enucleation, or an atrophic dwindling into innocuousness. If there is hemorrhage, the positive pole must, of course, be used, followed by the negative, for its greater denutritive power, as soon as the hemorrhage has been sufficiently controlled. The following case may be taken as a fair illustration of the results of the electrical treatment of this variety.

CASE I. *Small, submucous fibroid associated with hypertrophied uterus and amenorrhœa. Normal menstruation established seven days after two applications. After ten applications uterus reduced to normal size and tumor scarcely perceptible.*—M. H., a married woman, aged 38, was treated by the author at Dr. Bradford's clinic at the Pennsylvania Hospital. She had had seven children and three miscarriages, the last pregnancy ending six years previously. For two years had suffered from irregular menstruation, the last time of its appearance having been eleven months ago. Was troubled with a voluminous, purulent leucorrhœa and pain when walking. The uterus was found hypertrophied, the sound entering four inches. On the posterior wall of the cavity a projection was found about the size of a large shellbark. The os was patulous and the cervix congested. August 9, 1888, electrical treatment was begun with negative cauterization, fifty milliampères, for four minutes.

August 14th. Some pain for twenty-four hours after operation. The cervix is softer. Negative cauterization, forty milliampères, three minutes.

August 16th. Uterus tender to touch. Application postponed.

August 21st. Slight tenderness persists.

August 28th. Menstruation appeared on the 22d (for the first time in eleven months), accompanied by bearing-down pains. Negative cauterization, eighty milliampères, five minutes.

September 1st. Leucorrhœal discharge colored with blood. Positive cauterization, eighty milliampères, four minutes.

September 6th. Positive cauterization, eighty milliampères, four minutes.

September 13th. Positive cauterization, one hundred milliampères, five minutes.

September 20th. No further bleeding. The projection is much diminished, and cavity of uterus diminished to three and a half inches. Negative cauterization, one hundred and fifty milliampères, four minutes.

October 4th. Menstruation appeared on time, normal in amount and duration. Negative cauterization, one hundred and fifty milliampères, three minutes.

October 16th. The pelvic pains complained of have disappeared. Negative cauterization, one hundred and fifty milliampères, three minutes.

October 30th. Negative cauterization, seventy milliampères, three minutes.

November 13th. Menstruated again on date (October 30th), lasting six days. Cavity of uterus reduced to two and a half inches, plus, and the tumor appears only as a slight roughness on posterior wall.

Intra-mural Fibroids.—This form, while the most numerous, as already remarked, is also the form in which greatest distortion of the uterus occurs. It is peculiarly the subject of electrical treatment, being both most

amenable to it and least amenable to the more radical procedure of hysterectomy.

In beginning the electrical treatment of this form, intra-uterine cauterization should be given the preference over puncture, unless there is so great a distortion of the uterus as to make it impossible to carry a sound into the canal. Either tortuosity or stenosis is nearly always met with in these cases. When encountered, positive cauterization should be used for a time, with the electrode passed in as far as it will go; after a patulous canal has been attained, the negative cauterization may be resorted to for the more speedy action on the tumor itself. It is certainly desirable to act upon the whole of the cavity in cases of hypertrophied uteri with great tortuosity of the canal, and I am now engaged in an attempt to devise a flexible electrode that will traverse them with the same ease and freedom from injury as an elastic bougie. The following cases of this variety, which are still under treatment, may be related in detail as illustrative of the difficulties encountered and the progress attained after a comparatively short period of treatment :—

Case II. *Large, irregular, multiple fibroid filling lower half of abdominal cavity and extending two inches above umbilicus. After twelve applications the upper limit of the tumor is two and a half inches lower and the girth five inches less.*—M. W., a married woman, aged 38, referred by Dr. Bradford for electrical treatment at the Out-Patient Department of the Pennsylvania Hospital. After her last pregnancy, two years ago, she noticed a swelling to the right of the uterus, which has grown rapidly since and was still increasing in size at the time of beginning treatment (August 14, 1888). At this time

the growth consisted of a hard, irregular, multiple mass occupying the lower half of the abdominal cavity, a central nodule extending two inches above the umbilicus. The main portions of the tumor lay to the right of the median line. The os was patulous, but lay so high in the vault of an elongated vagina as to be reached by the finger with difficulty. Menstruation was regular but profuse, and attended with severe pain at the beginning and end of each period. Owing to pressure, locomotion was difficult, and there was much swelling of the legs and feet. The sound entered the cavity three inches with ease. At the first sitting negative intra-uterine cauterization was used, sixty-five milliampères, for four minutes.

August 16th. The application caused a considerable sanguineous discharge during first and second days, attended by some pain. Positive cauterization now used, one hundred and twenty-five milliampères, four minutes.

August 23d. The discharge continued five days, and was evidently a hastened menstrual flow. Positive cauterization, one hundred and forty milliampères, four minutes.

September 1st. No discharge followed last operation. Negative cauterization, seventy milliampères, four minutes.

September 6th. Slight sanguineous discharge since last application. There is a distinct lessening in size of the tumor, enabling the patient to wear dresses as much as four inches smaller in waist measure. The upper edge of the growth is now but one-half inch above the umbilicus. Negative cauterization, eighty-two milliampères, four minutes.

September 25th. Negative cauterization, one hundred and fifty milliampères, three minutes.

September 27th. Negative cauterization, one hundred and sixty milliampères, three minutes. This application gave considerable pain.

October 2d. The patient was flowing slightly, which was attributed by her to the treatment, but was really the menstrual flow, as subsequently appeared. Positive cauterization, one hundred and fifty milliampères, for three minutes, was employed, causing considerable pain in the menstrual period that immediately followed.

October 9th. Positive cauterization, eighty milliampères, two minutes.

October 13th. Negative cauterization, two hundred milliampères, two minutes. The upper edge of tumor is at least one inch lower than at last observation. It now shows deep sulci between its three lobes.

October 18th. Negative cauterization, one hundred milliampères, three minutes. Notwithstanding the use of clay, the patient was scarred slightly on the abdomen by this application.

November 13th. Considerable diminution in all dimensions of tumor since last application. The nodules are now quite movable on one another. Negative cauterization, one hundred and fifty milliampères, three minutes.

Still under treatment.

CASE III. *Large, smooth fibroid, wedged in the pelvis and extending to umbilicus. Rotation of tumor and emergence from pelvis as result of one application. Reduction in size under further treatment.*—Miss F. C., aged 40, was referred to the author for electrical treatment by her physician, Prof. Wm. Pepper. One and a half years ago she began to suffer from retention

of urine, which Dr. Pepper discovered to be due to the pressure of a uterine tumor. Has had several attacks of severe pain and symptoms said to be inflammatory, the last being particularly severe and confining her to bed from June 1st to August 15th of this year. Is liable to have pains in the tumor whenever she walks much, and is troubled with an irritable bladder and frequent micturition. The tumor is increasing decidedly, especially during the last six months. A fibroid mass filled the pelvis and extended up in the abdominal cavity as far as the umbilicus. It was smooth and firm, and ovoidal in shape.

The patient was admitted into the author's private hospital October 29, 1888. At Dr. Pepper's suggestion she was seen by Professor Goodell in consultation, who confirmed the diagnosis and succeeded in passing a sound five inches into the uterine cavity through the os, which was found high up under the pubes. The cavity of the uterus was in the anterior portions of the tumor, and the os scarcely recognizable. By request, Professor Goodell outlined the tumor on the abdominal surface by means of nitrate of silver.

November 2d. Electrode inserted five inches and negative cauterization, eighty milliampères, employed for five minutes. By reason of the deep situation of the active electrode there was scarcely any pain.

November 4th. The day after the application the patient felt some soreness in the region of the tumor, and was conscious of an increase in size. On examination this apparent increase was verified, and the cause was disclosed in the emergence of the mass from the pelvis. It had apparently rotated on its axis also,

as the cavity was now found to be in its posterior part, although the patient had been kept in bed twenty hours after the application. All symptoms of bladder pressure had disappeared. The vagina was now more roomy, and the os and cervix quite normal. Owing to additional tortuosity of the canal the electrode could be inserted but two and a half inches. Negative cauterization, one hundred milliampères, five minutes.

November 6th. Positive cauterization to enlarge canal, one hundred milliampères, five minutes.

November 8th. No better success in inserting electrode beyond two and a half inches. Positive cauterization, one hundred and twenty-five milliampères, five minutes.

November 10th. Inserted an elastic bougie five and a half inches, but electrode only two and a half. Positive cauterization, one hundred milliampères, five minutes.

November 12th. An elastic metallic electrode made of a spiral ribbon, insulated to within four inches of the extremity and tipped with a globule of shellac, was inserted five inches through an exceedingly tortuous canal. Negative cauterization, two hundred milliampères, five minutes.

November 14th. There is a decided shrinkage of the tumor in all its dimensions, and the patient is more comfortable than formerly. Full insertion of elastic electrode and negative cauterization, two hundred and fifty decreasing to two hundred and twenty-five milliampères, employed for five minutes. The higher strength gave pain.

The menstrual flow set in November 16th, lasting until the 21st; full and painless.

November 23d. Tumor diminished in size. The length of uterine cavity has increased to six and a half inches. Negative cauterization, two hundred and fifty milliampères, five minutes, with full insertion of electrode.

November 25th. Cavity six and a quarter inches. Negative cauterization, two hundred and fifty milliampères, six minutes.

November 27th. Skin on abdomen irritated, necessitating the clay being applied to back. Negative cauterization, one hundred and fifty milliampères, six minutes. Cavity six and a quarter inches.

November 29th. Cavity six inches. Negative cauterization, two hundred milliampères, four minutes, followed by one hundred and twenty-five for an additional four minutes. Dispersing electrode on abdomen.

December 1st. Cavity six inches. Negative cauterization, one hundred and forty milliampères, five minutes. Dispersing electrode on back and thighs.

Case still under treatment.

This case was treated with the apparatus at the bedside, and after each application the patient was invariably kept in bed from twenty to twenty-four hours, the applications not being made more frequently than every other day. An accurate record of the temperature showed slight rises on the evenings after each treatment.

It is at present impossible to say whether the decided lessening of bulk, which I have invariably found resulting in suitable cases, is due to the denutritive and atrophic action of the current on the fibroid tissue, or, as I at times suspect, to the contractile influence of the current on the muscular tissue of the uterus and on the

true myomatous tissue of the growth itself. That the latter explanation of the improvement thus far gained in Case III is inapplicable is made likely by the absence of the cramp-like pains that most cases complain of for a number of hours after each application. If we were sure that contractile effects played a principal part in the results obtained, there would be an advantage in increasing the current at each application to the limit of the patient's tolerance, but there would be no reason for continuing its duration a moment after this strength had been attained. The following case was treated mainly by applications of this nature, the current durations noted covering the time of increase also:—

CASE IV. *Intra-mural enlargement of uterus, with subperitoneal projection about the size of an orange. Growth filling pelvic cavity and extending upward to a level with anterior-superior spine of ilium. After eighteen applications the uterus is softer and quite movable, the projection no larger than a walnut and one inch lower.*—A. G., aged 24, married, a patient at Dr. Bradford's clinic at the Pennsylvania Hospital, by whom she was referred to the author for electrical treatment. She had one child eleven years old, and had not been pregnant since. Nine months before applying for treatment began to feel badly, and discovered a lump in the abdomen. She was troubled with a copious, yellow leucorrhœa and continuous pain in the left groin. Menstruation regular but scanty. Walking aggravated pain so much as to compel her to stop frequently.

Examination revealed an enlarged, hardened uterus, almost cartilaginous to the touch, filling up the greater part of the pelvic cavity, and with a subperitoneal pro-

jection on the left side about the size of a large orange. This projection extended up into the abdominal cavity to a level with the anterior-superior spinous process of the ilium. The sound entered three inches through a small os.

September 20, 1888. Negative cauterization, fifty milliampères, four minutes.

September 25th. Negative cauterization, seventy-five milliampères, four minutes. The tumor can now be freely handled, which could not have been done before on account of tenderness.

September 27th. Negative cauterization, eighty milliampères, four minutes.

September 29th. Negative cauterization, one hundred milliampères, four minutes.

October 2d. Complains of some tenderness. Treatment postponed.

October 4th. Cervix softer and tumor smaller. The tenderness has ceased. Negative cauterization, ninety milliampères, three minutes.

October 6th. Negative cauterization, one hundred and fifty milliampères, three minutes.

October 9th. Condition much improved symptomatically. Negative cauterization, one hundred and fifty milliampères, two minutes.

October 11th. Negative cauterization, one hundred and fifty milliampères, two minutes. Much reduction in size of projection noted.

October 13th. After last treatment, the cars being full, she was compelled to walk two miles home. Had much pain until middle of next day. Negative cauterization, one hundred milliampères, two minutes.

October 16th. Negative cauterization, one hundred and fifty milliampères, two minutes.

October 18th. Negative cauterization, one hundred and twenty-five milliampères, two minutes.

October 23d. Negative cauterization, one hundred and fifty milliampères, two minutes.

October 25th. Negative cauterization, one hundred and fifty milliampères, three minutes.

October 30th. The day after last application menstruation came on, accompanied by pain.

November 6th. Negative cauterization, sixty milliampères, two minutes. Uterus sensitive.

November 8th. Negative cauterization, sixty milliampères, three minutes.

November 10th. Canal narrowed. Positive cauterization, one hundred milliampères, three minutes.

November 13th. Negative cauterization, one hundred milliampères, three minutes.

November 27th. Patient's menstrual period was unusually long and free. The uterus is quite movable in the pelvis, and the cervix softer. The projection is not larger than a walnut, and can be moved separately from the body of the uterus; upper limit one inch lower. Still under treatment.

CASE V. *Intra-mural fibroid in posterior cul-de-sac, giving rise to retroflexion. Decided improvement after four cauterizations.*—Sarah R., colored, aged 42, applied for treatment at the Out-Patient Department, Pennsylvania Hospital, November 8, 1888. She had had seven children, but no miscarriages; youngest child seven years old. Her last confinement was severe, but made a good "getting up." One year ago had a prolapse of

the uterus, since which time she has been constantly ill. Menstruation regular, profuse, and attended with severe pain. Has a constant leucorrhœa, yellow in color and abundant at times.

Examination revealed a marked retroflexion. With finger in rectum a mass is discovered in posterior wall of uterus to the right of median line, about two inches in diameter, smooth and hard. Cavity, three and a half inches, plus, markedly retroflexed. On November 20th electrical treatment was begun by application of negative cauterization, one hundred milliampères, five minutes.

November 22d. Subjective symptoms improved. Negative cauterization, one hundred milliampères, two minutes.

November 27th. Negative cauterization, one hundred and twenty-five milliampères, three minutes.

December 4th. Uterus nearly straight. Negative cauterization, one hundred and twenty-five milliampères, three minutes.

December 8th. Has had a return of pain since the second day after last treatment. The retroflexion has returned. Rectal examination shows the tumor smaller and more nodulated.

Case still under treatment.

Subperitoneal Fibroids.—This variety is less amenable to intra-uterine applications than the intra-mural, on account of their remoteness from this method of direct treatment; yet in the second case related below considerable benefit was obtained without puncture.

Case VI. *Subperitoneal tumor in right cul-de-sac loosely attached to uterus. Three electro-punctures, resulting in one-third diminution of bulk and relief of*

symptoms.—Miss M. W., aged 46, who had been under the author's care for the sequelæ of rheumatism, was also troubled with a tumor in the pelvic cavity, lying to the right of the median line, and extending about an inch and a half above the pubic bone. Examination showed an ovoidal, hard mass lying to the right of the uterus, which it displaced, and measuring about five by three inches. The uterus was normal, and only moderately adherent to the tumor, which had existed a number of years. There were signs of pressure upon the veins of the legs by the tumor, and the bladder was exceedingly irritable.

February 11, 1888, the patient entered the author's private hospital, and on the 12th negative electro-puncture was performed, the needle being thrust through the vaginal wall into the most prominent part of the tumor. One hundred and fifty milliampères were used for two minutes, causing great pain. It was subsequently found that the insulating cover of the imperfect needle used was chipped, and that the vagina was cauterized. Beyond this there were no bad effects.

February 16th. Second electro-puncture. The insertion of a new needle was almost painless, but it was found to be too short, the current leaking to the vulva from the handle. Sixty milliampères were employed for one minute.

February 19th. Attempt at electro-puncture. The fibroid spear shown in the cut on page 69 was devised, and employed for the first time. Its insertion caused great pain, and, as there was some doubt felt as to where the point was, no current was given. There was no reaction.

February 23d. On examination, there is a cavity where there had been a protuberance in the tumor, and the whole mass is considerably reduced in size. Further treatment postponed until next intermenstrual period.

March 14th. Third electro-puncture. Insertion of spear caused considerable pain. It was made to penetrate about a half-inch into the tumor, somewhat above former puncture, and was connected to the negative cord. Two hundred milliampères were used for two minutes. There was a sanguineous discharge for eight hours. No rise of temperature.

October 15, 1888. The patient has been out of the city. Considers herself practically well, having no trouble now with her bladder. Examination shows the tumor fully one-third less than before treatment.

Case VII. *Three-lobed subperitoneal tumor springing from posterior wall of uterus and filling pelvis and lower third of abdominal cavity, accompanied by an offensive discharge. Exploring needle detected calcareous degeneration of an upper lobe. After twenty-two intra-uterine applications there is a distinct lessening in size and relief from the discharge and dysmenorrhœa.* —Sarah S., single, aged 41, was referred to the writer April 14, 1888, by Prof. Frank Woodbury, under whose care she had been for some years. A lump was first noticed in the abdomen about twelve years before, at which time she was greatly troubled with an excessive flow at the menstrual periods, accompanied by great pain. Of late the menstruation had become more normal in amount, but remained painful. Between periods had an exceedingly offensive leucorrhœal discharge, of a greenish-yellow color.

The pelvis and lower third of the abdomen were filled with an irregular, hard mass, extending nearly to the umbilicus, and separated by deep sulci into three lobes. The os was found with difficulty, but was so stenotic as to foil all attempts at inserting a sound or electrode.

April 15th. Unsuccessful attempt to insert a small Sims sound.

April 20th. Patient seen with Dr. Woodbury with a view to electro-puncture. The central lobe, which, owing to its thickness and irregular shape, presented a bulging protuberance in the median line, was so hard as to excite suspicions of calcareous degeneration. A steel needle was thrust into it through the abdominal walls, but could not be made to penetrate beyond a couple of lines. Electro-puncture abandoned.

April 25th. Filiform sound, insulated, passed into cavity of uterus two and a half inches with much difficulty. Negative cauterization (the sound being copper), sixty milliampères, five minutes.

April 27th. Sound made of No. 18 copper wire tipped with solder and insulated with rubber tubing was inserted more easily. Negative cauterization, eighty milliampères, five minutes.

May 4th. Os and cervix more normal. The offensive odor and character of the leucorrhœal discharge entirely changed. Negative cauterization, one hundred milliampères, five minutes.

May 11th. Ordinary platinum electrode inserted with difficulty. The uterus was found in front of the tumor very much anteflexed. Positive cauterization, one hundred milliampères, five minutes.

May 18th. Electrode inserted two and a half inches

with ease. Positive cauterization, eighty milliampères, five minutes.

May 25th. Negative cauterization, two hundred milliampères, three minutes.

At this time there was some diminution in the size of the tumor and the patient was free from any leucorrhœal discharge. As this patient was compelled to earn her living, the applications were made not oftener than once a week. Each treatment gave her some pain, owing to the superficial situation of the uterus, and on this account these and the subsequent applications varied in strength from one hundred to two hundred milliampères, generally being not more than one hundred and twenty-five. During June five applications were made; during July, three; August, five; September, two; and October, one. The second application in September was inadvertently close to a menstrual period, and was followed by the first dysmenorrhœal pain experienced since beginning the treatment. There was also at this time some fever.

November 16th. The present condition of the patient is as follows: General health much improved; no leucorrhœa; no dysmenorrhœa; cavity of uterus presents a normal curve; considerable shrinkage of the tumor, probably one-third. Instead of being three-lobed it now consists of three distinct tumors, movable upon one another. Patient still under treatment.

CHAPTER XII.

THE ELECTRICAL TREATMENT OF UTERINE HEMORRHAGE.

Menorrhagia.—The faradic current is the proper form of electricity to use in recent hemorrhages apparently due to relaxed fibre, rather than to an inflammatory condition of the mucous membrane. The indications for it are almost exactly those for ergot, as it presupposes an actual contractility of the uterine muscular fibre. Its advantages are: a quicker action than ergot, and the absence of the cramps that frequently attend the use of this drug. If the menorrhagic tendency, on the other hand, be accompanied by thickening and induration of the os and cervix, there is doubtless a cause for the extra flow in a morbid condition of the endometrium, which could be quickly removed by a few applications of the positive galvano-chemical cauterization.

The faradic current is applied to the interior of the uterus after the general method described elsewhere (page 75), the active pole being the intra-uterine electrode used in galvano-cauterization and the indifferent pole a large cotton pad on the abdomen or back. The negative pole of the rapid succession current is preferable, and I have obtained quicker responses from "swelling" currents—that is, currents increased and decreased every quarter of a minute, with the poles *in situ*. This last feature of the method is particularly effective in contracting unstriated muscular tissue.

The following cases exhibit the advantage of faradic over galvanic applications in recent hemorrhages:—

CASE VIII. *Acute menorrhagia with relaxed uterus. Failure of two positive cauterizations to control flow. Complete arrest after one intra-uterine, faradic application. Subsequent lessening of hyperplasia by negative cauterization. Cure.*—R. A., married, æt. 26, was seen in private practice, July 30, 1888. She had been perfectly well since last pregnancy, two years ago, until July 8th, when her ordinary menstrual flow came on as usual. This has continued ever since (twenty-two days). She loses much blood and has a great deal of pain. The patient was unable to assign a cause for her condition, which was possibly due to a miscarriage. The uterus measures three inches. Positive cauterization was used, eighty milliampères, for four minutes.

August 1st. Less pain, but only a trifling diminution of the bleeding. Positive cauterization, one hundred milliampères, for four minutes, was again used.

August 6th. The bleeding continues. A strong faradic current was now used for five minutes, with the negative pole intra-uterine.

August 8th. The bleeding ceased entirely on the afternoon of the first faradic application. The same current was again applied to reduce the size of the uterus.

August 10th. No bleeding. Pain about the back. Negative cauterization to reduce size, one hundred milliampères, three minutes.

August 12th. There has been but a slight discharge, due to the cauterization. Faradic current, five minutes.

The patient remained in excellent condition until her next menstruation, August 26th, which was so profuse that ergot was prescribed. This failed to control it

even with large doses, until, on the ninth day of the flow, the faradic current was again applied, followed by complete arrest in two hours. During the next intermenstrual period two positive cauterizations were made to reduce hyperplasia.

November 16th. Patient perfectly well. Menstrual periods last only four days.

CASE IX. *Acute menorrhagia following abortion. Bleeding not arrested by galvanic applications, but completely controlled by the faradic current. Cured.*—R. T., married, aged 37, was referred by Dr. Bradford for treatment at the Pennsylvania Hospital clinic. She was the mother of eight children, and had had two miscarriages. Since the birth of the last child, thirteen months ago, had not felt well. Ten days ago an abortion occurred of a two months' fœtus, and she has been bleeding since. Examination on October 4, 1888, showed os patulous, uterus subinvoluted, cavity three inches. Negative cauterization was used to destroy possible shreds, one hundred and twenty-five milliampères, three minutes.

October 11th. Negative cauterization, one hundred and fifty milliampères, two minutes.

October 16th. Still bleeding. Positive cauterization, eighty milliampères, two minutes.

October 18th. The bleeding not having been checked by the galvanic applications, a strong faradic current was used, negative intra-uterine, for two minutes.

October 20th. Bleeding much reduced. Faradic application.

October 23d. Bleeding ceased immediately after last operation. Uterus two and a half inches, plus.

October 25th. Discharged, cured.

Persistent Hemorrhages.—It is in the radical cure of persistent hemorrhages that Apostoli has led the way to most brilliant results, and in cases, too, that had been the opprobria of gynecologists. Others before him pointed out the hard slough at the positive pole of a destructive galvanic current, and noted also the readiness with which a retractile cicatrix followed the slough, but without his massive currents in association with the monopolar application the real value of this important remedy would have remained undiscovered.

The following cases were selected at the Pennsylvania Hospital out-patient clinic for a trial of the method :—

Case X. *Menorrhagia with marked hyperplasia of six years' duration. Complete cure after eight applications.*—E. B., a Russian, aged 45, the mother of ten children, the youngest of which was seven, applied for treatment April 4, 1888. She had been ill six years, suffering from irregular and profuse menstruation, occurring every two weeks, excessive in amount and accompanied by severe pain in the back. Between the menstruations there was a constant white leucorrhœa. Patient weak and much reduced.

Examination revealed the os patulous and cervix much congested. The sound entered three inches, plus. She was treated by various means until June 7th without material alteration of her condition. On this date she was referred to the author by Dr. Bradford, and negative cauterization (in the absence of a proper positive electrode), thirty-five milliampères, was used for seven minutes.

June 16th. The day after application felt pains in uterus resembling labor pains. At the present time is free from pain and feels stronger.

June 23d. Negative application, twenty milliampères, ten minutes. Remains about the same. On the 26th her period came on, lasting four days.

July 4th. The uterus is decidedly smaller. An appropriate electrode having been obtained, positive cauterization was used, eighty milliampères, five minutes. This application caused some immediate pain.

July 14th. Hemorrhage ceased the day after last application. Positive cauterization, seventy milliampères, three minutes.

July 19th. After last application had slight bleeding. Positive cauterization, eighty milliampères, four and a half minutes.

July 26th. Since last operation has had no hemorrhage, and her general condition is much improved. Ordered to report weekly for inspection.

Her next menstrual period appeared July 27th, just one month and a day from the last. The duration of this period was but five days. There was no leucorrhœa subsequent to it. The next two periods were exactly a month apart and normal in every respect. On September 28th the patient returned, complaining of pains in the back and limbs; there had been no discharge. Positive cauterization, two hundred milliampères, was applied four minutes. The subsequent events proved that this application was entirely too severe considering her improved condition. It was followed by pain and a brownish discharge, lasting six days.

October 13th. Feels much better. No bleeding and no pain. Says she wants the battery applied, as she feels better after it. Positive cauterization, fifty milliampères, two minutes. The uterus measures two and a half inches.

October 20th. Positive cauterization, fifty milliampères, three minutes.

November 13th. Her daughter states that the patient is feeling much better. The full four weeks between her periods continued without bleeding or discharge of any kind. The last menstrual period was unattended with the pain that had formerly troubled her. Discharged cured.

CASE XI. *Menorrhagia from retained secundines of five months' duration. Complete cure accomplished by the use of three positive cauterizations.*—Agnes Sharp, married, aged 22 years. No children; one abortion. Five months ago, while lifting a heavy tool-chest, became sick and aborted a six-weeks fœtus. Since then, menstruates every three weeks, losing a large quantity of blood for four days, accompanied by much pain. Has a constant leucorrhœal flow of large amount, white and tenacious, attended with pain in left ovarian region. Examination reveals uterus small, position normal, os small, vaginal surface healthy. Sound enters two and a half inches and reveals a tender fundus.

September 18, 1888. Positive cauterization, forty milliampères, four minutes.

September 20th. Positive cauterization, forty milliampères, four minutes. There has been no pain since the day after first treatment.

September 22d. Slight brownish discharge on the day after last application. To-day is feeling well. No treatment used.

September 25th. Felt well until yesterday, when she had some pain. Positive cauterization, forty milliampères, four minutes.

October 9th. Menstruation appeared October 1st, lasting four days, with lessened pain. Is now free from any discharge. To return next month.

November 1st. Menstruation appeared October 28th, lasting three days. Is entirely well at the present time.

CHAPTER XIII.

THE ELECTRICAL TREATMENT OF CHRONIC ENDOMETRITIS AND ENDOCERVICITIS.

Apostoli has recently called attention to the value of negative cauterization in the chronic catarrhal diseases of the endometrium.* Before the issue of his address upon the subject the author was convinced of the value of this application in those cases in which local treatment is imperative, and had been using it in doses of ten to thirty milliampères with most satisfactory results. This justly celebrated clinician was, however, led to the use of much stronger doses (eighty to two hundred and fifty milliampères) as the result of observations made upon this condition while treating fibroid tumors. Incited by his enthusiastic commendation, I have recently made some interesting experiments with the stronger currents upon cases seen with Dr. T. Hewson Bradford at the dispensary of the Pennsylvania Hospital; and while later experience still inclines me to look upon less than eighty milliampères with most favor in the majority of cases, I have had some exceedingly striking results from heavier currents in certain inveterate cervical disorders.

We have in these cases all shades of deviation from a normal mucous membrane, varying from a hyperæmic catarrh, with little or no change in the membrane, to a granular and eroded surface, with involvement of the Nabothian glands in the cervix, and infiltration of the

* "A New Treatment of Chronic Metritis," by Georges Apostoli.

fibrous tissue of the body and neck. In the milder forms, evidenced mainly by a leucorrhœal discharge from the cavity of the neck or body, the milder therapeutic application of ten, fifteen, or twenty milliampères, negative, directly to the diseased part will frequently check a persistent discharge after two or three treatments. The following case does not differ materially from a number of similar instances observed :—

Case XII. *Endometritis with moderate hypertrophy of six months' duration. Complete relief from discharge and subjective symptoms after three very mild negative intra-uterine cauterizations.*—Mrs. A. W., aged 32, consulted me March 28, 1888. Six months before she had caught cold when moving, and had suffered from leucorrhœa, headache, backache, and difficulty in walking ever since. At this time could go up-stairs only with great deliberation, owing to pain in stomach and back. On examination, the os was found to be patulous, with firm lips; uterus slightly enlarged; cavity, two and a half inches, plus. A negative galvanic application of ten milliampères was made to cavity for ten minutes. Two days after (March 30th) she returned with the report that the leucorrhœa had ceased after her first visit, and that her head was much better. On this day she was given twenty milliampères, for ten minutes.

April 5th. Negative application, ten milliampères, ten minutes; uterus softer. Headache has ceased.

April 8th. Negative application, ten milliampères, ten minutes.

April 11th. Reports herself entirely well. The headache, mental confusion, and backache have entirely disappeared, and she can now ascend and descend the stairs

with comfort. The os is less patulous, but the uterus remains larger than normal.

October 18th. Has remained free from leucorrhœa. Examination shows uterus enlarged, but, as she says she is well, nothing further is proposed.

In considering the apparent mildness of the applications which accomplished these marvelous results, we should not be led to think too lightly of the stimulating and alterative power of ten milliampères of current when concentrated on the small surface of electrode in contact with the cavity. The same amount of current concentrated to a similar surface contact on the exterior of the body would not only produce considerable pain, but a decided disturbance of the vascular supply of the surface also. This sensory disturbance is, of course, absent in the uterus, but the vascular irritation is doubtless more pronounced.

With distinctly hypertrophied and degenerated tissue surrounding the uterine cavity and outlet the problem is different. Here a destruction of the diseased layers must precede their regeneration, and a scientific agency that will accurately and aseptically dissolve the morbid endometrium, while at the same time stimulating a healthy reproduction, is a radical measure that commends itself even to the conservative mind. Such a surface-dissolving agency we possess in accurately measured and timed negative cauterization, which, strictly localized to the diseased part by recent methods, constitutes the most scientific and rational application that could possibly be conceived. In cauterizing the tissue, it adds no new elements of a foreign character to it to act subsequently as irritants, but simply breaks up the tissue itself into

its chemical components, and those left about the negative pole are quickly drained away or absorbed. The only disadvantage of the negative cauterizations is the sanguinolent discharge that flows from the dissolved edges. In cases with hemorrhagic tendencies this may occasionally give trouble.

This new electrical treatment of the conditions formerly regarded as "erosions" and "ulcerations" is, of course, a development of the older application of cup-shaped electrodes to the os, just as intra-uterine swabbing developed from the lunar caustic stick applied to the same part, but it is in an additional sense an advance on earlier methods by the adoption of accurate mensuration and control.

With its incalculable usefulness in the cure of morbid conditions of the endometrium, even including early malignant disease in this situation, we should not fail to remember a possible danger arising from overuse. A heavy cauterization, with one hundred to one hundred and fifty milliampères, lasting some minutes, is highly appropriate in the graver cases, especially those accompanied by hyperplasia, but is not to be thought of in cases of mere catarrh, when ten to fifty milliampères can be made to answer.

Not a little care should be bestowed also on the frequency of application in such cases, and in waiting for full results after a moderate number of applications have been made. Twice or thrice a week during one intermenstrual period will frequently cure an uncomplicated case.

Where the appearance of the cervix and the nature of the discharge indicate merely an endocervicitis, the

electrode should be insulated to within one and a quarter inches of the end, and only the bare portion inserted within the canal.

The following cases illustrate the treatment of these conditions with strong currents :—

Case XIII. *Chronic, purulent endometritis of five years' duration. Complete relief after eight negative cauterizations.*—E. L., married, aged 37, was seen first in private practice early in March, 1888. She had suffered from hemorrhage five years before, which had left her with a constant, abundant leucorrhœa of a greenish-white color and offensive odor. Menstruation was regular, abundant, and attended with considerable pain. Examination showed an eroded os with thickened lips. Uterus two and a half inches, plus, anteflexed, and slightly hypertrophied. At this visit, thirty milliampères, negative, was applied to the endometrium for five minutes. The odor from the discharge was so offensive as to necessitate opening the office windows.

March 12th. Discharge clearer and less abundant. Negative cauterization, eighty milliampères, four minutes.

March 16th. Electrode introduced with greater ease. Negative cauterization, one hundred milliampères, four minutes.

March 18th. Negative cauterization, one hundred milliampères, four minutes. Discharge clearer and much less offensive.

March 20th. Negative cauterization, eighty milliampères, three minutes.

Her menstrual period followed several days later, normal in amount and duration, and attended with less

pain than at any time for years. Several similar applications were made during the next intermenstrual period, when it was noticed that the discharge was much lessened in amount and entirely free from odor. The second intermenstrual period was free from discharge of any kind. Eight months later the patient was seen, and stated that she had remained entirely well since.

Case XIV. *Endometritis, with bilateral laceration of cervix, eroded os, and menorrhagia. After seven cauterizations the os and cervix present a normal appearance.*—S. M., a married woman, aged 42, referred by Dr. Bradford at the clinic of the Pennsylvania Hospital. She had had seven children and one miscarriage of a six months' fœtus, the latter occurring two years ago. The patient was in the House Department of the Hospital, and sent to the dispensary by the courtesy of Dr. Westcott, who suspected a malignant disease of the cervix. Menstruation very profuse, returning every three weeks. On examination, the os shows bilateral laceration, with the anterior lip so greatly enlarged and eroded that a malignant growth was thought probable. Uterus hypertrophied; sound enters three inches, plus, through a patulous os.

July 19, 1888. Negative cauterization, seventy milliampères, four minutes.

August 9th. Menstruation appeared on the 1st inst., lasting four days. Not so profuse as usual. Positive cauterization, ninety milliampères, five minutes.

August 14th. Positive cauterization, one hundred milliampères, four minutes.

August 16th. Positive cauterization, ninety milliampères, four minutes.

August 21st. Reports herself better than for a long time. Treatment deferred.

August 28th. Menstruation appeared on 22d inst., very slight, but lasting to present time.

September 6th. Her sickness lasted eight days. Positive cauterization, one hundred and fifty milliampères, five minutes.

September 8th. Positive cauterization, one hundred and fifty milliampères, five minutes.

September 13th. Positive cauterization, sixty milliampères, four minutes. The uterus has changed greatly since beginning the treatment. The os and cervix are firm and nearly normal to both sight and touch.

The ultimate result as regards the irregularity of menstruation is unknown in this case, as the patient returned home to a distant point.

CHAPTER XIV.

THE ELECTRICAL TREATMENT OF SUBINVOLUTION, UTERINE HYPERPLASIA, AND PELVIC INDURATIONS.

GALVANO-CHEMICAL cauterization would seem theoretically to be specially appropriate in the conditions mentioned in this chapter, combining, as it does, more or less destruction of a diseased endometrium with a tonic action on the uterine muscle and a stimulation of tissue change in the vicinity of the active pole. The evidence borne by the cases to be related, as well as by others mentioned elsewhere in this work, fully bears out this *à priori* reasoning. Whenever chronic enlargement existed, a shrinkage to the normal size is an invariable record in these notes, and adhesions as well as exudations are generally noted as disappearing.

In selecting the current to use with a case, however, the same conclusions apply here as in the treatment of hemorrhage. Recent cases, in which there is reason to believe there is but a congestion or engorgement rather than hyperplasia, should be treated with the faradic current in preference to the galvanic. In those cases of recent subinvolution accompanied by hemorrhage, indeed, the heavier galvanic currents do immediate harm, which is not warranted by any remote results of value. In chronic engorgements accompanied by cell proliferation and in pelvic indurations the galvanic current is indicated, and its use is exceedingly valuable. The single contra-indication is the existence of pus.

CASE XV. *Hyperplasia and menorrhagia of two*

years' duration. Improvement after four applications. —A. W., colored, aged 30, widow, no children, was referred by Dr. Bradford for electrical treatment at the Pennsylvania Hospital, July 14, 1888. She had had three miscarriages, the last one two years before, since which time she had been an invalid. Menstruation regular and for the last two months excessive, with slight pain. Leucorrhœa abundant, constant, and yellow in color. Suffers pain in left ovarian region and is easily fatigued in walking.

Examination showed uterus much enlarged and anteflexed, with thickened walls. Os small, cavity three inches. Various applications had been made without benefit. At this date negative cauterization, seventy-five milliampères, was employed for five minutes.

July 26th. Much better since last operation. Leucorrhœa controlled until two days ago, when she worked very hard. Negative cauterization, fifty milliampères, five minutes.

August 9th. Menstruation appeared two days after last application, lasting four days, painful, followed by leucorrhœa. Negative cauterization, ninety-five milliampères, five minutes.

August 16th. Says she is better. Negative cauterization, fifty milliampères, four minutes.

August 25th. Menstruation appeared on the 20th, lasting until to-day; *not painful*, but abundant. Treatment deferred.

August 28th. Reports improvement through a friend; no opportunity to measure cavity.

Case XVI. *Prolapsed ovary, surrounded by adhesions and indurations, of four years' duration. Uterus hyper-*

trophied, displaced laterally, and exquisitely sensitive. Much improvement after twelve applications.—Same clinic. E. C., aged 26, married, a native of Poland, was referred by Dr. Bradford, September 27, 1888. She had had three children and one miscarriage, the last pregnancy four years ago, since which time she had been in continuous pain and had grown progressively worse. For the last four weeks has been particularly bad, a sanguineous discharge having been constant. There is absolute dyspareunia, and any jar causes intense pain. Menstruation has been regular, normal in amount, attended with severe exacerbations after pain, followed by scanty, yellow leucorrhœa.

Examination showed uterus enlarged, somewhat anteflexed, and with fundus displaced to the right. Sound enters three inches with difficulty, producing excruciating pain. To the left of the fundus a mass is made out, consisting apparently of the ovary bound down by adhesions. The patient's physiognomy indicated intense suffering at every step. Treatment: positive cauterization, forty milliampères, three minutes.

October 2d. Positive cauterization, fifty-five milliampères, four minutes.

October 4th. Electrode inserted with ease, causing less pain. Negative cauterization, fifty-five milliampères, three minutes. The hemorrhage ceased after the second application. Feels much improved.

October 6th. Negative cauterization, seventy milliampères, decreasing to fifty on account of pain, four minutes. Patient says she is well, although the condition of uterus is only improved.

October 9th. Had much pain (cramps) after last

application. Parts are to-day less tender. Negative cauterization, thirty milliampères, five minutes.

October 11th. Much better of cramps. Negative cauterization, forty milliampères, three minutes. Electrode still turns to right.

October 13th. No pain whatever. Negative cauterization, fifty milliampères, three minutes.

October 20th. No pain. Negative cauterization, fifty milliampères, three minutes.

October 23d and 25th. Same treatment.

November 1st. Menstruation appeared on day of last treatment, excessive in amount first three days, but without pain.

November 6th. Positive cauterization, twenty-five milliampères, two minutes.

November 11th. Patient "has nothing whatever to complain of." Negative cauterization, sixty milliampères, three minutes.

November 13th. Uterus measures two and a half inches, with fundus somewhat to right. The mass to the left is scarcely discernible, and the ovary can be detected higher up. Still under treatment.

CASE XVII. *Hyperplasia, retroflexion, and dysmenorrhœa after amputation of the cervix. Complete physical and subjective restoration after four applications.* —Same clinic. J. A., single, aged 29, was referred for electrical treatment November 8, 1888. About three years since, while house-cleaning, suffered from overwork Subsequently came to the city with an elongated cervix, which was amputated by a gynecologist. There was no improvement; if anything, the symptoms have been worse since the operation. Menstruation regular,

scanty on the first day and abundant the second, when it ceases. Pain very severe both days. Has constant leucorrhœa, yellow and tenacious, but variable in amount.

Examination shows the os surrounded by a broad, truncated surface; uterus hypertrophied and retroflexed. Probe enters two and a half inches, plus. Cavity large enough to allow tip of sound to describe an arc of half an inch.

Treatment: Negative cauterization, forty milliampères, five minutes.

November 10th. Felt badly day after application, but is better to-day than for some time. The electrode inserted with more difficulty. Positive cauterization, sixty milliampères, four minutes.

November 13th. Positive cauterization, eighty milliampères, four minutes.

November 15th. Retroflexion entirely corrected. Uterus low down. Faradic intra-uterine application, swelling, two minutes.

November 17th. Uterus normal in both size and position. Faradic application to vagina.

CHAPTER XV.

THE ELECTRICAL TREATMENT OF PELVIC PAIN.

Pain, referred to some part of the pelvis or to some extra-pelvic portion of the body, may be said to be the principal symptom of the majority of diseases peculiar to women. It is for its relief that the patient seeks advice, and its abeyance or removal without the use of narcotics is usually a certain indication of restored health.

For clinical purposes such pain may be roughly classified as a symptom of (1) organic disease within the pelvis, such as either acute or chronic inflammations or engorgements, hyperplasias, displacements, foreign growths, or obstructive occlusion of the canal; (2) nervous dysmenorrhœa; (3) intermenstrual pelvic neuralgia; (4) hysteria.

PAIN ACCOMPANYING ORGANIC CHANGE.

Passing over acute inflammatory conditions, in which the use of electricity is usually contra-indicated, it is, of course, evident that a lasting relief from the pain attending the various organic diseases mentioned can only be attained when the organic conditions themselves are remedied. It is only recently that we have learned the inestimable value of strong electric currents in such a radical cure of some of these conditions, and their value cannot be better attested than by the results lately attained at the Out-Patient Department of the Pennsyl-

vania Hospital, where it has not been unusual for patients who had exhibited the physiognomy of pain for years to return smilingly to the clinic after but two or three applications, although the diseases themselves were but in the process of repair. As compared with purely neuralgic pains, the quick response of this variety is exceedingly striking.

While this relief is so quickly apparent in conditions of a chronic inflammatory nature, it should not be forgotten that acute inflammatory affections, particularly perimetritis, are an absolute contra-indication to the use of strong currents. My own views coincide fully with those of Apostoli on this point, although the absence of a really impressive experience in this direction may be due to an invariable postponement of the applications when acute tenderness is apparent.

Obstructive Dysmenorrhœa; Stenosis.—Where the rational history of an attack of dysmenorrhœa unites with the physical examination in revealing an undoubted obstruction to the flow of the menstrual fluid, relief can, of course, be gained only by enlarging the canal at the point of contraction. The efficiency of galvano-chemical cauterizations in effecting this purpose is becoming rapidly acknowledged, and there is no doubt whatever at the present time that in the positive cauterization we have the safest and most promising means of creating a permanently patulous canal, and a procedure that is destined to take the place of forcible dilatation in many cases, as this latter operation has displaced the lateral division of Sims, with its immediate dangers and subsequent ill effects.

That the negative cauterizations will also restore

contracted and distorted canals to their normal condition is proven by changes of this sort observed by the author while treating fibroid tumors. Cases in which the electrode was introduced with difficulty at first have never failed to show a progressive increase in calibre when strong currents were used, with either pole active. While this is true, it is probably best to use the positive pole in preference when a mere local enlargement is wished, as the positive eschar is said to be more retractile.

It is often difficult to say whether the apparently expulsive pains are really due to an obstruction in the canal or merely represent the explosive crises of a neurosis. The "pin-hole" external os is not apt to interfere in any way with the escape of the menstrual fluid, although it may cause sterility; obstructive stenosis is usually situated at the internal os. According to the late Dr. E. R. Peaslee, the average normal internal os of the *imparous* woman corresponds very nearly to a circle one-seventh of an inch in diameter, and that of a *parous* woman one-fifth of an inch. Beneath these diameters an internal os may be said to be obstructive.

The theory of the cause of most cases of dysmenorrhœa most favorably mentioned by Dr. W. Gill Wylie* is that of an hyperæsthesia of the lining membrane of the canal. Such a condition is most rationally treated by galvano-chemical cauterization, with moderate currents (ten to fifty milliampères). With this highly plausible theory to choose from on the one hand and stenosis on the other, the scientific user of electric currents is doubly justified in the use of an intra-cervical

* "American System of Gynecology," vol. i, p. 423.

application when external applications fail, merely confining himself to the lower dosage when in doubt of actual obstruction.

The details of this operation are given in Chapter V., the procedure there described being modified only in this particular: since the application is to be limited to the cervix, a corresponding length of metal only should be left bare at the extremity of the electrode, and after it has been made to enter the uterine cavity, the electrode should be slightly withdrawn until the bulbous extremity begins to re-engage the internal os from within. It is then held firmly in this position, with one or more of the operator's fingers in the vagina, until the completion of the operation, which should last at least five minutes.

There is no need to restrict the movements of the patient after this operation unless a current strength exceeding one hundred milliampères has been used. Antiseptic injections should be ordered, and the operation repeated once or twice a week during the three weeks available between the menstrual periods.

The following illustrative cases were referred to the author by Dr. Bradford, and treated at the Out-Patient Department of the Pennsylvania Hospital:—

Case XVIII. *Stenosis, with irregular and painful menstruation. Complete cure after six intra-uterine positive cauterizations.*—E. McA., aged 38, married; no children; never miscarried; puberty at fifteen years. Menstruates every two weeks, the flow being slight in amount, and attended with severe pain. Has a leucorrhœal discharge, yellow in color, and variable in amount and constancy. Examination at first visit (March 8,

1888) reveals a pin-hole os, but there is so much hyperæsthesia that a careful exploration cannot be made.

March 27th. Less hyperæsthesia. Small probe inserted through the external os, but not through the internal.

April 14th. Menstruated a few days ago. Sound introduced through the external os, but not through the internal. Electrical treatment advised.

July 14th. Electrode introduced with great difficulty. Positive cauterization, eighty milliampères, four minutes. The electrode became freer in the canal during the application. There was some pain during operation.

July 19th. The pains produced by the first operation lasted four days. Positive cauterization, thirty milliampères, five minutes.

July 26th. Claims that the mild application made at last visit caused pains, persisting three days. The os was found more patulous and slightly puckered. Simpson sound introduced to fundus.

August 2d. Positive cauterization, twenty-five milliampères, three minutes.

August 22d. After last operation felt much better. Menstruation appeared on the 9th inst., lasting five days and quite free. Had only slight pain in back. Positive cauterization, forty milliampères, four minutes.

August 30th. Much better of all subjective symptoms. Simpson sound inserted with ease. Positive cauterization, forty milliampères, four minutes.

September 15th. Positive cauterization, forty milliampères, four minutes.

October 9th. Menstruation appeared on September 22d, with less pain than usual.

November 13th. Menstruated October 26th, the flow being free, with very little pain. Considers herself entirely well. A Simpson sound enters two and a half inches with ease. Position normal.

CASE XIX. *Obstructive dysmenorrhœa of three years' duration. Great relief after one premenstrual positive cauterization. After four applications complete cure.*—Mary R., aged 32, married. Has had one child; no miscarriages. Since birth of child, three years ago, has had severe pain during menstruation, beginning two days before appearance of flow. The discharge is slight and pale for one day and more abundant subsequently, accompanied by large clots, to use her expression, "like hunks of meat." The periods appear sometimes twice a month, are excessive in amount, and painful throughout. Has moderate amount of leucorrhœa, yellow in color. Has intermenstrual pain in sacral region, but locomotion is not affected except immediately after menstrual period.

Examination revealed a stellate laceration of the cervix, movable uterus, and os covered with a profuse discharge. Sound enters three inches, plus.

September 18, 1888. Positive cauterization, seventy milliampères, four minutes. No particular pain.

September 20th. Her menses came on to-day, and she has less pain than at any time for three years. Absolutely no pain after sickness began.

September 27th. Os small, electrode inserted with difficulty. Positive cauterization, sixty-five milliampères, four minutes.

September 29th. Electrode inserted with ease. Positive cauterization, sixty milliampères, four minutes.

October 4th. Positive cauterization, sixty milliampères, four minutes.

October 9th. Announces herself as well. Directed to return after next menstrual period.

October 30th. Menstruation came on October 17th, lasting five days. The premonitory pains were entirely absent, and those during the flow much lighter. Uterus measures two and a half inches. Positive cauterization, seventy-five milliampères, two minutes.

November 1st. Patient is so well that further treatment is considered inadvisable.

PELVIC NEURALGIA.

Nervous Dysmenorrhœa.—That the majority of cases of dysmenorrhœa are purely neurotic may be inferred from the existence of a considerable proportion of cases without any appreciable stenosis of the uterine canal, and from the further fact that forcible dilatation frequently fails to relieve the painful crises. Even when this operation does produce a lessening of the pain, it by no means follows that the good results are due to greater patency of the uterine canal, for there is a possibility of the violence inflicted acting in a derivative manner on the affected nerve areas. But, casting a mere probability aside, and granting the positive value of an artificially gained patency in cases of undoubted stenosis, an overwhelming residuum of neurotics remain that tax our utmost endeavors to procure relief. What I wish to emphasize in this place is the view that such cases are largely identical with the peculiar condition known as *spinal irritation*, and that, like this condition, they may be made to disappear at times with magical celerity

under merely percutaneous galvanic applications from hypogastrium to spine (page 93) or to the spine alone (page 94). Such applications have the additional advantage of being properly adapted to young girls without an unnecessary shocking of wholesome modesty.

It is by no means claimed that this view of certain cases of dysmenorrhœa as a sort of spinal explosion is novel. Current literature continually points us in this direction, but the fault is that the rank and file abandon the mechanical generalizations more slowly than the leaders. The instrumentally deflowered maiden remains the rule rather than the exception, and it is high time that a halt was called in the indiscriminate abuse of forcible dilatation.

The galvanic dose in the percutaneous applications varies from ten to sixty milliampères *pro re nata*. Large, well-moistened electrodes, and the gradual manner, without shocks, should be used. The following cases may be taken as illustrations, the one first cited being the means of originally directing my attention to the value of the constant current to the spine in this complaint:—

Case XX (Orthopædic Hospital). *Nervous dysmenorrhœa. Complete relief under spinal galvanic applications.*—Miss S. F., æt. 30, received eight applications of the continuous current to the spine at the electrical clinic of the Orthopædic Hospital, during a period of two months, for a nervous affection. During this time she reported to me that her menstrual periods, which had given her pain for years, no longer troubled her, and that there was also an increased flow. This was before the days of the meter, but the current strength was probably

in the neighborhood of twenty milliampères, with the positive pole at the nape of the neck and the negative at the lumbar region.

Case XXI (Orthopædic Hospital). *Nervous dysmenorrhœa. Lessened pain under spinal galvanic applications.*—M. McB., æt. 20, was receiving tri-weekly applications of the galvanic current to the spinal region for pronounced spastic paralysis. After several months' treatment she volunteered the statement that she had less pain at her periods. Her weight also began to increase at this time, gaining three pounds in two months.

Case XXII (Private Note-book). *Dysmenorrhœa with scanty flow. Complete relief under spinal galvanic applications.*—Miss K. S., æt. 18. Began menstruating at sixteen. The flow had always been scanty and attended by pains across the back. Weight, ninety pounds. The constant current was applied to the back every other day, as described, the situation of the electrodes being so shifted as to include one region after another in a stabile action. The next period was painless and showed an increased flow. At the end of a month the weight had increased to ninety-five pounds. The treatment was discontinued, as succeeding periods were almost entirely free from pain.

Case XXIII (Private Note-book). *Dysmenorrhœa persisting after pregnancy. Improvement under spinal galvanic applications.*—Mrs. E. S., æt. 22, who had been under my care for ovarian pains, returned six months after the birth of her first child, suffering from an aggravation of a dysmenorrhœa that had troubled her throughout her menstrual life. The cervical canal was patulous and uterus normal. Applications of the constant current

to back were made twice a week for two months, with the result that her periods became quite comfortable. The pain did not entirely disappear for six months.

Case XXIV (Private Note-book). *Dysmenorrhœa with moderate anteflexion. Relief under spinal galvanic applications.*—Miss E. T., aged 21, a sister of the foregoing patient, began menstruating at the early age of eleven years, but never had pain until she had completed her twentieth year. Since her eighteenth year has had an uneasy sensation in the region of the left ovary. On examination, which was made because the patient thought she had strained herself in lifting, the uterus was found slightly anteflexed. Under constant current applications to the back her menstrual periods soon became free from pain. One year afterward there was a return of the pain, which was again dispelled by similar treatment.

In addition to these cases of pronounced dysmenorrhœa, I have a large number of instances recorded in my notes where young girls undergoing spinal applications of the galvanic current for different objects have volunteered the information that various amounts of menstrual pain have disappeared while under treatment. These cases generally improve in blood and weight also, but I have seen numerous instances where the lessening of the pain preceded any possible influence on the general health, being found in a period coming on but a few days after the beginning of the applications.

A systematic treatment of this sort should consist of thrice-weekly or daily applications, beginning at the termination of a period and lasting until the next flow has appeared. Two months of such treatment, combined with proper means for the regulation of the bowels, if

required, will usually be sufficient to make a permanent cure or improvement.

Intermenstrual Pelvic Neuralgia.—A persistent pain in the groin or iliac region, unassociated with other evidence of disease in the organs amenable to examination, may be safely ascribed to a neuralgic affection of the nervous supply of the pelvis. Much attention has recently been bestowed on the causal relation of normal and diseased ovaries to this pain, and a great mass of operative experience has accumulated to shed light upon the subject. As an observer of these cases after the performance of laparotomy, I am inclined to think that only those are bettered in which unequivocal evidence of organic disease existed prior to the operation, or in which a hysterical condition predominated, rendering the patient amenable to the profound mental impression of the procedure. It is not rational to expect to cure a more or less intense *neuralgic* pain in this region, even when it is apparently situated in the ovary itself, by a removal of this organ, for no analogous operation in any part of the body is attended by such results. It should be remembered that the ovarian nerves *terminate* in the ovary, and their removal is no more likely to cure the pain than is removal of the teeth of the lower jaw for neuralgia of the inferior dental nerve. If the nerve-trunks concerned in the pain could themselves be exsected, there would be a certain relief for some months or years, at least, as has been well proven by operations on the nerve-trunks of the face. A close examination of many of these cases of pelvic neuralgia will show that strictly neuralgic pain is rarely situated in the ovary. It is more often in the lower portion of the abdominal cavity, in

the pelvic bone, or in the anterior crural distribution on the thigh. Tenderness, on the other hand, is more likely to be limited to the ovary itself or to the nerves in its close proximity.

Unfortunately, the electrical treatment of the graver cases of pelvic neuralgia is no more likely to permanently cure them than is oöphorectomy. Such cases are closely analogous to the worst forms of *tic-douloureux*, and, like them, are likely to remain among the opprobria of medical science. While this is true of the more profound neuralgias of this region, as of others, it is also a fact that there are very few cases that are not more or less benefited by the systematic employment of the galvanic current through the skin or of vaginal faradic applications, some cases being undoubtedly cured. The method best adapted to the purely neuralgic type is the abdomino-dorsal application (p. 93), the negative pole being anterior.

There are also less profound neuralgic conditions (and these make up the bulk of the cases) in which the pain is strictly limited to either the ovary or its immediate neighborhood—cases of true ovaralgia, which, when associated with tenderness, are frequently mistaken for ovaritis. These cases, as a rule, are quickly relieved and cured by either abdomino-lumbar or vagino-abdominal applications of either current, accompanied by proper regulation of the bodily functions. It is possible that a subacute ovaritis does at times exist and yield to the treatment, and certainly none better could be thought of.

The possibility of a neuralgic condition in the pelvis being due to disease of the cord should never be lost sight of. Gynecologists are too prone to forget that

the pelvis is supplied with spinal nerves almost as richly as any other part of the body, and that it may be the seat of pains due to systemic diseases of the cord, localized meningitis, etc. I have observed evidences of one or another of these conditions in several cases referred to me after the removal of normal ovaries, the pain that the laparotomy was designed to cure still persisting. The failure of this operation to relieve the pain is, under such circumstances, inevitable. One of these cases was so striking as to deserve relation in detail:—

A young married lady from a Western city consulted me several weeks after one ovary had been removed by an eminent operator in New York city. Previous to the operation, it was said that a small tumor was diagnosed, but the section only revealed an enlarged ovary, which was removed. The condition which the operator sought to relieve, and which still persisted, was a stiffness of the lower limbs that almost amounted to an inability to walk, and a more or less continuous pain in the left ilium. She had been in this condition fifteen years, having been at first totally paralyzed in the lower limbs. During these years she had borne several healthy children, and the singular part of the case was that she walked well and was free from pain during each pregnancy, and to a much lesser extent during each menstrual flow. At this time her uterus was normal, with merely some relaxation of the vagina.

An examination of the lower limbs showed a decided spastic condition, with exaggerated pateller phenomenon, foot clonus, and contractures of the calf-muscles. The limbs were slightly atrophied, but responded well to both currents. It was clear from these facts, and the absence

of pressure symptoms as shown in the electrical reaction, that pelvic pressure or irritation was guiltless of a causative relation to the case. The symptoms pointed clearly to an organic change in the lateral columns and meninges of the lumbar enlargement of the cord.

The moral to be drawn from cases such as this is a forcible one. We should be exceedingly distrustful of hasty diagnoses when dealing with persistent pains in the pelvic regions, as in any other part of the body, and should not fail to employ the more simple neurological means of examination before arriving at conclusions.

The Pelvic Pain of Hysteria.—When a diagnosis of hysteria has been made in a case presenting symptoms of pelvic pain, the question arises: Shall the patient be treated locally as well as generally? The importance of a general treatment of the individual by seclusion, rest, electricity, and massage, or by the two latter agents, combined with exercise and mental diversion, cannot be underrated—especially when employed with the thoroughness only possible in a well-equipped private institution. I have, however, noticed that the association of a direct local treatment of the affected part of the body with this general treatment is frequently necessary, and that those so treated respond more quickly to the remedies. This is equally true of hysterical pelvic neuroses as of hysterical aphonia and hysterical paralysis, and one is led to suspect a direct action of the peripheral stimulus on the disordered volitional apparatus.

But local treatment in this class of cases does not demand the scientific exactness requisite in the successful treatment of organic conditions. Internal applications are usually unnecessary in pelvic cases, as in laryn-

geal cases of hysteria, equally successful results being obtained from external percutaneous applications of whichever current is most convenient. Here, as always in this protean disease, it is the operator rather than the method that determines the result. While local applications to the apparent seat of disease are generally best, a careful discrimination should be used in omitting this part of the treatment in most cases occurring in erethistic subjects. Any kind of local treatment is at times harmful, as tending to fix and deepen the patient's attention upon an organ or function already affected by undue introspection.

CHAPTER XVI.

THE ELECTRICAL TREATMENT OF UTERINE DISPLACEMENTS.

Flexions.—The *rationale* of the recently recommended method of correcting flexions with the faradic current is based upon the view that the uterus is a mus-

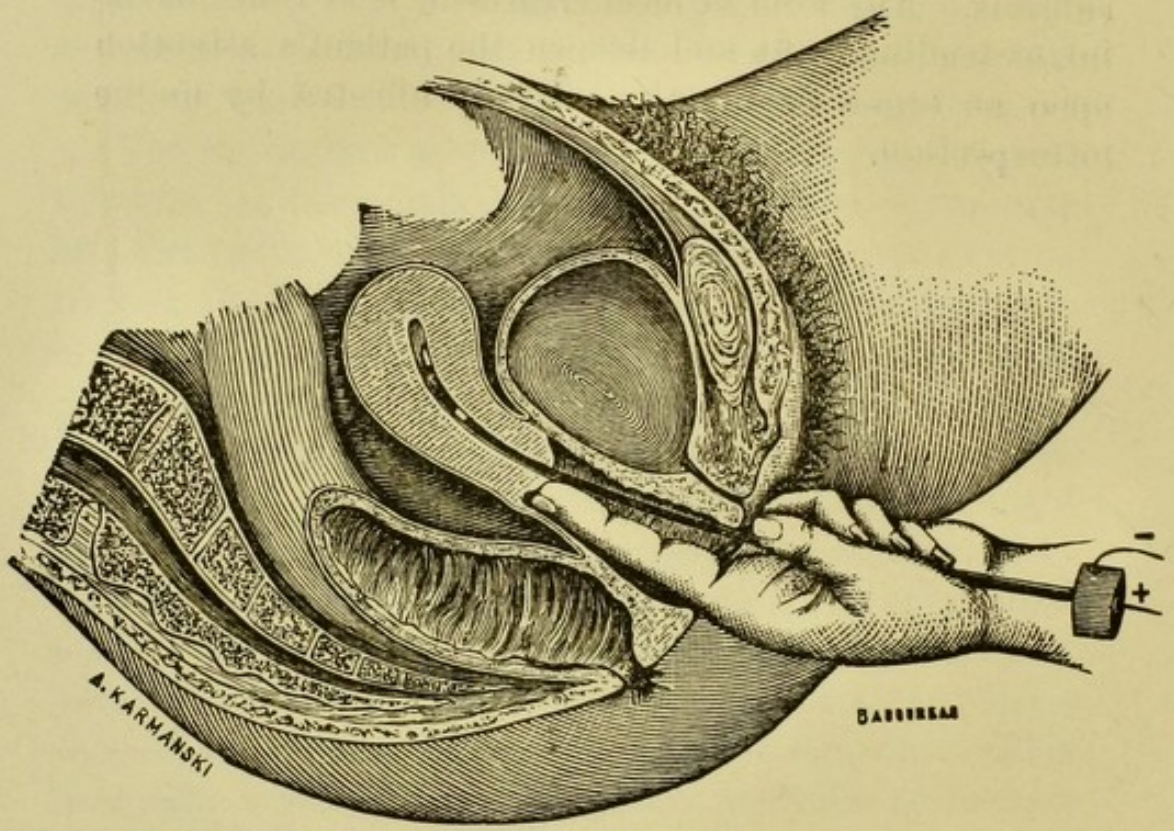

FIG. 33.—APOSTOLI'S BIPOLAR INTRA-UTERINE ELECTRODE IN POSITION.

cular tube which may be atrophied or relaxed on one side, permitting a bending at the point thus weakened. The rapidly successive faradic current is applied directly to the uterine muscle with a view to stimulating the entire organ into a contraction that, for the time at

least, will correct the deformity and lessen any engorgement accompanying it. This is done either after the monopolar method, the negative pole within the uterus and the positive as an abdominal dispersing pole, or the bipolar method of Apostoli is employed (Fig. 33). As these cases usually present difficulties in the insertion of the smallest sound, the usefulness of a more or less clumsy bipolar electrode is frequently limited. The necessity for flexibility is apparent, and in the bending these instruments are liable to crack, admitting moisture that tends to short-circuit the current. My experience with either form of faradic application is at present too limited to be of value.

Of the usefulness of monopolar galvanic applications (positive cauterizations), something more definite may be said. The superior efficiency of this current in weakened external muscles would seem to indicate an equally happy effect here, and in several recent cases most striking results have attended its use in the author's hands. The following case may be related as an illustration :—

Case XXV. *Sharp anteflexion produced by lifting. Failure of reposition. Complete and permanent correction as result of four positive cauterizations.*— Annie K., æt. 21, single, applied for treatment at the gynecological clinic of the Pennsylvania Hospital, Out-Patient Department, October 30, 1888. For two months there had been a constant leucorrhœa, tenacious, yellow, and voluminous. One week ago, while lifting a wash-boiler, felt a severe pain in the back accompanied by nausea. Since then has been prostrated, with pain in the back and painful locomotion. Menstruation has been

regular, small in amount, and attended with severe pain during the first two days. Examination showed uterus sharply anteflexed (Fig. 34). Cavity measured two and a half inches, plus.

On this date Dr. Bradford inserted the sound and brought the fundus to a normal position. Injections of hot water and potassium chlorate prescribed.

November 1st. Uterus in slightly better position. Fundus again replaced.

November 6th. Uterus almost in original abnormal

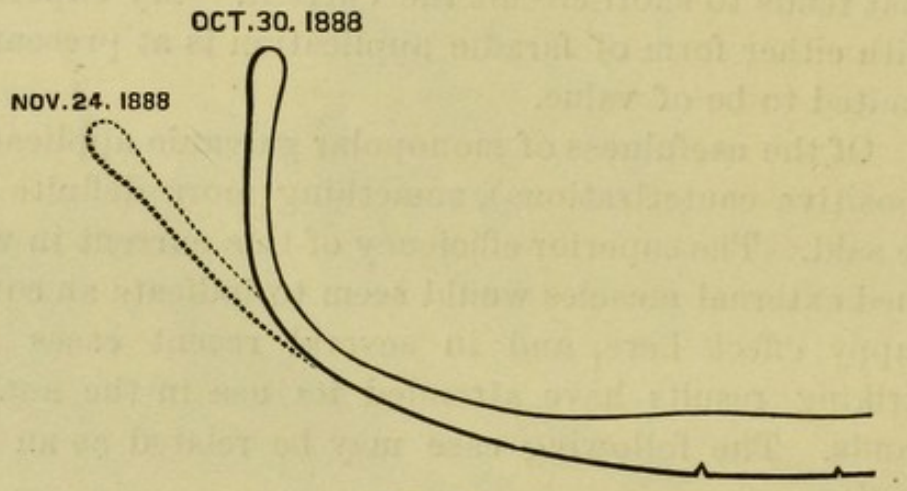

FIG. 34.

condition, and subjective symptoms not relieved. Positive cauterization, eighty milliampères, two minutes. The electrode was bent to the proper curve (see curve of October 30th, Fig. 34) and inserted with some difficulty.

November 8th. Slightly better position. Positive cauterization, fifty-five milliampères, three minutes.

November 13th. Had a sanguineous discharge lasting three days. Straighter sound enters with ease. Positive cauterization, fifty milliampères, three minutes.

November 20th. Felt badly for two days after application; on the fourth day felt perfectly well, and has done so since. Positive cauterization, thirty-five milliampères, three minutes.

November 22d. Cavity much straighter. Positive cauterization, forty milliampères, two minutes. Subjective symptoms have disappeared.

November 24th. Electrode of normal curve inserted with ease (see cut, Fig. 34). Positive cauterization, twenty milliampères, two minutes.

November 27th. Patient remains well. Uterus in normal position.

December 8th. Position remains normal. Menstruation appeared on 4th instant, lasting three days, without pain.

The exact method by which these applications achieved this result is uncertain. It may have been by simply stimulating the muscular tissue to a post-operative tetany, but the steadiness and quickness of the return to normal position makes it likely that a cauterization of projecting parts of the canal contributed to the result.

Versions and Prolapse.—There is likely to be a considerable future to the electrical treatment of displacements due to relaxation of the muscular bodies that maintain the uterus in a normal position, but at present the subject is somewhat theoretical. Dr. A. L. Smith (*American Journal of Obstetrics*, June, 1888), in an elaborate review of the subject, lays particular stress on the existence of muscular fibres in the so-called ligaments of the uterus, as well as on the importance of tone in the vaginal muscular tube in the maintenance of a

normal position. From this point of view the condition present in displacements is a muscular insufficiency, varying in degree from simple weakness of the muscles to their complete disappearance from atrophic degeneration. If this be so, it is obvious that mechanical support alone can do no more for their relief than can orthopædic apparatus alone in the treatment of analogous external muscular dystrophies. The rational treatment is a combination of artificial support and gymnastic exercises. As to which feature of the treatment should preponderate is not difficult to decide. The experience of orthopædists is, that a rigid support, while often most convenient and frequently curative, is yet liable to cause increased weakness of the muscles that are not in use. The gymnastic exercises (inclusive of faradic stimulation), on the other hand, are less liable to abuse, although not removed from the possibility of producing local exhaustion from too great an excitation.

The application of these rules to the treatment of muscular weakness of the vagina is very easily done. If the weakness has stopped short of total disappearance of the muscular fibres, a more or less forcible contraction can be obtained by either the faradic or galvanic current. In the galvanic application the negative pole should be applied within the vagina and the positive on the abdomen, the monopolar vaginal electrode of large surface shown at page 89 being used, with unbroken currents of ten to thirty milliampères. When currents greater than twenty milliampères are used the active electrode should be kept in motion (labile) for the double purpose of avoiding cauterization and promoting contraction.

The negative pole of the faradic current may be used in a similar way; but I prefer with this current to use the bipolar vaginal electrode, shown in the cut (Fig. 35). This electrode should not be used for galvanic applications unless the metallic surface is incorrodible. Astringent tampons are probably the best form of artificial support to use in conjunction with these applications.

If there be hyperplasia of the uterus at the same time, its reduction by negative cauterization is a necessary preliminary to muscular treatment; one or two applications of from fifty to one hundred milliampères will usually be sufficient, but the application of this amount of current to a displaced uterus should be invariably

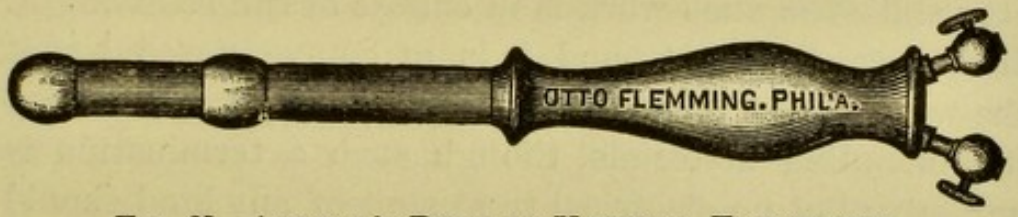

FIG. 35.—AUTHOR'S BIPOLAR VAGINAL ELECTRODE.

followed by rest in the recumbent position for from six to twenty-four hours.

A concentration of current upon the anterior or posterior ligaments in cases of simple version is, of course, more difficult than the vaginal applications. It has been advised that the active electrode be placed in the bladder in retroversion, and in the rectum in anteversion. Intra-uterine application to all the parts at the same time will frequently suffice, particularly if adhesions be present, as a faradic current of great strength may be painlessly applied in this situation.

CHAPTER XVII.

THE ELECTRICAL TREATMENT OF EXTRA-UTERINE PREGNANCY.

RIGHTLY considered, there is no conflict whatever between laparotomy and electricity in the treatment of this accident. The consensus of intelligent opinion in America inclines at the present time somewhat as follows:—

If rupture has occurred, an immediate laparotomy should be performed and the mass extracted, if an operator skilled in such work is in charge or can be obtained. If no operator is at hand, it is, of course, possible that the woman may survive the rupture without removal of the offending materials, though such a termination is unlikely: but no electrical treatment of any kind should be used at this time. After all acute irritation has subsided, negative vaginal or uterine applications of the galvanic current (ten to twenty milliampères) should be used to promote absorption of the resulting tumor. An immediate application of either current to the ruptured cyst is highly improper and likely to aggravate the mischief.

If, on the other hand, an extra-uterine pregnancy be diagnosed before rupture and prior to the fourth month, an electrical treatment is highly proper and will, most likely, result in a complete cure. But the object for which electricity is thus used should be clearly understood. To kill the fœtus is the only purpose at first. In accomplishing this, the faradic current is decidedly

most appropriate, as shock and arrest of circulation are, doubtless, the modes of death, and these require current interruption. Interrupted galvanic currents are equally effective, but are unnecessarily painful to the woman.

In applying the current the sac is included between a large moist electrode placed on the skin above it and a bulb-electrode placed either in the vagina or rectum. The internal electrode should be negative, and is merely pressed against the vaginal or rectal wall in the direction of the sac. There is no occasion whatever for electro-puncture, as a fatal concentration of the faradic current is usually passed through the intervening tissues with ease. The strength of the current should not be great, as there is some risk of rupturing the cyst if strong currents are used, causing violent contractions of the abdominal walls. This latter action is lessened if the abdominal electrode is large. This procedure may be repeated daily for several days to make sure of the results.

After the vitality of the ovum has been arrested two courses are open to the surgeon: either laparotomy for the removal of the dead mass, which is now more safely performed, or a mere promotion of the efforts of nature in removing the mass by absorption. The latter course will commend itself to many, since a number of instances are now on record where an electrically killed ovum has either partially or completely disappeared from the abdominal cavity. Brothers* has collected a list of forty-three cases treated by electricity. In two of these electro-puncture was used; in twenty-one, the

* *American Journal of Obstetrics*, May, 1888, p. 474.

faradic current; in sixteen, the galvanic; in two, both currents; in one, the franklinic; and in one the exact current used was not stated.

Of these cases, two terminated fatally. One of these, a case of Braxton Hicks, died from an aspirating puncture made five weeks after the electricity had been used. The other death was apparently attributable to the electrical application, an artery in the sac bursting during the procedure.

In all the cases mentioned in this list, except two, the fœtus was killed by the current, and, with the other exceptions mentioned, the tumor is variously stated as shrinking or disappearing. Of the two excepted cases the fœtus was expelled from the tube into the uterus in one, where it continued to grow until delivered at term (Garrigues). In the other the method was abandoned after two trials.

After the fourth month of gestation the considerable development of the cartilaginous and bony parts of the fœtus renders absorption unlikely; hence laparotomy is more strongly indicated. Whether the vitality should be previously destroyed is a question that must properly be left to the judgment of the surgeon.

CHAPTER XVIII.

THE ELECTRICAL TREATMENT OF MISCELLANEOUS CONDITIONS.

Amenorrhœa.—My experience justifies a most emphatic indorsement of the claims put forward by Engelmann respecting the value of electricity in cases of completely suppressed or scanty menstruation. In the negative pole of the galvanic current we have an agent that is all-powerful in the promotion of a normal flow, and this form of direct treatment is to be particularly recommended whenever the case is one of merely scanty flow and admits of local treatment. That a careful diagnosis should be made to exclude pregnancy, goes, of course, without saying. In cases I, IV, XVII, XVIII, and XXV, reported in detail in these pages, a careful reading of the notes will show that a scanty or absent menstruation existed in each before treatment. In each case an increased flow resulted from negative cauterization. Case I, in addition to the small fibroid that existed, was an instance of complete suppression that had lasted eleven months. As a result of two negative intra-uterine applications a normal flow appeared, which has recurred monthly since. Engelmann reports two cases in which intra-uterine faradic applications were followed by equally good results.

But our resources for the treatment of amenorrhœa are also markedly increased by electricity in those cases in which it is unnecessary to make a local examination.

As in the treatment of dysmenorrhœa in young girls, we should first make a fair trial of percutaneous applications, and the chances of immediate success are even greater in suppression than in the painful affection. Spinal or dorso-abdominal applications of the galvanic current (pages 93, 94), carried to the limit of some pain (thirty to sixty milliampères), are usually sufficient. The franklinic current is said to have been also used for this purpose.

It may be accepted as a well-proven fact that a galvanic current passed from the hypogastrium to the lumbar region will increase any case of merely deficient menstruation, if employed during the flow. I have unintentionally verified this several times.

The following case cannot be surpassed as an illustration of quick results from the percutaneous applications of electricity:—

Case XXVI. *Suppressed menstruation of six months' duration. Flow established as the result of one percutaneous application.*—Mary F., aged 22, a respectable girl of Irish birth, the picture of health, had not menstruated since arriving in this country, six months ago. From the age of fifteen until she went aboard ship she had been regular. At the time of application for treatment, October 24, 1888, she had been suffering from dullness of the head, confusion of mind, and low spirits, and there was a feeling of weight in the pelvis. Appetite and bowels normal. No local examination made.

Spinal galvanic application of sixty milliampères was made for five minutes.

October 25th. Six hours after application, her menstrual flow came on, slight in amount and continuing

to-day. Head symptoms much relieved. Application of yesterday repeated.

October 26th. Menstruation in full flow to-day. Yesterday's application was followed by an immediate increase in flow.

Subsequent inquiry showed that a normal period of four days' duration followed.

Hydrosalpinx.—Apostoli* reports a case of hydrosalpinx treated by negative electro-puncture, of which the following is a summary: Patient 25 years old, married, general health good. Three full natural pregnancies; abortion at two months, on September 21, 1887, twenty days after a violent fall on the back, followed by incessant pain, excessive menorrhagia, general derangement of health, with sharp pains in the right iliac fossa; no antiseptic precautions. Came to clinic October 27, 1887, with indications of a threatening pelvic peritonitis. Swelling of the whole upper part of the vagina, with fluctuation on the right side.

On October 27th first galvano-puncture, negative, on the left side, vaginal; one hundred milliampères, five minutes. Remained in bed for forty-eight hours, with some relief on the following days.

November 8th. Second galvano-puncture, negative, vaginal, in the *cul-de-sac*, right side, one centimeter; one hundred and forty milliampères, five minutes. Two days later spontaneous opening of a cyst and discharge of fluid, without either pus or blood. Cessation of all pain and diminution of swelling.

November 18th. First appearance of menstruation since abortion; flow continued freely for three days;

* *Brit. Med. Jour.*, May 12, 1888, p. 998.

pain on left side only. Since then local condition has become natural, and all symptoms have disappeared.

The periods of December and January were natural; health good, and allowing of regular work at the sewing-machine.

Cases of this sort would seem to be best adapted to puncture with Gehrung's trocar and canula.

CHAPTER XIX.

THE CONTRA-INDICATIONS AND LIMITATIONS TO THE USE OF STRONG CURRENTS.

The voice of authority cannot be too early raised against the indiscriminate and careless employment of the powerful agency treated of in these pages. It is in the nature of things that a power for good, when unharnessed, becomes an engine of evil in proportion to its potentiality; hence, an operator who cannot bring a calm and unbiased judgment, as well as electrical knowledge and skill, to this work had best leave it alone.

Without adding to what has already been said on the question of times and conditions constituting contra-indications to intra-uterine applications, or discussing at greater length the important questions of dosage and frequency of application, a few words may be devoted to the exact knowledge so far gained as to the failure of electrical treatment in certain definite conditions.

Papilloma of Broad Ligament.—The following case, the diagnosis of which was at first obscure, but which was subsequently determined by a laparotomy to be a papillomatous cyst of the broad ligament, presented such unmistakable symptoms of aggravation by strong currents as to deserve relation in detail:—

Case XXVII.—*Papillomatous cyst of broad ligament. Increase of cyst and aggravation of symptoms after two heavy negative cauterizations.*—H. B., aged 29, married, applied for treatment at the out-patient clinic

of the Pennsylvania Hospital, September 25, 1888. Though married four years, she had never been pregnant. Puberty at seventeen. Illness dated six months back. Menstruation regular, normal in amount, and attended with severe pain. Leucorrhœa profuse, variable, and white. Walking causes pain.

Examination showed uterus surrounded by a boggy mass, hypertrophied, and tender. Cavity measures three inches, plus. An aperient pill was prescribed and negative cauterization, sixty milliampères, employed for four minutes.

October 11th. About the same. Three days after application the menstrual flow appeared. Negative cauterization, one hundred and fifty milliampères, two minutes.

October 13th. There is an irregular mass to the right of uterus, extending nearly to umbilicus. On thorough examination, decided fluctuation is detected. The parts are more tender. Electricity discontinued.

Subsequent investigation showed no rise of temperature or permanent aggravation of the trouble as the result of this treatment, but it is readily seen that such would have been the case had it been continued longer.

Ovarian Tumors.—A careful review of the published cases in which attempts have been made to cure cystic tumors of the ovaries by electro-puncture or percutaneous galvanic currents is almost conclusive that such attempts have been, so far, either futile or harmful. It is true, however, that the reports of these cases show unmistakably that the operators rarely knew anything of electro-physics, and operated generally in so bungling a manner, or with such slight currents, as to make the

responsibility for failure uncertain. Among the most enthusiastic advocates of electro-puncture, Dr. Semeleder, of Mexico, for instance, directs the use of "a current which can be borne without pain when both poles are applied to the tongue," which would probably mean two or three milliampères at most. This gentleman made his first report of cases cured by electrolysis in 1875. One year subsequently his presence in New York City enabled him to demonstrate his methods upon a series of cases placed at his disposal by the physicians of that city; the result has been portrayed by Mundé* in a most interesting review of the whole subject, and was such that experiment in this direction has remained dormant since, two cases at least ending fatally. In the article alluded to, which should be carefully read by intending experimenters in this field, Dr. Mundé has collected a series of fifty-one reported cases, which he classifies as follows:—

Class A.	Cure,	25	cases.
" B.	Permanent improvement,	3	"
" C.	Temporary "	4	"
" D.	Negative result,	6	"
" E.	a. Peritonitis, recovery,	4	"
	b. Peritonitis, death,	9	"

The momentous facts of this table are, that in 25.4 per cent. of the cases decidedly injurious effects were directly produced by the punctures, in consequence of which 17.6 per cent. of the whole number died. There is no room to doubt the inexpediency of this treatment in the face of such mortality, as compared with ovariotomy

* "Gynecological Transactions" for 1877, p. 348.

in the hands of some of the remarkably expert operators of the present day.

Aside from this reason to question its expediency, the operation of electro-puncture into a cystic tumor with a solid needle has no rational basis in physics. Two principal modes of action are claimed for it. In one, the cure results from a direct destruction of the liquid contents by electrolysis. To do this a heavy current would be required, and the resulting gases, rising by gravity to the highest portion of the cavity, would speedily burst the cyst by distention. The magnitude of such an operation to get rid of the liquid is in striking contrast to that of a simple tapping, which would leave no gases behind.

Others speak of the alterative action of the current upon the cyst-walls inducing a stoppage of secretion and an absorption of the fluid present. This appears exceedingly plausible *if the liquid be removed first*, but to expect such action while the cyst is yet full is irrational. Under the latter circumstances there would be a current-spread to all portions of the cyst-walls, and if the cavity be at all large there is so great a diffusion of current as to render its local action inoperative.

APPENDIX.

Directions for Making the Battery Fluid.—The fluid to be used in portable galvanic batteries and in the cells of portable faradic batteries is made according to the following directions, the formula first given being the preferable one. The second formula may be used in case the bichromate of soda is not available.

No. 1. Dissolve four (4) ounces of bichromate of soda in one (1) quart of hot water in an earthenware or glazed-iron vessel. When cooled off, add to it four (4) fluidounces of commercial sulphuric acid and one-half ($\frac{1}{2}$) ounce of bisulphate of mercury. Mix well. The addition of bisulphate of mercury, while it may be dispensed with, tends toward improving the condition of the zinc plates.

No. 2. Dissolve one and a half ($1\frac{1}{2}$) ounces of bichromate of potassium in twenty-four (24) fluidounces of hot water in an earthenware vessel and add to it three-fourths ($\frac{3}{4}$) ounce of saltpetre. Allow it to cool to the temperature of the air, and then add three (3) fluidounces of commercial sulphuric acid. When cold again, add a solution of one-half ($\frac{1}{2}$) ounce of bisulphate of mercury in three (3) fluidounces of cold water, with a little sulphuric acid added to it. This quantum will yield one quart of the battery fluid and should not be used until cold.

This fluid should be changed if the battery shows signs of weakening. Its exhaustion is shown in the appearance of a bottle-green color at the edges, or when seen in a thin layer.

Directions for Amalgamating the Zincs.—All zinc plates used in acid solutions should continuously present a bright, silvery color, due to an abundance of mercury on their surface. Whenever they become blackened or rusty this coating should be renewed by dipping

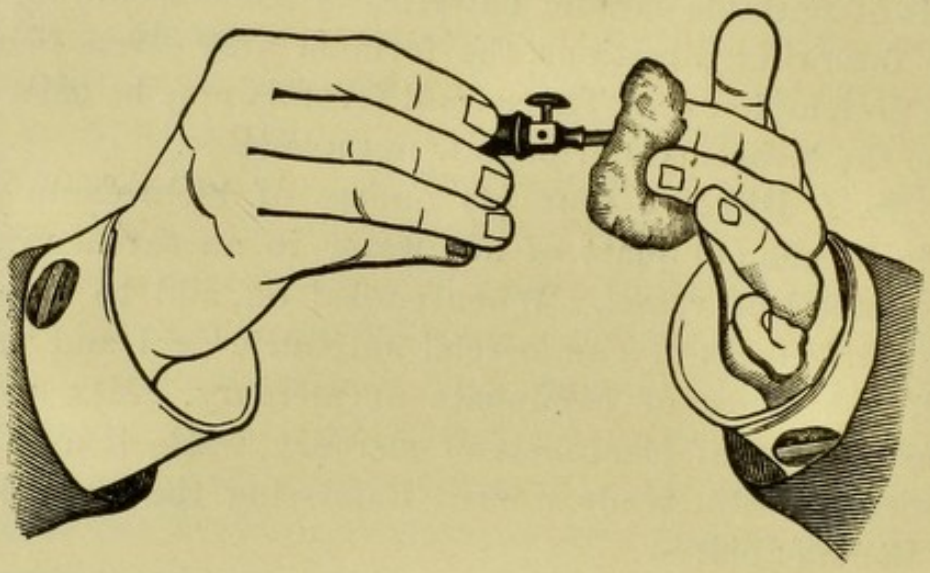

FIG. 36.—COVERING AN ELECTRODE DISK WITH ABSORBENT COTTON (FIRST STAGE).

them alternately in fresh battery fluid and mercury. If a good quantity can be made to adhere to any immersed portion of the plate it will diffuse itself subsequently over the whole surface under the action of the fluid.

Directions for Covering Electrode Disks with Absorbent Cotton.—The ordinary disk electrode used in muscular stimulation is generally sent to physicians with a covering of sponge. This is an excellent means of retaining the needed moisture between the metal and

the skin if the battery is to be used with a single case, but in a physician's practice such coverings soon become too filthy to be tolerated, and should be replaced by absorbent cotton, freshly applied for each case. This may be done in a few moments as follows: Take a thick pinch of absorbent cotton of even texture, somewhat larger than the disk to be covered, and, holding it on the fingers of the left hand (Fig. 36), place the disk on it, carry the edges up to the shank, and fix them in that position by a

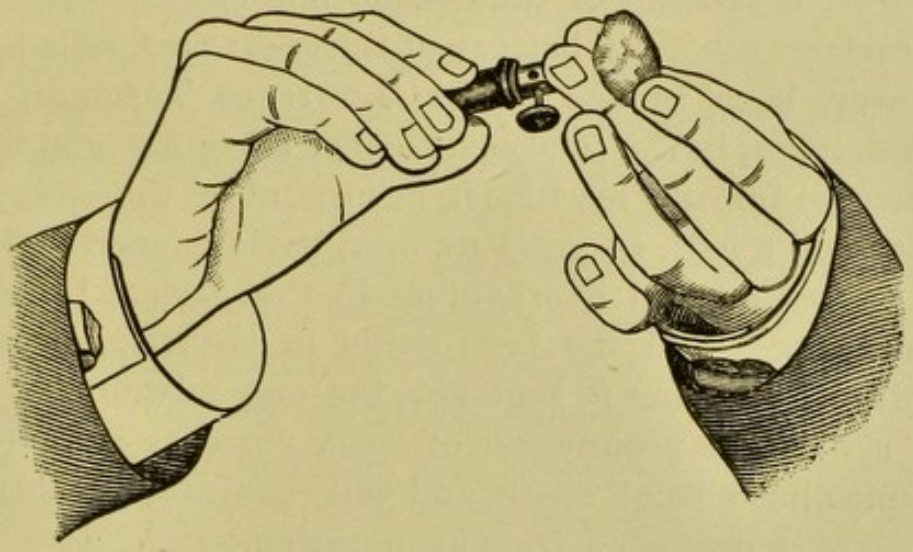

FIG. 37.—COVERING AN ELECTRODE DISK WITH ABSORBENT COTTON (SECOND STAGE).

twisting motion of the electrode (Fig. 37). An additional twist after it is wet serves to fix it more firmly. New electrodes are not as good as old ones for this manœuvre, but the new ones may be made to take the cotton by roughening or milling their edges. The cotton should be kept abundantly wet with warm water when in use.

Directions for Making a Cheap Galvanic Battery for the Production of Weak Currents.—At the meeting of the Philadelphia County Medical Society for April 7, 1887,

the author exhibited one cell of a permanent galvanic battery which had been constructed at a total cost for materials of but twelve cents per cell, exclusive of the labor of putting them together. Many inquiries relative to this cell have since been received from physicians throughout the country, and in giving the details of construction the author has been compelled to say that even a large number of the cells described cannot be depended on to give more than from fifteen to twenty-five milliampères, on account of the density and small surface of the carbons used. A battery of thirty-six such cells has, however, been in use by Dr. Lawrence Turnbull, of Philadelphia, in the treatment of ear affections, and this gentleman informs me that it is now, after the lapse of a year and a half, as good as new, having received but one inspection and overhauling in that time. Besides its cheapness and the instruction in electrical details involved in putting it together, the only advantages of this cell in the production of weak currents is that it occupies but a small space, and will require no attention for years if protected from evaporation.

The containing-jar is an ounce quinine bottle with wide mouth. The elements are a Leclanché zinc rod and an arc-light carbon stick, held together by two stout bands of rubber, and kept from touching by two blocks of rubber. The exciting liquid is a simple solution (under-saturated) of common salt or of chloride of ammonium, on the top of which a little oil is poured to prevent evaporation.

The zinc rod is cheap and easily obtained, and has a binding screw for the attachment of the wire from the carbon of the preceding cell. One electric-light carbon

(uncoated with copper) will furnish two carbon sticks of proper length if carefully broken across at the middle. After breaking the stick of the proper length, wind a bare copper wire about its upper end for several turns, and twist the wire tight with a pair of pliers, leaving about five inches of free wire attached to the carbon. Before setting the battery up, this upper end of the carbon, inclusive of the wire attachment, should be steeped in boiling paraffine-wax, to prevent incrustation by creeping salts. The two elements are then clamped together by the rubber bands (which may be made by snipping rings from a piece of three-quarter-inch rubber hose of good quality) and the separating blocks inserted at either end, properly protected by the bands. When these are inserted into the bottle and the salt water and oil poured in the cell is complete. The zinc of the first cell is connected with the wire attached to the carbon of the second, the zinc of the second to the carbon of the third, and so on, until all are connected. The positive pole of the battery is then the wire attached to the first carbon, and the negative pole is the last zinc.

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