ELECTRO-THERAPY IN GYNÆCOLOGY

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ELECTRO-THERAPY IN GYNÆCOLOGY

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DEDICATED

TO

E. M. S.

PREFACE

This book is not intended to be a textbook, either in Electro-physics or in Gynæcology. It is essentially a record of my own work, during the past twenty years, in Electro-therapy as applied to Gynæcology.

Whilst brought up to date, it is based upon numerous papers on that subject published by me at intervals in the medical journals, principally in *The Lancet* and *The British Medical Journal*. I am indebted to the Editors of these journals for permission to use the papers referred to for the present purpose.

I wish to take this opportunity of recording my special thanks to Dr. Murdoch Cameron, Regius Professor of Midwifery and Gynæcology, University of Glasgow, for kindly revising the clinical portions of the work; and to Dr. Walter C. Oram, B.A., Trinity College, Dublin (Honours and Gold Medal in Experimental Physics), Physician-in-charge of the Electrical Department, Northern Hospital, Liverpool, for valuable hints in the chapters on Electro-physics.

In passing the book through the Press I have derived considerable help from my daughter, Dr. Elizabeth Sloan Chesser, and from my son, Lieut.-Col. S. M. Sloan, R.A.M.C.(T.), whose acquaintance with the work of which this book treats has enabled me to profit by their many suggestions.

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INTRODUCTION

A FEW years ago it was suggested to me that I should write a book on the Treatment of Gynæcological Cases by Electro-therapy. Although I had every confidence in this form of treatment, and although my experience, even then considerable, had warranted this confidence, I declined to accede to the request. Now, however, that increased experience has further convinced me as to the benefits to be obtained from electro-therapy, I have agreed to undertake the task.

I am aware that the book may have many defects, but I shall try to avoid actual faults. One fault especially I shall endeavour not to commit, and that is the fault of over-enthusiasm. I shall, indeed, try to err rather on the side of under-stating the benefits to be expected by any one following out the treatment.

In all forms of therapeutics the personal equation enters largely into the question of success or failure, and, therefore, I cannot predict uniform success to every one beginning the treatment. He must be equipped with a sufficient knowledge of electro-physics and with a fair amount of experience of gynæcological diseases and of the ordinary treatment of these affections. If he then follows fully the guidance I give in this work, I believe that he will meet with much more success than he had in his previous gynæcological practice; whilst he will be impressed by a permanence in the benefits derived.

The gynæcological part of the book will be incomplete. I intend it to be so. No case will be dealt with which is obviously surgical, and only medical cases which have come directly under my own personal observation and have been treated by me mainly by electric methods will be mentioned. The electro-therapeutic part will also be incomplete. Some electric methods which might be most helpful in gynæcological cases, and which may have been found to be so by others, may not even be alluded to. For example, my experience of Roentgen-therapy has been too limited to permit me to refer to it; whilst the difficulty of obtaining the best out of the static machine, in this climate, has limited materially the use I have been able to make of this therapeutically useful form of electric energy.

I shall accordingly speak only of what I have done, and of what I know can be done by others. I trust that this attempt by me to explain my methods will enable others in the same field to do better work than I have myself done, by avoiding the mistakes which I made in acquiring experience.

In the chapters on Electro-physics all unnecessary and abstruse calculations and details will be omitted. These can be acquired, if desired, as the electro-therapeutist proceeds with his work. To burden the reader with such at the beginning of his work in a new department would be a mistake and would only tend to confuse. It is, however, necessary to give some clear idea of the general principles and laws of electricity as an introduction; and to explain the various forms of electric energy which may be employed. Any deficiency can easily be made up by a reference to one of the many textbooks on the subject.

I shall take it for granted that the reader has forgotten much, if not most, of what he previously knew of this subject, and shall endeavour to place myself in his position: putting the matter before him as I should wish it to be put before myself if I were approaching the practical study of the subject for the first time, as I am assuming the reader to do.

In recommending electro-therapy in diseases of women I do not mean to imply that the ordinary medical treatment of such cases is of no avail; but I believe that it is relatively so, when compared with the methods I am advocating.

A generation ago the remedial measures employed by gynæcologists consisted of mercury, opium, iodine, poultices, blisters, local blood-letting, hot douches, medicated pessaries, applications of caustics or antiseptics to the cervix, and to the interior of the uterus, with cotton-covered probes.

Ask a surgical gynæcologist what remedies he now advocates apart from surgical interference, including under this heading curettage of the endometrium, and he will answer, "Douching and tampons." I have asked several gynæcologists lately, and this was the answer I received.

In former days the practice of gynæcology was solely in the hands of the physician. When a surgical operation was required it was performed by the general surgeon. At the present time the gynæcologist is essentially and almost entirely a surgeon; and so bold and successful has he become, that no part of the abdomen is free from his inroads. Abdominal surgery is a field of operation now become his "by right of conquest"; for he it was who first proved his ability to occupy and retain it. It may well, therefore, be asked: Is medical gynæcology obsolete? So far as the carrying out of systematic medical treatment in pelvic diseases nowadays is concerned, the answer may well be "Yes"; for so little faith have the specialist and the general physician in this, that its measures are carried out with small expectation of benefit, and in a desultory way; and, therefore, with little likelihood of profit to the patient.

The physician's treatment nowadays consists of sedatives for dysmenorrhœa, ergot for bleeding, pessaries, antiseptic applications to the cervix, and, best of all, rest and tonics to improve the general health. Now, what I am prepared to prove is that more, much more, can be done with practically no drugs whatever, no tampons, no douches and little, if any, confinement to bed. True, I have not dispensed wholly with the measures I have enumerated, but I am becoming less and less dependent upon them. Indeed, I frequently, and with good results, dispense with them entirely; thus proving that the treatment I practise can bear a severe test.

Further, if electro-therapeutics be left out in the treatment of pelvic cases what is there of value left? Operative cases, even gynæcological surgeons will admit, do not comprise more than a small percentage of all cases of pelvic distress in women. What about the remainder? Must these be perfunctorily treated with the pretence that the best is being done for them? If so, think of the temptation which the gynæcological surgeon will be exposed to. Growing tired of casual attempts at relieving his patient medically, he is tempted to suggest and carry out a more rapid, and certainly a more radical, method by removing the organ which he has not the patience or the skill to cure. His very skill as a surgeon has become a source of temptation to him. This would be less of a danger if excision always meant cure. Ovaries can be easily removed, but the pain, which was the reason for the operation, frequently continues. For many years this has been admitted, and a reaction has set in, in the direction of less surgical gynæcology.

To show that gynæcological surgeons are looking to electricity as having a future in the treatment of diseases of women, I quote from Professor Howard Kelly of Baltimore, who is recognised as one of the most famous gynæcological surgeons of our day. In his book on Medical Gynæcology, 1908, page 103, he says: "It seems a matter for regret that the electrical treatment of various gynæcological affections should not receive more attention."

Again, Dr. Amand Routh, one of the foremost of London gynæcologists, said, in his address as President of the Obstetrical and Gynæcological Section of the Royal Society of Medicine, "What is to be the future of gynæcology? Is it to continue to become more and more surgical? I think not. Is it not more than possible that, in the near future, some president of the section will give an inaugural address upon 'Treatment other than Operative in Gynæcology,' and will base his remarks upon the wonderful discoveries being made in bacteriological, chemical, electrical, and radiological therapeutics ? "

Apart from electricity, including in this term electrochemistry, what substitute have we for semi-profitable medical treatment, or unnecessary, sometimes dangerous operations ? What hope can we offer to the woman who will rather bear the pain of her ovaries than lose them, and will prefer to submit to any treatment rather than to the removal of her womb ? Is there no substitute for the removal of a distressed organ but resignation on the one hand, or nerve prostration from the baneful effects of sedative drugs or so-called stimulants on the other ?

It will be my endeavour to show that electro-therapy may prove a substitute for these ; curing an organ, instead of extirpating it, and thus reducing to a great extent the necessity for surgical operations.

For the introduction of electro-therapy into the practice of gynæcology we are indebted to Apostoli. His work was much praised at first, then much condemned. Had Apostoli done nothing but enforce the value of electricity in the symptomatic treatment of uterine fibroids he would have done a good work. But his fame does not rest solely on his work on uterine tumours. Whatever decision may be arrived at regarding the effects of electrolysis on these tumours, I feel sure that Dr. Apostoli rendered a signal service to the profession by his scientific methods in electro-therapy. He contributed much valuable information based on his own experiments and observations, on the electrical treatment of most forms of pelvic disease ; though his work in this direction is either unknown or ignored by those who speak disparagingly of his better-known work.

That electricity in gynæcology means mainly electrolysis for uterine tumours seems to be the opinion not only of the profession in general, but even, though in a less degree, of electro-therapeutists also, with the exception of those engaged in the treatment of gynæcological cases by electro-therapy. This is evident from textbooks on electro-therapeutics and on gynæcology.

For twenty years past I have in most of my cases of gynæcology employed electro-therapy in some form, with results favourable to the more frequent application of electricity in this department of medicine.

When considering how to convey to others the impressions I have formed of the results of the work I have done in this field I feel that, whilst during the progress of the work I was unable to see the wood for the trees, on looking back I was in a sense unable to see the individual trees for the wood. With the change of perspective, due to lapse of time, my view had become broader and the details less clear. I have accordingly gone over in detail all my work in this department. That I have been able to do so with precision is due to the fact that all the cases were carefully noted at the time. Everything had been recorded, the successes and failures alike; not from any expectation of after-publication, but for my own guidance and satisfaction. Sometimes the record was a despairing one, sometimes a cheering one, but always a faithful one.

Many books have been written in recent years on electro-therapeutics; but there is, I believe, need for one confined to electro-therapy in diseases of women, and written wholly from personal experience. Especially is this the case at the present time; for during the past few years much advance has been made in electro-physics and electro-therapeutics. The latter was formerly almost entirely empirical, in the sense that it was based on clinical experience only. It has, however, now been established on a scientific basis.

I trust the reader will find what I have to say sufficiently convincing to induce him to test thoroughly the value of electric methods in the treatment of diseases of women in his own practice. I can assure him, if he does so, that he will not be disappointed with the final results.

CONTENTS

PART I

ELECTRO-PHYSICS

CHAPTER I

NATURE OF ELECTRICITY

CHAPTER II

ELECTRO-STATICS, OR ELECTRICITY AT REST

CHAPTER III

ELECTRO-DYNAMICS, OR ELECTRICITY IN MOTION

CHAPTER IV

IONS

CHAPTER V

THE LAWS GOVERNING IONIC ACTION

CHAPTER VI

COMPARISON OF ELECTROLYSIS, OSMOTIC DIFFUSION, AND IONISATION

CHAPTER VII

ALTERNATING AND OSCILLATING (HIGH-FREQUENCY) ELECTRIC CURRENTS

PART II

ELECTRO-MEDICAL APPARATUS REQUIRED

CHAPTER VIII

THE STATIC, GALVANIC, FARADIC, AND HIGH-FREQUENCY APPARATUS

CHAPTER IX

ACCESSORY APPARATUS

PART III

THE PRINCIPLES OF ELECTRO-THERAPEUTICS

CHAPTER X

STATIC, GALVANIC AND ALTERNATING CURRENTS

CHAPTER XI

HIGH-FREQUENCY CURRENTS

PART V

PELVIC AFFECTIONS

CHAPTER XIV

NEUROSES OF THE PELVIC STRUCTURES

CHAPTER XV

SUBINVOLUTION AND HÆMORRHAGE

CHAPTER XVI

SEPSIS OF THE GENITAL TRACT: VULVITIS, VAGINITIS ENDOCERVICITIS AND ENDOMETRITIS

CHAPTER XVII

PELVIC INFLAMMATIONS

CHAPTER XVIII

FIBROID TUMOURS

CHAPTER XIX

STERILITY

CHAPTER XX

AFFECTIONS OF THE FEMALE BLADDER

CHAPTER XXI

AFFECTIONS OF THE RECTUM AND ANUS

APPENDIX

LIST OF ILLUSTRATIONS

PART I

ELECTRO-PHYSICS

CHAPTER I

NATURE OF ELECTRICITY

Electrons; positive and negative charges; how to produce these; contact and friction; the electron theory of the constitution of matter; difference of potential.

Possibly in no department of Science has such rapid progress been made in recent years as in that of electro-physics. We are still unable to say definitely what electricity is: but it is now admitted to be a substance, and we talk of it, not simply as a force, but as a something the atoms of which can be, have been indeed, weighed and measured. This atom or unit of electricity is called an Electron.

Scientists were wont to speak of positive and of negative electricity, and of the several forms in which these may manifest themselves. All this has now given place to the study of electrons. Yet, although much new truth has been discovered, our present attitude towards electricity is much as it was before, but, of course, "with a difference." Many things in this science are still vague and uncertain, and the subject is beyond the power of the human mind fully to master.

Fortunately an elementary knowledge of electric principles is all that is required to enable the reader to practise electro-therapeutics with interest to himself, and with profit to his patients; and so I shall endeavour to place before him only what will be necessary, and that as briefly, but as plainly, as I can, giving more a mental picture of what is essential, than wearying and confusing him with details.

The only way to obtain a living knowledge of such a subject as electricity is by practical study with electrical appliances. Few of these are required; little apparatus and much experimenting with it will provide considerable interesting experience which cannot be obtained from mere reading. I have myself battled with many difficulties, have been puzzled as to results which were unexpected and confusing, but have sometimes in consequence gained a clearer view of what had before been confusing and therefore useless.

Instead of treating the subject of electro-physics from the standpoint of the ordinary textbook, I think I shall best help the reader if I approach the subject from my own outlook.

Electricity has been conventionally divided into static or stationary and galvanic or current electricity. Each of these has been spoken of as two kinds—positive and negative. The existence of positive electricity, however, is an inference only. No such thing may exist. Its presence has never been demonstrated, apart from the body which is charged with it. Negative electricity, on the other hand, means the presence of electrons, which I have said do exist and can be weighed and measured.

Both static and galvanic electricity owe their existence to contact. By merely causing one substance to touch another, you set up an electric charge in the two bodies; a negative charge forming on the one and a positive charge, whatever that may be, forming on the other. This is not generally recognised, but it is true, as I shall endeavour to show.

The old experiment of rubbing a piece of vulcanite with flannel was simply a case of touching the one with the other, but over a widespread surface, thus increasing the effect of contact by friction. Similarly, the friction of a glass rod with a piece of silk is a case of contact.

This is very well known, but it is not so well known to the uninitiated that mere contact of a piece of zinc with a piece of copper will have the same effect. Here no rubbing is necessary; the metals having simply to touch each other. In the case of the vulcanite and the flannel the electric charge in the vulcanite will be found to be negative, that on the flannel positive. In the case of the glass rod the converse is the case, the glass being charged positively and the silk negatively. The two metals I have referred to, the zinc and the copper, behave similarly to the above, the zinc in this case being charged positively whilst the copper is charged negatively. Nor is this law limited to the contact of solids, it is true also of contact of solids with certain fluids, as we shall see.

Let us first consider the nature of so-called positive and negative electric charge. What do these terms mean? How is their presence to be detected? How, again, are these separate charges to be differentiated?

I have mentioned that negative electricity is known, but that the existence of positive electricity is only a matter of inference; since it has never been separated from the body charged with it. Positive electrification may simply mean deficiency of negative electrification, that is of electrons. Negative electricity, on the other hand, is the condition in which the presence of active electrons can be detected. Since the terms negative and positive are still in regular use we shall retain them with the above reservation.

What exactly does take place when a body becomes charged with positive or negative electricity, no one knows. It has been suggested, it is almost admitted indeed, that all matter is composed of electrons. Rutherford and J. J. Thomson conceive an atom of matter as composed of a positive nucleus with rings of electrons revolving round it, like a planetary system of the infinitely little.

Regarding the theory of the formation of atoms by electrons on contact as a cause of electricity, Lodge suggests that "the atoms of a particular substance as iron or zinc have an electrical whirl of certain strength circulating in them as one of their specific properties." Thus substances will have inherent in them a state of relative stability or instability of their electrons. Some will retain the electrons, of which their atoms are made up, more tenaciously than others, and mere contact of the atoms of one substance which is capable of retaining these electrons firmly, with another which may hold these electrons less firmly, may cause the latter to lose an electron from some of its atoms. The electrons thus displaced will then attach themselves to the atoms of the other body; the one which parted with them becoming positively, and the one which received them, negatively electrified.

The reason why mere contact or friction between two bodies should produce a "difference of electric potential" between them, as this disturbance of electrical equilibrium is called, has often been a puzzle to me. The above explanation of this phenomenon may not be correct, but it satisfies better than would no explanation at all.

At all events, what might be called an electrical strain is brought about by mere contact of dissimilar substances, and thus a difference of potential has been established between the atoms of the one substance and those of the other. When contact ceases the old electrically neutral condition is reverted to. The presence of this electric strain can be proved, and its quality, plus or minus, ascertained. This electrical condition is dealt with in electro-statics.

CHAPTER II

ELECTRO-STATICS, OR ELECTRICITY AT REST

Electrical attraction and repulsion; induction; the electroscope, its principles and mode of action; conductors and insulators; Leyden jar, construction of; meaning of dielectrics; capacity of Leyden jars; electro-positives and electro-negatives in metals and in solutions; electrolytes; methods of conduction in metals and in liquids; relation of electricity to chemistry; relation of electricity at rest to electricity in motion.

For the study of this department of electricity what is called an electroscope is essential. This instrument can reveal the presence of the most minute quantity of electricity, as well as show whether the charge is a positive or a negative one. Fig. 1, p. 6, represents an ordinary gold-leaf electroscope.

To understand the principle of action of this instrument one must bear in mind the following points.

When a body becomes charged with electricity it becomes capable of attracting small light bodies in its neighbourhood, whether the charge be positive or negative. If one of these light particles be permitted to come into actual contact with the electrically charged substance, it becomes actually charged; and, instead of being now attracted, it is repelled: the law being that similarly charged bodies repel, and dissimilarly charged bodies attract, each other.

The attraction of light bodies by an electrically charged substance is strictly electrical. When a small ball of elder pith is brought near a positively charged glass rod, the electrical equilibrium of the former is disturbed. By "induction" a negative charge appears on the side next the glass rod; a positive charge equal to it in amount retreating to the further side. Thus the electrical charges on the rod and on the nearer side of the ball are dissimilar, and are consequently attracted; with the result that the electric charge drags the pith ball with it; the dissimilar or attracting charges being nearer each other than the similar and, therefore, repelling charges. Indeed, an electrically strained area is always present in the neighbourhood of any electrically charged body, opposite in sign to that of the body charged.

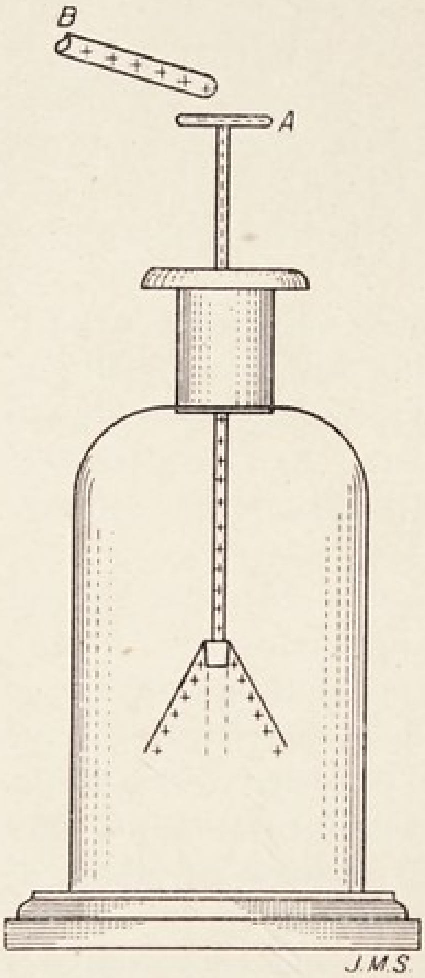


FIG. 1.—Gold-leaf Electroscope.

The ELECTROSCOPE (Fig. 1) is so constructed that the laws of induction, attraction and repulsion can be readily demonstrated. In the illustration (A) is a disc of brass fixed above the mouth of a glass bell-jar and connected to a metal rod, which passes through a cork, fitted to the neck of the vessel, well into the glass flask; the rod having two gold leaves fixed to its lower end.

When a charged glass rod (B) is brought near to the metal disc on the top, an electrical redistribution takes place in the metallic portion of the apparatus. By induction the brass disc and the neighbouring part of the metallic rod, being near the glass rod, become oppositely charged—in this case negatively—whilst a positive charge is driven to the other end of the rod where the gold leaves are attached. These leaves being similarly charged—that is positively—repel each other as in the illustration. If now the glass rod be removed the leaves will again fall together; electric equilibrium being re-established. If, however, the brass disc be touched by the finger, whilst the glass rod is allowed to remain in position, the negative charge on the brass disc will remain, being held there by the force of attraction of the positive charge on the glass rod; but the positive charge on the metallic rod and the leaves will escape to earth through the finger and body; the leaves immediately falling together again, since they have become of zero potential, that is of the same potential as the earth. When the glass rod is thereafter removed, the finger having first been withdrawn, all the metal of the instrument will become negatively charged in direct proportion to the proximity of the glass rod and the intensity of its charge, and so the leaves will again repel each other.

If, instead of a charged glass rod, a piece of vulcanite, previously rubbed with flannel and so negatively electrified, be held near the brass plate; and if, before removal of the vulcanite, the brass disc be touched by the finger, the same results will follow, but a final plus charge on the leaves will now preponderate.

To determine whether a body is charged positively or negatively, it is sufficient to bring the body to be tested near to the edge of the disc on the top of the electroscope, with a charge of known kind on its leaves. The body of unknown charge will at once attract an opposite charge to the disc. If the charge attracted be the same as that charging the gold leaves, these will come together; if the reverse, they will separate more widely. For example, let the leaves be charged negatively by a glass rod as explained above. If a rod of vulcanite, which has been rubbed and has consequently become negatively charged, be then brought near the brass plate the residual positive electricity still present will be attracted upwards, causing the leaves to be still more negatively charged; and so they will separate more widely. If a glass rod excited by friction and therefore positively charged be brought towards the instrument charged negatively, as we have above assumed, the negative charge will be attracted upwards, and so the leaves which we assume to have been negatively charged will collapse; to separate again on the removal of the charged glass rod.

The nature of the charge on any body can thus be ascertained, and by the nature of the effect produced the quantity can be fairly readily estimated. Collapse of the leaves is the only true test of polarity, unless the first motion of the leaves be closely observed; since, under certain circumstances, further divergence of the leaves may occur with similar or with dissimilar charges.

When left alone after having been charged the leaves of the electroscope will gradually lose their charge by dissipation into the air. The drier the atmosphere and the electroscope, the longer will the leaves remain charged, since dry air is an exceedingly bad conductor of electricity. It is not only the state of the atmosphere, however, which will determine the rate of dissipation, a large surface will lose its electricity sooner, and especially so will a pointed one. A moist body will quickly lose any electrical charge which it may have. A piece of metal would act similarly to the glass or vulcanite if rubbed; but in such a case it must be attached to a rod of glass or vulcanite, otherwise the electric charge on it will pass at once to earth through the hand holding it; metal being a good conductor of electricity, whereas glass and vulcanite resist the passage of the electrons.

Some bodies are, therefore, good, some bad conductors, or in other words good insulators, as they are called, of electricity. Besides metals, solid and liquid, carbon and certain substances in solution are good conductors. Water, though not a conductor in itself, becomes so in virtue of the dissolved salts which it always contains unless specially purified. Glass, vulcanite, resin, distilled water, rubber, silk, dry air, etc., are non-conductors, that is, are insulators. Many substances are partial conductors only, and none are absolute conductors or absolute non-conductors, the amount of resistance varying from the best conductor, which is silver, to dry air, which may be reckoned as an almost absolute non-conductor.

Leyden Jar

The quantity of electricity which an electroscope can contain and retain is relatively small, and we have seen that the electric charge becomes quickly dissipated unless the surrounding air and the instrument are very dry. An instrument called a condenser, on the other hand, is able to contain and retain a considerable amount of electric charge. This instrument is frequently employed in electro-therapeutics; and, since its principles are based on induction, its consideration may come in here. The condenser usually employed in electro-therapeutics is what is commonly called the Leyden jar. This apparatus is capable of storing up a large quantity of electricity; the retention being due entirely to the principle of induction. We have seen that any electrically charged body exerts an inductive influence all around it; bodies in its vicinity being charged oppositely on their sides nearest to the inducing body, and the air between keeping their opposite charges separate. In this case the air is said to be a dielectric; that is to say, a medium in which an electric strain can be produced. In the case of the Leyden jar the dielectric is glass, which, like air, is a good insulator or non-conductor.

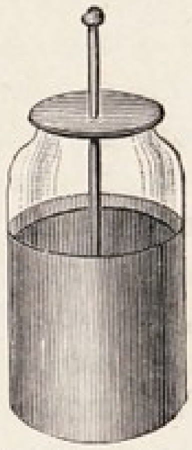


Fig. 2. — Leyden Jar. (From Lewis Jones' *Medical Electricity*, 6th Edition. London, H. K. Lewis & Co., Ltd. 1913.)

The ordinary Leyden jar (Fig. 2) consists of a wide-mouthed glass vessel lined inside and outside with tinfoil to within a few inches of the top. The inside foil is charged through a brass knob fixed to a metal rod which may pass through a cork, and, by means of a chain at its lower end, connect it to the metal lining the inside of the vessel. This inside coating may be charged directly from a static machine; or, more slowly and inductively, in the manner in which an electroscope is charged. If there were no tinfoil lining the outside, this charge on the inside of the jar would soon become dissipated into the air, but induction comes into action, and thus an opposite charge is attracted to the inside of the outer coating; the two opposite charges being held in the respective coatings and kept there by their attraction for each other. During charging the jar may be held by the hand, so as to connect the outer coating, through the arm and body, to earth; or this may be done by means of a metallic connection between the outer coating and the earth through a water-supply pipe.

The quantity of electricity which can be stored in this Leyden jar will depend on the electrical pressure or voltage to which it is charged, on the amount of the surface of the metal coatings and on the thinness of the dielectric between them—in this case, the glass. If a metal conductor, attached to the outer coating, be brought near the knob which is connected to the inner coating, a spark more or less great will pass across the intervening space of air. The jar will then be discharged. This discharging rod, as it is called, must be held by means of an insulating handle, or a severe shock may result.

The amount of electricity any particular Leyden jar can contain—that is, its capacity—varies in direct proportion to the potential at which it is charged; but the technical definition of the capacity of the Leyden jar is the quantity of electricity it can hold at unit potential; that is at the potential of one volt.[1] This capacity will be greater the thinner the glass is: that is to say, the nearer the opposite charges can get to each other without being able to unite. If an unduly high potential be applied whilst charging, and so the safe charge of the jar be exceeded, the dielectric may be perforated, or discharges may occur between the two coatings along the surfaces of the dielectric.

We have seen that mere contact of one substance with another of different constitution will give rise to an electric charge in both, some substances being electro-positive to others; that is, the atoms of the former more

[1] See footnote, p. 18.

readily part with an electron to the latter, and this in varying degrees. Thus zinc is electro-positive to copper, the latter is electro-positive to platinum, and still more to carbon.

Not only will solid bodies so react on each other, but, as was stated, a metal brought into contact with a saline solution will be similarly affected; and this brings me to a part of the subject of electro-physics, the study of which will be found, not only interesting, but helpful in giving a mental picture of the connection between electro-statics, or electricity at rest, and electro-dynamics, or electricity in motion; also of the nature of ions and their movements.

First, let it be understood that substances differ, not only in the ease or difficulty with which they permit of the passage of an electric current, but they also differ in the manner of conducting it. Metals seem to carry it by transference from atom to atom; whereas liquids capable of conducting electricity—electrolytes as they are called—are conductors in virtue of certain of the atoms of which they are composed having attached to them an electric charge—some positive and some negative. The arguments in favour of this will be considered when treating of ionisation: meantime, let it suffice to say that hydrogen, all metals, and all alkaloids, carry when in solution a positive charge; whilst oxygen and, in general, all acid radicles as chlorine, iodine, sulphuric anhydride, phosphoric anhydride, etc., carry a negative charge. When any atom or molecule carries an electric charge it is called an ion, or traveller. Where a negative and a positive ion are united, as in NaCl, the resulting molecule is electrically neutral.

The presence of these ions in a solution of an acid, an alkali, or a salt, is the cause of the solution being a conductor of electricity. As I shall show, these ions not only share in the carrying of a current of electricity, but they can themselves be made the cause of local electric movements and, as a consequence, can give rise to chemical action; not the reverse, as was formerly supposed.

I have been attempting in the leisure of recent months to find out the relation of what used to be called the various forms of electricity. I think the lines of research I have pursued in this direction are new; at least I have not seen any mention of them in my reading. Being simple, instructive and suggestive, I think they are worth reporting. My facts may be relied upon, my inferences are open to criticism. Even if some of these inferences are not strictly correct they may still be instructive; and may not, I trust, be seriously misleading.

The following simple experiment will suffice to make clear what I refer to.

Take a *narrow* glass vessel—say one of the shape employed for holding urine for the purpose of analysis, or a fairly large test tube. Nearly fill the vessel with a solution of NaCl—(one part of a saturated solution to seven parts of water)—to which have been added a few drops of phenol-phthaleine and a sufficient quantity of dilute liquor potassæ to render the liquid *very slightly* alkaline, as evidenced by a faintly red colour due to the presence of the phenol-phthaleine which, colourless in an acid or neutral medium, becomes red, in intensity proportional to the amount of alkalinity present. Put into this fluid a narrow strip or a rod of pure zinc, projecting to about one third of its length out of the solution. In a few minutes, the fluid at the junction of the metal with the top of the solution becomes, around the zinc, of a redder tint than the rest of the liquid; whilst on careful examination the fluid around that part of the metal which is immersed in the liquid will be found to be gradually losing its red tint. Shortly afterwards, the red colour of the top on the liquid will by diffusion spread to a limited extent downwards, and the under portion of the liquid will become perfectly colourless; whilst a fine white cloudiness will appear throughout the contents of the glass.

Now, how are these changes to be explained? The answer to this brings us to the connecting link between electrostatics and electro-dynamics. From contact of pure zinc with a slightly alkaline solution in the cold no action should, according to the laws of chemistry, result; for there is no acid to act on the zinc, and before an alkali can act on the metal the solution must be strong and hot. A chemical action, however, has taken place. The upper portion of the liquid has increased in alkalinity, as evidenced by the increase in depth of red colour, whilst the rest of the liquid has lost its alkalinity, as evidenced by the disappearance of the red colour there. On examination it will be found that the fine white cloudiness referred to is due to the presence of oxide of zinc. Since this chemical result is what the ordinary laws of chemistry, if dissociated from electrical action, cannot explain, we must look for another explanation, and electric laws give a complete answer to this.

As has been already said, mere contact of different substances will cause a disturbance of electrical equilibrium, that is, a difference of potential. It has also been pointed out that this was the case, not only between solids, but also when a metal was brought into contact with an electrolyte. In the above experiment the part of the zinc immersed has become positive to the liquid in which it was immersed, and the part of the metal above the level of the solution has become negative. Now the immersed part of the metal, being positive, will attract to it from the solution the negative ions—in this case the chlorine ions, or chlorions, as these are called—which, when they reach the lower or positively charged part of the zinc, will become de-ionised into ordinary chlorine. Two atoms of this chlorine will attach themselves to the two atoms of hydrogen of the water of solution with the formation of $2HCl$. This hydrochloric acid will dissolve some of the metal, producing soluble chloride of zinc; and the oxygen left after removal of the hydrogen from the water will act also on the zinc, forming oxide of zinc.

Meanwhile, the negative electric charges from the chlorions will be passed on to the upper or negatively charged portion of the zinc. Some of these electrons will escape into the air; whilst some of them will, as it were, drop on to the surface of the solution. There they will meet and neutralise the positively charged sodions, that is, sodium ions, surrounding the zinc at its junction with the solution. These sodions will thus become de-ionised: the metal sodium being set free. Since sodium cannot exist in a free state in contact with water it will combine with the HO of the water, forming sodium hydroxide; setting free the remaining atom of hydrogen from the H_2O. The sodium hydroxide being intensely alkaline will increase the red colour of the phenol-phthaleine in its neighbourhood. Later on this alkalinity will disappear; since the sodium oxide will combine with some of the $ZnCl_2$ now in the saline solution; forming zinc oxide and chloride of sodium; and so the process will be kept up, new alkali being formed to be again removed.

This explanation may not be absolutely accurate, but it is the only one I can give meantime. I have seen no record of this simple experiment, nor been able to obtain any explanation of it; and, therefore, I give the one which appeals to me as reasonable. It, I admit, presents some difficulties, but in my opinion it answers more than it fails to account for.[1]

The action, I may add, will go on till the zinc, if in

[1] Since writing the above, Professor G. G. Henderson has informed me that zinc is soluble, though very slowly, even in a cold and weak alkaline solution. Lest this should seem to invalidate my argument I repeated the experiment; employing, however, a neutral or slightly acid solution of NaCl, with exactly the same result as when a faintly alkaline solution was used, though the alkalinity at the top of the solution was slower in appearing. Therefore in the first instance the action is a purely electric one. This was my main contention, and so my explanation of the phenomena holds good. The question here is not whether zinc is soluble in an alkaline solution, or even in a neutral solution of common salt, but whether this solution is brought about by chemical or by electrical agency. I think I have proved that the latter is the determining cause; and that, not the alkali nor the NaCl, but the HCl, electrically generated in the lower portion of the solution, is the true solvent.

a thin strip, dissolves sufficiently to break away. That, during the action, there is an escape of electrons into the air, I have endeavoured to prove by the comparative rate of discharge of an electroscope, when its brass disc is connected to the upper end of the zinc; the glass containing the zinc and the solution being well insulated from the earth by a coating of shellac varnish. In this I have failed. I have been able to succeed, however, in the case of a zinc plate immersed in a strong solution of $CuCl_2$, where the reverse polarity in the metal is induced: the lower part of the zinc becoming negatively and the upper part positively charged.

When, in this experiment, the electroscope was charged positively, I, after many trials, invariably found that it required a longer time to discharge the electroscope than when the instrument had been charged negatively; showing that a positive charge must have been pouring into the electroscope from the zinc owing to the deposition on the latter of the positively charged copper ions.

I observed during this experiment that the deposition of the positively charged copper ion on the negatively charged zinc plate was much more rapid than the chemical action in the case of the NaCl solution had been; and this may account for the difficulty with the electroscope in the case of the latter. In the absence of such a direct proof my explanation must be taken as personal opinion only. But it matters little if a more scientific explanation should be required, so long as what I have said and suggested may help to fix electrical processes more vividly in the mind of the reader.

CHAPTER III

ELECTRO-DYNAMICS, OR ELECTRICITY IN MOTION

Definition; how obtained; the voltaic cell; electro-motive force; resistance; current; laws governing electric currents; properties and effects of a current of electricity; differences in current-conducting power; restraint of current; principles of the rheostat; difference of potential between various points throughout a galvanic circuit.

What we have just been considering affords an easy path from the study of electro-statics to that of electro-dynamics, or electricity in motion. It has been seen, in the case of contact of certain bodies with an electrolyte, how, by means of ions, the static condition can become dynamic; with the result of chemical action and escape of electrons. In the case of electricity in motion, however, we have to do, not with the escape of electrons, but with the harnessing of them—directing their path, measuring their force, controlling their amount, determining the chemical changes produced, etc.

Electricity in motion may be obtained by various means; but for our present purpose, that from the voltaic (galvanic) cell only need be considered. A combination of these cells is called a galvanic battery.

The key to the action, electrical and chemical, of the voltaic cell is the simple contact experiment of the zinc placed in a saline solution, which we have just been considering. We have seen that if a piece of copper and one of zinc be brought in contact, the former becomes negatively, and the latter positively, charged. We also saw that if zinc were in part immersed in an electrolyte that part in contact with the solution became positively, and the rest of the zinc negatively, charged. Now, if we substitute for the zinc a piece of copper the same result will follow, but in a much less degree; copper being less ready to lose its electrons than zinc under similar circumstances.

If a plate of zinc and one of copper be placed in the same saline solution, but *un*connected with each other, the immersed portions of each will, I find, be positive to the electrolyte, but the copper will be much less so. If these plates, however, be brought into metallic contact, by a connecting wire outside the fluid, the part of the zinc which is immersed will become increasingly positive, whilst that portion of the copper which is immersed will then become negative. The negative ions in the fluid will thus all go to the immersed part of the zinc, and the positive ions to the immersed part of the copper or negative plate.

The outer extremity of the zinc—the zinc pole, as we call it—will then obviously be able to pass on its negative charges (which have been deposited upon its immersed part) direct to the copper pole, and the latter pass on its positive charges (similarly deposited upon its immersed part) to the zinc pole; neutralisation taking place, not in the circuit, but at the two metallic poles. And so long as ions remain in the solution this double electric "current"—as it is called—will go on. The electric strain between these poles is called a "difference of potential."

This is the principle of all galvanic cells. In order to increase their power we join them, as has been said, to form a battery: connecting the negative, or zinc pole, of one, to the positive pole—copper or carbon as the particular combination may be—of the other, and so on. We thus obtain an electric pressure in direct proportion to the number of cells in the battery. This electric pressure is called electromotive force, or E.M.F., as it is usually put. It is calculated in volts; [1] each cell giving a pressure of from one to one and a half volts, according to its construction. For medical purposes a battery of

[1] See footnote, p. 18.

twenty to forty cells is required, yielding a total electromotive force of about thirty to sixty volts respectively, if in good condition. This voltage is not electricity in motion, it is electric potential or static electric pressure. It produces a " galvanic current " when the isolated ends or poles of the battery are connected by a conductor, and it can then display its various effects.

The amount of current which a given voltage can generate is determined by the resistance which it has to overcome in the circuit owing to the fact that the substances forming the circuit are not perfect conductors. If there be much resistance then the yield of current is less, and *vice versa*. The ratio is $\frac{E}{R} = C$ where E is the electromotive force, R the resistance, and C the current. As E is calculated in volts, so R is calculated in ohms, the current being measured in ampères.[1] A coulomb is the quantity of current represented by one ampère flowing for one second; or, which is the same in total amount, one hundredth of an ampère flowing for one hundred seconds. For therapeutic purposes our galvanometers register thousandth parts of an ampère—that is, milliampères.

It must be borne in mind that the resistance in the circuit is not limited to that part of the circuit outside the cells; for the internal resistance of the cell is often considerable; varying in amount in the different kinds of voltaic cells. What is called polarisation also acts in reducing the available voltage, by setting up a current contrary in direction to the true current of the cell. This arises from the deposition of hydrogen on the

[1] An OHM is the resistance of a column of pure mercury 106 centimetres long and 1 square millimetre in sectional area, at a temperature of 0° C.

An AMPÈRE is the amount of current which will deposit 0·00111815 gramme (0·017253 grain) of silver per second from a solution of silver nitrate.

A VOLT is the difference of potentials which must be maintained at the ends of a wire of one ohm resistance so that a current of one ampère may pass through it.

negative plate. Various devices are resorted to in order to counteract polarisation and so keep the voltage, and consequently the current, steadier. In the Leclanché cell (see Fig. 9, p. 59) binoxide of manganese is employed for this purpose; being mixed with powdered carbon and placed in a porous pit, the contents acting as a carbon plate. In the galvanic cautery cells bichromate of potash and chromic acid are employed to serve this purpose. The action of these de-polarisers is to supply oxygen to the evolved hydrogen deposited on the negative plate of the cell, and thus remove it.

The physical effects of the current are mainly magnetic, thermic and electrolytic. The magnetic effect is shown in the fact that a wire carrying the current is able to deflect the needle of a mariner's compass, if the wire through which the current is passing be held over or under the magnetised needle; the direction of the current determining the direction towards which the needle will be deflected.

When we speak of the direction of the current it is conventionally understood that the current flows, outside the cell, from the positive pole to the negative pole; whilst inside the cell it is flowing from the positive to the negative plate (see p. 17). In reality, however, as has been shown, a current is flowing in both directions.

Heat is always generated in an electric circuit, the amount being proportional to the product of the square of the current into the resistance.

As was seen to be the case with static electricity, so is it with electricity in motion. Through some conductors the current passes with very little difficulty—silver and copper, for instance, if pure and moderately thick, have extremely little resistance; whilst others, such as platinum and the element carbon, especially if of a very small cross section, cause a very considerable amount of resistance, and therefore of heat. This property, in the case of the platinum, is utilised in the galvanic cautery; whilst carbon is employed as graphite to restrain the current; where, with the given voltage, this would be in excess of the requirements. When so used, the instrument is called a rheostat.

It must be noted that, whilst the quantity of current throughout the circuit is the same at all points, the resistance in different parts of the circuit may vary indefinitely: therefore the heat may be very unequally distributed.

Since the $C \times R = E.M.F.$ between all parts of the circuit, the E.M.F. between these points will vary as does the resistance between them. This local E.M.F. we call the potential difference between these points.

In the case of the galvanic cautery the thermic effect of the current is taken advantage of; the platinum parts having as high a resistance as is required to cause the necessary heat; whilst the same amount of current will simply render the rest of the circuit warm—less or more at any one part of the circuit in proportion to the thickness and, therefore, to the diminished resistance of the wire there.

It has been necessary, in order to understand the nature of a voltaic (galvanic) cell, to refer to ions as the source of the energy of the cell. What is called "Ionisation," however, in electro-therapy, has to do not with what is taking place *in* a voltaic cell, but what is happening in an electrolyte through which a current is being made to pass *from* a voltaic cell; and, since ionisation has largely entered into electro-therapy in my gynæcological practice, it may be well to study this subject more fully, although it may involve some repetition, before going on to the consideration of other forms of electricity which are found to be of therapeutic value in gynæcology.

CHAPTER IV

IONS

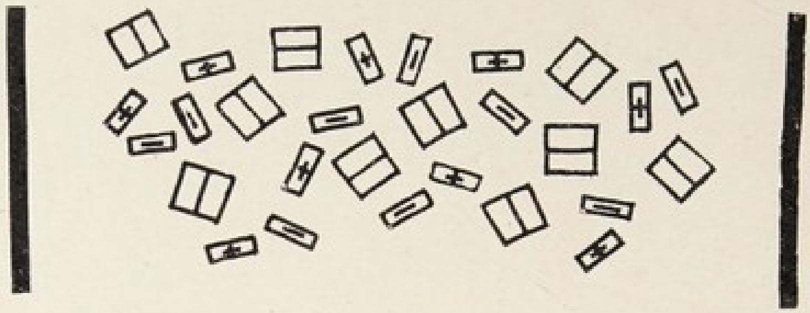
Definition of an ion; electrolytes and non-electrolytes contrasted; the bearing of osmotic pressure on the ionic theory; evidences from the effects of dilution of electrolytes.

In a previous chapter it was assumed for the sake of explanation that there existed particles called ions; and some particulars as to their nature and movements were stated. In this chapter the subject of ions will be more fully considered, and some arguments in favour of present day theories regarding them will be submitted.

An ion may be defined as a particle of matter, generally small, moving or capable of moving in virtue of an electric charge. It may be as large as a pith ball when charged by an electrified body, or as small as an atom of hydrogen; and that there are such things as ions, almost infinitely minute, I hope to be able to show.

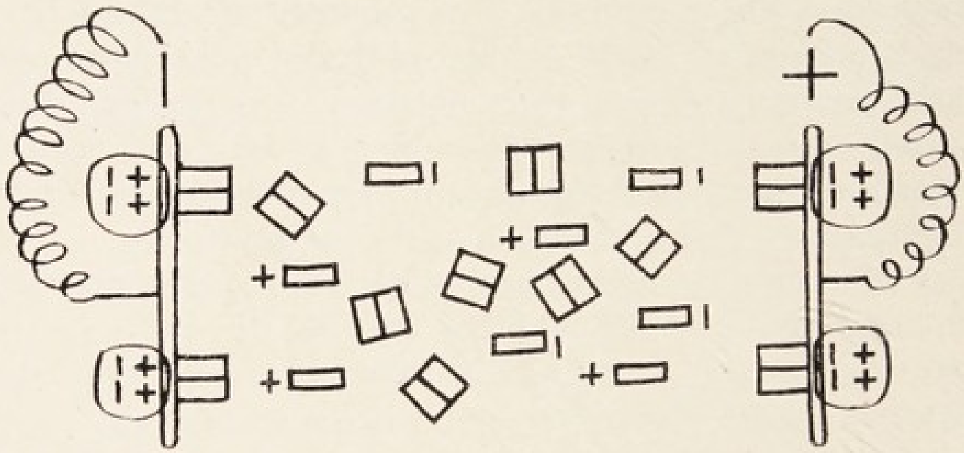
All solutions may be divided into electrolytes and non-electrolytes—that is, into those which are, and those which are not, conductors of the galvanic current. Examples of the former are acids, bases, and salts; of the latter, distilled water, alcohol, and solutions in distilled water of the following amongst others—sugar, gum, starch, pure albumin. Why do these latter-named substances refuse to conduct electricity? Simply because they consist of neutral molecules only; whereas the electrolytes have many of their molecules broken up into particles electrically charged; these being the carriers of the current, and, therefore, called ions, which simply means goers (see Fig. 3).

Some explanation may be needed regarding Fig. 3*b*. Here the circuit is represented as open. In the middle *a*



Arrangement of Particles in Aqueous Solutions of Acids, Bases, Salts, and in some Alcoholic Solutions.

b



The same when connected to the Terminals of a Battery.

c

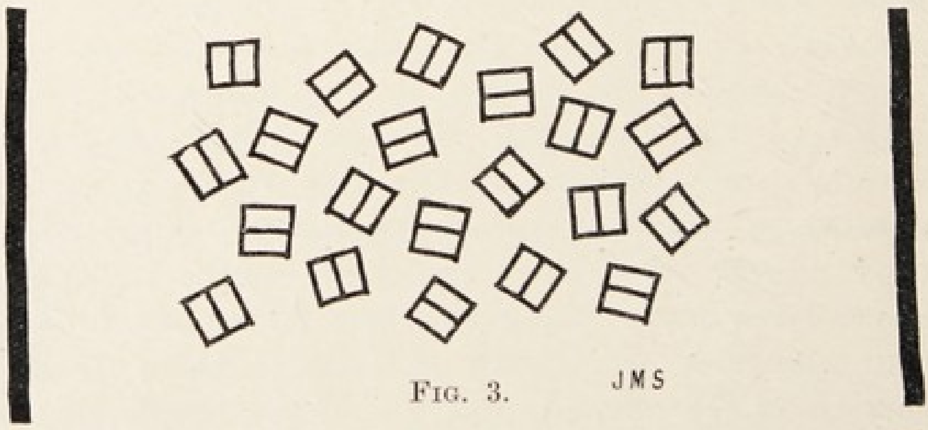


Fig. 3.

Arrangement of Particles in Distilled Water, Absolute Alcohol, Aqueous Solution of Sugar, Albumen, Starch, Alcoholic Solution of Iodine.

of the field the ions are seen having their electric charges directed towards the poles of the battery of opposite sign. At both electrodes[1] are placed two molecules, represented as if the atoms of which they were composed had parted with their electric charges and had joined to form a neutral molecule. This change, however, has not been entirely completed, for the electric charges are shown as just about to quit their atoms and become connected with opposite charges derived from the poles of the battery. As soon as the circuit becomes closed this will actually take place; the signs (+ and —) within each of the four circles adjoining the electrodes thus neutralising each other and the formation of the neutral molecule completed. As soon as this is done other ions will come to the electrodes and become similarly de-ionised. There is thus polarity and direction in the current.

If diagram—Fig. 3*b*—is understood as representing a solution of NaCl, then the result of the action of the current will be the appearance of molecules of chlorine at the positive pole and of molecules of sodium at the negative pole.

The electric conductivity of solutions containing these ions is only one evidence of their presence. The special behaviour of solutions when tested for their osmotic pressure also reveals a difference.

The amount of the osmotic pressure exerted by a non-electrolyte solution is directly proportional to its concentration. To prove this, fill a specially prepared porous pot with a strong solution of sugar. Through an opening in a rubber stopper insert a glass tube and connect this by rubber tubing to one limb of a long U-tube partially filled with mercury; immerse the porous pot in water, and await the result (see Fig. 4). It will be found in a short time that the mercury in the other limb of the U-tube will be pressed upwards by the expansion of the contents of the jar, through the inrush of water, till

[1] For the definition of this term see p. 32.

a balance is set up between the weight of the column of mercury and the pressure within the jar. Let this be noted, and then replace the contents of the porous pot with a solution of the same material, but half the strength of the previous one. After a few hours the mercury will be found to have risen exactly half as high; the pressure being in direct proportion to the number of particles in the solutions. In this case the particles are all molecules.

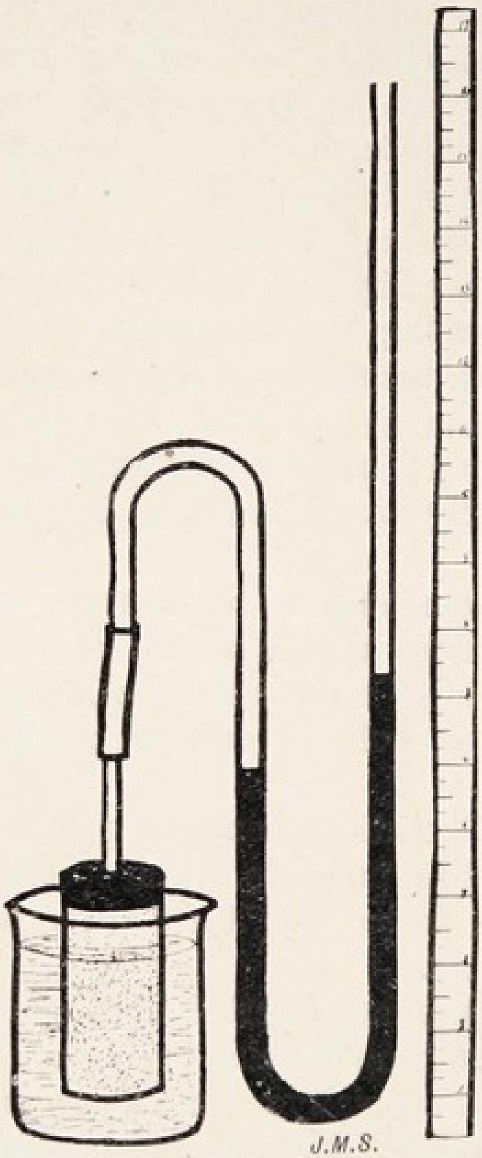


Fig. 4.—Osmotic Pressure Testing Apparatus.

Take, on the other hand, a solution of a salt—say chloride of sodium—and compare the results as in the case of sugar. It will be found here that, instead of the half-saturated solution producing a rise of the mercury only half the height of that resulting from the solution of twice the concentration, it will raise the column of mercury nearly as high as did the saturated solution.

What is the explanation of this? In the case of sugar all the particles are molecules, and these continue as molecules when the solution is diluted; whereas in the NaCl solution all the particles are not molecules, many of these having been split up, or dissociated as the process is called, into separate particles—namely, sodium and chlorine ions, or sodions and chlorions as they are called; for they differ in nature from what is known as sodium and chlorine. True, they are atoms of sodium and chlorine, but they are atoms carrying an electric charge which has changed their nature. They are in fact ions. These ions may join to form molecules and split up again as they rush about and come into collision with each other, so that imagination may picture the molecules breaking up into ionised atoms, these rushing about in a free state, re-uniting with changed partners and once more parting company to dart off again as independent ions.

In both kinds of solutions the molecules have no electric charge, a positive ion and a negative ion uniting to form a neutral molecule. As dilution of an electrolyte proceeds, more and more molecules become dissociated, and so the ions increase relatively to the molecules. During osmosis each ion acts as a separate particle, adding to the osmotic pressure as much as a molecule does; and as the electric conductivity in a fluid is proportional to the number of its free ions, this is found to be greater in diluted solutions than would be the case if no increasing dissociation took place by increasing dilution.

Let such tap water be taken as we have it in Glasgow, and it will be found almost as pure electrically as what is sold as distilled water. I find that, in a column of this water, 6 in. long and 1 in. in transverse section, I obtain, from a battery giving 50 volts, about 0·2 ma. only of current—that is to say, there are only as many electrically charged particles in the water as will yield this amount of electricity. If the water were absolutely pure there would be no resulting current, since it would contain no electrically charged particles—that is, ions. Pure water, is, therefore, we see as was affirmed, a non-electrolytic fluid; its resistance to the flow of electricity being practically absolute.

Dissolve some sugar or starch in this tap water and with a similar column and the same voltage, you will obtain no more, probably somewhat less, current, since the material dissolved has occupied some of the space previously occupied by the water with its few electrically charged particles. Dilute this fluid with an equal quantity of water, and you get practically the same amount of current as before the sugar was added. The conclusion obviously is that any current obtained is due solely to what ions there may happen to have been in the water, none of the molecules of the sugar having become broken up into ions.

Now, consider the case of a similar column of a saturated solution of NaCl. Here it will be found that the amount of current obtained through it from the same voltage is enormous compared to that through a similar column of the water in which it is dissolved. I give in Table I what I have found to be the results of continued dilution in this case. It will be seen that each dilution gives the indication of containing more free ions than would be

TABLE I

Currents in Columns of Solution of NaCl from 50 Volts.

Saturated	= 36	per cent.	600 ma.	1/32	= 1·125	per cent.	140 ma.
1/2	= 18	,,	575 ,,	1/64	= 0·56	,,	80 ,,
1/4	= 9	,,	500 ,,	1/128	= —	,,	45 ,,
1/8	= 4·5	,,	350 ,,	1/256	= —	,,	24 ,,
1/16	= 2·25	,,	240 ,,	1/512	= —	,,	13 ,,

expected from the amount of the dilution. Especially is this the case in the more concentrated solutions. This relationship diminishes as the dilutions increase until a dilution of about 1 per cent. is reached. By this time practically all the molecules have become dissociated, and with further dilutions the amount of current is practically directly proportional to the amount of concentration.

The conclusion is thus forced upon us that a saline solution contains, even in its most concentrated form, a large number of ions; and that by dilution the number of these becomes relatively increased.

To Arrhenius, of Sweden, we owe the placing on a sound experimental basis of the dissociation theory of electrolysis; that is, the breaking up of neutral molecules into the ions of their constituents and so forming an electrolyte. To Faraday we owe the laws of electrolysis; whilst to Professor Leduc of Nantes [1] belongs the honour in a pre-eminent degree of applying these discoveries to the service of medicine.

[1] *Electric Ions and their Use in Medicine*, 1908 (Wm. Heinemann, London).

CHAPTER V

THE LAWS GOVERNING IONIC ACTION

Valency; chemical equivalents; kations and anions; electro-chemical equivalents; Faraday's laws of electrolysis.

Valency

We have hitherto been considering ions as having simply an electric charge. This charge is either one atom of electricity—an electron as it is called—or a multiple of one; never a fraction of one. This unit of electricity is therefore indivisible, like the atoms in ordinary matter. Some ions carry two electrons; and, although others carry three or more, the chemicals most likely to be used in ionic medication carry one or two electrons only. These are called monads and dyads as the case may be. Positive ions may be considered as the reverse of negative ions. They carry an electric charge; but, as was pointed out, this electric charge may mean the absence, or rather the removal, of one or more electrons.

By valency is meant the combining capacity of an ion in electrons. Thus the valency of a monad is one; it is therefore mono-valent: the valency of a dyad is two; it is therefore di-valent.

Table II

Element.	Atomic weight.	Valency.	Chemical equivalent.
H	1.	1	1
O	16.	2	8
Cl	35·5	1	35·5
I	127.	1	127
Cu	63·5	2	31·7
Zu	65.	2	32·5

From the above table it will be seen that the valency of hydrogen is one and that of oxygen two. Therefore to make a neutral combination of hydrogen and oxygen two atoms of hydrogen are required for one atom of oxgyen. Thus the formula for water is H_2O. In the case of cupric chloride, copper being di-valent and chlorine mono-valent, two atoms of chlorine are required to neutralise one atom of copper; and so the formula for the neutral molecule is $CuCl_2$. The importance of the valency of an element must be recognised when calculating the total amount of that element which has been transferred by ionic penetration.

Kations and Anions

The electrons are given up at the poles only; where the ions, having lost their electric charges, assume their ordinary qualities—two atoms of the same element uniting to form an ordinary molecule of that substance, as we know it in nature. Or they may, as atoms, attach themselves to one or more of the atoms of the molecule water, and thus cause by secondary reaction decomposition of the water.

Table III

Examples of Kations and Anions.

Electro-positives (kations).		Electro-negatives (anions).
Copper	Cocaine	Chlorine
Zinc	Strychnine	Iodine
Quinine	Atropine	Salicylic acid radical
		Sulphuric acid radical

It was pointed out when dealing with electro-statics that similar charges repel and dissimilar charges attract each other; and so is it in electro-dynamics. Negatively charged ions are repelled from the negative pole in an electrolyte and are attracted to the positive pole; positively charged ions being repelled from the positive pole and attracted to the negative. The positive pole being called the anode and the negative pole the kathode, the negatively charged ions are therefore called anions or anode travellers, the positively charged ions kations or kathode travellers, since ions travel towards the poles of opposite sign. This distinction must be borne in mind in the practice of ionic medication (see Fig. 3*b*).

Calculation of Ionic Liberation

We are all familiar with what is meant by atomic weight in chemistry, and I have mentioned that some atoms carry one, some two, electrons or atoms of electricity. Now it will be obvious that whatever amount of electricity is given up when an atom with one free electron becomes discharged at a pole, twice as much will be given up when an atom with two electrons is similarly discharged.

The chemical equivalent, as may be inferred from what has just been said, is the atomic weight divided by the valency—that is, by the number of electrons with which the ion is charged. In the case of the monads the chemical equivalent will be the same as the atomic weight; whereas in the case of the dyads the chemical equivalent will be half of the atomic weight. Since one Coulomb, that is one ampère of current flowing for one second, is capable of displacing 0·0000104 of one gramme of hydrogen, or, in the case of any other body, this amount multiplied by its chemical equivalent, this is called the electro-chemical equivalent of the particular substance. The electro-chemical equivalent of hydrogen, therefore, being 0·0000104 (gramme) that of copper will be $0{\cdot}0000104 \times 31{\cdot}7$; that is 0·00032968 (gramme) or 0·33 of a milligramme approxmately; that of zinc 0·34 of a milligramme nearly; and so on for the other elements. Thus the total amount of any substance liberated by an electric current is equal to $c \times t \times e$, where c = current in ampères, t = time in seconds and e = weight of the particular substance liberated by one ampère in one second, that is its electro-chemical equivalent. This is a summary of what are known as Faraday's Laws of Electrolysis.

For example, the total weight of the ions of copper liberated by a current of 20 ma. for 15 minutes—that is from $0 \cdot 02$ (ampère) $\times$ 60 (seconds) $\times$ 15 (minutes) $=$ 18 coulombs—is $18 \times 0 \cdot 00032968 = 0 \cdot 006$ (gramme) $= 0 \cdot 1$ grain approximately.

CHAPTER VI

COMPARISON OF ELECTROLYSIS, OSMOTIC DIFFUSION, AND IONISATION

Experiments bearing on the physics of electrolysis; the laws of osmotic diffusion and ionisation; relation of electrolysis to ionisation stated in tabulated form; actual depth and amount of ionic penetration in the case of the copper ion, ascertained by experiment; probable chemical changes undergone by the copper ion after introduction into the tissues; disposal of the complex organic copper molecule in the tissues; entry of the copper into the protoplasm of the cells; effects of electrolysis and ionic penetration on animal tissue; size and weight of some of the atoms of matter; relative size and weight of an atom of electricity; comparative size of some septic organisms.

ELECTROLYSIS is a well-known term in gynæcological electro-therapy. Ionisation is a comparatively new term. These processes are alike, and yet different.

In Electrolysis the points of entrance and exit of the current through an electrolyte are called the ELECTRODES. In electro-therapy by an electrode is meant the appliance by which the current enters or leaves the tissues of the body. When the current is meant to act locally the electrode at that point is called the active one; whilst the other electrode, which may be placed on any convenient part of the body, is called the neutral electrode.

The term Electrolysis is used here in two senses: literally it means electro-chemical decomposition; and this is the sense in which it is employed in the immediately following experiments. When, later on, the effects of electrolysis on animal tissue are explained, the term includes, besides electro-chemical decomposition, the results of this on the tissues, when the bare active electrode is in close contact with the tissues, and is small relative to the amount of current passing. In electro-therapy, electrolysis has come to signify mainly the consequences to living tissue where the electrode is an electrically non-soluble one, such as platinum. Electrolysis is really taking place at the neutral electrode also; but here the action of the current is generally more diffused: at least the amount of surface covered by it ought to be large enough to make it so, and thus the local action at this electrode on the tissues should be negligible. The physical resemblances and differences, between electrolysis and ionisation, will be made fairly clear by the following experiments. The effects of osmotic diffusion will also be shown, since these have some bearing on both electrolysis and ionisation.

Physics of Electrolysis

Fig. 5 shows a series of three U-shaped tubes illustrating the physics of electrolysis, osmotic diffusion, and ionic penetration respectively.

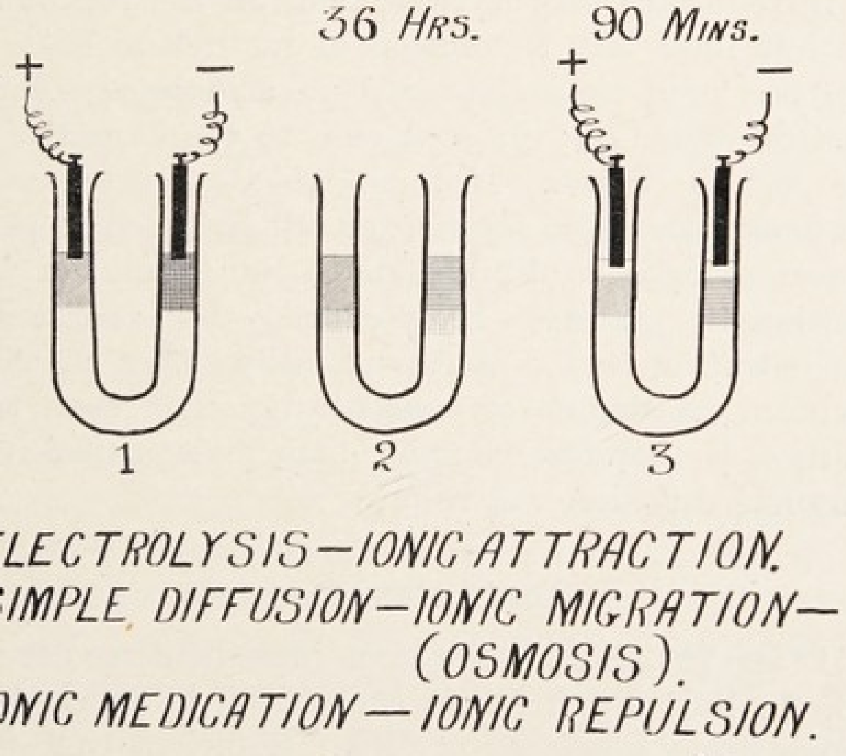


Fig. 5.

In tube No. 1, containing the liquid for illustrating electrolysis there are present, in solution, iodide of potassium, some thin solution of starch, and a few drops of phenol-phthalein ; the object being to prove the migration, in the solution, of the ions of iodine to the positive electrode, and of the potassium ions to the negative electrode. When the iodine becomes un-ionised by contact with the positive pole it will act as ordinary iodine, producing the strong blue colour of iodide of starch. When the potassium yields its electrons at the negative pole, it is unable to exist in water as a metal, and so will combine with hydroxyl extracted from the water molecule, setting the remaining atom of hydrogen free as a gas, and changing the phenol-phthalein into a distinctive red colour, indicating the presence of an alkali—in this case KHO.

Osmotic Diffusion

In the case of the U-tube (2) containing the liquid to illustrate osmotic diffusion, solution of common salt may be introduced into the tube, and, on the top of this in the left limb, say a solution of methylene blue, whilst into the right limb is poured an acidulated solution of tincture of iodine; in each case to the extent of about one inch in depth. If these added coloured solutions are denser than the solution of salt in the tube they will almost at once be diffused down the column of the salt solution by gravity. If of exactly the same molecular concentration they would practically never change their position. A degree of concentration less than the salt solution is therefore chosen; and, given sufficient time, complete diffusion will result.

Ionic Penetration

U-tube (3) contains the same ingredients as are in tube No. 2 : but, dipping into each limb, is an electrode of carbon from a battery of cells. Sufficient time to show the effect produced should be allowed, say, one hour.

A slight extension downwards of the colouring matter in diminishing depth of colour will be seen in the diffusion tube; but the deepest hue of colouring is at the top. In the case of the electrically treated tube, however, there is a marked difference : the junction between the coloured and the uncoloured solutions remains sharp. The upper part of the coloured portion, moreover, is not now at the highest part of the fluids; there being a depth of colourless liquid, of about a quarter of an inch in this case, at the upper parts; the current having driven the ions of the coloured fluids to that distance from their original position. In this case the total length of the coloured fluids, however, remain the same.

Limiting here the term Galvanisation to the interpolar migration of electrically charged particles towards opposite poles (the tissues being protected from the poles), and the term Electrolysis to *the results* of this migration *at* the poles, the relations of electrolysis to ionisation from the electro-therapeutic point of view may be put briefly thus—

1. During the passage of a galvanic current there is always chemical action at both poles; that is, there is electrolysis there.
2. Electrolysis is that which results from the attraction of ions *from* the tissues to the poles : Ionisation referring to the repulsion of ions from a particular pole *into* the tissues.
3. Where a bare, non-soluble, electrode such as carbon or platinum is applied, at either pole, directly to the tissues, the results are wholly electrolytic. Hydrochloric acid and oxygen will appear at the positive pole; whilst caustic soda and hydrogen will appear at the negative pole. Thus $2NaCl + 3H_2O$ will become $2HCl + O$ and $2NaHO + H_2$.
4. If the metallic electrode at the positive pole under the above circumstances be soluble in HCl, the action will be ionisation as well as electrolysis; for the ions formed from the solution of the electrode will be driven from the positive pole into the

tissues; seeing that they carry a positive charge when in solution.

5. When an electrolyte intervenes between a soluble electrode attached to the positive pole and the tissues, the action will be practically ionisation only; the electrode pole being too far away from the tissues for electrolytic action to tell upon them. If the electrode be, as it should, of the same chemical nature as the intervening electrolyte its solution will augment the latter, and thus keep up a sufficient supply of ions for migration into the tissues.
6. If an electrolyte intervenes between the electrode attached to the negative pole and the tissues, the electrolytic action is around the electrode only. The action on the tissues is, therefore, ionisation only; the negative ions of the electrolyte being driven into the tissues.

When the connections in an electrical combination are at all complicated it will generally be desirable, before beginning ionisation treatment, to make sure as to the position of the poles of the battery. This can be easily and quickly determined by the action of the extremities of the connecting wires on ordinary litmus paper slightly moistened. The ends of the wires should be placed on the paper, and about a quarter of an inch apart. As soon as the current begins to pass between the points of the wires an acid reaction, a red colour if blue litmus, will indicate the position of the positive pole, and an alkaline reaction, a blue colour if red litmus, that of the negative pole (see latter part of paragraph 3 above).

It has been pointed out how the quantity of ionic material, de-ionised and disengaged by the current may be determined. We found (p. 31) that what we might call a medium gynæcological dose of copper ions should result in the liberation of about one tenth of a grain of copper at the negative pole, or the removal of that amount from the positive (copper) pole, according to Faraday's laws of electrolysis. This would be so on the supposition that both poles were dipping into a solution of a salt of copper. This is what has been called the "theoretical yield."

The actual amount of ionisation for medical purposes, however, is something quite different. Hitherto it has been assumed that the quantity driven in during ionic medication will be the same as should be the total of that substance which would have been deposited at the opposite pole; and this error seems to me to prevail up to the present time. But this takes no cognisance of the fact that several ions besides the one desired are "on the move" at the same time. Early in my investigations I suspected that the actual amount would fall much short of the theoretical; and I have found this to be the case.

Since the laws of electrolysis give no indication as to the extent of penetration of the ions into organic tissues, nor of the quantity actually so moved on, under these conditions, I decided to determine these by actual experiments, also wherein these results would vary under varying conditions.

I accordingly set myself to elucidate the following points—

1. To what depth, measured in millimetres, does a given current in a given time cause penetration of an ion into the tissues?

2. Is this depth of penetration varied by modifications in the application of the current?

3. What is the total quantity of ionic material actually introduced into the tissues by a therapeutic dose of electricity?

4. What, if any, chemical change does the ion introduced undergo during penetration?

5. Does the ion pass into and through the tissues, as in diffusion—that is, mainly by channels—or does it enter also into the interior of the individual cells during its electric propulsion?

6. How does the ionic material act? If it is an antiseptic before introduction, has it the same property after it has penetrated into the tissues?

7. How is the ion disposed of after its introduction?

To some of these questions I have definite answers to give. In the case of others I have still some work to do, before satisfying myself on certain points as to the proper answer.

During these investigations I have limited my research to one ion—namely, copper. I had two reasons for this. In the first place, the best of my therapeutic results had been obtained in gynæcology from the copper ion. In the second place, one ion at a time I found more than ample to occupy the leisure time which was then at my disposal.

Before being able to determine correctly the amount of ionic material electrically driven into the tissues and the depth of its penetration, allowance had to be made for the effect of osmotic diffusion, which was going on at the same time. This was all the more important when conducting the following investigation, since the time required for the experiments was considerable; the surfaces operated upon being small, and, therefore, the amount of current available correspondingly limited. Besides, much more than a therapeutic dose must be applied in order to obtain a sufficient amount of material for calculating the penetration and the quantity for one therapeutic dose. Finding, as might have been expected, that the extent of diffusion was greater when the specific gravity of the fluid experimented with was increased, the solutions were always made of the same strength as was used in ionic medication, namely one per cent. of bichloride of copper ($CuCl_2$ $2H_2O$). Since, however, the density of the tissues to be treated by ionisation varies widely—skin and mucous membrane for example—I determined to find at the same time to what extent a difference of density would, if at all, influence the depth of ionic penetration.

For this purpose, the following method was resorted to: a diffusion control being employed to ascertain the amount to be deducted from the total combined diffusion and electric propulsion, and so to obtain the data for electric propulsion only.

In the first experiment, three U-shaped glass tubes, each with a transverse diameter of two cm. were employed. The material, the permeability of which was to be tested, was white of egg of different degrees of density. In one case the white of egg was boiled for five minutes and in the other for ten minutes. This coagulated albumin was supported on a column of solution of gelatin in water in which had been dissolved some common salt to make it a good conductor of electricity.

Fig. 6 will make clear how the experiment was conducted. Tube No. 1 was for the diffusion test, tubes 2 and 3 for the electric testing. Into each of the tubes was poured a sufficient amount of the warm strained gelatin solution as filled them to the level of about $2\frac{1}{2}$ ins. from the top. The tubes were set aside for the gelatin solution to become firm. There was then poured on the top of the gelatin in the right limb of No. 1 tube and the left limb of No. 3 tube as much white of egg, which had been well switched and had had its froth removed, as occupied a length of the tube equal to one inch. The contents of these two tubes (1 and 3) were then boiled in a water bath for five minutes. After allowing time for the gelatin to again set, some of the gelatin was removed from the top of the left limb of No. 1 tube, by pouring hot water into it, till the contents reached the same level as the top of the gelatin column in the other limb. As soon as the new surface of the gelatin was firm enough, as much as of the white of egg was poured in as made a column equal to that in the other limb containing the boiled albumin. A similar amount of albumin was put into the left limb of No. 2 tube. All three tubes were then placed in a water bath, their contents boiled for another five minutes, and the tubes set aside to cool.

Into each limb of each tube was then poured a column of about one inch of a one per cent. solution of $CuCl_2 2H_2O$.

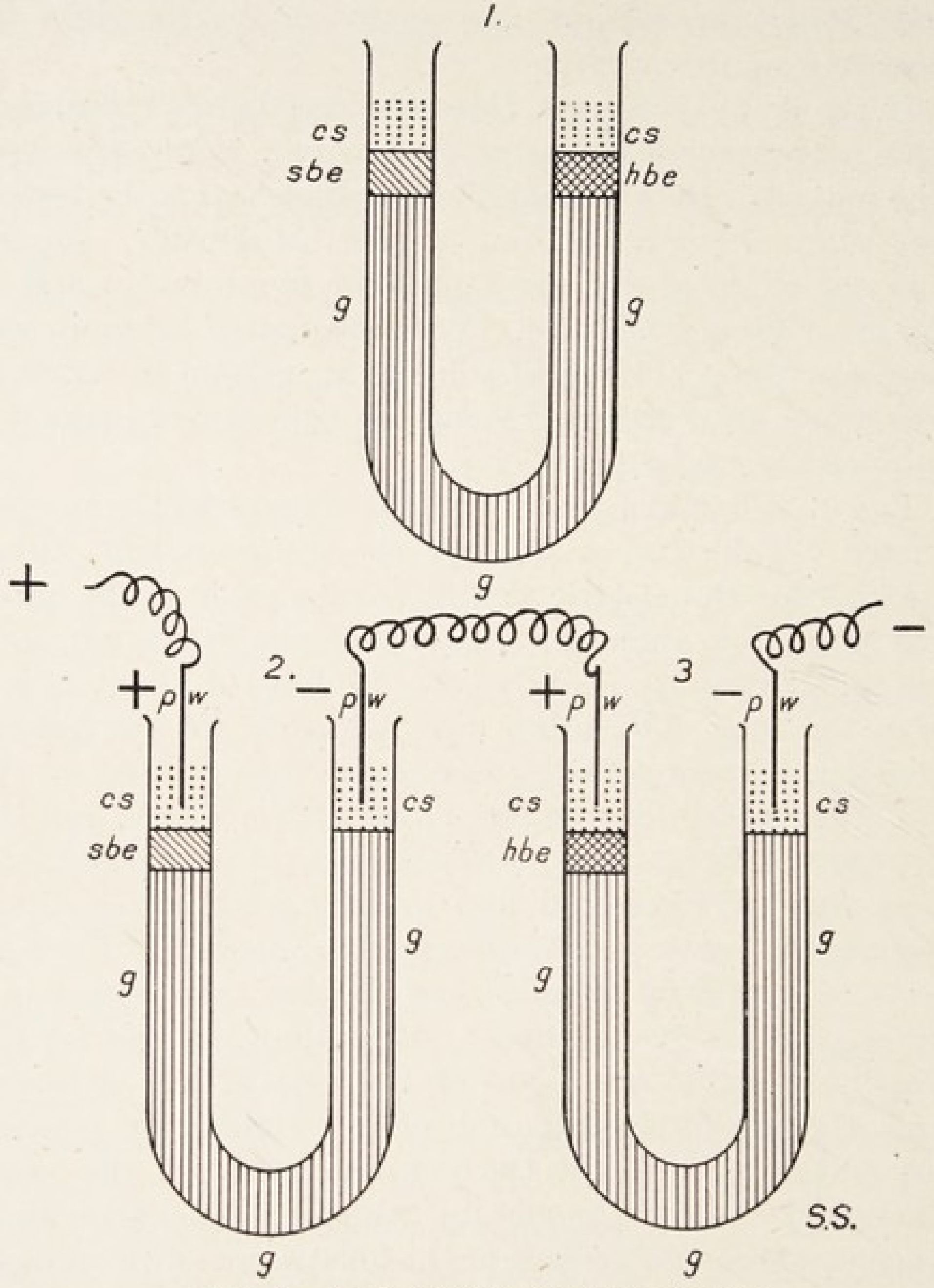


FIG. 6.—Ionic Penetration Experiment.

cs, copper solution; *sbe*, soft-boiled white of an egg; *hbe*, hard-boiled white of egg; *g*, solution of gelatin and NaCl; *pw*, platinum wires.

The result was then as in the above illustration; the letters attached to each of the divisions into which the tubes were divided fully explaining the nature of the contents of each tube. The electrical attachments were so made that the platinum wire electrodes dipping into the copper solutions in the left limb of tubes 2 and 3 were the positive poles of the combination, as shown in the illustration.

All being now ready for the testing, a current kept as steadily as possible at 13 ma. from a battery yielding 48 volts, was passed through the contents of tubes 2 and 3 for two hours; tube 1 being allowed to stand undisturbed. At the end of that time, the metallic attachments were removed, the copper solution poured out of the three tubes, and the surfaces on which they had been lying washed out gently with water.

The results were as follow: In tube 1, diffusion of the copper solution had extended down the column of white of egg which had been boiled for five minutes, that is in the left limb, to a depth of 3 mm. from the surface. In that of the right limb of the same tube where the albumin had been boiled for ten minutes, the diffused copper solution reached a depth of 1·5 mm. In tubes 2 and 3, where there had been combined diffusion and electric penetration during the same time—two hours—(and with a total quantity of current equal to about 90 coulombs), in the hard-boiled albumin limb the penetration was 4 mm., and in the soft-boiled limb, with the same (positive) pole, the extent of penetration was 5·5 mm, the purely electric penetration (2·5 mm. in each case) having been thus apparently in no way influenced by the rigidity or the resistance of the medium.

An experiment on similar lines was made, but, instead of egg albumin, a piece of the wall of the fresh stomach of the ox was employed; the animal having been killed a few hours before the experiment.

The arrangement of this experiment was as follows—

A glass tube open at both ends and having a diameter of about 2 cm. was held pressed down firmly upon a piece of the stomach wall, and as much of a one per cent. solution of the copper salt as made a column of about

1 in. above the tissue surface was poured into the tube. This was to serve as a control. The pressure of the tube against the piece of stomach wall was effected and kept up by fixing it by means of a clip, screwed to the stem of a retort stand. This proved easy and efficient. An exactly similar arrangement was made for the electric testing : a slender rod of carbon connected to the positive pole dipping into the solution, whilst a wet pad underneath the tissue served to carry off the current to the negative pole. The depths of penetration in the case of the U-tubes and of the ox-stomach experiment are thus comparable.

In the U-tube, in which there was combined diffusion and electric propulsion, the depth of penetration was 5·5 mm. in the less firmly boiled egg-albumin, and 4 mm. in the albumin which had been boiled for twice as long a time. In the case of the dense tissue of the ox-stomach owing to increased resistance to the current, only 5 ma. could be obtained from 48 volts. The length of time required for 90 coulombs was, therefore, five hours ; and the resulting depth of penetration of the copper was 3 mm. In the diffusion tests a penetration of 3 mm. occurred in the case of the soft-boiled albumin and 1·5 mm. in the hard-boiled portion ; whilst, with the dense stomach wall, absolutely no copper penetrated into the tissue after five hours' exposure to diffusion. Calculating 90 to 100 coulombs as equal to about five gynæcological doses, the total extent of penetration for one therapeutic application may therefore be reckoned as ranging from a half to one millimetre.

The calculation of the actual quantity of ionic material introduced by a given number of coulombs is a more elaborate matter ; because, since the colour test must be employed, it is necessary to have all the organic matter destroyed by a red heat and the solution made absolutely neutral, and as free from extraneous salts as possible. With practise I found the difficulties not very great and I believe that my figures will be substantially confirmed by any one who cares to repeat the experiment.

In the test with boiled egg-albumin the quantity of copper diffused into the two limbs of the No. 1 or diffusion tube was, as nearly as possible, the same—namely, 3·4 mg. pure copper in the one, and 3·3 mg. in the other. This result was quite unlooked for, since the difference in depth was so marked. In the tubes used for the electric testing, also, the same unexpected result took place; the quantity driven into each tube at the positive pole having been, in each case, 8·4 mg. of copper. In a previous experiment under similar conditions the amount of penetration differed, and so did the amount of copper affected; but the same relationship was established. The unsteadiness of the current during the greater part of the time rendered it difficult to say with absolute assurance the exact number of coulombs in each case; and the results may be expected consequently to differ somewhat.

The inference which I have drawn from a number of experiments is, that whilst the electric penetration of copper for a therapeutic gynæcological dose of ionisation varies from a half to one millimetre, the actual quantity of the copper ion introduced electrically with a similar dose, namely, about 20 coulombs, may be reckoned as about 1 mg.: that is, about one-sixtieth of a grain. Many more experiments would require to be made before a law could be formulated for each ion; but meantime the figures I have stated may, I think, be taken as not wide of the actual amount in the case of the copper ion.

The quantity of copper removed from the positive pole, on the other hand, according to Faraday's law, for 20 coulombs—which I am taking as a fair gynæcological dose—should amount, if there were no other ion present, to many times this, namely, about 6·6 mg. It must be understood that this quantity for one therapeutic dose is calculated as the amount electrically introduced and does not include the quantity which may pass in by diffusion. This, we have seen, is largely dependent on the medium through which diffusion has taken place, as well as on the time occupied in the process.

The next point in the inquiry was: What, if any, chemical change does the copper ion undergo after penetration? When employing gelatine alone as the medium, the $CuCl_2$ seemed to pass in simply as $CuCl_2$. But as the tissues of the human body cannot be considered merely as of the nature of gelatine, I set myself to find out what became of $CuCl_2$ when mixed with white of egg and with the juice of fresh meat. Now, although these two admixtures gave different results, they agreed in this, that the copper no longer remained part of an inorganic compound, but became an atom of a complex organic molecule; ceasing in both cases to give some of the usual reactions of an inorganic salt of copper. The copper thus does not enter into combination with the inorganic material in the tissues forming insoluble phosphate of copper—at least to the extent that might be supposed.

Alfred H. Allen[1] states that "if a few drops of solution of $CuSO_4$ be added to a solution of albumin, a precipitate of albuminate of copper will be produced which is soluble in excess of caustic soda or caustic potash, with the production of a fine violet coloration."

This is all the information I have been able to obtain regarding albuminate of copper. I have accordingly experimented with white of egg and $CuCl_2$, which is the salt of copper I have employed in ionic medication.

When a relatively large proportion of copper is added to egg albumin—say one per cent.—the combination becomes, I find, a semi-solid greenish white mass. If water be added to this and the mixture filtered, there flows through the filter a bluish-green solution, and the bright greenish white mass remains in the filter. The filtrate is bluish green and is miscible with water; whilst, after washing the insoluble contents of the filter, the mass

[1] *Commercial Organic Analysis*, 2nd edit., p. 12.

left is still of a bright green colour. This substance dissolves on the addition of excess of liquor potassæ with, as Allen states, the production of a fine violet coloration. A drop or two of liquor potassæ added to the filtrate produces the same violet colour. If one half per cent. of the copper salt be employed there is less of the insoluble and more of the soluble albuminate formed; whilst, if one tenth per cent. be employed there is no precipitate, only a green opalescent liquid; the copper having been completely converted into a soluble albuminate of copper.

The insoluble albuminate is thus perfectly soluble in excess of albumin, forming a different albuminate from that described by Allen; and, since there is abundance of albuminous material in the tissues, relative to the amount of copper introduced by ionisation, no part of the albuminate, unless possibly at the very surface, can be in an insoluble condition in the tissues.

I have tested the result of adding the copper salt to dilute blood serum, and, with some modifications, the same may be said of it as of egg albumin. I have corroborated this by adding liquor potassæ to a portion of animal tissue which had been subjected to the action of copper ionisation, and I find the resulting characteristic violet coloration very pronounced.

The generally accepted notion that during the ionic penetration of copper the oxy-chloride was formed is only, I now find, in part correct. Clinically, I know that this substance is deposited upon the eroded surface of the cervix uteri; but my recent investigations cause me to believe that little, if any, of this oxychloride enters into the tissues in this form.

The next point in my inquiry was: What becomes of the electrically driven ion? Does it find its way at once into the lymph channels and the blood capillaries, and so pass into the general circulation; or is it driven right on, through the cells instead of between them? In answer to this I shall quote a letter, received from the microscopist, Dr. Leslie Buchanan, who made for me the microscopic examination of the pieces of stomach wall referred to—

> "That which was subjected to ionisation is readily distinguished by having a portion of bluish-green colour highly condensed and fairly firm in comparison with the rest of the tissue. The cut surface of this condensed portion shows a greenish colour to about half its thickness (the total thickness of the tissue is 6 mm.), and exposure of the cut surface to a solution of sulphide of ammonium results in the conversion of the greenish colour into a very deep brown or almost black. The portion treated simply by diffusion shows no change from the normal either in colour or texture. Sections prepared for the microscope show that in the case of the ionisation the metal has passed through the mucous membrance and submucous tissue and lodged in the tissue of the muscle below. The metal is exceedingly finely divided, and is manifestly lodged *in* the tissue, not simply deposited on it—*i.e.* the metal is intra-cellular, not simply inter-cellular. It is evident that the mucous membrane has opposed considerable resistance to the passage of the metal, as a large amount of it is deposited on the surface of the tissue in addition to what has penetrated. In the case of the diffusion no metal is found either by the microscope, or by change of colour with ammonium sulphide, in the tissue itself."

Regarding the antiseptic action of copper in its organic form, I put this to the following test: Four tubes were taken, and into each was placed half an ounce of fresh urine of specific gravity 1020. To tube (*a*) was added 1 dr. of water; to tube (*b*) 1 dr. of white of egg. These were treated as controls. Tube (*c*) was the same as tube (*a*), but with one quarter grain of $CuCl_2 2H_2O$ added; whilst tube (*d*) was as tube (*b*), but with also a quarter of a grain of the copper salt added. Tubes (*c*) and (*d*) thus contained one part of the copper salt in 1200 parts of the slightly diluted urine. The four tubes were examined after ten days, when the contents of (*a*), (*b*), and (*c*) tubes were found to be distinctly fœtid. When examined eighteen days later, the contents of tube (*d*) were found to have remained still perfectly fresh. An albuminate of copper is, therefore, at least as powerful an antiseptic as the same proportion of the inorganic salt. I say *at least,* for, although some of the copper in tube (*c*) would probably be precipitated by the soluble phosphate in the urine, some in the tube (*d*) was also precipitated as albuminate of copper.

Since there is a solvent in the tissues for the so-called insoluble albuminate of copper, what then becomes of it? Does it simply pass into the general circulation, or may some of it still find its way into the protoplasm of neighbouring cells in the absence of repeated applications of the therapeutically applied galvanic current? Quite possibly: for local galvanic currents are normally in operation around it.

Pauli[1] states that "differences in the concentration of ions brought about through differences in their migration velocities constitute the source of differences in electrical potential." If this is so, then, since there is in the tissue fluids an electrolyte between these points of difference of potential, the result must be an electric current.

This statement is to me so interesting and important that I made, some time ago, many attempts to prove or disprove it with the aid of a delicate mirror galvanometer; employing a solution of common salt, with differences of concentration in the same liquid. I asked an expert in electro-physics and one in electro-therapeutics to join me in the investigation, with the result that we all came to the conclusion that the statement seemed to be untrue. However much it might be true, therefore, it was to me then a possible truth only.

Recently I again attacked the problem and discovered that, although not absolutely true, it was yet a half-truth.

[1] *Physical Chemistry in the Service of Medicine,* 1st edit., p. 42.

No matter how great might be the difference in concentration of contiguous solutions, no current could be observed to pass between them. I noticed, however, that there was generally a slight deflection of the needle at the moment of insertion of the platinum wires, which were connected to the galvanometer from the points in the solution where the densities differed; but this current immediately stopped when the wires were at rest in the solution. This led me to the conclusion that the difference in concentration alone was not sufficient to cause a current. If, however, whilst the wires were at rest and dipping into parts of the solution of widely different degrees of concentration, the fluid was then shaken, at once and on every such occasion a decided amount of deflection of the galvanometer needle ensued. Therefore there *is* a difference of potential and a resulting current, but only when there exists at one and the same time a difference of concentration and a flow or movement in the solution.

Now, this is exactly what exists in a greater or less degree throughout the living organism, there must therefore be, in and around the organic copper compound with which the tissues are impregnated, constant, although weak, galvanic currents; and consequently some degree of direct penetration into the interior of neighbouring cells by ionic propulsion, as when the therapeutic current is being applied.

I find that the more the disturbance of the solutions of different degrees of concentration, the greater is the current generated. Every muscular movement, therefore, must assist in the migration of ions introduced into the tissues in the manner we have been considering.

Effects of Combined Electrolysis and Ionic Penetration on Animal Tissue

To ascertain what would be the effects of combined electrolysis and ionic penetration when a bare electrode is placed directly on animal tissue, I took a piece of fresh animal tissue, thrust a copper electrode—simply a piece of copper wire—into one spot, and, sufficiently apart from that point, an electrode of platinum wire; attaching the copper electrode to the positive and the platinum electrode to the negative pole of the battery.

The current was allowed to remain in action for about fifteen minutes, when the platinum probe was easily lifted out of the tissue, a solution of sodium hydroxide (caustic soda) having formed at the negative pole as we saw previously; whereas the copper was adherent, since the oxygen and the hydrochloric acid, which had separated at the positive pole out of the NaCl and the H_2O of the tissue, had coagulated the albumin of the flesh around the electrode.

These were the results of electrolysis; but something else had taken place as well. When the part, where the copper wire had been inserted into the tissue, was examined, it was found that the HCl resulting from the electrolytic action had gradually dissolved some of the metal; and that the resulting copper ions had travelled a certain way from the positive pole into the tissue. This is ionic penetration. If the process had been allowed to continue sufficiently long it would have been impossible to remove the copper rod without tearing away some of the flesh. In that case, if the current were reversed for a few minutes, the copper being then attached to the negative pole, sodium ions would be attracted to it; the tissue would be softened, and so the copper wire could be easily lifted out.

Suppose the current, instead of being directed as above, were reversed, no metallic ionic penetration would of course take place from the copper electrode, now the negative one, and no solution of the platinum at the positive pole would be possible; because platinum is insoluble in hydrochloric acid. The result would then differ from what was observed above, in that, whilst the copper electrode would be bathed in the alkaline solution, the action at the platinum, or positive pole, would be more widespread; for, the acid evolved, being unable to combine with the platinum, is at liberty to penetrate into the tissues, acting as an acid caustic on the surrounding structures. The caustic action, on the other hand, at the copper electrode when it was the positive pole was less extensive; since the acid had acted on the copper, instead of on the tissues.

Size and Weight of Atoms

As we have seen that the amount of an ion deposited in the tissues, relative to the quantity of current passed, can be determined, let us now find what this means in ions. The quantity in grains gives no idea as to the *number* of ions which this weight may imply; and, before we can even in imagination conceive of this, it is necessary that we should know the size and weight of the ultimate atoms of matter.

All atoms may be considered to be of the same *dimensions*—at least, that is the present belief—and this dimension is given as 10 raised to the power of minus 8 of a centimetre (10^{-8}, or $\frac{1}{10^8}$ cm.); that is to say, a ten-millionth part of a *millimetre*. The *weight* of an atom of hydrogen is somewhere between 10^{-24} and 10^{-25} of a gramme—that is, about the ten-quadrillionth part. The weight of an atom of oxygen will, therefore, be sixteen times that of an atom of hydrogen, the weight of an atom of copper sixty-three times, and so on; the weight of any atom being the weight of an atom of hydrogen multiplied by the atomic weight of the particular substance, the actual weight of the atom of which is to be determined.

It may be interesting to mention here that the weight of an atom of electricity—an electron—has been calculated to be about the 1700th part of the weight of an atom of hydrogen, and its linear dimension about the 100,000th part.

Number of Atoms in a Therapeutic Dose; and size of Atoms Relative to that of Septic Germs

I have calculated the medicinal dose of copper ions in gynæcological practice as about one-sixtieth of a grain. It may appear that the mountain having been in labour a very small mouse has been born; but think of what this small fraction of a grain means in atoms. It means millions of millions of millions of ions of copper. It is as difficult to grasp the meaning of this as it is to appreciate the practically immeasurable distances of some of the stars in astronomical space.

Further, let it be remembered that septic organisms such as the streptococci are so large compared with these atoms that quite a large "force" of atoms could enter and take possession of one of these cocci; whilst, at the same time, as we have seen, the atoms in one therapeutic dose are so numerous that millions of millions of streptococci could be attacked by this large "force" of antiseptic ions out of this sixtieth of a grain of copper.

I have dwelt somewhat too fully, it may be thought, on the subject of ions. My excuse must be that I wished to give a clear mental picture of the principles of electricity in motion through an electrolyte, such as the body fluids; and, for a further reason, that ionic medication has formed a large part of my work in electro-therapy in gynæcology. The importance of the subject may therefore excuse—may, indeed, almost have required—some repetition.

CHAPTER VII

ALTERNATING AND OSCILLATING ELECTRIC CURRENTS

Induced currents; nature of origin from other currents and from magnetisation; primary and secondary coils, variation of voltage in; current more than voltage important in the primary coil; sinusoidal currents; brief statement as to the nature of high-frequency currents and the methods of producing them.

WHAT is called the induced current, the alternating current, or the faradic current, is of considerable value in electro-therapeutics; and therefore a brief account of it is necessary.

I make no apology for the use of the word *faradic*, any more than for the use of the word *galvanic*. These terms may be old-fashioned in the eyes of electrical experts. They are still employed, however, by electro-therapeutists, and for this reason I retain them.

We have seen that, in static electricity, an electro-static field cannot exist without a surrounding field of opposite polarity being induced. This is static induction. A similar result follows the presence of electricity in motion; but only when a current is started, stopped, increased, or diminished; and only in a neighbouring closed circuit. This, which is called an induced current, is momentary, and it occurs only when the other closed circuit is in the immediate neighbourhood of the acting or primary one. This induced current may be considered as an opposition current, an indication of resentment to electrical change—an inertia current, as it might be called. It is in an opposite direction to the inducing current when this is starting or being increased; but in the same direction as the exciting current when it is the result of a diminishing, and especially of a suddenly arrested current.

A current becomes intensified in its inducing power in proportion to the number of times the wire, along which it is passing, is wound round an axis. When thus arranged it is called a coil. The inducing coil is called the primary : the coil in which induction takes place being the secondary. Magnetisation has a similar influence; magnetisation, demagnetisation, and increase or decrease of a neighbouring magnetic field, will each act similarly to an electric field on a neighbouring closed circuit.

We have seen that an electric current will influence the needle of a mariner's compass. This is in virtue of its creation of a new magnetic field. So, not only will magnetism cause electricity, but electricity will cause magnetism. In the faradic or induction coil both of these principles are brought into action.

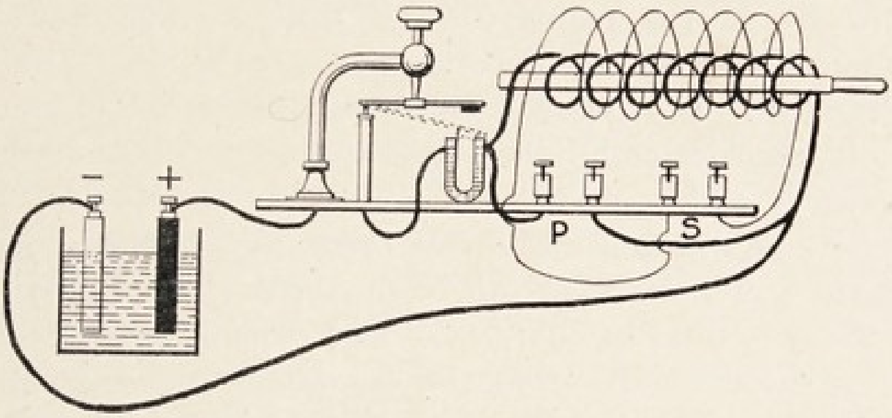


Fig. 7.—Diagram of the Faradic Coil.[1]

A study of the diagrammatic Fig. 7 will make the principle of the faradic coil clear.

The current is represented here as coming from the positive pole of a cell, passing to the adjusting screw of a vibrating hammer, thence to a horse-shoe magnet from which it is continued to the primary coil, and then back to the negative pole of the cell. The circuit is thus complete. As soon, however, as the core of the electromagnet has been sufficiently magnetised by the circulation of the current through it, the hammer is attracted towards the magnetised core; and thus the

[1] Slightly modified from Fig. 19, *Medical Electricity.* Lewis Jones, 4th edition.

circuit is broken at the point of the screw. The core thus loses its magnetism, the recoil of the spring, to which the hammer is attached, brings the hammer back to its original position, and so the circuit is again closed and the current resumed, to be again broken as before. The frequency of the vibrations is regulated by the screw. Sometimes the core of the primary coil is utilised for making and breaking the circuit, instead of the horse-shoe electromagnet. The connections of the primary and secondary coils to their respective terminals are clearly shown in the diagram. It will be observed that there is no metallic connection between the two coils.

In the construction of the faradic apparatus a hollow bobbin is wound with moderately thick copper wire so as to act as the primary coil. Into the hollow of the bobbin is inserted a core of soft iron, or a bundle of soft iron wires. Electrically insulated from this bobbin is wound another coil of long fine wire. This is called the secondary coil.

There is, at each make and break, an induced current in both coils. The current of make, as it accumulates—for it takes time to charge the iron core with its magnetism—causes a current in the secondary coil opposite in direction; whilst the break of the current in the primary coil causes in the secondary coil, as was stated, a sudden induced current in the same direction as that in the primary. The voltage of the current of break is higher than that of make in virtue of its greater suddenness of action. Not only so, but the greater the number of turns of the secondary coil, the higher will be the voltage of the resulting current; although there will accompany this higher voltage a lower amount, or quantity, of current due to the resistance of the longer wire. When a large amount of current is obtainable for the primary circuit, as that available from an accumulator; or when the internal resistance of the ordinary voltaic cells is low, and the quantity, therefore, relatively great in spite of low electromotive force, fewer turns in the primary coil are required. On the other hand, if cells of relatively high internal resistance, such as those generally used for electro-therapy, are employed—in which case small currents only will be available on account of the increase of resistance—the primary coil must be wound with a larger number of turnings: the magnetisation being in proportion to the number of turnings with the same amount of current. Thus 1000 turnings with 1 ma. passing through the coil will have the same inducing power as 100 turnings with 10 ma. passing through it. Of course this increase of resistance, due to increased length of wire, will require several cells combined as a battery; thus giving a higher electromotive force, so as to overcome this increase of resistance and produce the required quantity of current. It should be borne in mind that the increase of voltage in the battery is simply to overcome the resistance of the coil in order to produce a sufficient quantity of current; the amount of magnetisation being dependent, not on the voltage but on the quantity of the current circulating through the primary coil. I have known ignorance of this fact account for much disappointment in the employment of faradisation clinically. The best "faradic coils" are made with many windings in the primary, with power to tap these at various points to suit the current and voltage available.

The current from the primary coil, as the diagram (Fig. 7) shows, is a combination of an interrupted galvanic current and an alternating induced current.

There is an alternating current, sometimes employed in electro-therapy, called, from its origin, the magneto-electric current. Its other name—sinusoidal—arises from its nature. It is in the form of a curve rising from zero to a maximum and then descending through zero to a maximum in the opposite direction. It differs from the alternating induced current derived from a faradic coil, in that it changes at a regular rate and has not the abruptness of the faradic current.

High-frequency Currents

When two electrodes with a static charge and of opposite polarity are brought sufficiently near to each other a spark is observed to pass between them; which, though apparently instantaneous, is in reality made up of many oscillations before the two electrodes have become neutral. The same takes place between the terminals of an induction coil, if of large enough size, and especially if the coil be fitted with a condenser: which the induction coil we have been considering above for the production of faradic currents does not possess.

For the production of high-frequency currents a powerful induction coil is required. If each terminal of such a secondary coil be connected to the inside coating of separate Leyden jars with a suitable sparking connection between them, almost continuous sparking will occur. If a helix of thick wire be interposed between the outer coatings of these condenser jars, currents of very high potential will flow along this helix at enormous frequency. With one end of the thick wire helix attached to a condenser, such as a large metallic plate under a couch, and some other part of the helix attached to another condenser, such as the human body, a current of high potential and high frequency will oscillate between the couch plate and the body with powerful physical and therapeutic effects.

Considering the thick wire helix—the lower solenoid—as a primary coil with a secondary fine coil extending from it, similar oscillating currents, but of much higher voltage, can be obtained between the end of the primary coil and the termination of the secondary, the upper solenoid, or resonator as it is called.

These are very briefly the principles of the production of high-frequency currents. The explanation will be made somewhat clearer when, in the next chapter, the complete apparatus for the production of such currents is shown and explained, by means of a diagram.

PART II

ELECTRO-MEDICAL APPARATUS REQUIRED

CHAPTER VIII

STATIC, GALVANIC, FARADIC AND HIGH-FREQUENCY APPARATUS

The static machine; difficulties in working with; the static current, its value in electro-therapy; the static induced current; continuous current apparatus; the Leclanché cell described; method of connecting to form a battery; rheostats required; the cell collector; the shunt rheostat or volt selector; the electric cautery; the accumulator or secondary battery; its principles; voltage when fully charged; arrangement of cells "in parallel" for cautery and "in series" for the faradic coil; bichromate cells for cautery in Schall's battery; the faradic current outfit; the kind of faradic coil suitable for efficient electro-therapy; means of controlling its current; high-frequency apparatus; suitable induction coil; necessity for a good break; the Leslie Miller gas break; form of high-frequency solenoid employed by the author; the condenser couch.

THE STATIC MACHINE

A GOOD static machine is of great value in electro-therapy, but it is costly, and the difficulty of keeping it in a constant state of readiness is considerable in this climate. In Glasgow—a city not famous for its dry atmosphere —I have succeeded in keeping my static machine in fair order; but only by frequent attention, regular cleaning, and artificial heating. The beneficial results obtained from it have, however, quite repaid me for all the trouble and expense. The principal use I have put it to is in the form of the static induced current first proposed by Morton of New York. The illustration (Fig. 8) shows how this current is to be obtained from the ordinary static machine. The Leyden jars should be about pint size, and the spark gap capable of a very gradual separation.

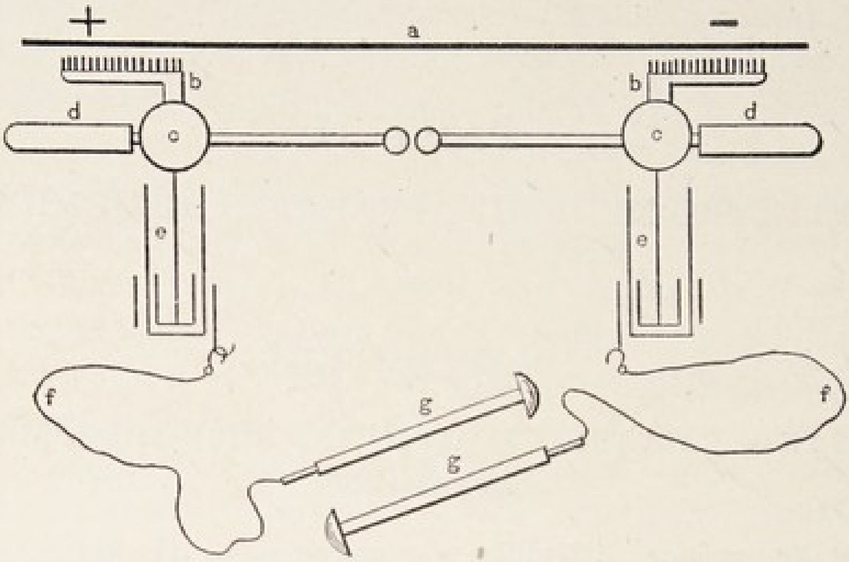


FIG. 8.—Static Induced Current: Diagram.[1]

a, rotating plate of a static machine; *bb*, collecting combs; *cc*, prime conductors; *dd*, discharge rods; *ee*, Leyden jars; *ff*, conducting cords; *gg*, sponge or other electrodes. The circuit-breaker is in the primary circuit, and the patient in the secondary.

The Continuous Current Apparatus

A battery of any convenient form of cells may be employed for galvanisation, regarding the advantages and disadvantages of which any textbook will supply information. I shall describe the Leclanché cell only, since I have relied upon it for many years as a source of electromotive force (see Fig. 9).

This cell is a zinc carbon one: the zinc terminal being, of course, the negative pole, and the carbon terminal the positive. The exciting ionic liquid is a strong solution of chloride of ammonium, which should reach to near the top of the cell. These cells can be easily kept filled up with tap water as required, the glass of the jars showing the levels. The zinc rods occasionally require scraping or renewing, but the porous pot which contains carbon in powder, mixed with black oxide of manganese to prevent polarisation, will with moderate use last for an

[1] From *Transactions of the American Institute of Electrical Engineers*, November 1893.

almost unlimited time. The internal resistance is fairly high; but this I have not found to be a drawback.

To form a battery of these cells it is sufficient to join the zinc terminal of one cell to the carbon terminal of the next in order: the first carbon terminal and the last zinc one being thus left as the poles of the battery.

Fig. 10 illustrates how any variety of cells should be connected so as to form a battery. In this figure the connections from the battery to a current reverser are shown.

Fig. 9.—Leclanché Cell.

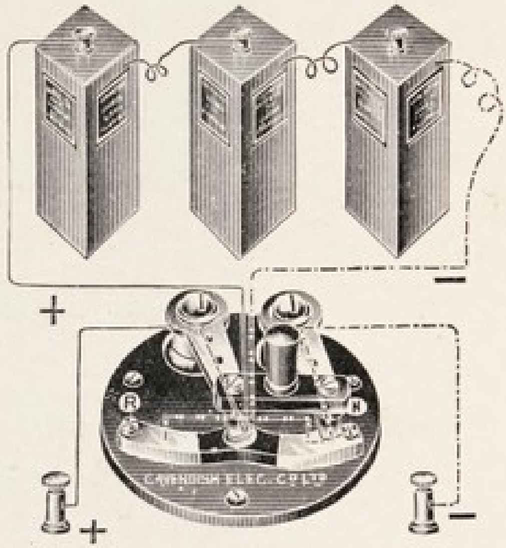


Fig. 10.—Small Battery of Cells, with Current Reverser attached.

For all electro-therapeutic purposes in gynæcology a battery of about thirty such cells, so as to give, if in good condition, an electromotive force of from 40 to 45 volts, will suffice as a source of electric energy. To restrain the current from this battery sufficiently I employ the usual sliding graphite rheostats. Three such, arranged in series—that is, so that the current passes through each of them on the way to the patient—may be fixed on a board with proper connections. A useful assortment will be found in, say, one of 10,000 ohms, one of about 2000, and a third of about 200 ohms. With the whole of such rheostats " on," such a battery as I have described can safely be started in full force : for thus the resulting initial current would not exceed two or three milliampères when, to the resistance of the rheostats, is added that of the patient. This is by no means a large quantity to turn on at once in pelvic cases.

Another means of restraining the current and gradually increasing it is the cell collector seen in Fig. 11, which illustrates a convenient form of portable galvanic outfit.

Fig. 11.—Portable Galvanic Outfit. The Cell Collector is seen on the left.

By means of this device a single cell of the battery can be put into action at first, and the current then gradually increased by adding as many cells as may be required. I employ both of these means of controlling the current according to the indications.

What is called a "shunt rheostat" is, however, almost a necessity for electrisation of the brain, especially in the case of sensitive patients. It is constructed on the principle that only part of the current, slowly increased by a sliding apparatus, is permitted to pass through the patient; the rest of the current passing simply through the wire rheostat back to the battery. Fig. 12 represents diagrammatically the principles of this instrument and the mode of operating it, as it would be if the current were

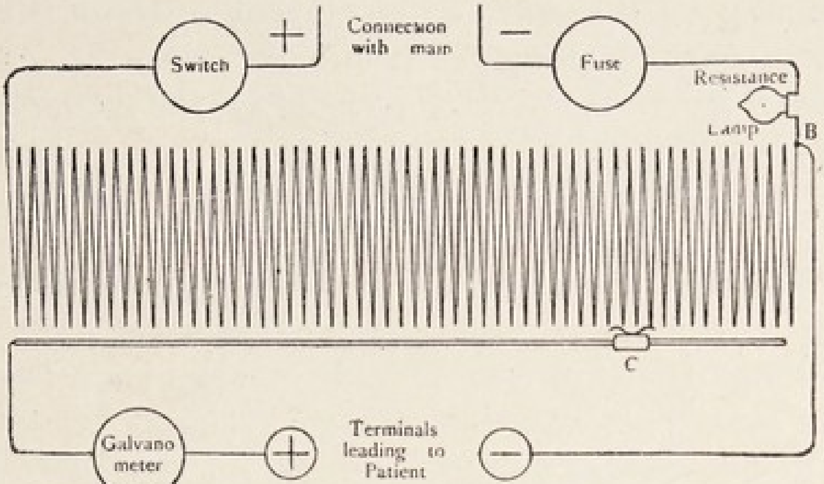


Fig. 12.—Diagram of "Shunt Rheostat." (Schall, London.)

obtained from the main electric supply; Fig. 13 illustrating the instrument itself, with a "cut-out switch" attached.

The shunt rheostat acts as a volt selector; and, if working properly, can be made to start from zero and have its voltage increased by exceedingly slow gradations.

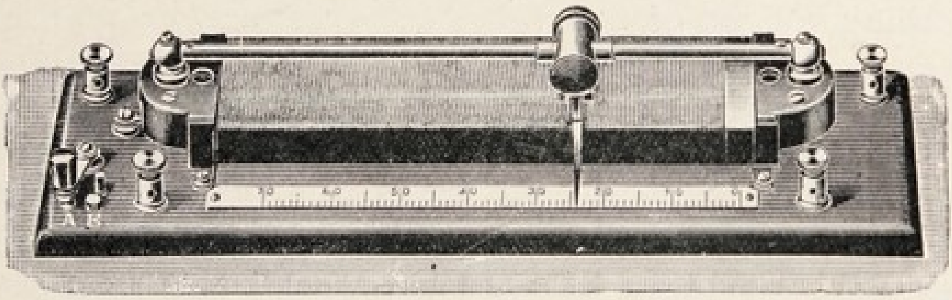


Fig. 13.—Shunt Rheostat or Volt Selector. (Schall, London.)

Thus applied there can be no possible shock from a sudden increase of current, as is apt to happen when the graphite rheostats, above described, are employed. These rheostats in series are unnecessary with the shunt volt selector. When, however, the latter instrument is employed, not in association with Leclanché cells, but from "the main," I do not approve of its employment, believing it to be not free from danger under these circumstances. This volt selector is excellent in pelvic applications, whilst, as I have stated, it is almost essential for galvanisation of the brain. The sliding portion of the instrument should work smoothly, so as to avoid jerks.

I employ all three means of current restraint; but if one form only is employed, the shunt rheostat, or volt selector, if working smoothly and not off the main electric supply, is the best.

The Electric Cautery

An electrical apparatus for cautery purposes is essential to the gynæcologist. The current for this may be obtained from an accumulator or secondary battery. This is sometimes called a storage battery; but it contains in no sense a store of electricity, any more than an ordinary voltaic cell does. It is a secondary battery in that, by the action of electrolysis on lead plates, a difference of potential is set up and retained till the cell is discharged; when it can again be charged from the main electric supply. Each cell should be charged up to an electromotive force of 2·5 volts. The advantage of such a cell is that it can be conveniently kept at its working voltage of two volts, when there is easy access to an electric light circuit. Its internal resistance is low, and so the output of current is relatively high.

For cautery purposes four cells are sufficient, with each of two pairs arranged "in parallel"; that is, with their two positive poles connected together so as to form one pole, and their two negative poles similarly connected to form the negative pole. There will thus be two double cells instead of four single ones. The total E.M.F. will then necessarily be reduced to four volts and the internal resistance correspondingly decreased. With the cells arranged in series, as is the case in a battery of Leclanché cells, these accumulators are admirably suited for faradic coils, the internal resistance of these cells being low. With two cells, arranged in series, there will be sufficient current, and, at the same time, sufficient voltage to overcome the resistance of the primary coil.

A battery of large bi-chromate cells will serve the purpose of an accumulator, and will be found convenient

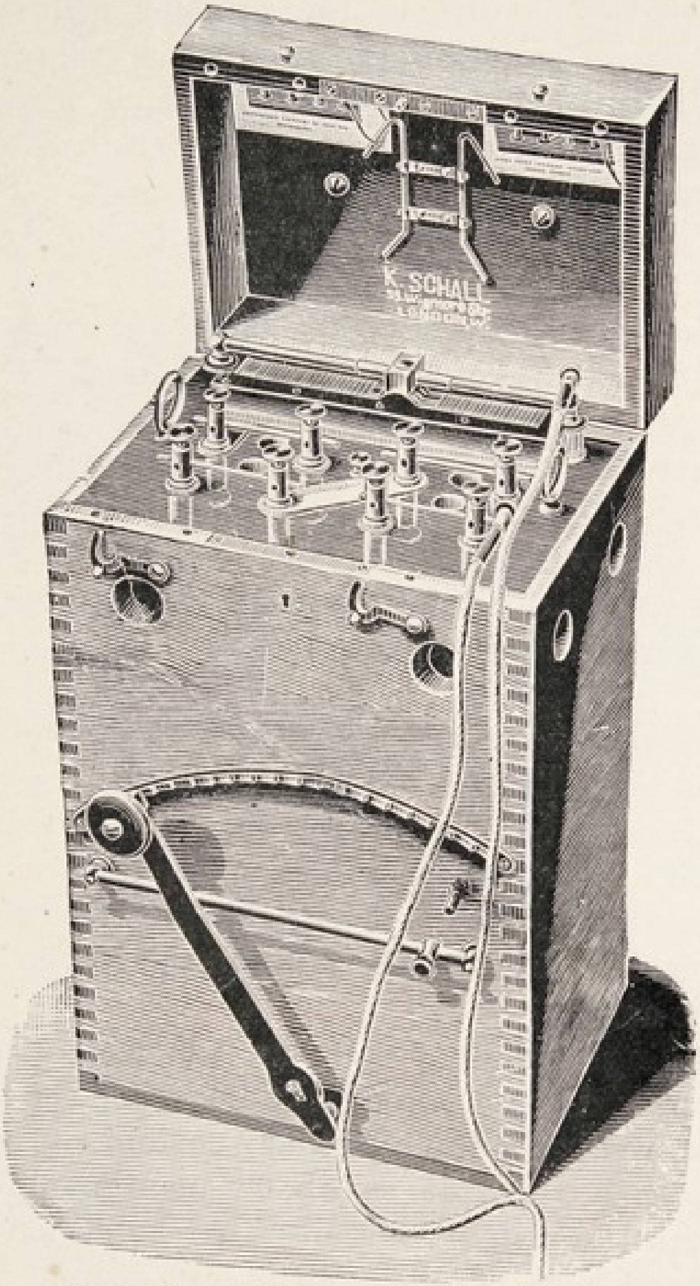


Fig. 14.—Bichromate Cautery Battery.

where there is no electric light circuit at hand. Schall's bichromate cautery battery is very reliable. It is essential, however, that the plates be kept clean and the solution fresh (see Fig. 14).

The Faradic Current Outfit

The possession of an efficient faradic or induction coil is essential in electro-therapeutics. It ought to have varying lengths of wire in the primary coil, with the means of easily selecting the number of those desired. The first layers should be of fairly thick wire for the purpose of giving large currents; which thin wire, owing to increased resistance, would unduly check. The same means of tapping should be present in the secondary coil; and this ought to be composed of a total number of turnings of at least 12,000. The vibrating hammer ought to be capable of having its vibration rate varied, and ought to be steady in its action.

There are various methods of restraining the induction coil current. This is of more importance than in the case of the galvanic current, especially if the application is to a sensitive portion of the body. For obtaining this restraint various devices are employed.

1. A low-power metal rheostat to restrain and regulate the current from the battery to the primary.
2. A movable core which can be entirely removed to start with; or if a fixed core, then a movable metallic tube over it as a shield; withdrawing the shield having the effect of increasing the action of the core.
3. A sliding secondary coil; as, the more this coil is removed from completely covering the primary, the weaker is the secondary current.
4. Besides a rheostat as above mentioned in series with the primary circuit—that is, placed between the source of the continuous current and the primary coil—there should be one of greater resisting power "in series" with the patient; which means, intervening between the secondary coil and the patient. The rheostat described for controlling the galvanic current ought to be

capable of being switched on to the secondary faradic circuit for this purpose.

For the safe and efficient use of this valuable current the whole of the above means of control should be at hand. In most cases this is essential.

Fig. 15 is an illustration of the ordinary sledge coil. The secondary coil is represented as partially withdrawn from the primary. For the relation of the component parts of the apparatus to the production of primary and secondary currents, see Fig. 7, p. 53.

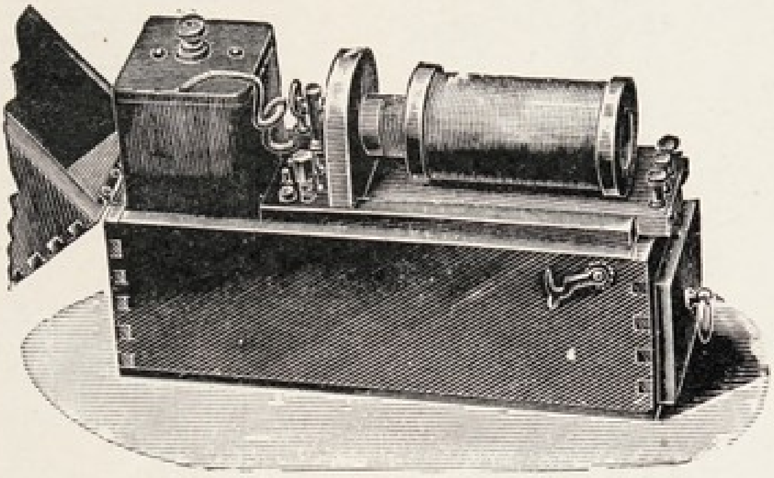


Fig. 15.—Sledge Faradic Coil.

High-frequency Apparatus

The cost of a complete outfit of high-frequency apparatus may prevent some from investing in it. It is indispensable, however, for the thorough carrying out of electro-therapy in gynæcology, and it will be found worth all the cost of the finest installation obtainable. The induction coil which I use for the production of high-frequency currents is a 12-inch one, and it is capable of giving a good thick spark.

The Leslie Miller gas interrupter is certainly the best of which I have had experience. It is efficient, free from the odour of gas, requires practically no cleaning or adjusting, and is ever ready, unless in the coldest weather, when there may sometimes be a little difficulty in starting it.

Fig. 16 illustrates the high-frequency apparatus which

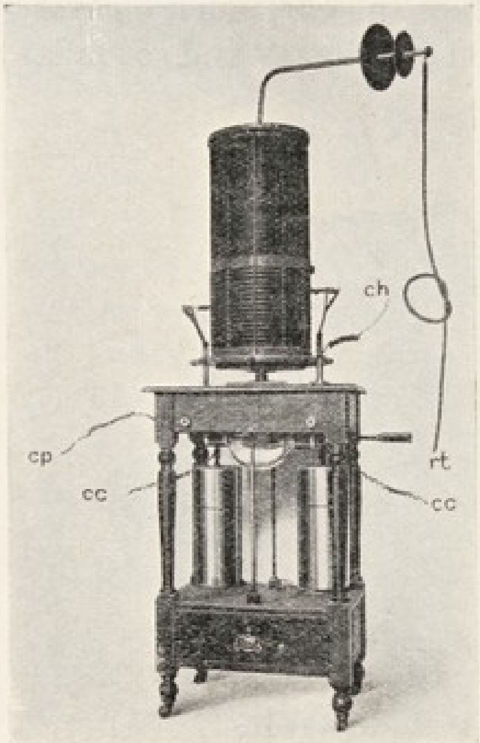


FIG. 16.—High-frequency Apparatus.[1]

cc, coil connections to sparking tube; *cp*, wire to couch plate; *ch*, wire to couch handles; *rt*, resonator terminal for effleuve, vacuum, condenser, mono-polar and bi-polar electrodes.

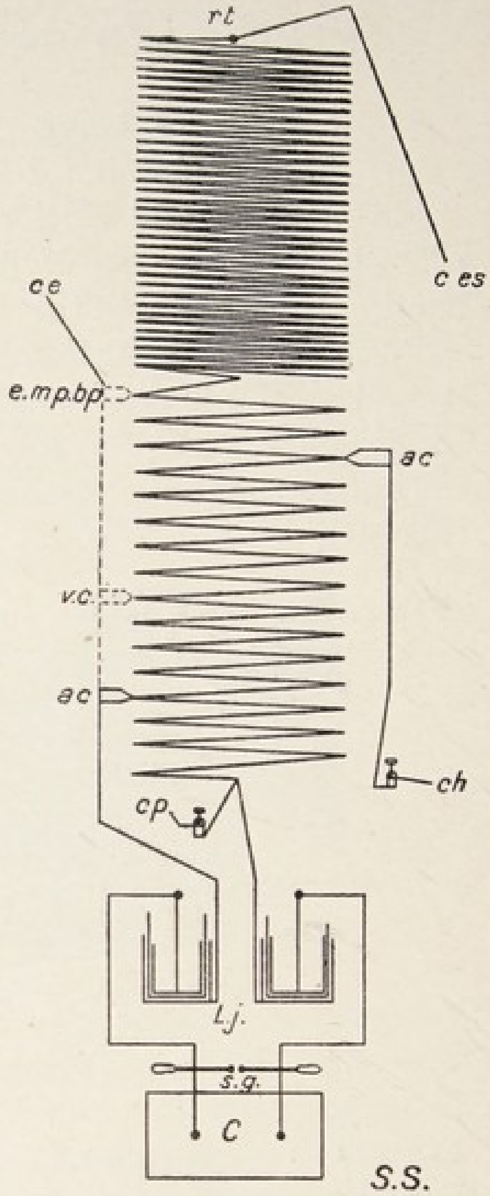


FIG. 17.—Diagrammatic Plan of High-frequency Apparatus.

C, induction coil; *sg*, spark gap; *Lj*, Leyden jars; *cp*, connection to couch metal plate in all high-frequency applications; *ac*, *ac*, position of movable contacts for auto-condensation; *ch*, connection to couch handles (in auto-condensation applications); *v.c*, position of left movable contact for vacuum or condenser applications; *e.mp.bp*, position of left movable contact for effleuve, mono-polar and bi-polar applications; *rt*, resonator terminal; *ce*, connection to electrode in bi-polar applications; *ces*, connection to effleuve, mono-polar, bi-polar, vacuum tube and condenser electrodes.

[1] Specially made by Mr Trotter, 40 Gordon Street, Glasgow.

I employ; whilst Fig. 17 is a diagrammatic view of it and explains the essential principles of high-frequency currents. The Leyden jars should be large, and should be kept clean and fitted with close metallic contact internally so as to avoid inside sparking. The sparking chamber ought to be frequently cleaned and dried with methylated spirit. I find that small pieces of unslaked lime, placed in the chamber, not only considerably deaden the noise,

Fig. 18.—The Condenser Couch.

but absorb the moisture. The spark regulating handle must also be kept clean, and should work out and in by means of a screw movement. The application of the effleuve, the vacuum and condenser electrodes and the bi-polar form of administering high-frequency currents will be further explained, in future chapters, where their employment is recommended.

Fig. 18 shows the "Condenser Couch." Besides its special use for high-frequency currents, it serves as a gynæcological couch for the employment of other forms of electro-therapy.

CHAPTER IX

ACCESSORY APPARATUS

Measuring instruments; the galvanometer, shunts in; the author's faradimeter, its construction and the method by which it is calibrated; reasons for employing it in all applications of the faradic current; high-frequency milliampère-meter; accessory apparatus; the current reverser; a current interrupter by means of a metronome; electrodes, etc.; special gynæcological electrodes; the author's special ionisation electrodes; importance of rigid wire connections, in continuous current applications; the author's vaginal and rectal high-frequency electrodes.

Measuring Instruments

In electro-therapy, as in other fields of science, exact measurement is of vital importance, and the recent advances in electro-therapy are largely the result of the careful applying and recording of measurements. For measuring the continuous current a galvanometer is employed, having its scale marked in milliampères. Any textbook on electro-physics may be consulted if the reader desires information regarding the construction of this instrument. It ought to possess what are designated shunts; so that part of the current which passes to the patient is allowed to pass away outside the instrument proper—9/10ths or 99/100ths, as the case may be—and thus the needle, by the same amount of swing, can be made to record 1 ma., 10 ma., or 100 ma., as may be required. The d'Arsonval Galvanometer is a reliable instrument (see Fig. 19).

When I began to employ electricity in the treatment of disease there was no instrument available for the measurement of faradic currents; and so one could be guided only by the sensations of the patient. The circuit might, indeed, be broken, and, unless a large current was being employed, neither the patient nor the operator might be aware of this. In recent years, however, I have used what I call a faradimeter, of my own design (Fig. 20), and it has given me much satisfaction and help.

I had observed that a patient receiving the faradic current on so sensitive an area as the brow could not detect the presence of less than a quarter of a milliampère, and so the instrument was constructed to indicate currents

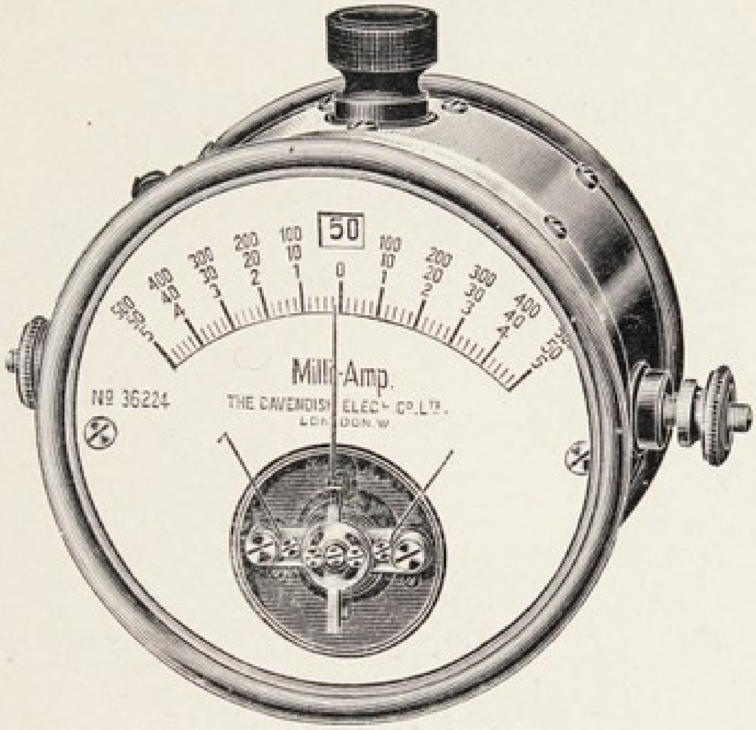


Fig. 19.—The d'Arsonval Galvanometer.

even smaller than this. The apparatus consists of two fixed bobbins of fairly long wire with a long thin vertical bobbin of finer wire, suspended between these by means of a bronze ribbon. Although the currents which it is measuring are in opposite directions, the needle does not oscillate as would the needle of a galvanometer if employed for such a purpose. The bobbins are so wound that the electromagnetic poles contiguous to the ends of the suspended coil are always of opposite polarity, and therefore one attracts what the other repels. The large bobbins, being fixed, cannot rotate, and so the whole force of the resulting magnetism tells on the suspended movable coil.

Calibration of the instrument was a difficult problem. At first I graduated the scale by means of a galvanometer, using the constant current from a battery; reckoning that this was the nearest I could get to accuracy; since

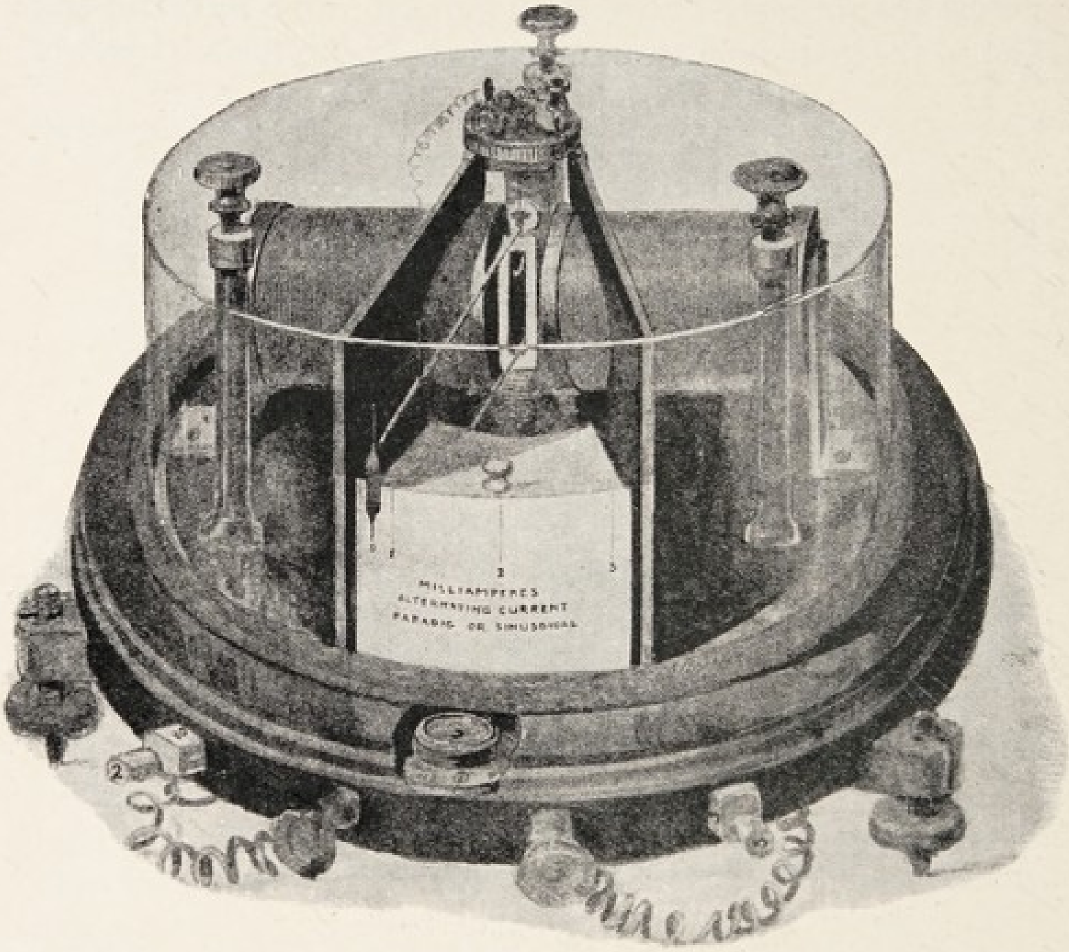
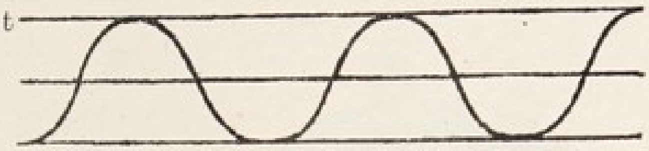


FIG. 20.—The Author's Faradimeter.[1]

on using the commutator of my sinusoidal apparatus for converting the alternating into the direct current I found little difference in the position of the needle on the scale of the faradimeter. The direct current was usually slightly stronger than the alternating; but was not invariably so. I found, however, to my surprise, when using the sinusoidal direct current, passing *it* through the gal-

[1] Made, from the Author's instructions, by Messrs. Baird & Tatlock, Glasgow.

vanometer, instead of the battery current, to calibrate with, that 1 ma. on the galvanometer became nearly what had previously been marked as 2 ma. on my scale. Two milliampères became nearly four, and so on—the record being nearly always doubled. I could only conclude that, whilst the galvanometric measurement was the average of this wavy current, my faradimeter gave me the distance of the *tops* of the waves from the zero line, thus—



Obviously, since the alternating sinusoidal gave practically the same amount of deflection at the same speed, and with the same resistance, the same reason holds good for the alternating as for the direct sinusoidal—namely, that the deflection of the needle was twice as much as the average of the current would have led one to expect. I have accordingly calibrated my instrument as if for the sinusoidal direct current. The scale may, however, be checked when desired by means of an ordinary milliampère galvanometer and a few Leclanché cells, if what has been stated above is borne in mind.

It may be said that no accuracy can be expected when measuring the faradic current, the character of the alternations varying so much by every slight change in the action of the rheotome. This is true, but in a small degree only, and it is not sufficient to diminish the value of the measurements for therapeutic purposes; for, if the reading does not give the actual measurement, it does give the virtual amount, and the record is relatively, if not absolutely, correct. But it may be asked: "What is meant by one milliampère of the faradic current?" I answer: It is the *electro-magnetic* equivalent of an amount of *sinusoidal alternating current* the *galvanometric measurement* of the *sinusoidal direct equivalent* current of which is one milliampère.

The measurement of the faradic current may be impracticable; it may even be unscientific to speak of this current in terms of the milliampère; but this result of an attempt to measure it is to the electro-therapeutist of practical value; nay, more, I am safe in saying that, with the same kind of coil, the same rapidity of vibrations of the rheotome, and the same amount of deflection of the needle, the therapeutic effect will always be the same. It is a reliable means of registering the presence of the current in the patient; and, other things being equal, it is an accurate register of the amount of current passing through the patient. I am not aware of any other instrument which can do so much.

Fig. 21.—High-frequency Milliampère-meter.

The faradimeter must be carefully levelled by means of the levelling screws when it is set up; and currents of cold air around it should, if possible, be avoided; since these might slightly displace the needle, temporarily, from the zero line.

In its present form the instrument has no iron cores and no permanent magnets. Its records are, in consequence, more reliable.

For measuring the amount of high-frequency current given, the hot-wire milliampère is employed (see Fig. 21).

Current Reverser

When, for any reason, the current has to be reversed, what is called a current reverser is required; otherwise the wires would require to be detached and re-attached, which would be a great inconvenience. (Fig. 10, p. 59, shows the instrument.) By means of this the current can be reversed easily and safely, with proper precautions. The main precaution is, that the current be gradually reduced to zero before reversing it, and then, after reversing the switch, as gradually increased to the desired amount.

Besides the usual vibrating hammer attached to the faradic coil, there ought to be at hand a means of making and breaking the current at intervals of one or two

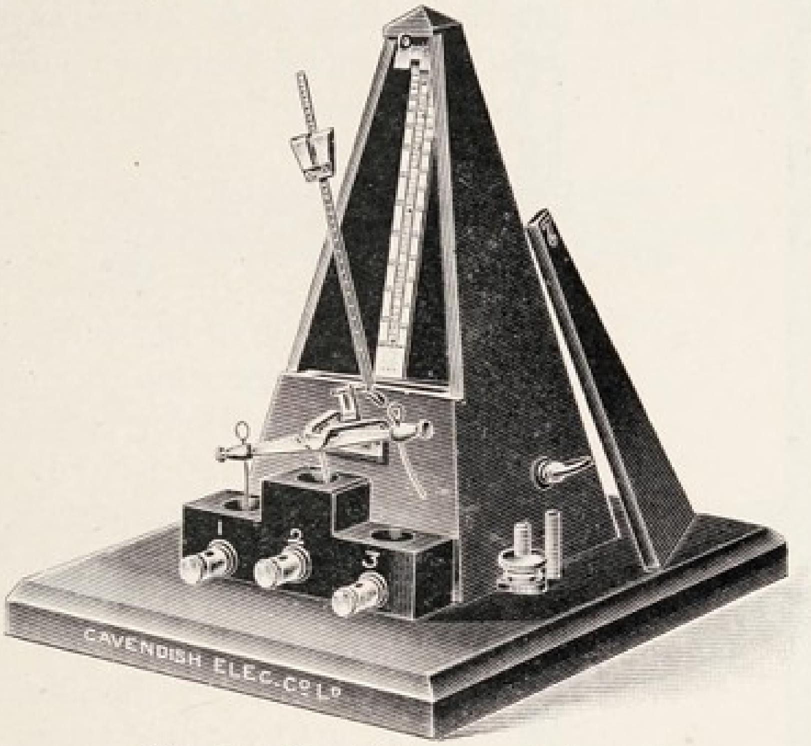


Fig. 22.—The Metronome Interrupter.

seconds, whether the current be galvanic or faradic (primary and secondary). This can be effected by means of a metronome; by which the rate can be easily regulated for any desired frequency.

Fig. 22 illustrates the kind of instrument I employ for this purpose.

A curved copper wire is attached to the moving arm of the metronome. As the latter swings, the ends of the wire dip alternately into the vessels of mercury in which wires are placed to carry the current to the patient. The higher the attachment of the movable weight to the moving arm, the slower will be the rate of interruption.

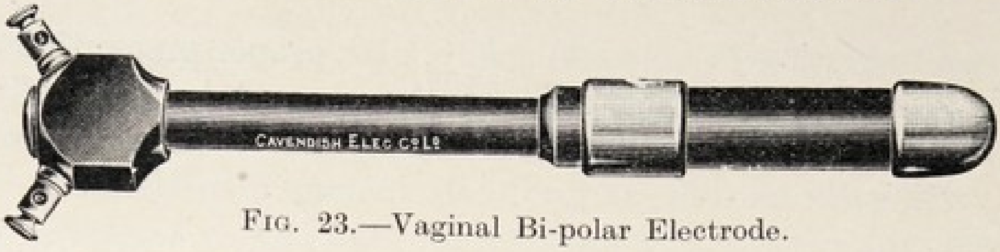


Fig. 23.—Vaginal Bi-polar Electrode.

If very slow interruptions are desired, the mercury can be removed from one of the cups, so that each double swing of the arm will give one interruption only.

Electrodes, Connecting Cords, etc.

In cases of strictly local application of the current, the neutral electrode is applied to any indifferent part of the body, and is positive or negative as may be required. The position of the neutral electrode is usually a mere matter of convenience. The electrodes must be pliable, soft, and of various sizes and shapes. They can easily be made at home. The essentials are thin soft metal or wire gauze as a basis, and a covering of some material which can be readily moistened when required, or, more important still, which can retain its moisture indefinitely, and thus be always ready. Of the former, layers of surgeons' lint are probably the best; of the latter I have found sculptors'

Fig. 24.—Intra-uterine Bi-polar Electrode.

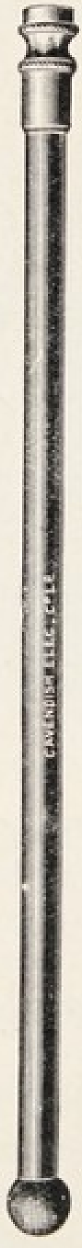


Fig. 25.—Carbon Ball Electrode.

clay to give me every satisfaction. The clay electrodes are warmed for an afternoon's use by being placed on the top of a closed copper pan filled with boiling water, and having a slightly raised rim round the top to serve as a tray, on which is placed a layer of flannel soaked in water; which, during the intervals of use, will be absorbed by the clay. Unless kept constantly moist these pads will fail to conduct the current, and will finally crack. The clay should be spread in a thick layer over the wire gauze, and both are wrapped round with "swansdown" cloth or surgeons' lint to keep the

Fig. 26.—Handle for Uterine Electrode.

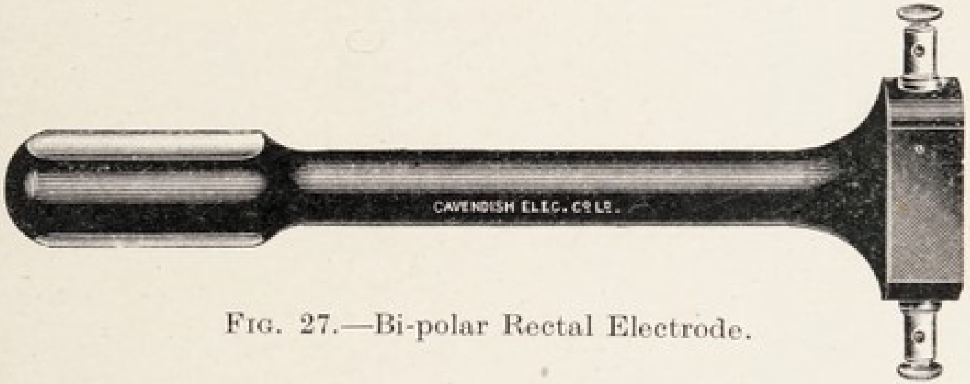


Fig. 27.—Bi-polar Rectal Electrode.

clay from escaping. The binding screw or connecting wire should be soldered to the gauze or metal plate. Clay electrodes are necessary for most pelvic or abdominal work and may be made 6 × 8 inches or larger. When small electrodes suffice, lint-covered ones are preferable. It will be obvious that when large currents are being employed, the neutral electrodes ought to be large in proportion to the current, in order to avoid pain and excessive local action through undue concentration of the current. In the case of the active electrode, however, it is desirable sometimes to concentrate the current at the point of application, and to confine it there as far as possible.

Special Gynæcological Electrodes

The Apostoli vaginal and intra-uterine bipolar electrodes are useful for faradisation (Figs. 23 and 24). For the vagina, a carbon ball covered each time with a fresh layer of cotton or of lint is used for the continuous current (Fig. 25). Its metal stem must be protected with rubber or vulcanite tubing. The bi-polar vaginal metal electrode must not be employed for the galvanic current, as the bare strips of metal might, if a strong current were employed, produce local burns on the vaginal walls. For the same reason the bi-polar intra-uterine and the bi-polar rectal electrodes (Figs. 24 and 27) must be used for the faradic or sinusoidal alternating current only.

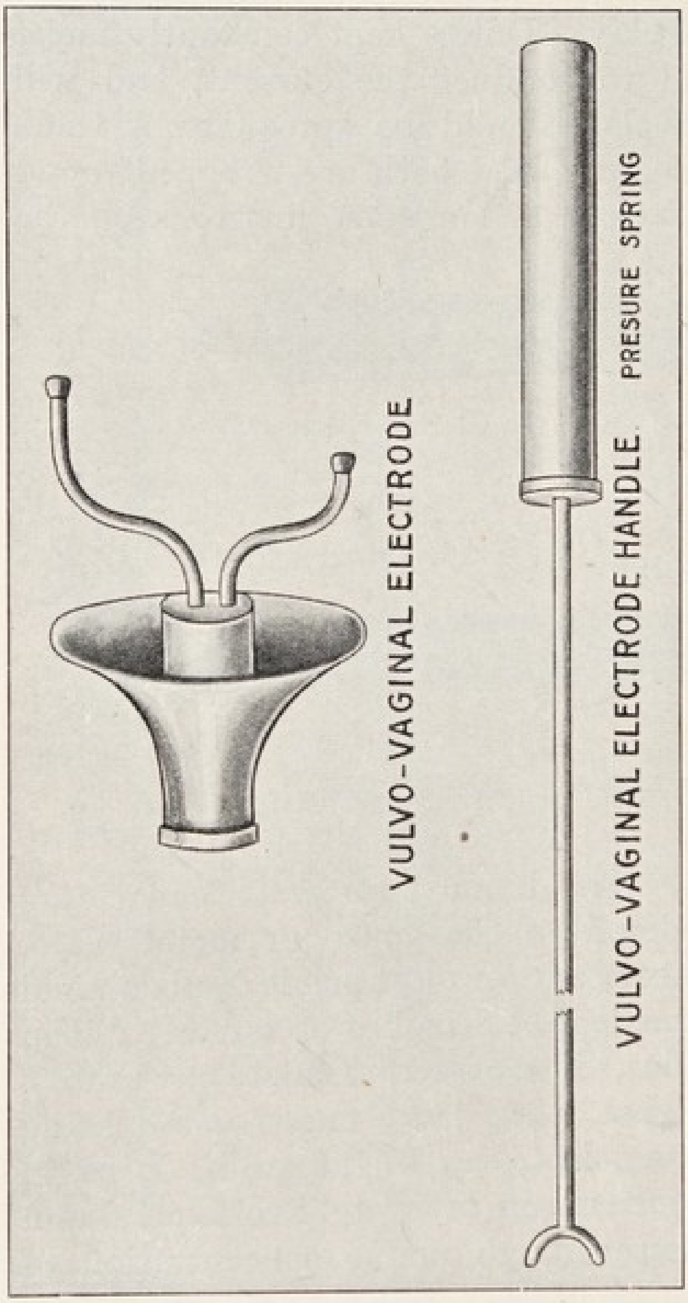


Fig. 28.

Fig. 26 shows a handle for the reception of uterine electrodes, for electrolysis or ionisation. The bi-polar intra-uterine electrode can also be used as a urethral or urethro-vesical electrode. The rectal bi-polar electrode is illustrated in Fig. 27.

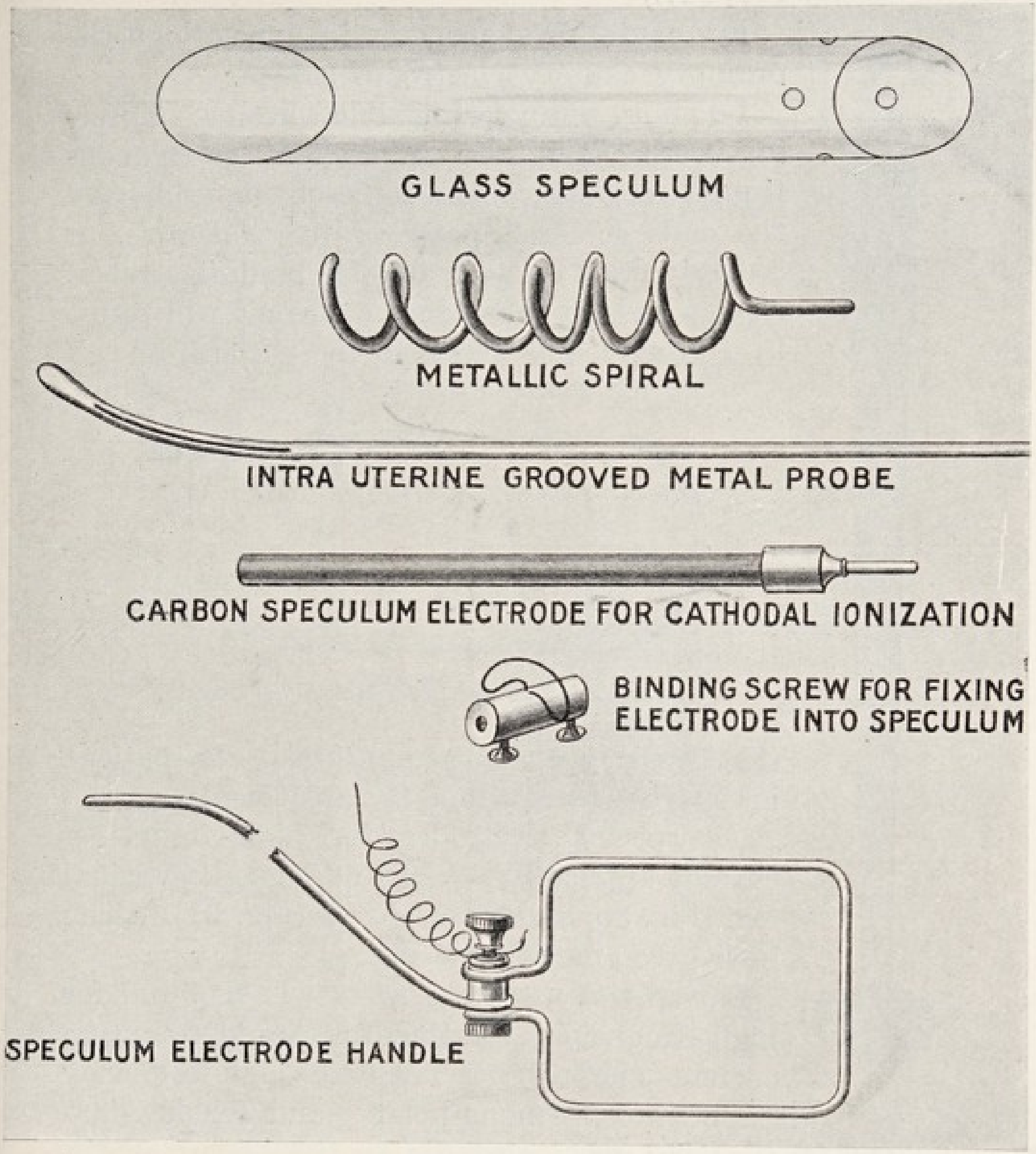


Fig. 29.—The Author's Ionisation Electrodes.

A group of electrodes which I have designed for ionisation is seen in Figs. 28 and 29.[1]

The long handle with the shot-bag resting on its base

[1] These instruments can be obtained from The Cavendish Electrical Company, 105 Great Portland Street, London, W., or from Messrs. Anderson & Buchanan, 54 Renfield Street, Glasgow.

renders the speculum electrode self-retaining. (Plates illustrating their mode of application are shown in Chap. XVI, pp. 140, 147.)

For cauterising purposes in gynæcology the ordinary cautery electrodes suffice.

I do not approve of flexible wire for connecting cords during the employment of the continuous current, unless it be strong and have the ends soldered properly to rigid wire, or securely fixed on good reliable binding screws: since a sudden break in the current will result in a disagreeable shock to the patient, and, if

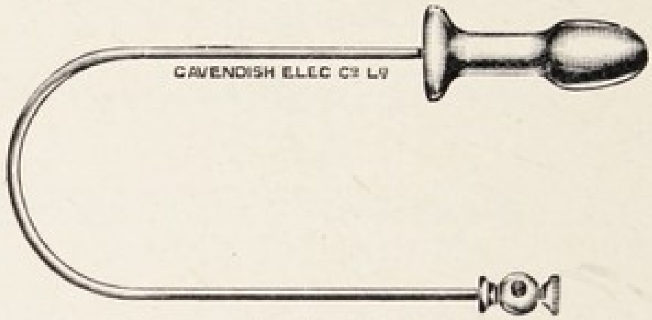


Fig. 31.—The Author's Rectal Electrode.

this occurs at a first application, the patient may refuse to continue the treatment.

As special electrodes for high-frequency current applications I have designed a vaginal one (Fig. 30) and a rectal one (Fig. 31), which have given me satisfaction.

No special uterine electrode is required for high-frequency treatment: the low-tension current one serving for both high-frequency applications—mono-polar—and for low-tension, uni-polar, currents to the uterus or the urethra.

Fig. 30.—The Author's Vaginal Electrode.

PART III

THE PRINCIPLES OF ELECTRO-THERAPEUTICS

CHAPTER X

STATIC, GALVANIC AND ALTERNATING CURRENTS

Introduction; importance of the When and the How in electro-therapy; its empirical employment; its position as a science; value of static electricity in general; the static induced current; its action on muscles; its advantages; the galvanic or continuous current; polar effects; physiological properties when interrupted; inter-polar action as illustrated by its effects on the brain; vaso-motor influence; effect of the galvanic current on the ions of the tissues; re-arrangement and control of ionic movements; effects on local vital galvanic currents; inter-polar clinical effects of the galvanic current; varieties of action according to dose; how to regulate the current so as to obtain sedative or stimulating results, and how to avoid irritation; the necessity for special care when inflammatory action is present in the inter-polar region; polar effects of the galvanic current due to ionisation; ionic migration to the poles—electrolysis; antisepsis due to repulsion of ions from the poles; ions suitable for comparatively superficial action; those to be employed for deeper penetration; how the former may in time reach the deeper structures; advantages of local ionic administration compared with general medicinal treatment; alternating currents, faradic and sinusoidal; electro-physical bombardment from; influence on ionic movements; clinical results dependent on the nature of the current administered—on the nervous system by the secondary, and on the muscular system by the primary, current.

Electro-therapy is now recognised and accepted as an important branch of medicine, and hardly any well-informed practitioner questions its possibilities. As a recent evidence of this I quote from the late Sir Lauder Brunton. In a contribution to *The Lancet* of July 24, 1915, on "Function Diseases of the Arteries," this distinguished physician says, referring to the treatment of these affections: "The use of electricity sometimes gives better results than anything else." No one now wonders at such a statement. The word "sometimes" in this sentence appeals to me strongly. A whole chapter could be written, with that single word as a text: showing that the causes of success or failure in electro-therapy resolve themselves simply into the When and the How of its application. This I hope to make plain in the present work, with reference to the successful employment of electro-therapy in gynæcology.

Electro-therapeutics cannot at present be classed as one of the exact sciences; but which of all the remedial agents now in use can successfully compete with electricity, when the point at issue is the certainty of effect following cause? In former times, when electric treatment was mainly in the hands of unqualified practitioners, it was employed empirically only. Even when its value came to be realised by pioneers in medical research, its advocates had little real scientific basis to work upon, and were often confronted with questions regarding its mode of action which they found difficult to answer. We are, however, in a somewhat more favourable position now to give a reason for the faith that is in us: although our best appeal is still to our results. In what follows I shall state the case for electro-therapy as a science—for so it may now be called. The advance in electro-physics and electro-therapeutics in recent times has been so great that before long no one will be able to understand how it was possible to ignore for so many years so great a healing force, and one necessarily accompanying every vital function in the body.

The Static Induced Current

Although static electricity is employed in a variety of forms, and is valuable in most of them, I shall, for reasons previously stated, refer here, and in a brief sentence, to one form of it only, namely, the static induced current. (See Fig. 8, p. 58.) This current is an admirable muscle stimulant, is quite painless, and can be regulated with the greatest nicety. Details as to its use will be given in a future chapter.

The Galvanic or Continuous Current

We have seen (p. 48) that, at the points of contact of a continuous current with animal tissue, very severe chemical and vital action may result. It is also well known that the sudden onset or release of a current will cause disagreeable muscular and nervous sensations. It is unnecessary to do more than mention these facts : for there are few persons who have not had personal experience of them. It is otherwise, however, with the steady flow of a current through tissue too deep to be directly influenced by surface contact at the poles of entrance or exit of the current. Yet if there is an interpolar effect, an effort ought to be made, as far as possible, to discover its exact nature, for this is often the field which it is desired to influence.

To do so, let me again appeal to personal experience. As the most sensitive organ in the body is the brain, this area is useful for testing the effects of electric currents on the organism.

If a soft, closely-fitting electrode be placed over the brow and another over the nape of the neck, and a galvanic current be passed between these electrodes, beginning from zero and gradually increasing the current till the galvanometer indicates 10 ma., flashes of light will be seen at every increase in the current ; these flashes ceasing when the flow has become steady. There will also be experienced a sensation of heat, tingling, and pain at the sites of the electrodes ; increasing with the increase of current, but finally disappearing if the total amount of current does not exceed 10 ma. At this stage "the patient" may be unconscious of the presence of the current. By and by a metallic or salt taste will be felt, and there will be an increase in the flow of saliva ; whilst if the eyes are now moved ever so slightly, so as not to move the electrodes and thus cause an alteration in the amount of the current, mild but vivid flashes of light will be perceived at every such movement of the eyeballs. Winking will suffice to produce these effects. There must, therefore, be some inter-polar influence at work even with a steady flow, for these results can take place only by an influence on the nerve centres governing the tongue, the salivary glands, and the retina. If the current be further increased a sensation of constriction is felt in the head; and if the patient is standing he will probably complain of giddiness. If, however, the current be then reduced to, say, 8 ma. a sense of comfort follows; and the patient will become sleepy. If he is communicative he will volunteer the information that the current is having a very soothing effect. Here, then, we have physiological evidence of inter-polar action and of comfort or discomfort, from the steady flow of the galvanic current, according to the amount of the dose administered.

We are not considering here the action at the poles, although we shall see that this is sometimes all-important. Whether the inter-polar region is influenced materially by the direction given to the current I have not yet been able to determine.

What are the physiological reasons for these subjective symptoms? In my opinion they are evidence of vaso-motor changes. They at least indicate that some modification of vital processes is taking place within the brain —probably vascular.

Since Leduc has drawn our attention to ionic movements and the influence on these of the continuous current, it will be readily admitted that vascular changes alone may not suffice to explain everything; for, in every cell in the whole inter-polar tract, the current will palpably influence the movements of all the ions in its path. And, in the weak dilution in which all the salines exist in the fluids of the organism, there must be complete ionisation (see p. 26). Without the presence of these free ions, indeed, no life is possible : whilst all metabolic processes are dependent upon them.

How exactly the continuous current will influence ionic movements we may not fully know. The current will at least put all those in its course, and therefore coming under its influence, into marching order, that is, will stimulate them. The various local currents which we saw to be continuously in action, due to local differences of potential, must also be either arrested or at least changed in direction. I am not referring here to the effect on any one ion, for it is not a case of ionic penetration : it is simply a case of ionic distribution and direction.

Inter-polar Clinical Effects of the Galvanic Current

I hope I have now satisfied the reader that the application of a galvanic current to the body cannot be devoid of an effect on the organism. There remains, however, to determine whether these proven effects are beneficial or harmful to a patient. I shall be able to show that they may be either helpful or hurtful; for no agent can be beneficial when rightly administered, without being also harmful when maladministered; and I have had sufficient evidence to satisfy me that this agent can act in both ways.

In galvanisation of the head, it was found that a moderate amount of current soothed, and an excessive amount irritated. The action of a mild dose of the galvanic current is therefore sedative, if the dose be not too small. In moderate doses it is a stimulant, and in doses midway between these it is probably both—a mild sedative action and a mild stimulation; promoting cellular activity as an after result. The dose, indeed, must be carefully regulated, and, as a rule, the patient's sensations must be taken by the practitioner as a guide; the quantity given at the next visit being, if necessary, modified according to previous experience. If a state of comfort has followed, the dose was correct as to quantity and time. If the result, however, was not restful but exhausting or depressing, either the amount or the duration should be reduced at the next application. When there is a chronic inflammatory condition, as in the application of this current to the posterior fornix of the vagina for inflammation of the broad ligaments, my experience has been that, if pain was complained of when a certain milliampèrage was reached, the pain usually ceased upon reduction of the current. The after-effects, however, have been generally very satisfactory, the thickening and the chronic pain subsiding. Any pain felt in the pelvis in the absence of inflammatory disease, from excess of current, is probably at the site of the electrode : that is to say, it is polar. Otherwise, there is no pain, even in the case of specially sensitive patients. If there is pain with a very small amount of current this indicates the necessity to stop the application as unsuited to the case at the time. This important therapeutic fact will be referred to again in the chapter on the treatment of pelvic inflammations.

Polar Effects of the Galvanic Current due to Ionisation

Leaving the subject of the inter-polar effects of galvanisation where conclusions have had to be based partly on inference, we come to that of ionic interchange at the poles. We are here on surer ground, as has been shown in a previous chapter. The effects are directly visible : the results can be weighed and measured, chemically and biologically. We have seen that ions can be driven electrically into the tissues; that they are capable of acting as antiseptics upon the interior of every cell, at any spot, to any depth and in any degree desired. With such a power in the hands of the physician there seems no limit to the possibilities of ionic treatment.

Tables IV and V illustrate the migration of ions electrically driven into the tissues through the mucous membrane. On the right side of the dividing line, which represents the position of the mucous membrane, are placed the ions of the NaCl of the tissues; on the left the ions of the ionising solutions. The conditions before, and the changes produced by, the application of the current, are made apparent; as is also the pole at which a positive or a negative ion should be applied.

IONIC MIGRATION

TABLE IV

	Left of mucous membrane	Right of mucous membrane	
	+ + +	+ + + + +	
Before +	Cu Cu Cu	Na Na Na Na Na	— Current
	= = =	— — — — —	
	Cl_2 Cl_2 Cl_2	Cl Cl Cl Cl Cl	
	+	+ + + + + + +	
After +	Cu	Cu Cu Na Na Na Na Na	— Current
	=	= = —	
	Cl Cl Cl Cl Cl_2	Cl_2 Cl_2 Cl	

TABLE V

	Left of mucous membrane	Right of mucous membrane	
	+ + +	+ + + + +	
Before —	K K K	Na Na Na Na Na	+ Current
	— — —	— — — — —	
	I I I	Cl Cl Cl Cl Cl	
	+	+ + +	
After —	K K K Na Na	Na Na Na	+ Current
	—	— — — — — — — —	
	I	I I Cl Cl Cl Cl Cl	

Table IV shows what would take place in the case of a solution of $CuCl_2$ when applied to a mucous membrane and attached to the positive pole: as Table V indicates how a solution of KI would behave when so applied from the negative pole; secondary reactions being omitted. In both tables it should be noted how the ions of the NaCl of the tissues act in the two cases: the negative chlorine ions passing out of the mucous membrane towards the positive pole as in Table IV, and the positive Na ions passing out of the tissues towards the negative pole as in Table V.

That microbes may vary in their susceptibility to different ions was suggested by the late Dr. Lewis Jones. I think this highly probable, though I have not yet put it to the test of experiment.[1] My choice of ion has been otherwise determined in the application of ionic medication to disease of the pelvis in women. I have divided the ions which I employ into those suitable for superficial action and those capable of penetrating into the deeper structures; and including, under the term superficial action, penetration into the interior of the glands of the mucous membrane.

By experiment I found, as has already been pointed out, that, by a therapeutic dose of copper ionisation, this ion could penetrate only to a depth of about 1 mm. How, then, can the tissues under this depth, though still comparatively superficial, be favourably influenced by so slight an ionic penetration? First, by diffusion through the capillaries and lymph channels; and, in the second place, by the further penetration of formerly introduced ions at later applications of the current to the tissues for the purpose of introducing a new dose of ions. Thus, in due time every cell of still deeper tissues will become impregnated by the antiseptic ions. Moreover, in conditions of very deep-seated septic inflammatory action such an ion as iodine will, by diffusion, penetrate earlier and deeper than copper or zinc; since, as we saw, some time has to elapse before all the albuminate of copper has become soluble. For these reasons, iodine would seem to be more suitable for comparatively deep-seated structures; copper and zinc for comparatively superficial ones.

When medicines are administered by the mouth, with the intention of reaching and so influencing a distant organ, it is obvious that, even if the whole of the drug should find its way into the circulation, the organ, which it

[1] As bearing on this, see "Remarks," Case No. 209, p. 271.

is desirable to supply it to, can have only a mere fraction of the total quantity circulating throughout the body; whereas in the case of local ionic medication the whole of the drug must pass first through the organ requiring treatment before it can reach and be diluted by the tissue fluids. The difference in favour of local ionisation as against the internal administration of the drug is thus enormous.

Alternating Currents, Faradic and Sinusoidal

I shall not attempt to differentiate therapeutically between faradic and sinusoidal currents. I am not prepared to say that there is much, if any, difference in action or in sensation between them. I shall, therefore, here confine myself to alternating currents from a medical coil, suitable for direct therapeutic applications.

In the employment of such currents the tissues are treated to at least two influences: to an electro-physical bombardment and to ionic backward and forward waves. The vital effect of the latter is not quite clear; but it is a fair inference that such a profound disturbance in ionic movements must have some vital influence.

The electro-physical results, however, may be even more important, for here we have an almost infinitely fine massage of parts which no finger can reach, yet from the stimulating or sedative influence of which no cell in the course of the current can escape.

It may be said again that these are mere theoretical inferences. But clinical proof that such currents do influence the organism—whether for good or evil—can be adduced. Here let me again appeal to their effect on the most sensitive organ of the body—the brain. I recommended a medical friend to try faradisation of the brain for insomnia and an irritable form of neurasthenia. He said this treatment had been tried on him once, and he would never forget the horrors of the sensation, or be induced to try it again. I succeeded, however, in persuading him to let me try it. He was then confined to bed, and in great nervous distress in spite of so-called sedative drugs, and he was obtaining practically no sleep.

I had had so much experience of the treatment of insomnia by means of the faradic current that I began the administration with the certainty of success : and, far from distressing him, the current was only a few minutes in action when he exclaimed : " Oh ! how delightfully soothing ! "

Let me explain the difference in action of the two applications in this case. Like the galvanic current the faradic can act as a sedative, a stimulant, or an irritant. For sedative action the secondary coil should be employed with a large number of turnings—12,000 I generally employ. The vibrations should be as rapid and as steady as possible. The effect with the proper dose is most soothing, and the patient can bear with comfort twice as much current, as measured by the faradimeter, than can be borne if these precautions are neglected.

When the faradic current is to be employed as a stimulant a smaller number of turnings in the secondary coil is to be preferred. There will then be a lower voltage and a larger amount of current. Of course an excessive dose in either case will irritate.

As a muscle stimulant the metronome interrupter—Fig. 22, p. 73, should be employed ; and the primary coil preferred if for internal use, as in the rectum or bladder.

CHAPTER XI

HIGH-FREQUENCY CURRENTS

Therapeutic effects of high-frequency currents, contrasted with faradic currents; clinical experiments with high-frequency currents; their value as therapeutic agents locally and generally; effects of high-frequency currents on the cardio-vascular system, on the peripheral resistance, on the pulse rate and the blood pressure, on the cardiac muscle; thermic effects of high-frequency currents; greatest near the electrodes and on the surface, reasons for this; diathermy; penetration of high-frequency currents into the deeper tissues; effects on the neuro-muscular system; influence of the spark gap; potential difference between various points of the body; measurements of these; explanation of apparent anomalies; evidence as to gastro-intestinal action of the current—physical and clinical; effects of high-frequency currents on the retino-cerebral mechanism; clinical evidence of cerebral action; attempt to test this physiologically by its effect on the retina; method of measuring the negative after-image as an indication of improved cerebral metabolism; avoidance of errors; results obtained from auto-condensation; local applications of the high-frequency current; effects of the effleuve; the vacuum electrode, mode of action; the condenser electrode; the bi-polar high-frequency current.

Therapeutic Effects of High-frequency Currents

It has been pointed out (p. 87) theoretically how faradic currents may be supposed to act therapeutically. Although the alternations of the faradic currents are rapid in the form in which they are generally employed in medicine, the oscillations of the high-frequency currents, as their name implies, are enormously more rapid; the rate per second amounting sometimes to thousands, even to millions. The patient, if in close contact with a metal electrode conducting the current to him is quite unconscious of the presence of these oscillations. Clinically, however, their effects can be demonstrated.

In a paper read by me, at the meeting of the British Electro-Therapeutic Society, I gave a summary of extensive experiments which I had conducted on the physiological action of high-frequency currents in disease.

Although many of these investigations had no connection with diseases peculiar to women, yet, as many of them bear on the argument for the employment of this form of electric energy in many cases of functional disorders in women, I think it best to reproduce briefly here some of my conclusions.

As in the case of the forms of electric energy already referred to, I base my arguments for the use of these high-frequency currents quite as much—possibly in a greater degree—on clinical as on physiological results. For a whole year after beginning to employ them in all sorts of morbid conditions—sometimes with good effect, sometimes with apparently no definite result—so uncertain was I of their value, that if I had been asked what I thought of them as an aid to treatment I would have had to confess frankly that I had not quite made up my mind. Far from this being my present mental attitude, if I were now asked such a question I would have no hesitation in affirming that the want of such a therapeutic agent would be to me a very great loss; would, indeed, seriously cripple me in my work as a physician, especially in the department of gynæcology.

As a local agent in certain obstinate cases, high-frequency treatment is indispensable. As a general application I am having more faith in its efficacy every year of my experience of it. It must, however, be used intelligently, and with a common-sense appreciation of its principles; and, more even than that, a skill in diagnosis and a practical knowledge of the condition of the patient whom it is intended to treat. The results of my experimental research, regarding the physiological action of high-frequency currents, in the form of auto-condensation, on the various systems, will be given in the immediately succeeding pages.[1]

[1] For details of the experiments on which the following conclusions are based, see *Some Physiological Effects of High-frequency Currents in Disease*, by the Author: *The Lancet*, June 8, 1907.

Effects of High-frequency Currents on the Cardio-vascular System

1. These currents at first cause in all cases diminished peripheral resistance.

2. This is followed, sooner or later, by increased cardiac force, when the currents are given in proper therapeutic doses.

3. The effect on the blood pressure and the pulse rate of this double action will depend on the cardio-vascular stability. Should this be normal, there may be no change whatever on either the blood pressure or the pulse rate, only an increase of blood flow, giving rise to slight elevation of the temperature of the blood.

4. Should there be a slight cardio-vascular instability, then the diminished peripheral resistance is only in part compensated by the heart, and so the blood pressure falls slightly and there may be no change in the pulse rate.

5. On the other hand, should the heart be in a state of asthenia and the blood pressure have been already low on this account, then, if the patient on reaching the couch is fairly fresh, there having been nothing to depress or fatigue just before the treatment, the increase of the cardiac force obtained from the current may so overpower the tendency to peripheral relaxation that the blood pressure rises whilst the pulse rate falls.

6. Again, should matters be as in the last case, with the exception that the patient has recently been fatigued or unduly excited, the heart may be unable to respond to the action of the current; just as the breeze which will fan a steady flame may extinguish a flickering one. The heart may be at first staggered; the cardiac force failing to rise to the occasion. The result will then be a dangerous fall of the blood pressure with a relatively high pulse rate. Any immediately succeeding fatigue, though moderate, may, in such a case, give rise to the immediate need for stimulants.

7. The after effect is, in cases of low blood pressure due

to diminished cardiac force prior to the treatment, a higher level of blood pressure, if the dose has been a moderate one.

8. If the blood pressure be already high, due to the high peripheral resistance from albuminuria, for example, with somewhat weakened cardiac action, the current will probably, acting as a cardiac tonic, have the effect of still further raising the blood pressure without increasing the rate of the pulse.

9. Where the conditions are as just stated, but owing to long illness the cardiac asthenia is great, as shown by a high pulse rate which no medicine can reduce, the favourable effect on the pulse rate is striking.

10. When the blood pressure is high for the individual's age and there is no apparent disease to account for it, I have observed that, after several applications of the current, the blood pressure is diminished and there is a lowering of the pulse rate, where this was previously abnormally high.

11. In some instances of intermittence—radial only or cardiac as well—the intermissions may diminish or disappear, although this intermittent pulse may have caused anxiety to the patient for many years. Should the intermission have existed for a short period only, as from temporary gastro-intestinal disorder, this may cease after two or three applications of the current; probably from the beneficial effects of the current on the gastro-intestinal canal.

12. When the pulse rate is variable before the current application, it may become quite regular and steady immediately after.

Some confusion, in judging of the influence of the current on the blood pressure, is apt to arise where the effect of immediately preceding exertion or excitement has been to raise the blood pressure, and to lower or raise the pulse rate, before application of the current. If the pulse rate has diminished, then the heart has been quite able to respond to the exertion and so has become slower. If raised, the heart has not been able to respond, and so has to beat faster on account of the fatigue. If no change has taken place in the pulse rate—this having been normal before—a good opinion may be formed of the cardiac force.

As a result of these currents a considerable amount of heat is evolved. The greatest increase of heat is near the electrodes, and this diminishes in amount in proportion, as a rule, to the distance of the parts tested from the electrodes. The heat here is not blood heat, but only surface or superficial tissue heat.

The late Dr. Lewis Jones contended that the therapeutic effects of high-frequency currents were mainly due to heat production. That this is so in part I admit, in the case of local applications of the current; but, as I shall show, the resistance in the deeper structures is so low that little heat is evolved there. This explains why in my experiments the temperature in the mouth and the rectum remained as a rule unaffected, whilst that of the arms was generally considerably raised, as was originally pointed out by Lieut.-Col. W. F. Somerville, M.D., of Glasgow.

The question of "diathermy" need not occupy our attention. This is bi-polar and local and the heat evolved is local: whereas in high-frequency, as applied medically, the application is usually mono-polar and general. That diathermy would be of value in gynæcology is quite probable, but I have had no experience of it.

Penetration of High-frequency Currents into the Deeper Tissues

It has been generally assumed that high-frequency currents are confined practically, if not wholly, to the surface; and that their physiological effects arise from their action on the peripheral nerves and the peripheral circulation. My researches have quite convinced me that there is electro-physical evidence that this is not so.

Before going into this matter, however, let me say that, if any one should doubt the fact that these currents traverse the neuro-muscular apparatus, let him, with one hand holding one of the usual couch electrodes, place another electrode, held by an insulated handle, on the upper portion of the sterno-mastoid muscle of the same side, *and with metallic connection of the sterno-mastoid electrode to the hand electrode,* but with a small break in the connection, to act as a spark gap, of about two millimeters. The strong muscular contractions induced in the forearm and neck will convince him of the fact. An objection to this will probably be made that it is the spark which is causing the contractions, and not the current from the hand to the neck. Well, let this experiment be repeated without any flow of current, by removing the hand from the electrode, but retaining the spark gap to the connection between the couch terminal and the neck, and it will be found that so long as the hand electrode is held, so long will there be muscular response; but as soon as the handle is let go no muscular contraction will occur, although the connection to the neck still exists through the spark gap. The resistance between the hand and the neck is so great as to cause a decided fall of potential in the current by the time it has reached the neck, and so a current from the hand to the neck can pass back through the conducting wire and the spark gap to the hand, thus completing a circuit with a sufficient amount of current, passing through the neuro-muscular tissues of the arm and neck, as to cause muscular contractions, due to the make and break of the current at the spark gap.

Another objection which might be raised is, that the current causing the muscular contractions is not a pure high-frequency current. If by that is meant that when high-frequency currents are pure they do not cause muscular contraction, I admit this. All the same, however, they are high-frequency currents; the only difference being that at the time they are suffering from a frequent change of potential, through the irregular action of the spark gap; just as the galvanic current causes muscular contraction only when its potential is changed.

During my experiments, I observed that the difference of potential between any two points on the surface of the body varied greatly, usually in proportion to the distance between these points. This difference of potential was measured by the distance the charge was able to spark across between the extremities of two wires, the other extremities of which were in contact with the points whose difference of potential was to be tested.

The difference of potential, from that at the hand holding the couch handle, amounted to about 1·5 mm. at the fore-arm; 3 mm. at the axilla; 4 mm. at the waist; 4 mm. at the groin; and 4 or 5 mm. at the foot. Notwithstanding this, the difference of potential from the hand to the mouth was practically the same as that from the hand to the rectum; and the difference of potential between the neck and the groin was five times as great as that between the mouth and the rectum. That is to say, the resistance and the route between the mouth and the rectum are not those by the chin, neck, breast, and abdominal walls, but by the gastro-intestinal tract. Again, the difference of potential between the axilla and the groin was less than that between the axilla and the waist. Why, indeed, unless the current had gone from the axilla to the groin not simply by way of the body wall, but also by the gastro-intestinal canal? I have come to suspect, indeed, that it takes an even easier road, namely, by the thoracic and abdominal viscera, as well as by the gastro-intestinal tract. For, if by the latter route only, then, though the ohmic resistance of the gastro-intestinal canal is not great, it is certainly greater than would be that of a No. 14 copper wire of the same length, say 25 ft.

Now the difference of potential is, as we have seen, proportional to the resistance, and Fig. 32 shows the drop of potential due to this length of copper wire, as equivalent to a spark gap of 1 mm., whilst the difference of potential between the mouth and the rectum is almost as if these were different parts of a metallic plate over which the current is flowing easily.

It is well known that, with such currents, the bending back of a conductor on itself adds considerably to its

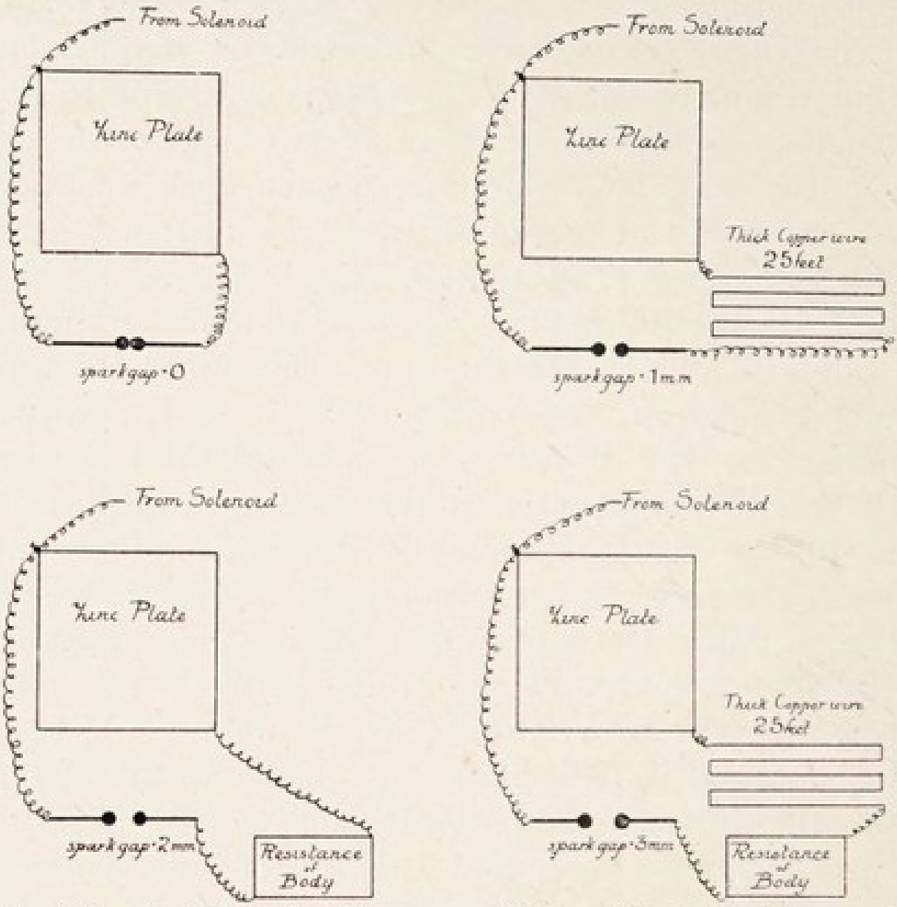


FIG. 32.—Relation of Difference of Potential to Resistance in High-frequency Currents.

resistance. In the illustration these twistings are represented as numerous; but, in the actual experiment, this was not so. Besides, if this objection is raised by the physicist to my argument, it would cut both ways; for neither is the intestinal canal straight.

The current as the patient receives it on the couch in the form of auto-condensation must thus be acting on the whole of the thoracic and abdominal contents; and so there is no wonder that this electric energy has an influence on the appetite and on the general health.

Effects of High-frequency Currents on the Retino-cerebral Mechanism

We have considered the physiological effects of high-frequency currents from the points of view of the cardio-vascular, thermo-genetic, and gastro-intestinal systems. Can any or all of these results explain the various signs and symptoms we obtain from this treatment? I am sure they cannot. They give no explanation of certain sensations remarked upon by patients, when undergoing auto-condensation treatment. One patient will say that the after-effect is a sense of "comfortable weariness in contrast to fatigue or faintness." Another I have heard remark: "I feel, for an hour or two after, a restful weariness, which is just lovely." One patient, after the vacuum electrode from the high-frequency solenoid had been applied to the supra-orbital region for neuralgia, remarked to me the following day: "I don't know what you have done to me or how you have done it, but since yesterday a load has been lifted from my mind and all my cares are gone." For years this patient seemed to have a weight of care on her, and there had, I knew, been much cause for this. Yet at her subsequent visits and until I last saw her she declared that her burden of mental distress had not returned. Unfortunately this is an exceptional case; but it will serve as an illustration of the point I wish to enforce, viz., that some action on the central nervous system takes place under the therapeutic use of these currents. How is this effect to be seen or measured? We cannot see what is going on in the brain, but we may see and measure what is going on in the retina, which, after all, is a prolongation of the brain. What is called the "after-image" may, by the measurement of its duration, give us some indication of the condition of the retino-cerebral mechanism.

The after-image is an impression left on the retina, for some time after the light which caused it has been withdrawn. It may be positive or negative. When testing for the negative after-image I hang up, in front of my eyes, a large card, the upper half of which is white, the lower half being black, except for a large white letter in its centre. If the eye has been kept fixed on the white letter with the dark back-ground for a definite number of seconds or half seconds, and if then, at once, the sight is transferred to the centre of the white portion of the card, the letter will be seen there; but it will now be a dark letter against a white back-ground. The duration of this negative after-image, in seconds or half seconds, was the test employed in these experiments.

Physiologists, whose works I have consulted, declare that the duration of this after-image is proportional to the cerebral fatigue present. Haig maintains that the undue prolongation of the *positive* after-image is due to a state of collæmia of the capillaries of the retina, and this condition, according to him, is caused by excessive uric acid in the blood, which again is a cause of cerebral malnutrition. I tried to measure the duration of the positive after-image on myself, but gave this up, for several reasons. The exposure of the eye to a strong light for several seconds was uncomfortable, if not mischievous; besides, it seemed impossible for me to fix a moment of time in the course of its disappearance as a measure of its duration, and further it continually eluded me in my endeavour to keep it stationary. I then decided to measure the duration of the *negative* after-image as an index of the cerebral fatigue. I soon, however, had reason to doubt whether its duration was directly proportional to the cerebral fatigue, and I began to suspect that it was rather inversely proportional to this; since the fresher I was, the longer did the after-image remain. I also noticed that the duration was longer in the morning than at night, and longer with the young and the strong than with myself. On satisfying myself as to these points, I consulted various other authorities and discovered that the opinions of physiologists were about equally divided on the subject of the after-image as an indicator of the retino-cerebral condition; some maintaining that its duration was directly proportional to the fatigue, others that it was inversely so.

The results of my experiments have led me to the following conclusions.

The duration of the negative after-image is different in different individuals. In the same individual it differs according to the state of the health, being longer when the person is well and fresh than when ill and fatigued; also, according to the time of day, being, at least in my own case, longest just after breakfast, and shortest at bed-time. I could, indeed, tell with a fair amount of certainty how fit or unfit I was going to be during the day by taking my negative after-image in the morning, and I could fairly correctly gauge what its duration was going to be when I had finished my day's work. When, by reason of temporary good spirits giving me the *feeling* of being particularly fit, I expected to find it high in spite of a specially hard day's work, I discovered that this was not the case; the duration being less than my sense of well-being would have led me to expect. I can, with a metronome beating half seconds, reckon the duration in my own case to a quarter of a second. A considerable amount of experience is necessary, however, to be able to measure with sufficient accuracy the duration of one's own after-image, and it is more difficult in the case of other people.

The examination must take place as nearly as possible at the same hour, the light must be the same, the distance of the light from the image the same, and the distance of the eye from the object and the image also the same. Besides, the metronome must beat exactly for the same number of half seconds, before the eye is turned towards the white paper. The after-image generally appears at once, but with some people there is a delay of a few half seconds before its appearance. With most people the image returns two or three times, but this is not to be reckoned in the measurement. Unless the eye be kept fixed on one spot the record is spoiled. Accordingly I fix a pin in the centre of each paper to keep the eye fixed on; since, if it wanders from the spot it should be fixed upon, the image at once disappears.

Fig. 33 is a good example of a negative after-image record in a case where the benefit derived from the high-frequency current was most marked. The average for the six times noted before the beginning of the treatment is, it will be observed, slightly under 11·5; that for the

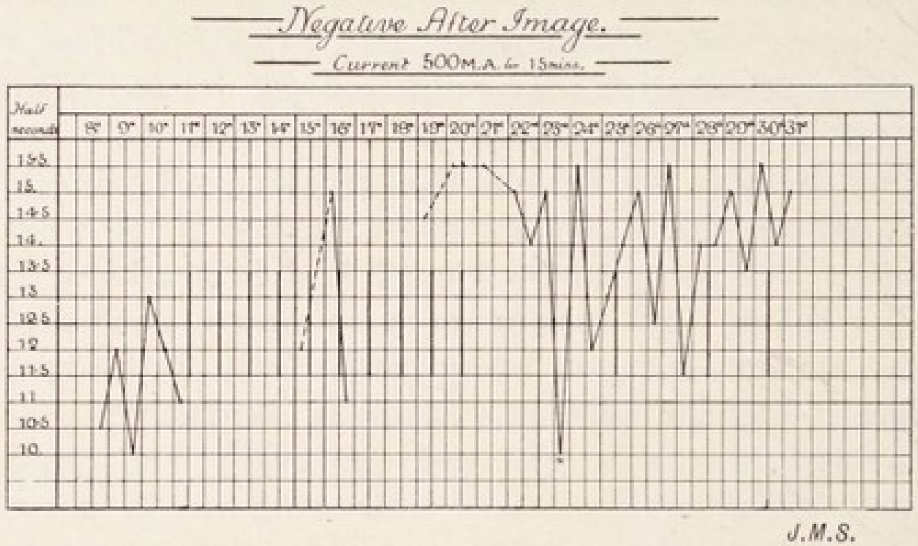


Fig. 33.—Negative After-Image Record.
The heavy vertical lines indicate the auto-condensation applications. Observations taken 10 a.m. and 11 p.m.

time succeeding the treatment slightly over 14. Note the effect of fatigue on the 23rd; and also that, when the duration of the image is ceasing to be so favourable after the treatment had stopped, one application of the current—on the 25th—has raised the night record to a higher level than that of the morning of the same day.

What has just been said regarding the actions of high-frequency currents has reference to that form of application of it called auto-condensation. Here the current enters the body by metal contact at both hands, and spreads itself from these points over the whole body.

Local Applications of the High-frequency Current

High-frequency currents are also employed in other forms besides auto-condensation. The effleuve or electric breeze from the top of the upper solenoid is first and essentially local in its action; but it is general also and has all the effects of auto-condensation, though in a minor

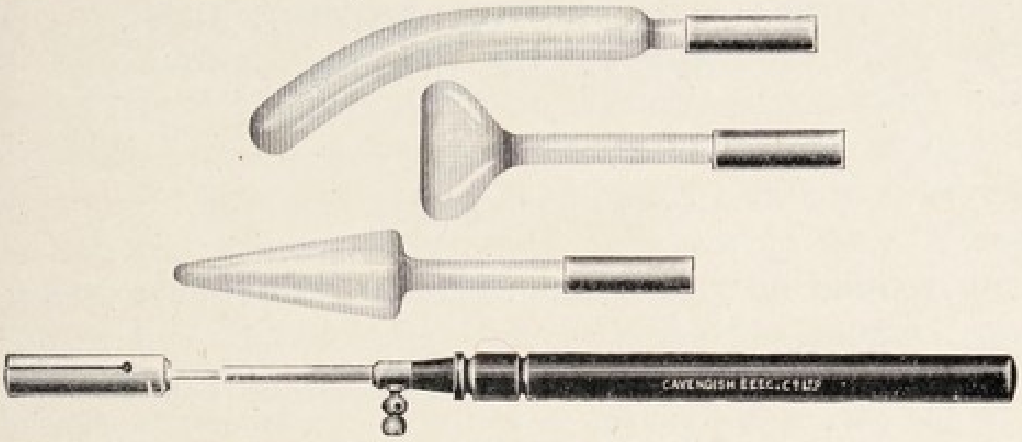


Fig. 34.—Vacuum Electrodes and Handle.

degree. The local effects are heat and extremely fine electric massage. I have found this treatment very serviceable in certain local disorders.

The vacuum electrode (Fig. 34) acts in a similar manner, though its local effects are more active, and probably its therapeutic influence is more confined to the surface.

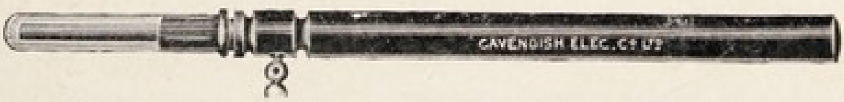


Fig. 35.—Condenser Electrode.

The condenser electrode (Fig. 35), which is a glass tube with a metal rod within, is similar in action to the ordinary vacuum electrode, but it is more heating and stimulating. By its means deep electric massage can be obtained.

The only other form of high-frequency application I have employed is the bi-polar (see Fig. 17, p. 66). Here the effect is almost wholly limited to the desired tract; the rest of the body being only to a slight degree electrically charged.

PART IV

CONSTITUTIONAL DISEASES, MOSTLY FUNCTIONAL, TO WHICH WOMEN ARE SPECIALLY LIABLE

CHAPTER XII

DISORDERS OF THE CEREBRO-SPINAL NERVOUS SYSTEM

Influence of the pelvic organs on constitutional diseases in woman, and on her emotional nature; neurasthenia, importance of diagnosis of the patient as well as of the disease, varieties of neurasthenia, delusional psychasthenia, simple psychasthenia, cerebral irritability; treatment by faradisation, by galvanisation; gastro-intestinal neurasthenia, treatment of; headaches, varieties according to cause, appropriate treatment for each, cases amenable to electrical treatment; insomnia, causes of; treatment of psychic insomnia; the insomnia of neurasthenia; treatment of insomnia by faradisation of the brain; details as to a series of cases so treated; associated neuroses, nature of; neuritis, cranial, treatment of; neuritis of the eyeball, treatment of; spinal neuritis, diagnosis of, treatment; distant pains due to spinal neuritis, treatment of; sciatica, treatment of, by the condenser electrode; lumbo-pelvic neuritis, nature of.

The title of this book being *Electro-Therapy in Gynæcology*, it follows that it must deal, not simply with affections of the pelvis in women, but with the general diseases or disorders of women. Before the days of modern gynæcology, the influence of the pelvic organs on the woman was not fully realised. Present-day gynæcology, however, is apt to go to the other extreme; in that, when a woman is ill, especially if the illness be vague and difficult to diagnose or locate, there is apt to arise a suspicion that there must be something wrong in the pelvis to account for the illness. This, no doubt, is often true; but, whilst some morbid condition may, under these circumstances, be found in the pelvic organs, such as leucorrhœa, prolapse or displacement of the uterus, or some symptom such as pain in the neighbourhood of the ovary, any one of these may be, not a cause, but a mere accompaniment of the illness.

Whilst a mistake may be made in ignoring the pelvic condition, my experience in the treatment of diseases of women is that too much attention may be devoted to the womb, and too little to the woman.

In selecting the special disorders which are more likely to be met with in women than in men, we naturally look to what woman's emotional nature may specially expose her when, from any cause, her vitality has been lowered. Emotional strain exhausts her more readily than it does man. Hence her greater proneness to neurasthenia, which I shall place first for consideration amongst the special disorders of women.

Neurasthenia [1]

This disease, for it is not a mere functional disorder, affords an example of the importance of diagnosing the patient as well as the disease. Though unstable emotions predispose to neurasthenia, this disease is often accompanied by some physical affection, either as a cause or as a consequence. The higher nerve centres have a marked influence in neurasthenia, for, when these are stimulated pleasantly, the symptoms may for the time being disappear : only, however, to return with increased severity when reaction sets in.

There is no one form of electric treatment for neurasthenia. In the delusional psychasthenic form of it electric treatment is, in my experience, of no avail.

[1] For clear statements of the modern views of neurasthenia, its varieties and its treatment, the reader should consult the contributions of Dr. Agnes Savill and Lieut.-Col. W. F. Somerville, M.D., R.A.M.C. (T.); read at the meeting of the British Medical Association in Aberdeen, July 1914.—See *Archives of the Roentgen Ray*, February 1915, pp. 325–332.

When there is mere psychasthenia, in the literal sense of a worn-out brain, much may be done by faradisation or galvanisation of the brain, under proper precautions.

This is not the place to discuss the treatment of neurasthenia by diet, drugs, change of environment, rest, physical exercises, etc., so I shall confine my remarks to its treatment by electro-therapy. All other measures are or may be valuable in giving a fair chance to electro-therapy, but, without this, cure will be materially hindered.

In few cases is it more important to seek for the etiology of a disease in each individual case than in neurasthenia. Probably physical shock is less frequent in women than in men as an exciting cause. A gynæcologist will at once seek for special causes, and some of these, such as pruritus or so-called ovarian pain, are exceedingly amenable to electro-therapy.

Where there is cerebral irritability accompanying the psychasthenia, I would advocate the application to the head of the faradic, in preference to the galvanic, current. This opinion is opposed to that of some of the highest authorities, but I speak as experience has taught me. As previously mentioned, the proper current here is that from a secondary coil with many windings, since sedative action is desired. When the sledge coil is used the sedative action will be greatest when the secondary coil completely covers the primary. This form of coil has the advantage that the current can be increased by extremely slow gradations. If the current is too strong to permit of the complete overlapping of the primary, the current supplied to the primary coil must be decreased, or a greater amount of resistance added in series with the patient. This increase of resistance may also be brought about, if necessary, by applying the electrodes soaked in ordinary tap water instead of in solution of salt; and squeezing them almost dry before application. The magnetic hammer of the instrument must vibrate at as rapid a rate as possible, and care must be taken that the hum, which is an indication of the frequency of vibration, is constant, since any sudden change in this is apt to be followed by a shock. For this purpose the platinum points must be kept clean, whilst the means of graduating the current to the primary coil should be reliable, and should be kept under constant observation. The amount of current as measured by the faradimeter should be, to start with, a very small fraction of a milliampère, and at the first sitting no more than one third of a milliampère will probably be permissible. At future sittings the current may be gradually brought up to one, or even one and a half milliampères, but the sensations of the patient will afford a guide. Thickly covered and smoothly applied clean electrodes are essential, otherwise the patient will complain of pain before the full therapeutic dose has been reached. This will also be the case if the current is increased with undue rapidity. The applications may be made every day or every second day, and for fifteen minutes at a time. In electrification of the brain, especially, there should be mental and physical rest for about an hour before, and after, each treatment.

When the galvanic current is applied to the head the same precautions as to rest before and after each treatment and also as to the electrodes are essential; *whilst special care must be exercised in gradually increasing the current from zero and also in gradually reducing it.* The minimum current here should be 7 ma., but the duration may be for thirty minutes.

Where the symptoms of neurasthenia are more gastro-intestinal in their nature the want of tone is in the ganglia of the abdominal sympathetic nervous system. Here dorso-abdominal faradisation is the most suitable form of treatment, details as to the proper method of carrying out which will be found in Chap. XIII.

Headaches

Apart from cranial neuritis headaches may be divided according to their cause into those arising from—

(1) Emotional strain; (2) ocular defects; (3) toxæmia; (4) reflex irritation; (5) organic disease of the nasal passages, the ear, or the brain or its membranes.

If the cause is in active operation no benefit can be expected from electro-therapy in cases of headaches. When long-continued nerve-strain has been the cause, much may be done by improving the general health; and thus placing the nervous system in a less vulnerable condition.

Prominent symptoms may serve as a guide to treatment. For example, sleeplessness, as will be shown, is almost certain to be removed by faradisation of the brain; abdominal distress by dorso-abdominal faradisation; general nerve depression by high-frequency auto-condensation, and so on. Where auto-condensation is indicated it will be necessary to enforce rest before and after the applications, otherwise more harm than good may result.

In the case of ocular defects, where the headache will be worse at night, electro-therapy must be resorted to only after the oculist has failed to give relief to the pain; and the special conditions present will afford indications as to the treatment. (See p. 110.)

Most physicians will say that little benefit can be expected from the electrical treatment of headaches due to toxæmia. So far from this being the case it is just in such cases that electro-therapy will often tell. Leaving out of consideration dental sepsis, which is one of the most common causes of toxæmia, for this is the dentists' province, gastro-intestinal septic conditions, often due to lack of abdominal nerve force can, I know, be greatly benefited by electrical applications to the abdomen as a tonic (see Chap. XIII) or as a stimulant of intestinal muscle, as we shall see when referring to the treatment of constipation. Detection of the seat of the septic infection is often difficult. In the case of women the pelvis must, of course, be carefully examined as a likely source. Sometimes the bladder is an unlooked-for situation of the sepsis. These infections, as we shall see, are peculiarly amenable to electric treatment.

Headache due to reflex irritation must obviously have the cause treated rather than the effect. In a case recently electrically treated by me for throbbing—pulsation—in the head I was disappointed at the limited success of the treatment. I had been ignorant of the presence of a purulent discharge from the ear; no complaint having been made of this at the time. When the ear condition was cured the throbbing almost wholly disappeared.

In organic disease of the brain, careful consideration will be necessary before resorting to electric treatment; but with caution much may be done by it to assist the reparative powers of nature.

Insomnia

There is perhaps no more distressing complaint than chronic insomnia. It may accompany neurasthenia or be due to various kinds of perverted metabolism of the brain. Alcoholism is a common cause: so is emotional shock or prolonged strain. Sleeplessness due to pain or other disturbing influence is not under consideration here, since we are considering what might be called psychic insomnia only.

The insomnia of neurasthenia is very amenable to electric treatment; so are all forms of sleeplessness, apart from that due to pain, if the cause is not at the time in active operation. If it is, complete success cannot be expected any more than it is expected in other morbid conditions, or from other forms of treatment.

Whilst almost any form of electro-therapy—static, faradic, galvanic, high-frequency—can be administered so as to induce sleep, and, whilst any form of electric treatment which will do so is to be preferred to drugs, I know of no surer remedy for insomnia than faradisation of the brain. At a Meeting of the Glasgow Medico-Chirurgical Society on February 15, 1901, I read a paper entitled " Experience of Faradisation of the Head, on Scientific Principles, in the Treatment of Chronic Insomnia and Associated Neuroses."[1]

A series of forty-five cases so treated was presented in detail. A reference to the original paper will satisfy the reader that no other form of treatment could successfully compete with that employed in the cases recorded. The following is a summary of the results in percentages.

Cured, absolutely or practically . . .	45·5	per	cent.
Sufficiently relieved to have made the treatment a success	32·5	,,	,,
Only slightly relieved	11	,,	,,
No benefit received, but none the worse of the treatment	9	,,	,,
Slightly adversely affected; the resulting distress having lasted, however, for a short time only	2	,,	,,

If these results are carefully analysed it will be found that in the uncomplicated or psychic cases there was only one failure, and in that case it is recorded that the cause of the insomnia was at the time of treatment in acute operation, and that only one application of the current was made. The average number of treatments given was six, and the largest number in any one case was twenty-four.

Fear of the treatment is no hindrance to its beneficial action. In one case the patient had so great a dread of the current that very special care had to be exercised in applying it. The result was that her terror soon passed off; and, a few minutes after being fully under the in-

[1] See *Glasgow Medical Journal*, August 1901.

fluence of the current, she exclaimed: "Oh! this is lovely! I could sit here all day." This patient was pregnant at the time. Her sleeplessness returned after her confinement; but one application of the current to the head sufficed to cure her again of her insomnia.

The nature of the associated neuroses in this list of cases may be gathered from the following expressions employed by patients when stating their symptoms: "oppression on the top of the head, nervousness, trembling feelings in the hands and feet, the fidgets, giddiness, mental excitement, headache, shakiness, a nervous fear, a tremble in the head, brain fatigue, confusion of thought," etc. It is some satisfaction to know that all the nerve troubles in this formidable list can be alleviated by the proper administration of an electric current, if only the exciting cause has ceased.

Cranial Neuritis

The principal forms of neuritis met with in women are cranial and spinal. In the case of the former, patients will come complaining of "headache," but a careful inquiry will elicit the information that the pain is in the scalp only. It is a neuritis. There is usually a periodic element in it, although it may be present more or less all day, and may often prevent sleep at night. There is great tenderness on pressure when the pain is most acute.

I had under observation recently a severe case of cranial neuritis where the pain extended over the whole of the scalp, darting down over the face. The pain had lasted two years, and was becoming unbearable. The patient had a copious vaginal discharge, with scalding and pruritus of the vulva. This must have aggravated the neuritis, but I do not think that it could wholly account for it. Before applying to me an oculist had been in charge of the case. Finding that the correction of errors of refraction was of no avail, he sent her to a physician. No improvement following, she came under my care. The patient finally recovered completely, but, as there was more than mere electric treatment, it may be difficult to determine to what essentially the cure was due. The pelvic condition was rectified by electric treatment, mainly ionic medication. Arsenic, iron and strychnine bi-palatinoids were administered alternately with quinine in fairly large doses. In the patient's opinion, and in my own, the cure was largely due to the vacuum electrode and effleuve applications to the head and the administration of auto-condensation; the last of which was given for an attack of mild general peripheral neuritis, which developed in the course of the treatment.

In mild cases, or in those of limited extent, the effect of high-frequency treatment is at once obvious. In cases similar to the above, every possible additional aid must be employed.

Neuritis in the Eyeball is not an uncommon complaint. It sometimes happens that the oculist has pronounced the errors of refraction as fully corrected, and the structures of the eye as free from disease; and still there remains a persistent pain in one or both eyeballs. The application of a round-ended vacuum tube with a mild high-frequency current will at first give great relief; and will, after a few applications, completely remove the pain. The patient should hold the handle to which the vacuum tube is attached, and she can regulate the amount of current by laying one or more fingers of the other hand on the tube, so as to draw off part of the current from the eye. Five to ten minutes' application should be given to each eye.

Spinal Neuritis

Spinal neuritis is more common than is usually supposed. It is well known that in neurotic subjects there are two regions of the spine where pressure will cause pain. These are the mid-dorsal and the lumbar regions.

I have found the effleuve from the high-frequency solenoid of great assistance in relieving this tenderness, and, at the same time, improving the general health.

In what might be called spinal neurasthenia—a neuro-muscular asthenia with an aching sensation over the spine—much benefit will follow the effleuve from the high-frequency solenoid to the whole of the spine for fifteen to twenty minutes—three or four minutes at a time over as much of the spine as the effleuve may be able to cover.

It is seldom that any error is made in the strength of the effleuve when applied to the spine for neuritis. It should be as strong as possible—just beyond sparking distance. The pain may be increased somewhat on the following day, but this increase will be temporary only. In one case, under my care, the pain was made much worse, and had continued so for several days. The treatment seemed entirely unsuitable, since at the next visit even a mild application at once increased the pain. Extremely weak applications, however, soothed, and a continuance of such mild treatment effected a cure.

Certain indefinable pains in the thorax, or abdomen, can be traced to the spinal nerve supplying the part, at its point of exit from the spinal canal; pressure on which spot will elicit or intensify the pain.[1] The treatment which I have employed for this has been the vacuum electrode (Fig. 34, p. 101) applied gently to the root of the nerve if the tenderness is acute. The condenser electrode (Fig. 35, p. 101), with fairly firm massage, is to be preferred when deep pressure is required to elicit the pain. This treatment has given me every satisfaction, and the result has generally proved a source of surprise to the patient, who has been relieved of a pain in one place by treatment of a part considerably distant from it. The so-called ovarian pain is often thus traced to its source and cured.

[1] See "James Watson Lectures," by Dr. T. K. Dalziel, *Glasgow Medical Journal*, September 1914.

Sciatica

The treatment of perineuritis of the sciatic nerve is similar, but here the condenser electrode, alone, should be employed along the course of the nerve trunk, and with as deep pressure as the patient can bear. One of the cases of sciatica treated by me in this manner had resisted many forms of treatment for five years. The pain left and has not again returned, although the treatment was applied several years ago. The electrode is attached by its connecting wire to the top of the upper solenoid; the left movable contact, which is connected to the lower solenoid, being applied to the sixth, seventh, or eighth ring, according to the strength of current which the skin can bear.

Lumbo-pelvic Neuritis

I have seen no mention of this condition in gynæcological literature, but the affection has been recognised by me for many years. Pain is complained of in the pelvis only, but on careful examination no pathological change can be found to account for it. If gentle pressure, however, be applied to the walls of the pelvis on both sides, one or more spots will be found, pressure on which will intensify the pain of which the patient has complained. Sometimes pressure on the lower lumbar spine on the same side as the pelvic pain will cause a tenderness which is not found on the other side. The spinal spot can be treated in the manner just described. The treatment at the seat of the pain in the pelvis will be described under the chapter dealing with similar pelvic affections.

CHAPTER XIII

ABDOMINAL DISORDERS

Evidences of "abdominal neurasthenia"; dorso-abdominal faradisation in, series of cases so treated, description of treatment; theories as to the action of the current on the nerve ganglia of the abdomen; general neuro-muscular asthenia, causes of, difficulty in the cure of, by non-electrical measures, applications of auto-condensation in, precautions necessary; muco-colitis, high-frequency treatment in—mono-polar and bi-polar, intestinal ionisation in.

Asthenia of the Abdominal Sympathetic Nervous System

Various functional disorders are usually associated with the abdominal distress frequently complained of by women, for which no organic cause can be detected. These are sometimes described by the patient as a sense of sinking in the epigastric region, a feeling of "goneness," as one patient expressed it, a lack of interest in life, or a general sense of neuro-muscular exhaustion, markedly distinguishable from typical neurasthenia, in which the psychic element is an essential one. The term visceral neurosis describes many such cases.

Dyspepsia, arising from want of nerve tone, will probably be present, with sickness due to an attempt to force the appetite by tonics or by tempting food. Emotionalism will often be, not simply a result, but a primary cause, of the abdominal disorder; as is sometimes witnessed when anxiety or mental distress is followed by an attack of flatulence with abdominal pain or sickness. Visceroptosis, when due to relaxation of fibro-muscular supports is another evidence of abdominal neurasthenia; so also are peripheral vaso-motor disturbances, such as flushings and some forms of Raynaud's disease.

These affections are specially amenable to electric treatment; and, in my experience, dorso-abdominal faradisation gives excellent results.[1]

Dorso-abdominal faradisation was given by me in fifty-seven cases with the above symptoms, and the table opposite gives the results of the treatment. All the cases, except a very few, were women; and, since the conditions of ill-health noted are just such as women are specially liable to, I give the entire list. Other ten cases were recorded; but since some of these had only one or two applications, any improvement which took place could not in fairness be attributed to the treatment. In others the final result was unknown to me. Of course, amongst the successes there were varying degrees of success, as was the case amongst the failures also. The word "success" means that all the symptoms were practically removed, and the term "failure" means that any improvement was so little as to be practically valueless.

With reference to the list of diseases or disorders in the accompanying table, I do not claim that an affection has been defined when it is labelled. The classification, however, is, though not strictly correct, sufficient for practical definition, although I had a difficulty in classifying some of the cases. Regarding the causes, or accompanying conditions, these were often complex; I have, however, endeavoured to classify them as they impressed me at the time.

In applying this treatment the electrodes must be large and should be placed—the posterior one over the lower dorsal region, and the anterior one large enough to cover the whole of the abdomen. Sculptors' clay electrodes for this purpose are a convenience and a comfort. The dose of the current which the patient can bear should be proportioned to the size of the electrodes—from 7 to 10 ma. for fifteen minutes I have found to be sufficient. The patient must always be cautioned, with this treatment,

[1] See "The Therapeutic Value of Alternating Currents Applied to the Abdominal Sympathetic Nervous System," by the Author: *The Lancet* for May 30, 1903.

Table Showing the Results of Alternating Currents Applied in 57 Cases of Asthenia of the Abdominal Sympathetic Nervous System.

Diseases or Disorders.	No. of Cases.	Causes, if known; and accompanying conditions, if any.												
		Actively Septic Teeth.	Septic Endometritis.	Influenza.	Chronic Alcoholism.	Gastric Catarrh.	Intestinal Sepsis.	Epilepsy.	Obesity.	Inflammation of Uterus or of Uterine Appendages.	Anaemia.	Cause unknown.	Successes.	Failures.
Atonic dyspepsia	4	—	—	1	—	1	—	—	1	—	1	—	3	1
Visceral neuroses	15	—	3	1	2	1	—	—	—	1	1	6	12	3
Neuro-muscular asthenia . .	16	2	4	2	—	—	—	1	1	2	—	4	15	1
Asthma	1	—	—	—	—	—	—	—	—	—	—	1	1	—
Lumbo-pelvic neuritis . . .	5	—	—	2	—	—	—	1	1	1	—	—	3	2
Persistent sickness, with or without diarrhœa . . .	6	—	—	1	1	—	1	—	—	—	—	3	5	1
Peripheral vaso-motor disturbances, paretic or spasmodic .	5	—	2	—	—	—	—	—	—	—	—	3	5	—
Psycho-neurasthenia . . .	2	—	—	—	—	—	—	—	—	—	—	2	—	2
Uterine atony	1	—	1	—	—	—	—	—	—	—	—	—	1	—
Angina pectoris	2	—	—	—	—	—	—	—	—	—	—	2	1	1
Total	57	2	10	7	3	2	1	2	3	4	2	21	46	11

that a sense of weariness—possibly of fatigue—is likely to follow in the evening of the day of treatment or on the following day. This information will cause surprise, since there may be no consciousness of a current; but it will be necessary to inform the patient of it so as to prevent any risk of after-exhaustion from subsequent exertion. Every alternate day will suffice for this treatment. The nerve centres in the abdomen will soon regain their tone and the general health and comfort of the patient will be promoted.

The following conclusions as to the kind of case which benefits, and the kind in which dorso-abdominal faradisation is likely to fail, may be taken as fairly accurate—

A.—Cases likely to benefit.

1. Those cases of uncomplicated neuro-muscular asthenia in which the cause has ceased, or has been removed, have proved most amenable to the treatment. By neuro-muscular asthenia I mean neurasthenia minus its psychic elements.
2. Regarding cases of visceral neuroses almost as much can be said.
3. Cases of persistent sickness, some of them of reflex character, have done well under the treatment, the only failure in this list having been one in which the liver was considerably enlarged.
4. The treatment may be relied upon in vaso-motor cases, all of the five cases having been successful.

B.—Cases likely to prove unsuitable.

1. The treatment was of no avail in the cases of psychic neurasthenia.
2. In cases where inflammatory mischief is present in the pelvic organs the result is not likely to be good. In such cases vaginal electric applications, as described in a future chapter under Pelvic Affections, have given the best results.

3. Where septic endometritis exists, only a very temporary improvement will follow, although this may be made a permanent one if the treatment is resorted to after curettage or intra-uterine electro-chemical treatment has removed the septic condition from the uterus.

4. Epileptics are likely to derive no benefit from the treatment.

I had two cases of angina pectoris with no apparent evidence of organic disease. As the table shows, recovery ensued in one, but the treatment in the other appeared to have no beneficial influence, or rather seemed to make the symptoms worse. Perhaps in the one case the success was due to the anterior electrode having been placed during part of the treatment over the cardiac region; and, in the case of failure, I suspect the dose given was too large. This patient had a somewhat alarming collapse during one of the applications.

The following reasons seem to me to justify the conclusion, that the favourable results recorded are to be attributed to the action of the current on the abdominal sympathetic nervous system.

1. There are anatomical reasons: the electrodes were placed, one behind the origins of the splanchnic nerves, and the other in front of the nerve fibres and ganglionic cells of the abdominal sympathetic nervous system.

2. I have pointed out that, in faradisation of the head, therapeutic doses produce more or less psychic phenomena, showing that there is faradisation of the brain as well as of the scalp; and so, in faradisation of the "abdominal brain," as the abdominal sympathetic nervous system has been called, it may fairly be assumed that the current will act on the ganglionic nerve cells of the abdomen as a stimulant, when sufficiently large doses are given. Now, physiologists state that stimulation of this ganglionic system will cause exhaustion, and this is exactly what takes place after applications of the current. This

exhaustion is often great; but I have observed that it is, within certain limits, a favourable sign if followed by sufficient rest; for, after a proper amount of rest, there follows the opposite condition of a comfortable sense of vigour and well-being, but only when the rest obtained is proportional to the exhaustion felt. I may add here that I have never known a patient in the least degree the worse for this treatment afterwards. Query: Is the after-exhaustion due to sudden absorption of toxins from the alimentary canal, caused by stimulation of absorbing power due to stimulation of the ganglia of the sympathetic nervous system? The fact that this period of exhaustion and its amount diminish as the case favourably progresses, may be due to the amount of toxins diminishing by improved nutrition of the digestive organs; for the dose of the current is generally increased later in the course of the treatment, and then with generally slight fatigue only.

3. I have made some experiments on blood-pressure, pulse and temperature, before and after the applications. These show a practically constant rise of from five to thirty or more units in the blood pressure, without, as a rule, any change in the pulse-rate, but with a slight fall of the temperature in the mouth and in the rectum. If there should be a fall of the pulse-rate there is less increase of the blood pressure, but still some. This shows that the rise of blood pressure is not due to an increase of cardiac rate, which is often rather considerably reduced, so I infer that it is due to a mild stimulation of the sympathetic system, causing a diminished relaxation of the arterioles of the splanchnic area. This, I take it, is also evidence in favour of the direct action of the current on the sympathetic ganglia, since a paresis of these ganglia causes, pathologists tell us, a congestion of the abdominal organs.

4. I feel sure that the element of suggestion may be almost entirely eliminated, for the following reasons: (*a*) no rash promise is made to the patient beforehand;

(*b*) the current is so weak, compared with the large size of the electrodes, that the patient often complains of getting nothing at all; (*c*) the after-exhaustion is certainly an argument against suggestion; (*d*) some of the experiments, two of which were made on medical men, were on those little likely to be influenced by suggestion; and (*e*) there was an absence of early or sudden benefit, this having been rather slow and somewhat delayed, even in finally successful cases.

It must not be inferred that the only form of electric treatment, or even the best treatment for the morbid conditions mentioned in the above table, is dorso-abdominal faradisation. I have treated such cases by other forms of electro-therapy and with quite as much success. Auto-condensation, or the effleuve applied to the spine and over the abdomen, will give probably as good results in many cases, though not so good in others. The great temptation to resort to other methods lies in the fact that dorso-abdominal faradisation requires for its proper application the undressing of the patient, and, where two forms of treatment have proved equally efficacious, one is apt to turn to that which gives the least trouble to the patient.

General Neuro-muscular Asthenia

This is a condition, which, although not specially due to asthenia of the abdominal sympathetic nervous system, is nevertheless sometimes associated with abdominal distress. Here again worry, anxiety, overwork, etc., are often contributory causes. Influenza may have preceded the illness.

The patient complains of being run down, of feeling unduly irritable, of having little appetite, and of obtaining insufficient sleep; whilst she is conscious of feeling as wearied when waking in the morning as when going to bed. Tonics and even change of air may have been tried without any beneficial result. Rest for a day or two in bed has probably been tried, but the benefit has been temporary only. No organic disease can be detected, and no help can be obtained from drugs. This "symptom-complex," rather than this "disease," is almost certain to be benefited by high-frequency auto-condensation. If the patient's life can be regulated whilst undergoing the treatment, then I am safe in saying from experience that "cure" is a certainty, even in such obstinate cases as I have defined. That is on the assumption that the original cause of the illness has ceased. It is usually impossible to remove the cause wholly; but no success can be expected from the treatment if, at the time, the cause is still in active operation.

Mere applications of auto-condensation in these cases are of little avail if the patient should come for the treatment fatigued or excited. *Indeed dangerous exhaustion will likely follow in such cases.* Nor must the time immediately following the treatment be spent in hurrying off to some duty. For a period of at least two hours after, the patient must rest, though not necessarily in bed. A sensation of drowsiness must not be resisted, sleep being rather encouraged. A sense of comfortable weariness is a good omen, and this should be aimed at in deciding as to the dose and the duration of the application. To start with 200 ma. for fifteen minutes will generally suffice, whilst I rarely exceed a dose of 400 ma. for twenty minutes in after applications.

At least twelve applications, which should be of fifteen minutes' duration, will be required. These may be given at first three times a week; afterwards twice weekly. Patients must be discouraged from talking during the application of the treatment.

Muco-colitis

Muco-colitis is not included in the foregoing table, because when I compiled the paper, referred to at the beginning of this chapter, I had not treated such cases with electricity. Since the year 1903, however, I have applied electric methods in the treatment of muco-colitis with very good results. The method I have found suitable is the bi-polar high-frequency oro-rectal application. A spoon-shaped metallic electrode (Fig. 36) is held on the tongue by the patient. The electrode, illustrated in Fig. 31, p. 78, is inserted into the rectum and connected to the terminal from the top of the resonator; the mouth electrode being connected to the left movable contact placed on the top ring of the thick wire solenoid (see Fig. 17, p. 66).

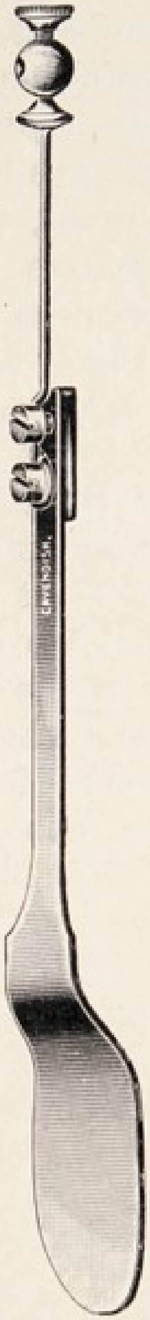


FIG. 36. — The Author's Mouth Electrode.

A current of about 150 ma. is given for fifteen to twenty minutes on alternate days. Great care must be taken, when making this application, to ensure that there are no loose connections in the circuit, otherwise the current will be jerky and most painful to the patient. For this reason the treatment must be started with as small an amount of current as possible; and, only when it is found to run smoothly, should it be brought up to the maximum milliampèrage.

I have also found mono-polar rectal applications from the top of the resonator useful in muco-colitis; but if the bi-polar oro-rectal application can be successfully applied it is to be preferred.

In cases of muco-colitis, especially, all other means recognised as possible aids should be employed. Of this nature I have found enemata of solution of borax and chlorate of potash—a dessert-spoonful of each to about thirty or forty ounces of warm water—very useful when employed on days when the electric treatment is not being applied. I have treated not simply mild cases, but some of considerable severity, in this manner, with satisfactory results. As an internal medicine I have found occasional doses at bed-time of calomel and quinine helpful, followed by a saline aperient in the morning. Here, again, it may be said that the electric application can have had little effect on the disease. I am satisfied, however, that this is not so; and muco-colitis is so obstinate an affection that it is not advisable in its treatment to omit any remedy likely to be of service.

I have had almost no experience of intestinal ionisation in muco-colitis, the methods I have indicated having given me so much satisfaction; but my son, Lieut.-Col. S. M. Sloan, R.A.M.C. (T.), who has had considerable experience of muco-colitis, speaks favourably of its treatment by ionisation. He employs a solution of salicylate of soda, attached to the negative pole, daily for two weeks, then on alternate days for about three weeks, each application being preceded by a copious enema. The result, even in a most severe and intractable case, was entirely satisfactory.

PART V

PELVIC AFFECTIONS

CHAPTER XIV

NEUROSES OF THE PELVIC STRUCTURES

Plea for electro-therapy in affections of the pelvis, cases suited for the treatment; galvanic cautery; pruritus, vulvar and anal, cases not requiring electric treatment, cases suitable, method of treatment; pelvic distress, nature and causes of; how to distinguish between pelvic neuritis and pelvic inflammation; "ovarian pain"; results of electrical methods contrasted; removal of sepsis important; faradisation, value of the secondary current for pain and of the primary for relaxation of uterine supports; dysmenorrhœa, varieties, those requiring general electro-therapy, those requiring local applications, methods, precautions when complications present.

In advocating the employment of electro-therapy in pelvic diseases in women, I am not suggesting that electricity is required, or is suitable for, all pelvic affections; for this is not the case. Nor am I to be understood as proposing that this remedy is to be employed here merely as a supplement to the ordinary orthodox methods of treatment; for I believe that, properly employed, it can be made, in the case of most of what might be called the medical diseases of women, to supplant all other therapeutic measures. This may seem a bold statement to make, but I speak from a considerable experience both of the old and of what may be to many the new method.

At the same time the electro-therapeutist is, or at least ought to be, a general physician first of all; and therefore he will be prompt to use all possible aids towards the relief of his patients. The more experience, however, he acquires in electro-therapy, the less will he feel dependent on non-electric measures. I have frequently had to resort to one of the latter, namely, the galvanic cautery. Electro-therapeutists cannot claim this as part of their armamentarium; for it is a cautery (just as the Paquelin instrument and the red-hot wire are cauteries), and not, properly speaking, an electro-therapeutic agent. I have found it serviceable in certain affections of the vulva and the vaginal portion of the cervix where electrolysis and ionisation had failed.

Presuming that the reader already knows what non-electric measures can do in medical gynæcology, I shall seldom refer to these. They are not generally successful, as I have already pointed out. Nevertheless their employment may sometimes hasten a cure; although, for the cure to be permanent, reliance must in many pelvic affections be placed practically on electro-therapy alone.

In the following chapters no attempt will be made to treat of all the affections of the female pelvis, but of those only which I have found amenable to electro-therapy. As will be seen by reference to p. 173 of the Appendix, which contains a list of the complaints thus treated by me, I have divided these into fifteen heads. Some contain one disease only, some one symptom only; whilst others include a number of so-called different diseases such as the septic class and the group dealing with what might be called the neuroses.

Though far from complete, the affections dealt with are those which frequently come before the general practitioner; and which, through his supposed inability to treat successfully, he is tempted to hand over to the gynæcological surgeon.

Practically no attempt will be made here to deal with descriptions of the various ailments, their cause, pathology, diagnosis, etc., it being taken for granted that the practitioner is already sufficiently familiar with this side of the subject; or, if not, that he will find other sources for obtaining his information.

Only where it may be necessary to differentiate between varieties of the same affection for the purpose of treatment, will suggestion be offered.

PRURITUS[1]

Any practitioner who has had to treat gynæcological affections must frequently have been consulted as to this symptom, for it is a symptom only. It is perhaps the most annoying of all the troubles of women. It may, indeed, if not cured or relieved, end in serious mental disease. In most cases pruritus can be removed by simple treatment, such as thorough cleanliness, of which the patient may not have previously recognised the importance. On the other hand, I believe that, in certain cases, excessive cleansing may induce or increase the disease ; and, what is worse, cause a morbid concentration of attention on the part of the patient to the vulva. Again, pruritus may be due to an abnormal condition of urine or of vaginal discharge, and may disappear on the removal of the cause.

In a considerable number of cases, either the cause is irremovable or the itching may so persist after the removal of all suspected causes, that the physician is at a loss to account for it, and so masturbation may be suspected. This is sometimes given as a cause, but I think it is more frequently a consequence ; and thus the evil becomes an increased source of danger to the patient's emotional balance. It is just in such cases that electro-therapy may arrest serious mental danger, after the failure of all other therapeutic attempts.[2]

A medical man who had sent a severe case of pruritus to me for electrical treatment, in reply to my request, two years after, to be informed if the benefit derived from the treatment had been lasting, wrote to me as follows: "I am glad to say that my patient keeps very well and seems to have no trouble. It is a blessing that

[1] See also Appendix, p. 275. [2] See case No. 204, Appendix.

this harassing ailment (harassing both to doctor and patient) can be dealt with so satisfactorily and speedily."

The treatment of pruritus of the vulva or the orifice of the vagina, if high-frequency apparatus is available, is exceedingly simple; and, as a rule, the cure can be effected in ten or fourteen days; unless in very chronic cases, when about a month's treatment may be required. The case just referred to was nearly four weeks under my care.

A vacuum electrode (see Fig. 34, p. 101) attached to an insulating handle is connected by a well-insulated flexible wire to the top of the upper solenoid of the high-frequency apparatus (see Figs. 16 and 17, p. 66); the left-hand movable contact being attached to the seventh or eighth ring of the lower solenoid, and an amount of current applied which will not irritate the patient or produce excessive heat in the electrode. In case the electrode should slip out of the vagina, and thus alarm the patient, it should be fixed in position by means of a weight applied to the handle before turning on the current, which, at first weak, ought to be gradually increased till the desired effect is produced. No part of the metal attachment should be near enough to the patient to permit of sparking; and, as has been said, the current must not be too strong or too prolonged to cause undue heat in the electrode, otherwise a dermatitis may follow from the treatment. If this should arise the applications must be stopped and appropriate remedies applied till the electric treatment can be safely resumed.

If the itching is mainly in the labia majora, a flat, mushroom-shaped vacuum tube will suit best, but, if within the vulva or at the orifice of the vagina, a conical glass electrode is the proper one (see Fig. 34, p. 101). This is the one suitable in the case of pruritus of the anus. In the latter case the electrode ought to be inserted to the extent of at least two-thirds of its length, so that the anus may be distended as much as the patient can comfortably bear. A heavy weight on the electrode handle will be necessary to keep it in position; and the electrode ought to be warmed and well smeared with vaseline before introduction. The electrode can quite safely be heated by placing it in warm water. After each application the tube should be thoroughly cleansed with soap and warm water, and afterwards with methylated spirits.

Pelvic Distress [1]

Cases of pelvic distress are often met with apart from any apparent pathological changes in the pelvic organs. They are, therefore, neuroses—cases of abnormal sensation only. True, prolapse of the uterus and of the vaginal walls cannot quite, without some explanation, be called a neurosis. But it is not the prolapse alone that is complained of, it is a dragging sensation accompanying the prolapse; for a downward displacement of the womb may exist without any sensation of distress. This distress, however, when present, can often by means of electro-therapy be practically removed; although the prolapse may seem to have been but little benefited.

I find singularly little mention made in works on gynæcology of pelvic neuritis and other forms of pelvic distress, apart from pathological accompaniments; but patients often complain of abnormal sensations in the pelvis or the vulva without any obvious cause. The annoyance from these is often great; although patients may have a difficulty in defining them. Pain (not a neuralgia in the ordinary sense of the term) is sometimes complained of in the pelvis; although no evidence as to its cause can be discovered. Pressure against one side or the other of the interior of the pelvis will sometimes elicit this pain; or the tenderness may be found to be present over the whole of the internal pelvic walls. Occasionally the origin of this pain may be traced to the lower lumbar and sacral spinal regions, where tenderness

[1] See also Appendix, p. 276.

on pressure will also be found present. (See Lumbo-pelvic Neuritis, p. 112.)

The practitioner is apt to conclude that tubo-ovarian disease exists when bi-manual pressure of the broad ligaments causes undue pain. When this is the case and yet there is no evidence of inflammatory changes there, if the finger be pressed against the adjoining parts of the pelvis and every part touched be found to be more or less painful, there is a pelvic neuritis, and this may be the sole cause of the pelvic distress. In these cases there is often a constitutional neurosis; and the knowledge of this may go far in entitling the practitioner to negative actual pelvic disease as the cause of the pain.

The so-called ovarian pain is frequently simply a pelvic neuritis; there being no actual disease of the ovary present. If the true nature of this pain is realised, and especially if there exists at the same time a tenderness on pressure of the roots of the lumbo-sacral nerves at their exit from the spinal column, electro-therapy can almost certainly be trusted to cure it.

In the Appendix (p. 276) will be found a record of some of the abnormal sensations with which this chapter deals, stated in the words of the patients who complained of them. The treatment of these sensations is generally very unsatisfactory; but this is no reason for assuming that they exist in the patient's imagination only; although this is a natural conclusion to come to when one has failed to remove them. At least it is a conclusion consolatory to the physician, although annoying to the patient if told of it.

If the reader will study table (*b*) in the Appendix (p. 277) he will observe that, with galvanisation or faradisation or both combined, out of a total of twenty cases so treated, only nine were "cured" and six were greatly benefited; whereas in five the treatment was a failure. On the other hand, where the cases were treated by ionisation, and high-frequency, singly or in combination, out of a total of eighteen, there were "cured" fourteen, greatly benefited three, and in only one case is a failure recorded. This cannot be a coincidence merely; the numbers are too large to make this probable.

An inference which it may be reasonable to draw from these facts is that sepsis may have a share in causing the pelvic distress; and, considering how prone the pelvic organs are to sepsis, it is, I think, a fair inference.

When, beside the pelvic distress, there exists sepsis of any portion of the genital tract, or where inflammation is present in the appendages, these conditions will naturally first receive attention, in the hope that, with their removal, the pain or other abnormal sensation, will disappear. Should the removal of the sepsis not result in the removal of the pain, the nature of the treatment will depend on the diagnosis as to the cause of the pain. If simple intra-pelvic neuritis be diagnosed, the treatment should be by vaginal mono-polar high-frequency currents; directing the metal plate of the electrode against the part where there is tenderness on pressure. Should there be tenderness at the spinal nerve roots, then, to this internal treatment, may be added treatment of the tender parts of the spine; by the effleuve if the tenderness on pressure is acute, by the vacuum electrode if sub-acute, and by the condenser electrode if chronic. The more chronic, the deeper and firmer should the application of the last named be.

In many conditions other than pain, high-frequency applications will be of service owing to their local tonic effects, which are undoubted if the applications are properly made. The vulva may be thus treated, when necessary, with satisfactory results.[1]

Where the distress is due largely to lack of muscular tone, most benefit will be derived from the static-induced current; a metallic electrode being inserted into the vagina, and the neutral electrode—the ordinary wet pad—on the abdomen. Detailed instructions as to this method will be found on page 169, where the treatment for obstinate constipation is described.

[1] See case No. 197 in the Appendix.

In the absence of the high-frequency apparatus, faradisation will certainly be worthy of a trial. Out of the total cases treated (see Table (*b*), p. 277), thirteen, it will be observed, had faradisation alone. Of these it is recorded that seven were "cured," three greatly benefited, and only three failed to respond to the treatment. This is, it will be admitted, quite a satisfactory result.

If faradisation is employed for pain, or aching sensations, the current should be a mild one, and should be obtained from a secondary coil of many windings; the vagino-abdominal form of application being employed. If for muscular relaxation, the primary coil will be the appropriate one; interrupting the current by means of the metronome interrupter,[1] if the relaxation be severe. Sometimes the vaginal bi-polar electrode alone may be used (see Fig. 23, p. 74) instead of the method described, where it is not advisable to undress the patient.

Dysmenorrhœa [2]

The various forms of dysmenorrhœa will require different modes of electrical treatment.

Purely functional or spasmodic dysmenorrhœa can be best treated by general electrification. Thus the physical health will be improved and nerve tone increased. This may be effected by auto-condensation, that is the couch treatment with high-frequency currents; or, where the illness is visceral in origin, by dorso-abdominal faradisation.[3] If general treatment should fail, applications of bi-polar vaginal faradisation (Fig. 23, p. 74) may prove successful. In this case the current should be taken from the secondary coil. If both of these should fail, it may be assumed that the case is not one of a purely functional nature, but that some pelvic pathological condition exists; the removal of which may cure the dysmenorrhœa.

[1] See p. 73. [2] See also Appendix, p. 277. [3] See p. 114.

The other forms of dysmenorrhœa—the congestive and the membranous—require special local pelvic electric applications.

For congestive dysmenorrhœa, the treatment should be such as is suitable for pelvic inflammations, including metritis. For the membranous form, ionisation of the endometrium has in my hands given excellent results. Here the electrode may be of zinc or of copper. I prefer the former, unless in cases which it has failed to cure.

The precautions necessary in intra-uterine ionisation will be found detailed at pp. 145–148. It is, perhaps, unnecessary to point out that the best time for ionisation of the interior of the uterus, in membranous dysmenorrhœa, is during the first half of the inter-menstrual period.

CHAPTER XV

SUBINVOLUTION[1] AND HÆMORRHAGE[2]

Meaning to be attached to the term subinvolution; treatment recommended—faradic or high-frequency current; complications. Hæmorrhage—menorrhagia and metrorrhagia, ionisation recommended in, copper the more efficient ion, precautions necessary.

Simple Subinvolution

It is unnecessary here to discuss what may be the true pathology of simple subinvolution of the uterus. The signs and symptoms of the cases to which I have given this name were an enlargement of the uterus after recovery from confinement and not due to fibroids, a sense of weight complained of by the patient, impaired general health, no menorrhagia or metrorrhagia, and no clinical evidence of a septic condition of the endometrium.

Such cases are not numerous in my experience, hæmorrhage being a fairly constant accompaniment of subinvolution; and also, in a mild degree, sepsis of the endometrium.

Cases of subinvolution, in which there is apparently a hypertrophy only, should be treated by intra-uterine primary faradisation by means of a bi-polar electrode (Fig. 24, p. 74)—or with the mono-polar high-frequency current by means of my high-frequency vaginal electrode (Fig. 30, p. 78). Either of these forms of current should suffice. The amount of the faradic current should be gauged by the sensations of the patient, and measured by the faradimeter, to ascertain if there is any change in the amount of tolerance of the current as the case progresses. About eight milliamperes may be considered an average dose here. When the vaginal application of the mono-

[1] See also Appendix, p. 278. [2] See Appendix, p. 279.

polar high-frequency current is used, the connection to the vaginal electrode is taken from the top of the upper solenoid, or resonator as it is sometimes called, and a dose of from 150 to 250 ma. given; starting the treatment with the smaller dose.

In cases of a more or less septic nature—a chronic metritis it might then be more appropriately named—intra-uterine electrolysis has proved efficient in my hands; but I believe intra-uterine ionisation is to be preferred. In the latter case, smaller doses of the galvanic current will be required; and therefore the danger will be less. General high-frequency treatment by means of auto-condensation will, by improving the general health of the patient, reduce the bulk of the subinvoluted uterus.

Hæmorrhage—Menorrhagia and Metrorrhagia

In uterine bleeding, apart from fibroids or malignant disease, I have found electro-therapy a reliable form of treatment, when the measures generally used for the treatment of such a condition have failed. When the uterine canal is patent, there is no difficulty or danger, in the absence of intra-pelvic inflammations.

The best form of electrical treatment of uterine hæmorrhage is by ionisation, either with zinc or copper. If the cavity of the cervix readily bleeds, when being cleansed by means of a cotton-covered probe, treatment should be at first confined to the lower segment of the uterus. The bare copper electrode will be found the most efficient, with a dose of from 15 to 25 ma. from the positive pole. In mild cases zinc ionisation may be tried first. Although less efficient than copper, the zinc electrode will be easy to remove; whereas if the bare copper electrode is employed, it will always be necessary, as has previously been pointed out, to reverse the current, so as to free the electrode from the electrolysed and ionised tissues; otherwise pain and bleeding will certainly follow any attempt to remove it. This is done by gradually reducing the current to zero, reversing the current, then gradually increasing this till the same amount has been reached as was given during ionisation, and continuing this dose for one third part of the time given to the ionisation. If the electrode is not perfectly loosened then and easily removed, one minute more of the reversed current will generally be sufficient. No force must be employed during attempts at extraction.

In hæmorrhage from the body of the uterus, the electrode must be introduced to the fundus. I generally begin this treatment with the zinc intra-uterine electrode, so as to avoid the possible pain and bleeding apt to follow the use of the copper electrode; but when zinc ionisation fails, copper ionisation must be substituted for it, after which, apart from the inconvenience referred to, success may be expected.

As in the treatment of septic endometritis the intrauterine electrode ought, if possible, to be passed into the uterus through a speculum and for the same reasons. When this cannot be done the handle and shield method will probably succeed (see p. 148). Sometimes, however, owing to stenosis of the internal os, even the latter method of introduction of the ordinary electrode may be impossible. One such case I had under my care. The hæmorrhage resisted all forms of treatment, local, constitutional and electrical; and the patient looked as if she had hardly any more blood to lose. The cervical cavity had been ionised, but this did not stop the hæmorrhage, and I found it impossible to get beyond the cervix with even a specially fine electrode made to suit the case. I told the patient I was despairing of success and that I feared she would require curettage. This was to me a humiliating confession to have to make. I had never failed before. The patient begged me to try again, as she was very anxious not to require to take chloroform. I did so, and succeeded. A current of 25 ma. was applied for fifteen minutes, when, the current being reversed for three minutes, the electrode was easily withdrawn. There was practically no bleeding afterwards.

I have said that the current has generally to be reversed for about one-third of the time of the ionisation, and yet in this case one-fifth of the time sufficed. This was probably due to the presence of blood around the electrode, which would thus free itself more readily than would have been the case if the metal had been in contact with the unprotected endometrium as in the treatment of septic endometritis.

Probably, in the case above referred to, the stenosis could have been removed, once the fine copper electrode had been passed, by attaching it to the negative pole and employing a very large current for a sufficient time. The widening of the internal os thus brought about would not be owing to physiological relaxation but to a solvent action of the caustic soda, derived electrically from the chloride of sodium of the tissues (see p. 35, section 3). Besides the fact that such a procedure would have, at least temporarily, increased the bleeding, the large amount of current required is, I suspect, not entirely safe; moreover, the stenosis can be overcome by other and less dangerous methods.

CHAPTER XVI

SEPSIS OF THE GENITAL TRACT: VULVITIS, VAGINITIS, ENDOCERVICITIS AND ENDOMETRITIS [1]

Vulvitis, varieties, cases suitable for ionisation, methods of application. Vaginitis; electrodes suitable for combined vulvo-vaginitis, for simple vaginitis, for localised vaginitis; method of employing the author's vulvo-vaginal electrode; speculum ionisation. Endocervicitis, obstinate nature of; value of ionisation in erosions; methods of employing ionisation; the proper ion to be employed; precautions to be observed; possible caustic action of the current. Endometritis; how to apply the intra-uterine electrode; precautions; warnings as to danger from the treatment.

If, in the whole realm of therapeutics, there ever can be absolute assurance of success, it is in the field of ionisation for septic disease. Nothing in ordinary medical therapeutics can equal it.

The theory on which ionisation is based has been discussed in Chaps. IV and V, and the practical results, physical, chemical and biological, have been demonstrated in Chap. VI. It would be well for the reader to have a clear mental grasp of what I have attempted to describe in these chapters, before beginning to practise ionic methods of treatment.

Vulvitis

There are various forms of vulvitis, and many causes of it. Most of them, as a rule, do not require electrotherapy for their cure.

The most common form of vulvitis met with in practice is what might be called erythema intertrigo. The whole of the vulva and the neighbouring skin are red, tender and itching. The cause here may be incontinence of urine or irritation from vaginal discharge. The patient may be

[1] See also Appendix, p. 280.

stout, and the vitality is generally lowered. After removal of the cause, which may often be done by electric treatment, simple remedies will generally result in cure.

When, with this erythema, there is some induration of the skin and mucous membrane, electro-therapy may, in obstinate cases, be required. In chronic purulent vulvitis, electric treatment will generally be necessary; and here the cure will be more speedy and more lasting than under any other treatment. If pus be seen exuding from the vulvo-vaginal glands, and other measures have failed, electro-therapy will almost certainly succeed. The cause may be an old-standing gonorrhœa, whose presence may be unsuspected; or the organism may be the pneumococcus. Whatever the micro-organism the best treatment is ionisation; although, in my experience, the need for any form of electric treatment in vulvitis does not often occur.

For ionisation of the vulva, either the copper or the zinc ion can be employed. For this purpose the strong copper spiral (see Fig. 29, p. 77) is quite a serviceable electrode. The vulva externally and internally should be covered with about a dozen folds of surgeons' lint, soaked in a one per cent. solution of bi-chloride of zinc or of copper, and the spiral pressed against this and held firmly in position there by means of the speculum electrode handle, with a heavy weight resting on its base. A current of 15 to 20 ma. for fifteen to twenty minutes is sufficient: the positive pole being, of course, attached to the vulvar electrode; seeing that the ion to be driven in there is a metal and therefore electro-positive.

The neutral electrode may rest on the patient's breast outside the clothes, with her hands placed upon it. A piece of waterproof sheeting, or a folded towel, placed under the electrode will serve to protect the patient's dress. A shield of thin rubber or gutta-percha tissue should be placed between the pad and any rings the patient may have on at the time; otherwise, owing to the concentration of the current at the ring, a burn might result. If there should be even a point of abraded surface on the hands or fingers this must also be protected, since the current will concentrate there, owing to diminished resistance to its passage.

The ionic applications should be given as a rule twice a week. It is better to allow an interval of at least three days between the applications. A few such treatments will suffice to bring the vulva to a normal condition.

Vaginitis

Vulvitis and vaginitis are almost certain to be present together, and the two can be treated at the same time by means of the vulvo-vaginal electrode. (See Fig. 28, p. 76 and Fig. 37, p. 140.) This instrument, if employed for both affections at the same time, ought to be made of metal—zinc or copper. The metal electrode must be separated from the vulva and orifice of the vagina by 8 or 10 layers of surgeons' lint, moistened with one per cent. solution of the bi-chloride of the metal employed. An opening should be made in the centre of the folds of lint, through which the vaginal projection of the electrode may be passed into the vagina. This vaginal projection must be protected by a stout tube of india-rubber about 2 ins. long, and so applied as to project about 1 in. into the vagina. This is necessary for protection of the orifice of the vagina, otherwise serious burns may result owing to the difficulty of covering this part with a sufficient number of folds of lint, and at the same time preventing the escape of fluid from the vagina.

In cases where the vulva requires no treatment and vaginitis is present, or when the vulva has been treated by the means formerly described, the electrode should be made of vulcanite with its tubes of copper or zinc.[1]

In this electrode the binding screw is not attached to the retort stand but to the upper or inlet tube, which is the electrode portion proper of the instrument.

In the case of the vulcanite instrument, no covering of lint is required, but the protecting elastic shield must still

[1] This instrument can be supplied by The Cavendish Electrical Company, Great Portland Street, London, W.

always be placed over the vaginal portion of the instrument; otherwise the extremity of the electrode tube there will almost certainly touch the soft parts at the vaginal orifice and cause a troublesome burn from the current.

To manipulate the vulvo-vaginal apparatus requires some experience and much care, but if properly managed, its action is perfect and it is completely under control, whilst the inconvenience to the patient is *nil.*

Having been informed that some medical men have found a difficulty in applying this electrode successfully, I shall give the steps required in their order and in detail, so that there need be no difficulty with it.

1. Pass a speculum and remove with a cotton-covered Playfair's probe all discharge within reach. Remove the speculum and place a bed-pan, slipper-shaped and previously warmed, under the pelvis sufficiently to secure that the vulva overhangs the opening of the vessel.
2. Pour into the douche receptacle, suspended by a hook about 3 ft. above the level of the couch, 20 oz. of a one per cent. solution of the bichloride of zinc or copper according to the ion decided upon; having first closed the stop-cock of the douche tube.
3. Place a heavy retort stand on the couch between the patient's knees with its base towards the patient, and have the rod which is to connect the stand to the electrode lying close at hand. Then place a heavy weight, such as two heavy books or the shot-bag, or both, on the base of the stand.
4. Fix the inlet india-rubber tube on the upper metallic tube of the electrode and the outlet rubber tube on the lower one; then apply the spring handle on to the projecting part of the electrode between these tubes; and, having made sure that the projecting piece of elastic tubing is over the vaginal prominence of the electrode, pass it well into the vagina; then press the electrode firmly against the vulva all round, insert the connecting rod into the opening

of the spring handle, and place the curved end of this rod under the projecting arm on the upper part of the upright of the stand, at such a height

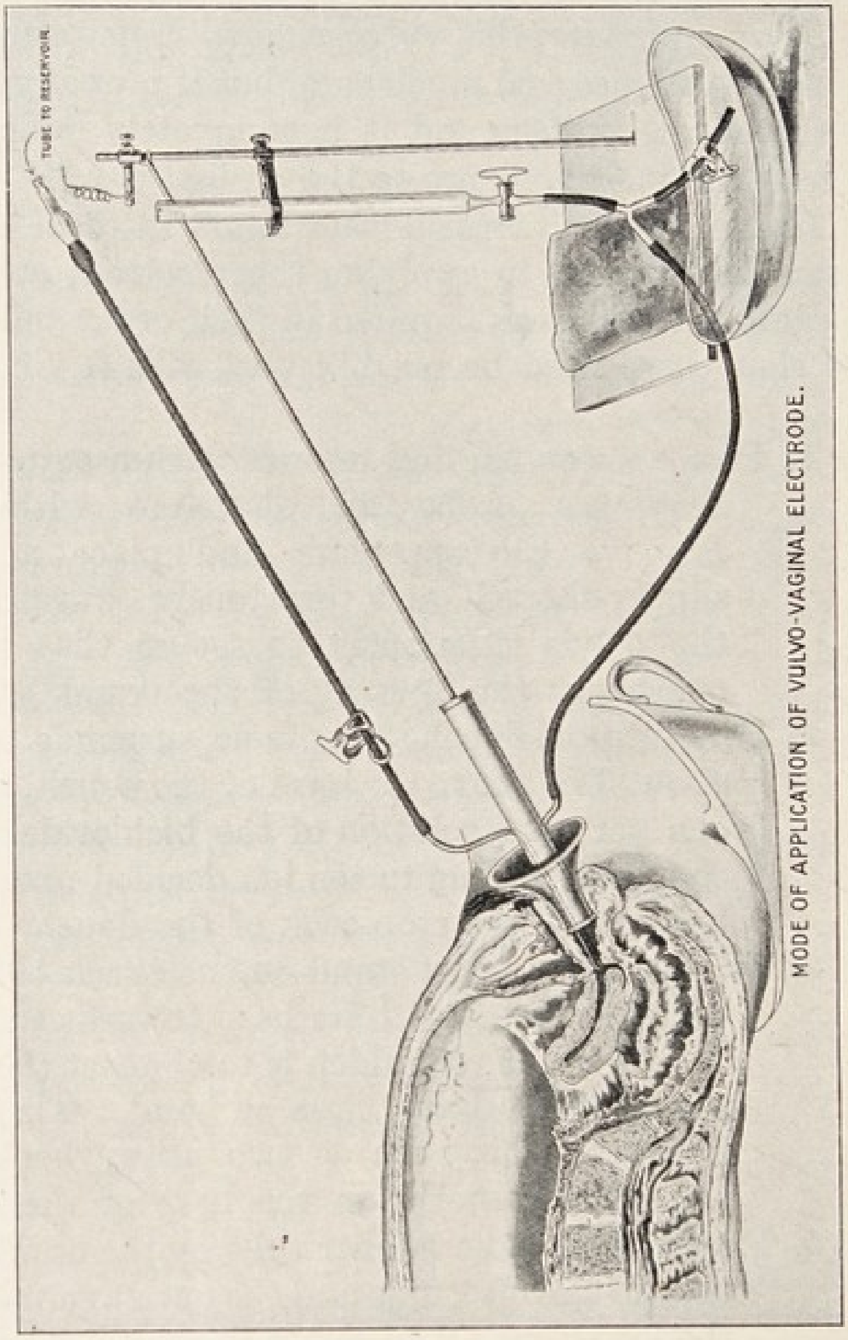


FIG. 37.

as will keep the electrode securely and uniformly over the vulva. Next bring the stand near to the patient so as to increase the pressure against the vulva to the extent which the patient can bear.

5. Now pass the burette into the clip of an arm of the retort stand, connect the single limb of the Y-shaped glass tube by means of a short length of rubber tubing to the tip of the burette. Insert one of the remaining limbs of the Y-shaped glass tube into the outlet rubber tube from the electrode, and the third limb into a short rubber tube, having a spring stop-cock attachment. Dip the end of this tube into a small basin placed conveniently at the side of the retort stand. Everything will then be arranged as shown in Fig. 37.
6. Finally open the stop-cock of the inlet tube, also that at the outlet tube which is lying in the basin, and allow several ounces of the fluid to pass through the vagina into the receiving basin; now and again compressing the outlet tube with the fingers so as to distend the vagina somewhat. When the solution passing through has become clean, close the outlet stop-cock, and, if the tap of the burette is open, as it should be, the fluid will rise in this tube. Let this continue till the patient complains of excessive distention of the vagina, or till some fluid escapes from the vagina into the slipper. Should the latter take place first, apply more pressure against the vulva, either by increasing the weight on the stand or by bringing it nearer the patient, and continue the flow into the vagina till the head of fluid in the burette reaches about 12 ins. above the vaginal orifice; then close the stop-cock of the inlet tube.

If properly managed a "head" of fluid of from 12 to 24 ins. can be obtained in the burette, without the escape of more than a few drops from the vagina into the slipper; and the whole process can be carried out without a drop of the solution soiling the patient's dress.

The rise and fall of the fluid in the burette with the respiration will give evidence of the distention of the vagina. Should this up and down movement with the respiration not take place, there is a block at the vaginal orifice preventing the entrance of the solution into this cavity. If the elastic attached to the vaginal prominence of the electrode be stout enough this can hardly happen.

When everything is in a satisfactory condition, and the wire connections are completed—the wire from the positive pole attached to the vulvo-vaginal electrode and that from the negative pole to the neutral electrode—the current is slowly turned on till a dose of from 20 to 50 ma. has been reached. The duration of the current ought to be fifteen to twenty minutes.

Should the level of the fluid in the burette fall during the treatment, owing to escape of the solution from the vagina, the supply stop-cock can be opened occasionally to restore the original level, and the outlet stop-cock can be opened, if necessary, to reduce the level if previously unduly high.

A "head" of about 12 ins. in the burette is generally sufficient force to apply; although double this may be reached without any risk from intra-uterine distention. Indeed, a "head" of 8 ins. above the level of the vaginal orifice is, I have found by experiment, sufficient to lift a weight of four or five pounds; and evidently suffices, as the result shows, to overcome the pressure of the roof of the pelvis when the patient is in the dorsal position.

If a large current—over 20 ma.—is desired, the clay electrode may be applied over the abdomen. This is less convenient, since it requires partial undressing of the patient, but it is more thorough and the hands can seldom tolerate a current exceeding 20 ma.

It is well to ascertain how much fluid has been retained in the vagina during each application. This can be done at the close of the treatment by closing the burette tap and opening the outflow one, thus letting the fluid pass from the distended vagina into the receiving basin, which should have been previously emptied. The quantity will be found to measure from 2 to 6 oz. according to the capacity of the vagina.

The distention of the vagina by the process described will ensure that no part of this cavity escapes ionisation. Besides the vagina the interior of the cervix and of the uterus will also be ionised in a mild degree, leaving the thorough ionisation there as the next step in rendering the whole of the genital tract aseptic.

It would be difficult to say to what extent the distention of the vagina with such a head of fluid as 24 ins. enables the ionising fluid to enter the interior of the uterus, and whether it would be possible for it to reach the tubes if their uterine ends are patent from disease. I cannot speak with assurance on this point, but I think it is reasonable to consider this possible to a sufficient extent to be of service.

Should the vaginitis be limited to the vaginal surface of the cervix, as I find is sometimes the case, it will suffice to pass the perforated end of the glass speculum (Fig. 29, p. 77) into the vagina, clean the cervix and nearly fill the speculum with the ionising solution. Then place in the speculum a small spiral of the metal whose ions are being employed, and fix the spiral, by means of the speculum clip, on to the speculum electrode handle shown in Fig. 29, p. 77, taking care that the metallic spiral is just long enough to dip into the solution.

For the method of fixing the speculum during this application see Fig. 39, p. 147. In this figure a slipper is represented as placed under the pelvis of the patient. This protection is not absolutely necessary in speculum-ionisation, seeing that the fluid in the speculum can be removed by means of a glass syringe, with a piece of rubber tubing attached to its nozzle, at the close of the application, instead of withdrawing the speculum and allowing the contents to flow into the slipper.

The solution will, forced by the head of fluid in the speculum through its openings, be brought into contact with the whole of the upper part of the vagina, ionising the part affected. This is a much simpler process; and, on account of the limited nature of the vaginitis, may be sufficient to cure it; whilst at the same time, acting on part of the interior of the cervix in a mild degree as a preliminary step to a more energetic treatment there. The milliampèrage of the current will depend upon the size of the speculum. Ten milliampères will be enough if a very small tube be used, 20 ma. if a large one.

I have frequently observed a strictly localised cervical vaginitis, limited usually to the posterior lip of the os. It is not an erosion, and seems to be of the nature of eczema erythematosum. The cause of its presence is obviously a long-continued mild irritation due to the escape of septic material from the os. It must be of some importance since the cervical neighbourhood never becomes absolutely aseptic till this red patch is cured. I have not found it amenable to ionisation, but it is easily cured by a superficial application of the galvanic cautery. It does not tend to return, although two applications of the cautery may be required to complete the cure.

Endocervicitis

The cavity of the cervix is, of all portions of the genital tract, most frequently the seat of sepsis, and it is sometimes the only part requiring treatment. Even after curettage this is the situation where antiseptic applications are mostly found to be necessary to complete the cure of the sepsis. In endocervicitis, ionisation gives the surest prospect of an absolute cure. The treatment of the cervix can be of a very thorough nature; for there is not the same risk from severe treatment of the cavity of the cervix as in the case of the interior of the uterus.

The intra-uterine electrode can be employed for this purpose. If the os be gaping and eroded and the cavity of the cervix wide, a special cervical electrode (Fig. 38) is to be preferred. The whole of the cervical cavity will then be within the reach of the electrode; its base being in close contact with the patent and granular os. This electrode should be inserted in the manner shown in Fig. 39 for the insertion of the intra-uterine electrode by means of the glass speculum. The position of the neutral electrode would be, as mentioned previously, a matter of convenience or dose (see p. 142).

Fig. 38. — The Author's Cervical Electrode.

Nothing has impressed me so much in the practice of ionic medication as the rapid improvement brought about by this means in the treatment of cervical sepsis. The discharge, from having been muco-purulent and copious, becomes milky in appearance and of small amount; whilst the gaping os becomes normal in size with the everted mucous membrane drawn in, and the erosions rapidly heal. All those changes may possibly be brought about in time by regular thorough applications of carbolic acid or iodised phenol, but one properly made copper ionic application will produce more effect than a month of such treatment; and, once cured, a return of the disease is rare. I do not think, indeed, that I have ever seen a genuine case of relapse: and many of my cases I have had more or less under observation for years after treatment.

If zinc is the ion chosen, the electrode should be inserted bare; but if copper, the metal ought to be covered with cotton wool, soaked in a solution of a salt of this metal. This will prevent adhesion of the copper, and a necessary reversal of the current to prevent bleeding on withdrawal. My impression is that copper, although less convenient, is more powerful as an antiseptic ion than zinc.

If the erosion of the cervix be extensive, about an ounce of the ionic solution ought to be poured into the speculum. The dose here should be 15 to 20 ma. for fifteen or twenty minutes. The wire from the positive pole, it may be mentioned again, should be connected to the handle to which the cervical electrode is attached.

Some reaction almost invariably follows this treatment. From one to four days after, the discharge will be more or less purulent, even if the cervix should seem to be free from sepsis. I have observed that, after an erosion has become almost entirely covered with new epithelium, an excessive dose of the current may strip part of the young epithelium off. Without further treatment, however, the process of healing is resumed. It has been a caustic, not a septic effect.

Endometritis

Ionisation is the form of treatment which I have mainly employed in endometritis. If there is any evidence of endocervicitis, the cervical cavity ought to be rendered aseptic before the endometrium is treated. The intra-uterine electrode is best introduced into the uterus through the glass speculum (Fig. 39) after cleaning the parts around and within the cervix. There is sometimes considerable difficulty in passing the electrode up to the fundus of the uterus, but if the speculum be pressed well back against the perineum (the patient being in the dorsal position) this difficulty will be removed as a rule; since the uterine canal is generally dilated in endometritis. The electrode after having been passed, is fixed to the speculum by means of a clip; the outer extremity of the electrode is then connected by a tubular binding screw to the end of the long handle, upon the supporting base of which a shot-bag rests to steady the apparatus, as shown in Fig. 39. Should the patient then complain of pain, the current must not be applied until this pain has passed off. It may be due to pressure of the tip of the electrode against the fundus. To relieve this, unscrew the connection to the speculum so as to take off the strain and then re-apply the screw. If the patient should still complain of pain, remove similarly any strain from the handle, on the base of which the shot-bag is resting, or alter the direction of the electrode by altering the position of the handle, and the pain will, after a few minutes, subside.

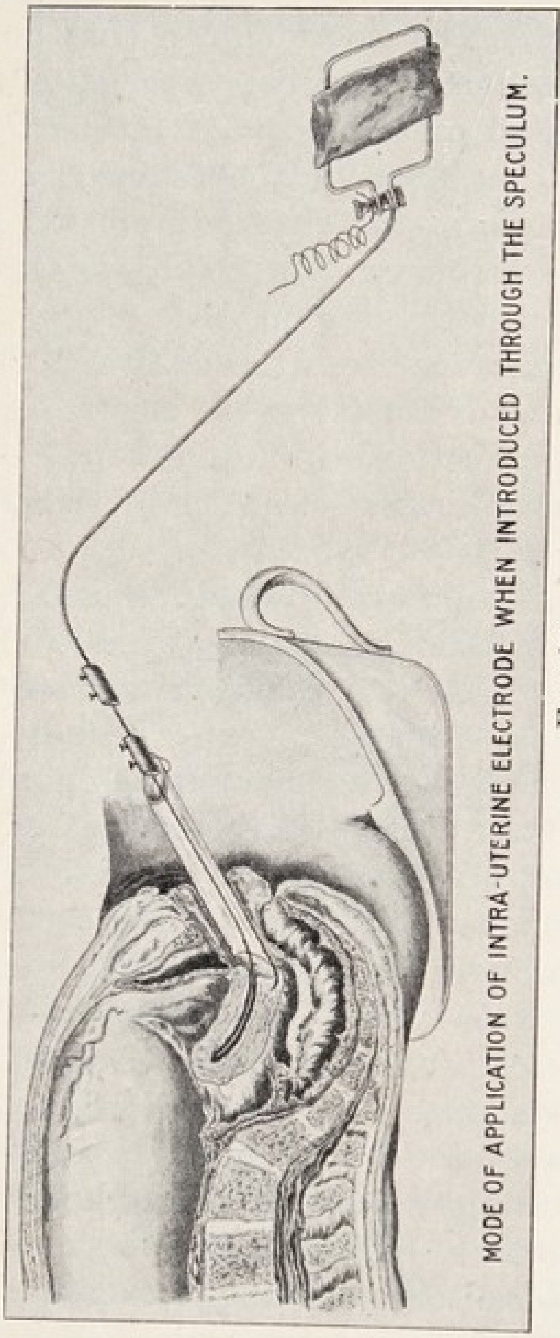


Fig. 39.

MODE OF APPLICATION OF INTRA-UTERINE ELECTRODE WHEN INTRODUCED THROUGH THE SPECULUM.

The object of all this care is to ensure that if there should be internal pain during the passage of the current, it is necessary to know whether the pain is caused by the current, both for diagnostic information and for safety.

When there is a suspicion of inflammation of the tubes or ovaries, it is to be borne in mind that too large a current may do serious damage. Under such circumstances, warning is always given by pain, which lessens with the reduction of the current; finally ceasing if conditions are favourable to the treatment.

Should the pain continue when the current has been completely stopped, this is a danger signal. The case is, for the time being, an unsuitable one for the galvanic current.

If there be much difficulty or pain from the insertion of the intra-uterine electrode to the fundus through the speculum, the instrument ought to be introduced like the ordinary intra-uterine sound with the patient on her left side. The electrode can thus be manipulated and introduced more easily; especially when the uterus is antiverted or antiflexed, for thus the fundus can, with the guiding finger in the vagina, be pushed upwards and the handle of the electrode pressed more fully back against the perineum. A shield is necessary over the part of the electrode lying in the vagina to protect the mucous membrane from the caustic action of the current. The outer extremity of the electrode should be passed, before introduction, through a handle for ease of manipulation and for connection to the positive pole. (See Fig. 26, p. 75.)

Cleanliness is especially necessary in this mode of application, to avoid the introduction of vaginal septic discharge into the uterus. Here douching as a preliminary, even when performed by the practitioner, is not sufficient; for, after douching and passing a speculum, I have found a considerable amount of coagulated septic material around the cervix. This must, therefore, be removed, by means of a cotton-covered probe passed through a speculum, before douching.

Ionisation of the interior of the uterus with these precautions is a perfectly safe operation. Beyond the avoidance of cold and fatigue, no special care on the part of the patient is necessary after the application. During winter weather, however, especially when the patient has to make a long railway journey home, special care should be exercised. Of course this would be the case more or less with almost any intra-uterine treatment undertaken at the physician's house.

CHAPTER XVII

PELVIC INFLAMMATIONS[1]

Electro-therapy *versus* surgery; differential diagnosis unimportant; cases unsuitable for electro-therapy; cases amenable to it; dangers, how to avoid; selection of ion; modes of application; treatment, first antiseptic by ionisation; removal of exudations by vagino-abdominal galvanisation, by faradisation, by high-frequency currents; possible danger from bi-polar high-frequency applications in ovaritis.

THOSE who are unacquainted with what can be done by electro-therapy in gynæcology will probably be sceptical as to its influence for good in pelvic peritonitis and pelvic cellulitis. Even Kelly, the distinguished American gynæcologist, whose opinion I have quoted as favourable to a more extended employment of electricity in gynæcology, writes as follows: "Every case in which any lumpy or resistant areas are felt to the one side or to the other of the pelvis, should be looked upon as probably operative."[2] In such cases, he adds: "Electricity, I believe, is of no service."

Nor do more recent authorities in gynæcology speak with less conviction in favour of operation as a rule in pelvic inflammations. Cameron, indeed, one of the leaders amongst modern gynæcological surgeons, is even more emphatic; believing non-operative measures to be not only futile but often dangerous in chronic inflammatory conditions within the pelvis. Proceeding to criticise the non-operative measures to which most gynæcologists trust in salpingo-oöphoritis, he states[3] that, in his opinion, "cotton-wool tampons which

[1] See also Appendix, p. 282.
[2] *Medical Gynæcology*, Howard A. Kelly, 1908, p. 325.
[3] *Manual of Gynæcology*, S. J. Cameron, 1915, p. 474.

have been saturated in ichthyol or in glycerine and carbolic acid are often introduced into the vagina to assist in the absorption of the inflammatory products. The writer does not favour this treatment, as the results are usually disappointing; and, moreover, the pressure of the tampons on the inflamed appendages is apt to cause considerable discomfort. Beneficial results can occasionally be obtained in cases of chronic salpingo-oöphoritis by curettage of the uterus, but the writer performs this operation only when the thickening in the appendages is slight, and peritoneal adhesions are apparently absent. Curettage may even prove harmful, as it may bring on an attack of acute inflammation."

I have spoken to many eminent gynæcologists on this subject, and I find that they are in practical accord with these authors regarding the necessity of operation in nearly every case of pelvic peritonitis. Whilst they admit that a few cases may recover without operation, they believe such cases to be exceptional, and are ready to relate them with evident satisfaction.

My experience is that *exactly the reverse* is the case. Operation should be not the rule but the exception. A reference to p. 283 of the Appendix at the end of this book will show that, at the most, out of a total of 53 cases of pelvic inflammation treated, two only, so far as known to me, required to be afterwards operated upon; whilst only in six others was the electric treatment not a success.

In these cases the evidences of pelvic inflammation were, generally, exudations in the pelvis, tender on pressure, accompanied generally by pelvic pain, subject to exacerbations—which may be due to fatigue, cold, menstruation, etc.—and causing general ill-health. They are not necessarily puerperal in origin, because they are often found in virgins. They are, as a rule, not easy to differentiate, and the original cause may be unknown; although it may be taken for granted that sepsis has been, from some source or other, the starting point.

Baldy[1] writes regarding cellulitis and peritonitis: "Inflammation of the cellular tissue always accompanies a severe peritonitis, and the two are indistinguishable from a diagnostic point of view." "It is utterly impossible for any one to make a practical distinction between these two phases of a common disease; and the formulæ as given only tend to complicate the understanding of what is possible and what is clinically true. The difference is purely theoretical; practically and clinically they are part and parcel of the same disease—viz. pelvic inflammation."

Although I believe this to be true as a rule, yet, on occasions, some differentiation may be made. For example, a cellulitis may be traced from the upper portion of a cervical tear, along the base of the broad ligament; a salpingitis may be distinguishable by bi-manual palpation; or, sometimes, the only clinical evidence of pelvic inflammation may be a tender prolapsed ovary.

When cellulitis is uncomplicated with peritonitis the pain is said by Cameron to be much less. "Parametritis," he says,[2] "seldom renders the patient a chronic invalid; being, in this respect, unlike perimetritis, which often causes continuous suffering, after the acute stage has subsided."

I have observed this, when asking a patient as to pain in an old cellulitis which I had detected but of which no complaint had been made, and have been told that any pain she had had was on the side of the pelvis where the cellulitis was, but that the pain had never been severe.

In the notes of my cases, it will be observed that, although sometimes an attempt has been made to differentiate the parts inflamed, frequently evidence is given simply of the presence of some pelvic inflammation.

My electric treatment of all pelvic inflammations has resolved itself into, to begin with, antiseptic electrotherapy, and afterwards the removal of the inflam-

[1] *Textbook of Gynæcology*, Baldy, 1894, pp. 482–483.
[2] See p. 520.

matory products, and improvement of the tone of the pelvic contents, by electric measures. There is almost always a considerable amount of sepsis present in the genital tract in these cases, and this is generally dealt with as early as possible; but sometimes the sepsis of the inflamed structures themselves first receives attention. Although it would be well to get rid entirely of the sepsis in the cervix and endometrium, before treating the inflamed structures, the electric treatment required for this purpose, as I have indicated in a previous chapter, might be a source of danger, even if the treatment were very cautiously applied.

The rule which I observe in the treatment of cases of pelvic inflammation is as follows: if there is any suspicion of the presence of pus or of a cyst in the pelvic cavity no electric treatment is given. Such a patient should be sent to the surgeon at once. Cases of acute pelvic inflammation, it need hardly be said, are also unsuited for electricity. It is in cases of inflammation, more or less chronic, that electro-therapy is serviceable.

Sub-acute cases must be dealt with very cautiously if electricity is being administered; but even here, much may be done by electro-therapy if correctly administered.

I have stated that severe measures for the treatment of the sepsis usually inseparable from pelvic inflammations are to be deprecated, and that pain, arising from the current, should be treated as a warning. This refers to direct applications to the uterine canal and especially to the uterine cavity; but vaginal ionisation is not so open to this objection. When ionising the vagina, this operation is generally performed for sepsis of the walls of that cavity, and the appropriate ion is one which it is meant should confine itself for some time to the surface of the mucous membrane and the interior of the vaginal mucous glands. For this purpose zinc and copper are suitable. Vaginal ionisation should be a perfectly safe procedure even in the presence of pelvic inflammations. There is not the danger due to concentration of the current with its consequent caustic action, as is the case when the cervical or the uterine cavity is being treated by electrolysis or ionisation. A large amount of current may be given in vaginal ionisation; for, acting as it does on the whole surface of the distended vagina, it is widely distributed, and therefore less likely to act either as a polar or as an inter-polar irritant. Thus, when there is subacute pelvic inflammation, such treatment is comparatively safe.

But, in these cases, when the intention is not to ionise the vaginal walls specially, but to ionise the inflamed pelvic organs through the vaginal walls, a more diffusible ion than zinc or copper is required. Such an ion is iodine. The strength of the iodine ionising solution which I employ contains 2 per cent. of iodide of potassium and 0·2 per cent. of liquor iodi. Passing into the tissues as iodide of sodium, as we have seen, it will enter the lymph channels and the capillaries in the first few minutes of its application, and thus be distributed to the inflamed structures, the continuance of the current causing the antiseptic ion to enter into the protoplasm of the cells of the inflamed tissues and the interior of the micro-organisms there, instead of at once passing into the general circulation. (See pp. 85, 86.)

The most effective ionisation here will be from the distention of the vagina by means of my vulvo-vaginal electrode, the management of which has already been fully detailed. In the absence of this apparatus, or if, for other reasons, it is not convenient to use it, speculum ionisation as described for vaginitis limited to the cervical region (see p. 143), though less efficient, will still be of considerable service. Here also for reasons just stated the iodine ion will be the proper one with the attachment, of course, from the negative pole to the speculum electrode. In this case, a spiral of metal ought not to be employed in the speculum, but a carbon rod, as shown in Fig. 29, page 77. This rod must not be so long as to impinge on the cervix. It need simply dip into the solution in the speculum, in which position it is held by means of the clip and the speculum electrode handle.

Thus the treatment of pelvic inflammation is essentially anti-septic, although no attempt may be made at first to cure the gross sepsis in the uterine mucous membrane. When the pelvic inflammation has sufficiently subsided to permit of the uterine cavity being safely treated, the method of treatment will be similar to that employed for endocervicitis and endometritis, with an amount of caution regulated by the stage of the pelvic inflammatory condition at the time.

Should there be erosion of the os, and any reason to fear that an electrode inserted into the cervical cavity would be dangerous to the inflamed structures, some progress may be made towards cure of the sepsis there by means of speculum liquid ionisation, and the rest of the genital tract may afterwards be rendered aseptic from below upwards.

As soon as this has been done, the products of the pelvic inflammation—adhesions and inflammatory exudations—may be removed by electricity, which will act as a tonic and absorbent. For this purpose vagino-abdominal galvanisation may be found of service. At first a current of 15 or 20 ma. may be tried. Should this cause pain galvanisation should not be proceeded with. If no pain results, the dose can be increased step by step till 80, 90 or 100 ma. as a dose may be safely administered. No electrolytic action on the tissues must be permitted. To prevent this the carbon ball electrode should be employed (see Fig. 25, p. 74). This must be covered with many layers of lint or a large quantity of cotton wool, soaked in a warm solution of common salt. By means of any ordinary perineal retractor its introduction into the vagina is easy and painless. In this method I do not think the direction of the current, that is, its polarity, is of importance.

If galvanisation cannot be borne or should prove unsuccessful the faradic current should be employed from a secondary coil of many windings. It can be applied either by means of the bi-polar vaginal electrode (Fig. 23, p. 74) with as large a current as the patient can comfortably bear, or by means of the vaginal high-frequency electrode —(Fig. 30, p. 78)—with the neutral wet pad electrode on the abdomen. The polarity here is unimportant. If sufficient progress is not being made by this method, the mono-polar high-frequency current, from the top of the upper solenoid, is likely to prove effectual. A current of 200 ma. may be given by means of the high-frequency vaginal electrode above referred to. The patient will not be conscious of this current at the time; but a sense of weariness and a desire to sleep will generally follow each application. If this should not take place, the inference is either that the quantity of current applied or that its duration was insufficient. The average time is fifteen to twenty minutes and the application should be repeated on alternate days. The metal plate of the electrode should be applied, as far as possible, closely against the inflamed structures. If there is general pelvic peritonitis the electrode ought to lie in the posterior fornix of the vagina, of course with the metal plate upwards.

In cases where the only evidence of pelvic inflammation is a prolapsed and tender ovary I have found that *bi*-polar high-frequency treatment (see p. 101), even in moderate doses, may cause considerable pain in the ovary. While this may be taken as evidence that this current so applied has a real action on the ovary, it is more than likely that it may be a dangerous one. There is no danger, however, from the mono-polar application of the current in the vagina. I have had evidence that it is at least sometimes effective: the pain diminishing, the ovary becoming steadily smaller and less prolapsed, till it is with difficulty reached with the examining finger; and, when examined bi-manually, being found of normal size and consistence, and free from pain on gentle pressure.[1]

[1] See case No. 182, Appendix.

Simple perimetritis—that is, with no direct evidence of involvement of the broad ligaments—may, when the endometrium has been rendered aseptic, be treated by mono-polar high-frequency applications; the ordinary platinum, zinc or copper intra-uterine electrode being employed with the usual antiseptic precautions. There is no chemical action from high-frequency currents.

Although the benefit may not be at once apparent, chronic pelvic inflammations can often be finally, and apparently completely, removed by local applications of high-frequency currents after pelvic asepsis has been secured.

CHAPTER XVIII

FIBROID TUMOURS [1]

Cases suitable for operation; those suitable for electro-therapy; essentials in treatment—the removal of hæmorrhage and pain; electrolysis; ionisation, details as to methods and selection of ion; treatment of pain, guidance as to suitable current to employ.

THERE were, a generation ago, many heated discussions as to whether fibro-myomata were best treated by surgical operation or by electricity. Surgeons have become so skilful now that there is less scope for electro-therapy in the treatment of fibroid tumours of the womb. I am prepared to admit that operation should be the rule here. Still, if electricity is appropriately applied, it will, I believe, materially reduce the necessity for operation. It might even sometimes be employed tentatively, for, if carefully applied, there is absolutely no risk from electrolysis or ionisation; whereas, if operation is undertaken, the risk is always a real and may be a grave one.

If surgeons have become more skilful in their art electro-therapeutists have become more scientific in their methods. Thirty years ago the mortality from the surgical removal of uterine fibroids was too high to warrant the rejection of a remedy which could hold out a reasonable promise of present alleviation and future safety. On the other hand, in my opinion, some former electro-therapeutic substitutes for surgery in fibro-myomata were not scientific and were frequently not safe.

I shall here occupy no time in discussing the relative merits of electro-therapy and surgery in the treatment of these tumours. There need be no rivalry between

[1] See also Appendix, p. 285.

the two. Each has its proper and limited field of action.

There are three methods of dealing with uterine fibroids. Many of these tumours are best left alone. Some ought to be passed at once to the surgeon; whilst the remainder should, at least tentatively, be left in the hands of the electro-therapeutist. The last, only, concern us here. On what principles is the selection to be made, and how, electrically, are the selected cases to be treated?

First, whilst I believe that by electro-therapy fibromyomata may be reduced in size, at least so far as clinical appearances go, this is not an invariable result; nor, indeed, is it one to be seriously aimed at. Certainly a reduction in bulk by the necrotic action of the current is highly objectionable.

The only proper field for the electro-therapeutic treatment of uterine fibroids is in the treatment of the accompanying hæmorrhage and pain. If the bleeding tumours are inoperable, or operation is declined by the patient, the electric treatment is that for hæmorrhage apart from fibroid tumours, as described in Chap. XV; and the suitable mode of application is electrolysis alone, by means of a platinum intra-uterine electrode, or a combination of electrolysis and ionisation by means of a soluble electrode such as zinc or copper: in either case with attachment to the positive pole.

That this treatment should sometimes fail is not a matter for surprise, if the application of the uterine electrode be entirely limited to an amount of uterine surface capable of being covered by it at one time. The uterine cavity may be so increased in cases of submucous fibroids that, although one part of the endometrium is cured of its thickened bleeding overgrowth, there may remain extensive surfaces unacted upon. In the treatment of uterine hæmorrhage apart from fibroids this is an important fact, as was pointed out; but it is an essential one in the treatment of fibroids: as may be inferred from a consideration of the condition of the endometrium in cases of submucous fibroids as described by Roberts, who says,[1] when enforcing the importance of recognising the fact that the bleeding is not from the tumour but from the endometrium: "Sometimes the most remarkable changes are found in the endometrium. The whole endometrium is involved in an overgrowth of its elements, wrongly called 'endometritis,' but it is not, as such, an 'itis' at all. The condition is really adenoma of the body of the uterus; vessels, glands, and stroma share in the general overgrowth, and the mucosa may sometimes be half an inch thick; or pedunculated adenomata (mucous polypi) are found. This increase in thickness is not so in every case, but appears to occur mostly in uteri with large submucous fibroids; with subperitoneal growths the endometrium may not be affected at all, or may even be atrophied. Atrophy of the mucosa in uteri containing fibroids which project into its cavity is also seen. On the surface of such a tumour there is no endometrium, or only a few atrophied remains. In the depression into which such a tumour fits in the opposite wall a similar atrophy of the endometrium is found—it is due to pressure—while around the tumour is a distinct collar or corona of vascular endometrium, and at its very edge many of the delicate vessels of the endometrium are ruptured. Exactly the same condition occurs in the opposite pit into which the fibroid fits: deep in the hollow no endometrium, at the edge of the cup thick endometrium and a vascular corona of ruptured vessels."

The effect of an electric local application will thus depend on the parts of the uterine cavity in which the electrode is lying.

It is obvious from the above quotation that the part of the endometrium into which the electrode can easily pass will be that part which is in most need of treatment; whilst, owing to the pressure of the tumour at the atrophied portions of the endometrium, these are the parts which the electrode will have a difficulty,

[1] *Outlines of Gynæcological Pathology*, p. 173.

fortunately, in reaching. These facts should be borne in mind during treatment. The electrode ought, at each sitting, to be applied to every part of the thickened and vascular endometrium. This is an easy matter in electrolysis alone and even in ionisation, when the zinc electrode is employed; but it will be most inconvenient, and possibly dangerous, with the bare copper electrode, owing to the difficulty, and the risk of bleeding, when detaching this electrode after reversal of the current.

In septic endometritis or in uterine hæmorrhage apart from fibroids the cavity of the uterus is so limited, compared to what may be the case with a submucous fibroid, that the action of the zinc or copper electrode may, whilst lying in the middle of the cavity, influence sufficiently the whole of the endometrium. At least, I have not found it invariably necessary to apply the electrode to more than the middle line of the uterine cavity in cases of sepsis or hæmorrhage; although in some cases it may be advisable to do so—essential even, if the cavity of the uterus should happen to be dilated. Should electrolysis or zinc ionisation fail to arrest the hæmorrhage, copper intra-uterine ionisation may be relied on to do so. To avoid the danger arising from frequent changes in the position of the electrode after reversing the current, it will suffice to limit the electrode at each sitting to one site: changing this at subsequent applications till the whole of the cavity of the uterus requiring treatment has received it.

The large doses of the current formerly given in the treatment of fibroids are quite unnecessary for the control of the hæmorrhage. If the platinum electrode, as in simple electrolysis, be employed, from 20 to 50 ma. for a period of twenty minutes ought to suffice; allowing five minutes for each part of the endometrium treated. I do not think that, for many years past, I have ever exceeded a current of 80 ma. There is practically no danger from small currents, but there is danger from large ones: such, for instance, as 120 to 200 ma. Galvano-puncture I have never ventured to employ.

Electricity may do much for the pain or other symptom of pelvic distress sometimes complained of in fibroid disease. If the pain is situated low down in the pelvis, mono-polar vaginal applications of high-frequency currents will be the appropriate treatment. If over the abdomen, the effleuve will help; or vagino-abdominal faradisation from the secondary coil may be tried. If there should be spinal tenderness the treatment advised for this at p. 111 should be applied.

CHAPTER XIX

STERILITY [1]

Voluntary sterility; accompanying diseases as a cause of sterility; treatment of these by electricity; stimulation of pelvic organs by electrical applications.

A reference to the notes of cases in the Appendix will show that many cases in which pregnancy has followed electric treatment are not included amongst the cases of sterility removed by electricity; for pregnancy might have followed without the electric treatment. Again, cases of sterility, where pregnancy has not followed the treatment, are also excluded when no mention has been made by the patient of a desire for pregnancy; seeing that the absence of pregnancy may have arisen from voluntary sterility.

In order scientifically to test the influence of electro-therapy on sterility the following conditions are essential. First, there must be no cause for suspicion of voluntary sterility. Secondly, when the sterility is evidently, or probably, due to pelvic disease, this must have been cured by electric methods. Thirdly, it must be evident that, in the absence of disease, the sterility would probably have been, without electric treatment, lasting or even permanent.

In the cases which I have labelled as sterility, the first condition has been ensured; since, in these cases, the patient's main object in coming for treatment was the sterility which she was eager to have corrected. The second essential has also been met, since any existing disease has been removed by the electric applications; the

[1] See also Appendix, p. 286.

third, also, since a sufficient amount of time had elapsed to cause the patient anxiety.

In reckoning a case a success or a failure it must, in fairness to the treatment, be conceded that some of the causes of sterility are incurable owing to a radical defect in the patient or her husband; also, that it is quite possible that pregnancy may have sometimes followed the treatment, although this fact is unknown to me.

The proper treatment of sterility by electric methods alone is: first, the cure of existing disease by this agent; secondly, the improvement of the general health by the same means; and, in the third place, the stimulation of the pelvic organs by the tonic effects of electric applications there.

The most common removable pathological causes of sterility are sepsis within the genital tract, and pelvic peritonitis. Besides these, certain constitutional disorders may largely contribute, such as obesity and general debility. Regarding pelvic causes, it has been seen how often electro-therapy can prove an efficient remedy for these. In the case of obesity or general debility, auto-condensation treatment will often be found a valuable aid to other remedies.

The electric methods have all been previously dealt with. It has been pointed out how vagino-abdominal galvanisation, or faradisation, or vaginal mono-polar high-frequency applications, can, in moderate doses, act as pelvic tonics or stimulants. No special instructions are necessary in the case of sterility; except that the local stimulation here should be carried out more vigorously than if only improved tone is required. Larger doses of the currents selected as suitable for tonic effects will act as congestive agents—a stage of treatment just beyond that for tonic effects; but the dose must not be so large as to cause pain or distress, since this would be employing the current as an irritant. If vagino-abdominal faradisation should be employed for this purpose the vibrations ought to be less rapid than if sedative effects are desired; also the current should be taken from fewer windings of the secondary, or, if more stimulation is desired, from the primary coil, or from the slow sinusoidal form of the alternating current. A dose of about 8 ma. in either case may be given for twenty minutes at a time. Amongst the various electrical methods which may be tried for tonic or stimulating action on the pelvic organs, I consider high-frequency mono-polar vaginal applications the most reliable. Here the vaginal electrode (Fig. 30, p. 78), ought to be placed in the posterior fornix, with the metal plate directed upwards, as recommended for the treatment of general pelvic peritonitis, the proper dose being 150 to 250 ma.

Having such varying therapeutic effects, electricity may be employed as a valuable aid to other methods in the treatment of sterility; or it may be relied upon alone, according as the personal experience of the physician and the state of health of the patient may dictate.

CHAPTER XX

AFFECTIONS OF THE FEMALE BLADDER

The irritable bladder, diagnosis and treatment. Incontinence of urine, pathology of; treatment by primary faradisation. Nocturnal incontinence, suggestions as to electric treatment when other measures have failed. Cystitis, if simple, chronic and persistent; first sedative, afterwards stimulant applications.

Irritability of the Bladder[1]

Cases of irritability of the bladder are usually difficult to cure by the ordinary methods, though dilatation of the urethra sometimes suffices.

The condition is fully described by Matthews Duncan in his classical work *Clinical Lectures on Diseases of Women.* He calls it "The Irritable Bladder." Its diagnosis is made when the following conditions exist: frequent micturition, pain, normal urine, and the bladder walls painless and elastic when the sound is pressed against them. The employment of faradism in these cases gives most satisfactory results.

The intra-uterine bi-polar electrode (Fig. 24, p. 74) is introduced into the bladder with the usual antiseptic precautions. The current is taken from the secondary coil; the sedative form of the current thus being employed. A dose of 3 or 4 ma. for fifteen minutes will generally suffice at each sitting. This is about as much as the patient can comfortably bear. Only a few applications may be required, and success may be confidently anticipated if the case answers the description given of it above.

[1] See also Appendix, p. 287.

Incontinence of Urine[1]

The cause of this distressing affection is generally some injury to the bladder, such as prolonged pressure during parturition, causing paresis of the sphincter. All my cases have been in women who have borne children. The treatment is that for enfeebled muscle; and the primary faradic current, especially if interrupted,[2] is a suitable one to employ. Here also the intra-uterine bi-polar electrode will serve. The current does not require to be so strong as to give pain or distress; and it can be applied daily or on alternate days for fifteen to twenty minutes at a time. A larger dose can be borne if both electrodes are within the bladder, but if the instrument is passed in so far only as to have one of the electrodes within the bladder and the other, the near one, in the urethra, a much smaller dose must be given. The treatment in this manner will be more effective since it is not the walls of the bladder which are at fault but the sphincter muscle. The average dose will be found to be 2 or 3 ma.

Nocturnal Incontinence of Urine[3]

I have had a very limited experience of the treatment of this affection by electric methods and a very limited amount of success. Electricity might be tried in nocturnal incontinence, either along with the usual measures or after these have failed. If it is decided to try it, the continuous current, the faradic current or the effleuve of the high-frequency should be applied to the spine. Failing these, intra-vesical faradisation from the secondary coil should be tried.

Cystitis[4]

This is a disease which need not be treated by electro-therapy unless other measures have failed; but in cases

[1] See also Appendix, p. 288.
[2] See p. 73.
[3] See also Appendix, p. 288.
[4] See also Appendix, p. 289.

of simple, chronic, persistent cystitis, the proper application of electricity will seldom result in disappointment: at least this has been my experience. Having once become chronic, the disease is kept up by an atonic condition of the muscular coat of the bladder; which induces retention of residual decomposing urine. This atonic condition can be successfully combated by electrotherapy.

The main causes of complaint by the patient are pain and frequency of micturition. From these, bi-polar intravesical applications of the current from a secondary coil of many windings will afford the patient great relief. Although at first the passage of the electrode may give great pain, this pain will diminish with each application and will finally cease. The bladder will be soothed and its muscular tone increased. This will permit of a greater distention and a more thorough emptying of the bladder. As has been previously stated the faradic current has probably no antiseptic action.

I assume that none of the cases which I have treated was due to tubercle, since the treatment was successful with them all.

CHAPTER XXI

AFFECTIONS OF THE RECTUM AND ANUS

Hæmorrhoids, high-frequency currents advised in; suitable electrodes for; permanence of cure. Fissure of anus, method of treatment by ionisation. Constipation, nature of cases suitable for electrical treatment; the static induced current, how to employ it and how to regulate its relative action on the rectum and on the abdominal muscles.

Haemorrhoids [1]

Hæmorrhoids can be practically cured by high-frequency local applications with almost absolute certainty. The rectal metallic electrode shown in Fig. 31, p. 78, has proved, in my experience, an efficient one. It is made of two sizes and is so constructed that the whole surface of the anus, the anal canal and the lower part of the rectum, are exposed to its action : in this manner differing from the usual rectal electrode. If the larger size can be inserted without difficulty or pain, it is to be preferred. Protruded masses will, under the treatment, disappear from sight, and the bleeding will cease. The applications should be mono-polar, that is the attachment should be made from the top of the upper solenoid through the milliampère meter to the electrode : the left lower solenoid contact being placed on the top ring (see Figs. 16, 17, p. 66), and a dose given of from 150 to 200 ma. for fifteen minutes. The number of applications will depend on the severity of the case.

It is well known that hæmorrhoids are apt to return after apparently successful treatment; but this has not been my experience after electric applications. I have rarely, indeed, required to repeat the treatment.

[1] See also Appendix, p. 290.

Fissure of the Anus can generally be successfully treated by zinc ionisation. The electrode should be a thin pointed strip of zinc; and a current of about 3 ma. should be applied from the positive pole for ten minutes. Should some pain remain after the fissure has apparently healed it may be due to the fact that at first, owing to the pain, the patient could not press sufficiently to disclose the whole of the fissure. She will then, however, be able to press out more vigorously with the decrease of the pain, and so the remainder of the fissure will be reached.

A previous application of cocaine may enable a view of the whole of the fissure to be obtained at the first application.

Obstinate Constipation [1]

In all the cases of constipation for which I have employed electro-therapy the affection has been severe and obstinate. In some of them it was *absolute*. In such cases the patient has had regularly to trust to mechanical emptying of the bowel, and sometimes the physician has had to be summoned to clear out the rectum; which may be best done under these circumstances by digital pressure through the posterior vaginal wall.

Whilst the static induced current has proved beneficial in muscular relaxation of the vagina, it has, in otherwise incurable cases of constipation, proved to be the only effective remedy. The treatment, which is painless, may be applied on alternate days and, as a rule, not more than twelve applications will be required.

The method of procedure [2] is as follows: A large warm clay pad is placed over the abdomen and the electrode employed in the treatment of hæmorrhoids is inserted into the rectum. These electrodes are connected to the *outer* coatings of the Leyden jars, as shown in Fig. 8, p. 58. The length of the spark gap, which connects

[1] See also Appendix, p. 290.

[2] For further particulars regarding the static induced current see pp. 57, 80.

the *inner* coatings of the Leyden jars, should be one or two millimeters only at first; and this should be very gradually increased as the patient can bear it comfortably; till a length of about half a centimeter has been reached. The Leyden jars should be about a one-pint size, and the impulses from 80 to 90 per minute. To obtain so slow a rate it will probably be necessary to permit only half of the plates of the static machine to revolve. During the applications the rhythmic contractions of the levator ani muscle can be seen and felt. If the rod or stem of the electrode be held in the hand it will be felt to be drawn upwards at each impulse, and yet the patient will have no pain or distress of any kind. It may sometimes be found difficult to regulate the relative contractions of the abdominal and the rectal muscles: but this can be effected by varying the amount of surface of the pad which is allowed to rest on the abdomen. The more the surface of the abdomen is covered by the pad the more will the rectal muscle act; the less the surface of the abdomen covered the more will the abdominal muscles respond. The practitioner must be guided here by the sensations of the patient, the strength of the current being noted in millimeters spark gap.

In the absence of the static apparatus, much benefit may be derived, in comparatively mild cases of constipation, from the primary faradic current. In such cases the bi-polar rectal electrode, shown in Fig. 27, p. 75, is the proper one to employ.

APPENDIX

REPORT OF OBSTINATE CASES OF PELVIC DISEASE IN WOMEN TREATED BY ELECTRIC METHODS DURING THE PAST TWENTY YEARS

Nature of cases omitted; table of complaints treated; list of cases; summaries of results in the case of each of the ailments, and comments thereupon.

In this section of the book I propose to submit a complete list of cases of pelvic disease in women, which have been treated by me, wholly or mainly, by electro-therapeutic means. Many gynæcological cases, partly treated by electric methods, are omitted. Those *omitted* comprise the following—

1. Those resulting in cure where some electric treatment was applied immediately after curettage: the curettage being, in my opinion, the main cause of cure, and the electricity only an adjunct.
2. Those in which all the usual forms of treatment were being employed plus some electric applications; but where there was no evidence that the latter had any special influence on the progress of the case.
3. Cases in which only a few applications were made. For exceptions, see cases 4 and 210.
4. Cases in which the electric treatment was general only, no pelvic applications having been made; with two exceptions, Nos. 115 and 139, and for a special reason to be afterwards explained.

Although this reduces the total quantity very considerably, it yet leaves a sufficient number—212 cases—to judge as to the value of the treatment. (Of those omitted, one only, an unsuccessful one, will be referred to in the commentary on the list of cases, see p. 284.)

For a study of these I have arranged the complaints under fifteen heads. In a few instances two records are made of the same patient. Here the complaints treated were quite different, or were at considerable intervals of time apart.

Where two or three ailments are tabulated in the same case, these are arranged in order of importance or severity. The remarks, which are sometimes within inverted commas, as having been the words employed by the patient, do not always seem in accord with the actual result as stated by me. The explanation of this is, that patients vary in their manner of stating their case; some speaking of an improvement in terms of exaggeration, others the reverse. I have accordingly inserted what I had evidence of as being a fair estimate of the result of the treatment; whilst giving also the patient's view as to her condition at the close of the treatment; or, as is usually the case, a considerable time after the cessation of treatment.

It should also be noted that, in the column of brief notes of cases, symptoms are referred to as present, though in the previous column no mention is made of them. This is especially the case where pruritus is noted as present without being referred to in the column for complaints. The inference to be drawn from this is that the particular symptom omitted was considered by me as only a bye-product of some other condition; as, for example, pruritus caused by irritating vaginal discharge and disappearing with the cessation of the septic discharge without any special treatment for this symptom.

The following table of Complaints, which precedes the complete list of cases, contains practically all the pelvic affections which I have treated, almost entirely, by electro-therapy. The cases are numbered in chronological order. To have arranged them pathologically would have been impracticable. I have, however, in the pages following the list of cases, grouped them according to their pathology, as far as this is possible.

The dose of electricity employed, the mode of administration and the duration of the treatment, are all omitted from column 4. For particulars regarding these the reader is referred to Part V—Pelvic Affections—and to the pages following the notes of the cases.

COMPLAINTS[1]

(*a*) Pruritus—vulvar and anal.
(*b*) Pelvic distress—dragging sensation due to prolapse; neuritis and other abnormal sensations, external and internal.
(*c*) Dysmenorrhœa—various forms.
(*d*) Subinvolution without hæmorrhage.
(*e*) Hæmorrhage, apart from fibroids—menorrhagia and metrorrhagia.
(*f*) Septic vulvitis, vaginitis, endometritis, or metritis.
(*g*) Pelvic inflammation—cellulitis, peritonitis, salpingitis, ovaritis.
(*h*) Fibroids.
(*i*) Sterility, when a cause of mental distress to the patient.
(*j*) Irritability of bladder—functional.
(*k*) Incontinence of urine.
(*l*) Nocturnal incontinence of urine.
(*m*) Cystitis.
(*n*) Hæmorrhoids.
(*o*) Constipation, when otherwise incurable.

[1] I have chosen the word "Complaints" here instead of "Diseases," since some of the ailments mentioned are symptoms only.

Cases.	Complaints.	Brief Notes of Cases.
1.	Fibroid.	Married, age 30, no children; hæmorrhage, due to fibroid tumour of the uterus; had been curetted.
2.	Irritability of bladder.	Married; irritable bladder, micturition every half to one hour for one year.
3.	Pelvic inflammation.	Married, age 29, one child; pelvic pain, fulness and tenderness in right and posterior fornices.
4.	Subinvolution.	Married, age 32, two children; leucorrhœa, uterus enlarged and cavity dilated; no improvement from previous intra-uterine medication, etc.
5.	Septic vaginal discharge.	Married, age 25; intermenstrual "yellow discharge."

Nature of Currents employed.	Results.	Remarks.
Intra-uterine electrolysis.	Symptoms relieved.	"Practically none of the hæmorrhage now, tight feeling in the abdomen gone since shortly after the electric treatment was begun, abdominal swelling decidedly less." Report one year after beginning of treatment.
Faradisation of[1] bladder, bipolar.	Practically cured.	Passing urine only once every two hours now.
Galvanisation and Faradisation — vaginal.	Symptoms relieved.	"Well."
Intra-uterine electrolysis.	Treatment beneficial.	Pregnancy after one application.
Intra-uterine electrolysis.	Treatment beneficial.	Almost no discharge, but what is there is still muco-purulent.

[1] The term Faradisation employed in Column 4 means the Secondary Faradic Current, or the rapid sinusoidal, unless otherwise stated in the column for "Remarks on Results."

Cases.	Complaints.	Brief Notes of Cases.
6.	Pelvic inflammation.	Married, age 30; pelvic pain, uterus drawn to left side and slightly adherent posteriorly; left and posterior fornices tender on pressure.
7.	Subinvolution.	Married, age 29; pain when walking; uterine canal $3\frac{3}{8}$ in.; acute retroversion.
8.	Pelvic inflammation.	Single, age 32; pain in right iliac region; right ovary enlarged.
9.	Septic endometritis.	Married, age 23; copious intermenstrual yellow vaginal discharge; a bearing-down and burning sensation.
10.	Septic endometritis.	Married, age 31; uterus lies to right side and somewhat fixed; canal of uterus $3\frac{1}{2}$ in., muco-pus on sound after withdrawal.
11.	Pelvic inflammation; dysmenorrhœa.	Married, age 30, no children; pain in left side; prolapse of left ovary; painful menstruation.

Nature of Currents employed.	Results.	Remarks.
Faradisation—vaginal.	Practically cured.	"Have kept very well for a long time, no pelvic distress now"; *per vaginam* examination shows no evidence of disease.
Intra-uterine electrolysis.	Cured.	Feels "so well now"; no more treatment required.
Faradisation.	Greatly relieved.	"Feeling very well now, only a suspicion of pain"; ovary less in size.
Intra-uterine electrolysis.	Cured.	"Not only practically but actually well."
Intra-uterine electrolysis and Faradisation.	Slightly improved only.	Curetted later; final result unknown.
Faradisation—vaginal.	Greatly benefited.	"No pelvic pain at all now; last period more painless than for years."

Cases.	Complaints.	Brief Notes of Cases.
12.	Septic endometritis; salpingitis.	Married, age 25; yellow vaginal discharge; right tube is thickened to about three or four times its normal size and is firm but not sacculated; probably gonorrhœa.
13.	Fibroid.	Married, age 38, never pregnant; fibroid in right wall of uterus, sound $4\frac{1}{2}$ in. at least; dysmenorrhœa; hæmorrhage.
14.	Subinvolution.	Married, age 39, several children; a dragging sensation in pelvis; almost constant sickness, uterine canal 4 in.
15.	Pelvic inflammation, right side.	Single, age 30; induration in left broad ligament, *right* ovary enlarged but movable, pain in *right* side; see case No. 182.

Nature of Currents employed.	Results.	Remarks.
Intra-uterine electrolysis.	Temporarily cured.	Note at close of treatment: "No discharge at all now; the first real influence on the discharge was the electricity"; broad ligaments now perfectly normal; was curetted by me two years later on account of some return of the discharge.
Intra-uterine electrolysis.	Treatment beneficial.	Reduction of size of uterine canal, relief from bleeding and from pain.
Intra-uterine electrolysis.	Practically cured.	"Very well, better than for years."
Vaginal Galvanisation and Faradisation.	Cured.	"Very well now and back to work"; no evidence now of pelvic disease *per vaginam*. See case No. 182.

Cases.	Complaints.	Brief Notes of Cases.
16.	Pelvic inflammation.	Married, age 26, one child; pain in left iliac region for two years; fulness in posterior and left fornices.
17.	Pelvic distress.	Single, age 34; pelvic pain, "a gone feeling," epilepsy.
18.	Menorrhagia; pelvic inflammation.	Married, age 45, two children; menstrual discharge excessive and fœtid; pain; uterus fixed and tender on upward pressure.
19.	Subinvolution.	Married, age 25, two miscarriages; retroversion of uterus; uterine canal $3\frac{1}{4}$ ins.
20.	Incontinence of urine.	Married, age 46, several children; clothing almost constantly wet with urine; when moving about urine dribbles away, even if bladder is newly emptied.

Nature of Currents employed.	Results.	Remarks.
Faradisation—vaginal.	Cured.	"Very well indeed"; no evidence of disease *per vaginam*.
Faradisation—vaginal.	No benefit whatever.	Still in indifferent health in spite of all kinds of treatment and much change of residence.
Intra-uterine electrolysis.	Practically cured.	Perfectly free from the old symptoms.
Intra-uterine electrolysis and Faradisation.	Improved.	Length of uterine canal reduced to 3 ins.
Intra-vesical Faradisation.	Greatly relieved.	"No discomfort, considerable improvement, but escape of urine if hurrying"; primary faradic current.

Cases.	Complaints.	Brief Notes of Cases.
21.	Pelvic inflammation — distress more than pain.	Married, age 29, never pregnant; "a burning heat" in the pelvis, utero-sacral ligaments tender on pressure.
22.	Dysmenorrhœa; menorrhagia.	Married, age 23, never pregnant; dysmenorrhœa always, more or less; menorrhagia only occasionally.
23.	Pelvic inflammation.	Married, age 29, one still-born child; firm, irregular, fixed mass in posterior fornix, extending equally on each side nearly to pelvic wall.
24.	Fibroids.	Single, age 35; a myomatous uterus, hæmorrhage and pain.
25.	Dysmenorrhœa; pelvic inflammation; sterility.	Married seven years, age 27; sterile; dysmenorrhœa; uterus antiflexed; right ovary in posterior fornix, enlarged and tender; frequent turns of sickness.

Nature of Currents employed.	Results.	Remarks.
Galvanisation—vaginal.	Very slight improvement.	Very neurotic; patient lost sight of; final result unknown.
Intra-uterine electrolysis.	Cured.	Menstruation normal; pregnancy followed, date unknown.
Galvanisation—vaginal	Greatly relieved.	"Never was so well as now"; post-uterine thickening decidedly less than prior to electric treatment; "can now lie on my back with legs stretched out."
Electrolysis—intra-uterine; Faradisation.	Probably no benefit received.	Final result uncertain; probably operation.
Galvanisation and Faradisation.	Successful.	Menstruation much easier than formerly, sickness less; became pregnant ten months after beginning of treatment.

Cases.	Complaints.	Brief Notes of Cases.
26.	Metritis; salpingitis; sterility.	Left tube thickened and tender, length of uterine canal $3\frac{3}{4}$ ins.; four years married, never been pregnant.
27.	Pelvic distress.	Single, age 32; "a weak, smarting feeling" in the left side of the pelvis.
28.	Cellulitis; ovaritis.	Married, age 30, two children; fulness in both fornices, or rather a sense of resistance to the examining finger, with pain; enlargement and prolapse of right ovary.
29.	Ovaritis.	Single, age 40; uterus retroverted; both ovaries prolapsed and very tender to the touch; has been curetted.
30.	Fibroid.	Married, age 40, two children; pain and hæmorrhage, fibroid on anterior and right wall of uterus; sound passes in fully 5 in.; epilepsy.

Nature of Currents employed.	Results.	Remarks.
Intra-uterine electrolysis.	Successful.	Pregnancy after two months' treatment.
Faradisation—vaginal.	Practically cured.	"Hardly ever feel the pain now."
Galvanisation and Faradisation — vaginal.	Temporarily cured.	Well for two years, then probably a re-infection.
Faradisation—vaginal.	Slight benefit only.	Very little improvement till second curettage, after which patient said, "The improvement seems miraculous."
Faradisation only.	Practically no benefit.	Treatment casual; afraid of electric treatment in any form.

Cases.	Complaints.	Brief Notes of Cases.
31.	Dysmenorrhœa.	Single, age 30; neurasthenia; dysmenorrhœa; has been curetted.
32.	Dysmenorrhœa.	Single, age 25; dysmenorrhœa since first menstruation.
33.	Pelvic distress from perimetritis.	Single, age 35; pain in back and left side for three years, uterus drawn back by adhesions.
34.	Membranous dysmenorrhœa.	Married six years, age 30; never pregnant; retroversion of uterus; dysmenorrhœa, menstrual membrane brought to me.
35.	Septic endometritis; pelvic inflammation.	Single, age 23; endometritis; some dragging of uterus to left side; right ovary enlarged and prolapsed.

Nature of Currents employed.	Results.	Remarks.
Galvanisation and Faradisation — vaginal.	No relief.	Life too strenuous.
Faradisation—vaginal.	Cured.	Periods normal; "never had so little pain."
Faradisation and Galvanisation — vaginal.	A partial cure.	"Longer spells of feeling well"; uterus less displaced and less tender on upward pressure.
Faradisation and intra-uterine electrolysis.	Practically cured.	Membrane never absent at any period till galvanic current applied to interior of uterus.
Intra-uterine electrolysis.	Cured.	"Feel better than for two years, no more need for electricity"; uterus normal in position and movable without pain, no ovary felt, broad ligaments seem normal.

Cases.	Complaints.	Brief Notes of Cases.
36.	Pelvic inflammation.	Married, age 25; one miscarriage; uterus acutely retroverted and retroflexed, fundus fixed in left fornix.
37.	Menorrhagia; pelvic inflammation.	Married, age 34; two children and two miscarriages; menstruation too frequent, clots many and large; uterine canal fully $3\frac{3}{4}$ ins., cavity dilated; fulness in right fornix and some fixation of uterus, pain when attempting to push uterus up.
38.	Metritis.	Uterine canal $3\frac{1}{2}$ ins., sound causes pain, internal os contracted; ten months married, no pregnancy; aged 39.
39.	Pelvic neuritis.	Widow, age 46, two children; pelvic distress, great pain, "trembling" over abdomen; sleeplessness; extreme tenderness on pressure over bodies of lumbar vertebræ and around both ovaries.

Nature of Currents employed.	Results.	Remarks.
Faradisation—vaginal.	Practically cured.	Medical treatment also; "never felt so well for years as now."
Intra-uterine electrolysis.	Cured.	"Menstruation has become all right, normal amount, no pain; the past has been a record year in point of health"; pregnancy eight months after beginning of electric treatment.
Intra-uterine electrolysis.	Much improved.	General health much improved; said to be looking exceedingly well; uterine canal $3\frac{1}{4}$ ins.
Galvanisation and Faradisation — vaginal.	No improvement.	Intra-uterine medical treatment also failed.

Cases.	Complaints.	Brief Notes of Cases.
40.	Pelvic distress.	Relaxation of rectum, backache, general weakness.
41.	Cystitis.	Married, age 60, several children; has been in bed almost entirely for three months; pain in bladder almost constant; bladder sound causes pain and gives some sense of resistance when pushed against bladder wall.
42.	Pelvic inflammation.	Married, age 43, several children; inflammatory tumour in posterior fornix, firm and tender; burning sensation in left side, spreading over hypogastrium; retroversion of uterus, pessaries could not be tolerated.
43.	Great pelvic distress; pelvic inflammation.	Single, age 19; severe pain in pelvis, especially at menstruation; inflammatory mass in left fornix.

Nature of Currents employed.	Results.	Remarks.
Faradisation—rectal.	Much improved.	"Feel certain there is a decided improvement."
Intra-vesical Faradisation.	Practically cured.	"Very little trouble from bladder; almost well."
Faradisation; iodine ionic medication—vaginal.	Cured.	No improvement until ionic medication employed, in spite of all forms of treatment for years. Under the ionic treatment the swelling in posterior fornix gradually and steadily lessened and became movable; whilst the uterus became normal in position without a pessary.
Faradisation—vaginal.	Symptoms not improved; but inflammatory mass removed.	Continuous and varied medical treatment also; inflammatory condition removed, but pain not relieved.

Cases.	Complaints.	Brief Notes of Cases.
44.	Fibroid; pelvic distress.	Married, age 41, never pregnant; subperitoneal fibroid adherent to pelvic wall; no menorrhagia; pain in left side, not worse at periods, but worse if standing much.
45.	Septic endometritis; pelvic distress.	Married, age 55, two children; yellow discharge from vagina for six years; "weak and tired feeling in lower body" since menopause seven years ago; prolapse of uterus; pain after walking.
46.	Dysmenorrhœa; perimetritis.	Married, age 37, never pregnant; dysmenorrhœa since first menstruation; uterus retroverted, some adhesions.
47.	Pelvic inflammation; septic endometritis.	Married, age 26, never pregnant; uterus retroverted and slightly adherent; hard mass lying against left pelvic wall, tender on pressure, evidently inflammatory; septic uterine discharge.

Nature of Currents employed.	Results.	Remarks.
Electrolysis—intra-uterine	Treatment beneficial	"Quite free from pain if not overworking."
Faradisation.	Practically cured.	General and local treatment also, but the faradic current required afterwards to complete the cure. "No bearing down and no pain. Can walk six miles at a stretch."
Galvanisation—vaginal.	Practically cured.	"Could not desire to be better."
Intra-uterine electrolysis and Faradisation.	Inflammatory condition cured. Sepsis not benefited.	Very comfortable; no induration left, and no pain, but required curettage after for the sepsis; final result "Improved." Mass described as lying against the left pelvic wall cannot now be felt.

Cases.	Complaints.	Brief Notes of Cases.
48.	Endocervicitis; dysmenorrhœa.	Married, age 23, one child; pain in right side, worse just before menstruation; cervix excoriated.
49.	Septic endometritis.	Married twice, age 39, never pregnant; vulva and vagina wet with muco-pus, excoriation of cervix.
50.	Endocervicitis; ovaritis.	Married ten years, age 28; never pregnant; os excoriated; right ovary enlarged and prolapsed.
51.	Fibroid.	Married, age 31, never pregnant; fibroid, abdominal tumour nearly 2 ins. above umbilicus, steady increase of swelling, of hæmorrhage, and of pain; patient very anæmic and very weak.
52.	Subinvolution; pelvic distress.	Married, age 37, one child and one miscarriage; pain in pelvis; enlargement of the uterus.

Nature of Currents employed.	Results.	Remarks.
Faradisation.	Practically cured.	Required antiseptic applications to uterus also.
Intra-uterine electrolysis and Faradisation.	No improvement.	Antiseptic applications also employed; advised curettage.
Faradisation only.	No improvement.	Curetted afterwards, with but little improvement.
Intra-uterine electrolysis.	Practically no benefit from treatment.	Cessation of growth, and temporarily of hæmorrhage; death from sudden hæmorrhage two weeks after last application.
Intra-uterine electrolysis and Faradisation.	Practically cured.	"Quite well, unless for some bearing down."

Cases.	Complaints.	Brief Notes of Cases.
53.	Sterility.	Married, age 34, two children; sterile for three years; no evidence of pelvic disease.
54.	Endometritis; cystitis.	Married; endometritis, uterine canal $3\frac{1}{2}$ ins.; cystitis.
55.	Endometritis; sterility.	Married, age 23, one miscarriage; leucorrhœa since marriage two years ago; complains of sterility, although only fifteen months since miscarriage.
56.	Pruritus vulvæ.	Married, age 48, several children; very severe pruritus of vulva, frequent vulvar abscesses.
57.	Irritability of bladder.	Single; frequent micturition, urine normal, urethra had been dilated.

Nature of Currents employed.	Results.	Remarks.
Intra-uterine electrolysis and Faradisation.	Unknown.	
Intra-uterine electrolysis; intra-vesical Faradisation.	Unknown.	Treatment stopped after one month.
Intra-uterine electrolysis.	Cured.	Pregnancy followed.
Various.	Slight improvement.	No other treatment of any service; all currents helped, but only to a slight extent.
Intra-vesical Faradisation.	Considerably improved.	"Much less bladder trouble."

Cases.	Complaints.	Brief Notes of Cases.
58.	Irritability of bladder.	Married, age 40 ; three children, irritability of bladder, micturition every five minutes.
	Hæmorrhoids.	Same patient ; bleeding piles for many years.
59.	Nocturnal incontinence.	Single, age 17 ; nocturnal incontinence of urine all her life ; a mentally defective girl.
60.	Septic endometritis ; pelvic distress.	Widow for eight years, age 29, four pregnancies, including two miscarriages ; burning heat in hypogastrium, orgasms about once a day ; yellow vaginal discharge ; had been curetted.
61.	Septic endometritis ; dysmenorrhœa.	Married, age 34, never pregnant ; yellow vaginal discharge for years ; dysmenorrhœa.

Nature of Currents employed.	Results.	Remarks.
Intra-vesical Faradisation.	Practically cured.	Now micturition every two to three hours; patient said current was "very soothing."
High-frequency —mono-polar.	Practically cured.	"Got very much benefit from the electric treatment."
Intra-vesical Faradisation.	No benefit.	No improvement at all; dilatation of urethra also with no benefit.
Faradisation.	Considerable benefit.	Much less burning heat and much less discharge.
Intra-uterine electrolysis.	Considerable benefit.	"Treatment has done much good in many ways."

Cases.	Complaints.	Brief Notes of Cases.
62.	Metritis.	Married eleven years, age 36, never pregnant; menstruation scanty and fœtid; backache.
63.	Fibroid.	Widow, age 47, one child; fibroid tumour in anterior wall of uterus, increasing hæmorrhage and yellow discharge, great pallor and weakness; apparent length of uterine canal $2\frac{3}{4}$ ins., but enlargement of abdomen quite evident when patient dressed.
64.	Septic endometritis; pelvic inflammation.	Married, age 37, one child; copious dirty yellowish discharge around cervix; retro-displacement of uterus; tenderness on pressure in left fornix.
65.	Dysmenorrhœa; menorrhagia.	Married one year, age 25, no pregnancy; painful menstruation, worse since marriage; menorrhagia; uterus retroverted, with fundus adherent in left fornix; dragging pain on right side of pelvis; had been curetted with partial benefit.

Nature of Currents employed.	Results.	Remarks.
Intra-uterine electrolysis.	Considerable benefit.	Improvement in nature of menstrual discharge and in general health.
Intra-uterine Electrolysis and Faradisation	Great improvement.	"A great deal better; energetic and fit for work"; improvement continued after treatment ceased to be required. Later report: "Only about half as much discharge during menstruation."
Faradisation.	Slight improvement only in septic condition; great improvement otherwise.	Final result: "So much better"; uterus in normal position; curettage was afterwards required for the septic condition.
Faradisation and Galvanisation	Practically cured.	"Very well indeed" at close of treatment.

Cases.	Complaints.	Brief Notes of Cases.
66.	Septic endometritis; pelvic inflammation.	Married, age 28, two children and one miscarriage; uterus enlarged, fixed and tender; yellow discharge; very poor health.
67.	Pelvic distress.	Married, age 30, one child and several miscarriages; coccygodynia.
68.	Fibroids.	Married, age 40, never pregnant; multiple fibroids, no hæmorrhage, but frequent mild attacks of peritonitis.
69.	Cystitis.	Married, age 25, never pregnant; pain after micturition for years, pain on pressure of sound on bladder wall, pus in urine.
70.	Pelvic inflammation.	Single, age 20; soft elastic inflammatory mass in left fornix, filling up the side of the pelvis; uterus moves with it but both are practically fixed.

Nature of Currents employed.	Results.	Remarks.
Faradisation—intra-uterine and vaginal.	Septic condition not improved. Otherwise practically cured.	"Stronger, no pain, appetite good, doing all my own work now"; but still yellow discharge.
Galvanisation and Faradisation.	Considerable improvement.	"Less pain in coccyx than for a year and a half."
Intra-uterine electrolysis, Faradisation and high-frequency.	Great improvement.	Decrease in bulk of abdomen, tumours became more easily differentiated after high-frequency current.
Intra-vesical Faradisation.	Cured.	"No bladder trouble whatever" after treatment.
Faradisation.	Practically cured.	"Well and practically free from pain." Tumour in left fornix has almost disappeared.

Cases	Complaints.	Brief Notes of Cases.
71	Dysmenorrhœa.	Married, age 30, one miscarriage; pain from two to three days before onset, during the period, and till the discharge ceases.
72.	Pelvic distress.	Married, age 40, one child and two miscarriages; a burning sensation in the pelvis, with backache.
73.	Incontinence of urine.	Married, several children; expulsion of urine on sudden movement, urine normal; cystocele and rectocele.
74.	Septic endometritis; dysmenorrhœa.	Married, age 32, four pregnancies; constant yellow discharge; pain lasting nearly all the time of menstruation; has been three times curetted.
75.	Pelvic distress.	Married fourteen years, age 39, never pregnant; "an open feeling" in the vagina: due to relaxation of vaginal walls.

Nature of Currents employed.	Results.	Remarks.
Faradisation.	Cured, at least temporarily.	"Absolutely no pain" during following menstruation, but final result unknown.
Galvanisation.	Treatment beneficial.	"I feel sure the treatment is doing good."
Intra-vesical Faradisation.	Cured.	"Really quite well"; primary faradic current employed.
Faradisation.	Cured	"Very well now."
Faradisation—vaginal.	Cured	"Feeling firmer and better"; primary faradic current employed.

Cases.	Complaints.	Brief Notes of Cases.
76.	Right salpingitis and ovaritis.	Married seven years, age 28; never pregnant; right tubo-ovarian inflammation, intense pain on touching the right ovary; uterus enlarged.
77.	Incontinence of urine.	Married, age 35, one child; incontinence of urine since confinement 2½ years ago, vulva scalded by the urine.
78.	Incontinence of urine.	Married, one child; urine comes away when lifting anything or laughing.
79.	Pelvic distress	Single, age 26; a "sick pain" in the pelvis; was curetted with no relief.
80.	Pelvic distress.	Married, age 34; six children; pelvic neuritis; curettage was of no avail.

Nature of Currents employed.	Results.	Remarks.
Faradisation—vaginal.	Practically cured.	Uterus smaller, ovary not now enlarged, indurated mass smaller, general health good.
Intra-vesical Faradisation.	Cured.	"Can now dance with no discomfort whatever"; primary faradic current employed.
Intra-vesical Faradisation.	Practically cured.	"Bladder now almost no trouble"; primary faradic current employed.
Faradisation—vaginal.	Practically cured.	"Better than for years."
Faradisation—vaginal.	Cured.	Her medical attendant says: "Completely better of the neuritis."

Cases.	Complaints.	Brief Notes of Cases.
81	Pelvic distress.	Single, age 35; pain in left side of pelvis; uterus had been fixed in retroversion, ventrofixation performed; backache was less after the operation, but the pain in the left side was worse.
82	Cystitis.	Married, age 48, several children; bacteriuria, attacks of great sickness and intestinal colic.
83	Pelvic distress.	Single; vague pains in vulva, bladder and pelvic cavity; a history of cystitis.
84.	Pruritus	Married, age 40; several children. "Eczema inwardly, intense and almost like to take my reason away." Had been curetted for endometritis.
85	Pelvic distress	Single, age 35; frequent intense orgasms; had been curetted and had an ovary removed with no benefit.

Nature of Currents employed.	Results.	Remarks.
Faradisation—vaginal.	Treatment beneficial.	"Walking much more and with less pain"; had dorso-abdominal current also.
Intra-vesical ionic medication.	Practically cured.	"The following winter was the first for years requiring practically no confinement to bed."
Faradisation.	Little benefit.	Think there was afterwards an operation for "ulceration of the bladder."
High-frequency.	Cured.	"Very well now in every way." Electricity of little avail till second curettage; but pruritus cured only after resuming the high-frequency treatment.
Various.	Slight benefit only.	More relief from the electrical treatment than from any other, but not much satisfaction from any form of treatment.

Cases.	Complaints.	Brief Notes of Cases.
86.	Fibroid.	Single, age 40; increasing hæmorrhage from fibroid, which reaches almost to the umbilicus, and occupies nearly the whole of the pelvic cavity.
87.	Constipation.	Single, age 27; constipation *absolute*, following operation for piles,
88.	Hæmorrhoids.	Married, age 32; three children; large painful pile, partly external and partly internal; anal fissure.
89.	Incontinence of urine.	Married, age 50; several children; prolapse of anterior wall of vagina, with incontinence of urine; watch-spring pessary gives only slight relief.

Nature of Currents employed.	Results.	Remarks.
Faradisation.	Beneficial effect on the hæmorrhage.	Diminished hæmorrhage, but continued growth of tumour; primary faradic current employed.
Static induced.	Cured.	"I can honestly say I never felt better than I do now."
High-frequency and ionic medication	Practically cured.	Practically well, no hæmorrhoids now. Fissure of the anus required zinc ionisation to cure it.
Faradisation—intra-vesical.	Practically cured.	"The electricity has made a great difference in me." Primary faradic current employed.

Cases.	Complaints.	Brief Notes of Cases.
90.	Pelvic distress.	Married, age 25, three children; pain in upper left iliac region, disappearing on resting; throbbing pain in mid-hypogastric region during the night; both pains since first confinement five years previously, except during six months of pregnancy; pain on pressure in neighbourhood of left utero-sacral ligament.
91.	Septic endometritis.	Married, age 32, two children; very copious purulent discharge, fœtid and "soaking everything."
92.	Dysmenorrhœa; pelvic inflammation.	Single, age 40; dysmenorrhœa for years, pain during two days preceding flow, "a sort of suction pain"; uterus displaced to left side and flexed, uterine canal $3\frac{1}{2}$ ins.; uterus was dilated and curetted; pain "terrible" some months after the operation.

Nature of Currents employed.	Results.	Remarks.
Faradisation—vaginal.	Cured.	"Feeling awfully well since the internal electrical applications."
Ionisation—intra-uterine.[1]	Cured.	Discharge now simply a milky mucus, her doctor says. "There is a tremendous change. The discharge is about a twentieth part of what it was."
Faradisation only.	Temporary benefit only.	Improved, but relapsed probably on account of fatiguing occupation: was a school teacher.

[1] When intra-uterine ionisation is mentioned, only, in this column, there had frequently been vaginal, and occasionally vulvar, ionisation also, preliminary to the applications to the interior of the uterus. It should also be mentioned, in this connection, that, when endometritis is noted in column 2 as the complaint requiring treatment, there was usually endocervicitis also, with more or less vaginitis, and, though with much less frequency, vulvitis.

Cases.	Complaints.	Brief Notes of Cases.
93.	Pelvic inflammation.	Married, age 47, never pregnant; chronic fixation of lower segment of uterus; constant pelvic trouble for twelve years.
94.	Hæmorrhoids.	Hæmorrhoids for one year, pain and copious bleeding; ordinary treatment of no avail.
95.	Hæmorrhoids.	Married, age 40, two children; pain and hæmorrhage from piles for one year.
96.	Pelvic inflammation.	Married, age 40, several children; tenderness and thickening of left broad ligament; a dragging pain in left iliac region.
97.	Pelvic inflammation.	Single, age 30; uterus retroverted; retro-uterine inflammatory mass; adherent ovary; dysmenorrhœa and intermenstrual pain.

Nature of Currents employed.	Results.	Remarks.
High-frequency.	Practically cured.	"Feel now as if the pain never would come back."
High-frequency.	Cured.	"No pain, no bleeding, only a sense of fulness."
High-frequency.	Practically cured.	"Practically no trouble from the piles now."
High-frequency.	Greatly benefited.	Very much improved; pain in pelvis almost gone, but left broad ligament still thickened and tender; no return of the pain in the side six months after.
High-frequency.	Practically cured.	Her doctor says: "Improvement has continued since you saw her; she can go about now as an ordinary human being; was quite unfit for anything before."

Cases.	Complaints.	Brief Notes of Cases.
98.	Pruritus vulvæ.	Single, age 26; "fearful itching" at vulva, in no way improved by ordinary treatment.
99.	Constipation.	Married; "no rectal expulsive power."
100.	Pelvic distress.	Single, age 26; weakness and pain in pelvis; had been successfully treated for septic endometritis by curettage.
101.	Pruritus ani.	Married, age 40, two children; pruritus of the perineum, eczema of anus; no relief from local medicinal applications.
102.	Constipation.	Married, age 66, several children; atony of rectum, constipation sometimes absolute.

Nature of Currents employed.	Results.	Remarks.
High-frequency.	Cured.	Was still practically free from pruritus six years after treatment.
Static induced.	Practically cured.	"Very small amount of aperient required now."
High-frequency.	Cured.	"Very much better in every way, no pain and no weakness now."
High-frequency.	Practically cured.	"Last night was the first whole undisturbed night for six years"; final report, "practically free for past two years."
Static induced	Cured.	"Had practically no trouble for six years after."

Cases.	Complaints.	Brief Notes of Cases.
103.	Constipation.	Married, age 30; chronic obstinate constipation.
104	Dysmenorrhœa; sterility	Married $2\frac{1}{2}$ years, age 27, never pregnant; dysmenorrhœa, sometimes severe; dyspareunia all through married life.
105.	Constipation	Married, age 36, several children; chronic severe constipation.
106.	Nocturnal incontinence.	Age 14; nocturnal incontinence, vulva scalded, meatus and vaginal orifice congested.
107.	Pelvic inflammation.	Married, age 40, two children; pain in right iliac region, especially if standing much or over-working; some fixation of uterus; inflammation in right broad ligament.

Nature of Currents employed.	Results.	Remarks.
Static induced.	Cured.	"I do not think you realise the good you have done me."
High-frequency and static induced.	Cured.	Pregnancy followed treatment.
High-frequency and static induced.	Cured.	"Bowels move naturally now."
Faradisation and high-frequency.	Treatment beneficial.	"So much better now." Improvement became more apparent a few weeks after cessation of treatment.
High-frequency.	Practically cured.	"Pain has not returned." Induration in pelvis less.

Cases.	Complaints.	Brief Notes of Cases.
108.	Dysmenorrhœa; sterility.	Married, age 35, one child and one miscarriage, about six years ago; membranous dysmenorrhœa; curetted $4\frac{1}{2}$ years ago without any relief.
109.	Septic endometritis.	Single, age 21; purulent endometritis, erosion of cervix; anæmia.
110.	Cystitis.	Married; prolapse of anterior wall of the vagina; frequent painful micturition, pus in urine, burning sensation in urethra when urine is being passed.
111.	Septic endometritis; pelvic distress.	Married recently, age 38; purulent endometritis; dysmenorrhœa; a burning sensation in the pelvis; curettage seemed to give no relief.

Nature of Currents employed.	Results.	Remarks.
Ionic medication—intra-uterine.	Cured.	Her doctor says: "Membrane feathery now, no pain; pregnancy followed." See case No. 177.
Intra-uterine ionic medication.	Practically cured.	General condition much better, practically no discharge now.
High-frequency.	Cured.	"Improvement all along the line; can retain urine from three to five hours."
Intra-uterine ionisation.	Cured.	Vaginal discharge small in amount and white.

Cases.	Complaints.	Brief Notes of Cases.
112.	Pelvic inflammation; septic endometritis.	Married, age 30, one miscarriage; twice curetted after abortion; said to have had peritonitis; ten weeks in bed; present complaint hypogastric pain, never free from this for more than one day at a time; some fulness and tenderness in the left fornix; prolapse of ovary; some muco-pus around cervix.
113.	Pelvic distress.	Single, age 30, pelvic neuritis; sciatica; pain, sickness and headache during menstruation.
114.	Metrorrhagia.	Married, age 42, four children; metrorrhagia, practically continuous; curettage and intra-uterine monopolar high-frequency applications had failed to arrest the bleeding.
115	Metrorrhagia.	Single, age 35; great nerve prostration; uterine hæmorrhage twice each month; sleepless and "nervous"; has just had a month's holiday with no benefit.

Nature of Currents employed.	Results.	Remarks.
High-frequency.	Pelvic inflammation cured; septic condition not benefited.	Vaginal mono-polar application only, still pus around cervix, but no evidence of pelvic inflammation *per vaginam;* curettage after, result unknown.
High-frequency.	Not benefited.	High-frequency applications externally only, curettage advised; latest report from her medical attendant: "Condition remains still unchanged since she was curetted; there is still pain and weakness."
Ionisation.	Cured.	Bleeding stopped, after two intra-uterine applications of copper electrode, and it has not returned.
Sinusoidal—dorso-abdominal.	Cured.	Great improvement in general health; sister says the improvement is "miraculous."

Cases.	Complaints.	Brief Notes of Cases.
116.	Septic endometritis; pyo-salpinx.	Married, age 45, five children; copious yellow discharge from vagina, in spite of long-continued treatment, including curettage on two occasions; left pyosalpinx which fills and empties itself into the uterus at regular short intervals; tongue always foul.
117.	Septic endometritis.	Single, age 32; copious purulent discharge from the vagina, in spite of curettage four months ago, always yellow fur on tongue; carbolic acid applications to uterine cavity of no service.
118.	Diabetic pruritus vulvæ.	Married, age 70, several children; diabetic pruritus vulvæ.
119.	Metrorrhagia; septic endometritis.	Married twice, age 48, several children; metrorrhagia, bleeding comes in gushes; inter-menstrual yellow discharge; severe abdominal pain daily in the early morning, lasting for about one hour, uninfluenced by diet, evidently toxæmic, frequent attacks of sickness.

Nature of Currents employed.	Results.	Remarks.
Intra-uterine ionic medication.	Cured.	Discharge now slight and white only; freer from pain than for eight or nine years; tongue is at last perfectly clean.
Ionisation—intra-uterine.	Cured.	Report one year after close of treatment: "Never so well as now since the discharge started; no syringing required."
High-frequency.	Practically cured.	No pruritus now unless after gross error of diet.
Intra-uterine ionisation.	Metrorrhagia cured; septic condition slightly less only.	Report ten months after end of ionic treatment: "Periods normal in amount, but still some yellow inter-menstrual discharge; the abdominal pain has practically gone since the new treatment began." Had only four intra-uterine copper electrode applications.

Cases.	Complaints.	Brief Notes of Cases.
120.	Septic endometritis.	Married, age 35, one child; thick muco-pus around a lacerated cervix
121.	Septic endometritis.	Married, age 32; one child; mass of muco-pus around cervix, firm and dry on account of alum douches; has had yellow discharge more or less for years; was two or three times curetted.
122.	Uterine hæmorrhage.	Married, age 37, never pregnant; hæmorrhage more or less ever since age 17; intermenstrual pain in both iliac regions for years; length of uterine canal $2\frac{1}{2}$ ins., though by digital examination body of uterus seems to be larger than this would indicate.
123.	Septic endometritis; dysmenorrhœa.	Single, age 29; copious discharge of muco-pus from the vagina, which has lasted for several months; dysmenorrhœa; was curetted some years ago.

Nature of Currents employed.	Results.	Remarks.
Ionisation—intra-uterine.	Cured.	Absolutely no discharge around cervix two years after; had had four ionic applications only.
Ionisation—intra-uterine.	Cured	Her doctor reports two years after treatment: "Has remained absolutely well ever since the treatment."
Ionisation—intra-uterine.	Great improvement for nine months.	Report three months after: "Able to do what before seemed impossible, better than for years." Report by her husband nine months after close of treatment: "There is no doubt the treatment did her good." Bleeding returned, and she was arranging to return from Ireland for treatment when she died suddenly from heart failure.
Ionisation—intra-uterine.	Practically cured	Last report: no vaginal discharge, and practically no dysmenorrhœa since the ionic treatment. (See case No. 190.)

Cases.	Complaints.	Brief Notes of Cases.
124.	Septic endometritis; menorrhagia.	Married, age 28, one child, inter-menstrual pain; yellow discharge since confinement; prolapse of anterior wall of vagina; uterine cavity dilated, length of canal $3\frac{1}{4}$ ins.; menorrhagia; excoriation of cervix.
125.	Purulent endometritis.	Married, age 35; walls of vagina bathed with pus in spite of systematic and frequent douching; was curetted five years ago.
126.	Septic endocervicitis.	Married, age 35, several children; toxæmia, copious muco-pus around cervix; cervical erosion, about the size of a shilling, which bleeds when touched with a cotton-covered probe; uterus retroverted.
127.	Cystitis.	Married, age 53; urethritis and cystitis, chronic.

Nature of Currents employed.	Results.	Remarks.
Ionisation—intra-uterine, high-frequency and static induced.	Cured.	Very well, quite firm and practically no discharge now; husband says "she is a new woman."
Ionisation—intra-uterine.	Greatly benefited.	"Practically no yellow discharge, never got so much benefit from any treatment." Report some months after cessation of treatment.
Ionisation—intra-cervical.	Cured.	Report at end of treatment. Absolutely no muco-pus around cervix; no erosion now; uterus still retroverted. (See case No. 187.)
Ionisation.	Much relieved.	"General uneasiness much less."

Cases.	Complaints.	Brief Notes of Cases.
128.	Septic endocervicitis.	Single, age 35; erosion of os, which is covered with muco-pus; pruritus of vulva and anus, anæmia.
129	Purulent endometritis	Married, age 33, four children; "continuous white-yellowish discharge between times"; general health poor; pain on upward pressure of uterus, and in posterior fornix; broad ligaments normal; cervix injected, but no erosion; pus in lumen of speculum, uterine canal $3\frac{1}{4}$ ins.; anxious to avoid operation.
130.	Septic endocervicitis.	Married, age 32, four children; yellow discharge for years; severe laceration of left wall of cervix; erosion, fully the size of a florin, around os

Nature of Currents employed.	Results.	Remarks.
Ionisation—intra-uterine.	Cured.	Discharge now simply pure mucus; general health improved.
Ionisation—intra-uterine.	Cured.	At close of treatment only slight mucus around cervix, no pain on upward pressure of uterus or in posterior fornix. "All right in every way"; extract from letter six months after cessation of treatment.
Ionisation—intra cervical.	Practically cured.	Cervical erosion healed, general health much improved; a slight tendency to yellowish discharge one year later.

Cases.	Complaints.	Brief Notes of Cases.
131.	Pelvic inflammation.	Married, age 31, several children; pain in right iliac region; yellowish discharge since first confinement; uterine canal dilated; right ovary tender but not enlarged; right tube thickened and tender; dysmenorrhœa; chronic diarrhœa; general health very poor; local and general treatment for three months before, and for five months after, curettage, with practically no benefit.
132.	Septic endometritis.	Married four years, age 30; never pregnant; inter-menstrual yellow discharge, large yellowish cheesy mass over and around cervix; cervix around os red; uterine canal $3\frac{1}{4}$ ins., "generally ill" since marriage; probably gonorrhœa.
133.	Septic endometritis—possibly pyosalpinx also.	Married, age 38, one pregnancy; a yellow discharge lasting for two or three days at middle of the inter-menstrual period, preceded by pain and uneasiness, which are relieved after discharge has passed.

Nature of Currents employed.	Results.	Remarks.
Galvanisation —vagino-abdominal.	Cured.	Thickening in right tube removed under galvanic current, chronic diarrhœa cured by vacuum electrode in rectum.
Ionisation—intra-uterine.	Great improvement.	"No discharge now." Greatly improved in every way, but copious *white* muco-pus *per speculum* around cervix; treatment discontinued.
Ionisation—intra-uterine.	Cured.	Inter-menstrual purulent discharge cured; three months' treatment required.

Cases.	Complaints.	Brief Notes of Cases.
134.	Septic endometritis; sterility.	Married, age 29, two children; toxæmia, weakness and pain in pelvis; intermenstrual yellow discharge; sterility for three years, causing mental distress.
135.	Septic endometritis.	Married four years, age 40, never pregnant; has been advised dilatation and curettage by her medical attendant for septic endometritis and general weakness.
136.	Septic endocervicitis.	Single, age 35; pallor and emaciation; muco-pus around cervix, os raw looking; melancholia.
137	Cystitis.	Married; urethritis and cystitis, pyuria, micturition required about every half-hour; bladder sound 4 ins., slight pain at fundus, compared to the pain of passing the sound along the urethra; drugs and special diet of no service.

Nature of Currents employed.	Results.	Remarks.
Ionisation—intra-uterine—and high-frequency.	Successful.	"No weakness and no pain, discharge slight and pure mucus." Became pregnant six weeks after cessation of treatment. Report six years after: Has had three children since the treatment; and seems to be in perfect health.
Ionisation—intra-uterine—and high-frequency.	Cured.	"No discharge since; very well."
Intra-cervical ionisation.	Septic condition cured.	Cervix normal, os perfectly clean and healthy looking, no improvement in the melancholia.
Intra-vesical Faradisation.	Cured.	"No bladder trouble now. Wonderfully well."

Cases.	Complaints.	Brief Notes of Cases.
138.	Constipation.	Married, age 42; great depression of spirits; alternate constipation and diarrhœa; has had operation for hæmorrhoids, followed by frequent dilatation of anal canal for stricture.
	Menorrhagia — profuse.	Same case.
139.	Dysmenorrhœa.	Age 32, single; dysmenorrhœa. "Pain comes and goes as the discharge stops and flows." Neurasthenia; uterus infantile and flattened.
140.	Dysmenorrhœa; septic endometritis.	Age 23, single; dysmenorrhœa for four years, pain lasting for twelve hours from onset of menstrual flow; internal pain at mid-time of a shooting nature; inter-menstrual yellow discharge for a year; was curetted five months ago; pain just as severe and continuous since, and yellow discharge increased; sent to me for ionic treatment.

Nature of Currents employed.	Results.	Remarks.
High-frequency and static induced.	Practically cured.	More power of expulsion now and of retention.
Ionisation—intra-uterine.	Practically cured.	"Much less discharge monthly than formerly."
High-frequency—auto-condensation.	Much improved.	A neurotic patient, general electric treatment employed only: "much improved in every way."
Ionisation—intra-uterine.	Cured.	"Now all right."

Cases.	Complaints.	Brief Notes of Cases.
141.	Sepsis of genital tract.	Married, age 40; septic discharge from vulva, vagina, and uterus said to have been continuous and yellow for two or three years; has been curetted for this three times; vulva now bathed with "laudable pus" in spite of regular douching.
142.	Pelvic distress.	Single, age 25; aching sensation at vulva when standing (no cause discoverable); abrasion of lips of os about 1 in. in diameter; small tumour in posterior wall of cervix.
143.	Dysmenorrhœa; septic endometritis; ovaritis.	Single, age 28; dysmenorrhœa, with almost constant sickness; intermenstrual discharge constant, very copious and fœtid; erosion, size of a florin, round os; ovaritis.
144	Pelvic distress.	Married, age 40, two children; occasional spasms in hypogastrium; some fixation of uterus with pain on upward pressure; pain at internal os from passage of sound.

Nature of Currents employed.	Results.	Remarks.
Ionisation—vulvar, vaginal and intra-uterine.	Temporary benefit only.	Discharge became mucous only, and of small amount, but again became more purulent and the treatment was discontinued; her medical attendant, in reply to my inquiries, says she is "disappointed."[1]
Ionisation and high-frequency.	Great improvement only.	Great improvement, but still some sensation of weariness.
Ionisation—intra-uterine—and high-frequency.	Practically cured.	"Practically quite well now."
High-frequency.	Practically cured.	"Practically none of the pelvic discomfort since."

[1] See comments on this case, p. 281.

Cases.	Complaints.	Brief Notes of Cases.
145.	Hæmorrhoids.	Married, age 65; several children; protrusion of large mass of bleeding piles.
146.	Endocervicitis—septic.	Married, age 32, two children; pain in lumbar and left iliac regions since second confinement, six months ago, increased by upward pressure of uterus; intermenstrual discharge; erosion of os.
147.	Hæmorrhoids.	Married, age 54, two children; hæmorrhoids.
148.	Menorrhagia.	Widow, age 45, two children; menorrhagia; uterine canal 4 ins., cavity roomy, walls unduly hard; great exhaustion; pallor and emaciation—"fibrosis uteri."
149	Septic endometritis; dysmenorrhœa.	Married, age 35, never pregnant; dysmenorrhœa and septic endometritis; was curetted nine years ago.

Nature of Currents employed.	Results.	Remarks.
High-frequency.	Practically cured.	No bleeding, piles much reduced in size.
Ionisation.	Cured.	Clear mucus only, erosion healed.
High-frequency.	Practically cured.	"No bleeding or distress of any kind now, in spite of fatigue."
Electrolysis and intra-uterine ionisation.	Cured.	"Never had so satisfactory a period in my life as last one: perfectly well now."
Ionisation—intra-uterine.	Practically cured; much less pain.	"Much better and able to face any trouble, but only if I take sufficient rest; there is sometimes a slight milky discharge, and still some pain during menstruation." [Extract from letter four months after cessation of treatment.]

Cases.	Complaints.	Brief Notes of Cases.
150.	Septic endometritis; salpingitis.	Married, age 44, three children; pain and "burning heat" in right iliac region, more or less continuous, but worse during the past few weeks; discharge slightly yellow for two months; discharge around cervix mainly mucous; now some thickening of right tube; cervix severely lacerated.
151.	Septic endocervicitis.	Single, age 30; purulent discharge from vagina; coagulated muco-pus around eroded cervix.
152.	Septic endometritis; dysmenorrhœa.	Single, age 45. "Worn out," "nervous and sleepless." Muco-purulent discharge from uterus; dysmenorrhœa.
153.	Septic endocervicitis.	Single, age 32; discharge of pus from the vagina; excoriation around os, about three quarters of an inch in diameter.

Nature of Currents employed.	Results.	Remarks.
Iodine vaginal ionisation; vaginal galvanisation; and high-frequency.	Practically cured.	Practically well, but still the "burning heat." (See case No. 180.)
Ionisation—intra-cervical	Practically cured.	Almost perfectly well in every way.
Ionisation—intra-uterine.	Practically cured.	"Almost quite well; very great improvement in general health."
Ionisation—intra-cervical.	Cured.	Erosion healed. "Feeling much fitter and cleaner. The treatment has done much more for my general health than the holiday did."

Cases.	Complaints.	Brief Notes of Cases.
154.	Septic endometritis.	Married, age 38; never pregnant; general ill-health; uterus anteflexed; uterine sound passes in $3\frac{1}{2}$ ins.; uterine cavity dilated; muco-pus around cervix; os excoriated.
155.	Septic endometritis; pelvic inflammation.	Married, age 33, three children. Had been curetted and had zinc ionisation $2\frac{1}{2}$ years ago for endometritis and sterility. Pregnancy followed $3\frac{1}{2}$ months after. Now endometritis and chronic inflammation in left broad ligament since confinement.
156.	Septic endometritis; pelvic inflammation; sterility.	Married seven years, age 32; one confinement full time, one year after marriage; septic endometritis; broad ligaments thickened and tender to touch. Treatment desired mainly on account of sterility.

Nature of Currents employed.	Results.	Remarks.
Ionisation—intra-uterine.	Practically cured.	Had an attack of pelvic hæmatocele during menstruation, after septic discharge had disappeared. Slight return of septic discharge temporarily. Complete absorption of hæmatocele. Last report six months after cessation of treatment: "Very well."
Ionisation—intra-uterine, Faradisation and high-frequency.	Septic condition removed, but pelvic inflammation not benefited.	Discharge became clear mucus only: had an attack of pelvic peritonitis during course of treatment by intra-uterine high-frequency applications. Required abdominal section afterwards on account of continuance of the pelvic pain. Report from the Surgeon: "Cystic ovary and chronic salpingitis."
Ionisation—intra-uterine—and high-frequency.	Septic condition and pelvic inflammation removed. Treatment for sterility unsuccessful.	Some flaky discharge only—not purulent; pelvis seems absolutely free from induration or other abnormal condition: no pregnancy when case last heard of.

Cases.	Complaints.	Brief Notes of Cases.
157.	Pruritus.	Single, age 32; "nervous system shattered, afraid of becoming insane." Nymphæ hypertrophied, sensitive and notched; hyperæsthesia of hypogastrium.
158.	Pruritus; septic endometritis.	Single, age 32; "intolerable itch"; yellow inter-menstrual discharge for years; erosion of cervix. Severe muco-colitis.
159.	Dysmenorrhœa; menorrhagia.	Married, age 44, one child, no miscarriages; dysmenorrhœa; severe menorrhagia. Ionisation required after removal of cervical polypus by galvanic snare.
160.	Pruritus.	Single, age 30, vulva unduly red; pruritus of vulva and anus.
161.	Septic endometritis; pelvic distress; sterility.	Married, age 35, one child, one miscarriage; seven years sterility; perineum and cervix lacerated; rectocele; metritis; dragging sensation in pelvis; muco-pus in vagina.

Nature of Currents employed.	Results.	Remarks.
High-frequency.	Cured.	"Nervousness nearly all gone." No hypogastric or vulvar irritation now.
High-frequency and intra-uterine ionisation.	Cured.	"Absolutely well, better than for twenty years."
Ionisation.	Practically cured.	Not nearly so much discharge, and almost no pain, during menstruation. Further treatment unnecessary.
High-frequency.	Practically cured.	No pruritus of vulva, still *slight* pruritus of anus.
Ionisation and static induced.	Septic condition practically cured. Result of treatment of sterility unknown.	Practically well, only pure milky mucus at vaginal orifice; vaginal walls much less protruding, "feeling much firmer."

Cases.	Complaints.	Brief Notes of Cases.
162.	Septic endometritis.	Married, age 31, pruritus; uterus acutely retroverted and fixed by adhesions; muco-pus around cervix; erosion of os.
163.	Pelvic inflammation.	Married, age 42, two children; last seven years ago; right ovary enlarged, prolapsed and tender; right tube thickened, left also, but to a less degree; generally "unfit"; has been curetted.
164.	Septic endometritis; sterility.	Married, age 36, never pregnant; has been curetted two or three times; had chloroform for some uterine purpose twelve times; sterility a cause of great distress; uterus small and drawn towards left side of pelvis; muco-pus around cervix.
165.	Sepsis of genital tract.	Married, age 50, never pregnant; "womb trouble" for about twenty years; vaginitis mainly at present.

Nature of Currents employed.	Results.	Remarks.
Ionisation—intra-uterine.	Cured.	Her medical attendant reports: "Very little discharge and now mucus only; in very good health; uterus in excellent position; became pregnant, but aborted owing to physical strain."
High-frequency.	Great improvement.	Right ovary seems less enlarged, practically no pain on bi-manual pressure; not quite well, but "still improving."
Ionisation—intra-uterine—and high-frequency.	Septic condition cured. Treatment of sterility unsuccessful so far as known.	Discharge slight and simply pure mucus after treatment, but no pregnancy yet reported.
Ionisation—vaginal.	Cured.	Only slight pure white mucus now; never so free from sepsis. "Never felt so well; better than for twenty-five years."

Cases.	Complaints.	Brief Notes of Cases.
166.	Septic endometritis; double tubo-ovarian disease.	Married, age 27, two children; yellow vaginal discharge for years; cervix torn and everted; tubo-ovarian disease on both sides.
167.	Septic endometritis; localised vaginitis.	Widow, age 60, one child stillborn; septic vaginitis and endometritis for years.
168.	Septic endometritis; pelvic inflammation.	Married, age 27, four children; was curetted for menorrhagia; pruritus vulvæ; copious muco-pus in vagina; thickening of left broad ligament. Subject to attacks of peritonitis.
169.	Septic metritis; pelvic distress.	Married, age 41, three pregnancies, but only one full time; pain in left side of pelvis for five or six years; uterus retroverted; eversion of lips of cervix; uterus enlarged and cavity dilated; muco-pus adhering around os.

Nature of Currents employed.	Results.	Remarks.
Ionisation—intra-uterine.	Slight improvement only.	Patient was inattentive to instructions, casual in her visits, and finally stopped attendance; there was still muco-pus present, but less pain and less induration. Believe there was an operation ultimately.
Ionisation—intra-uterine.	Cured.	Not a trace of discharge round cervix, even after several intervals of three months each.
Ionisation—intra-uterine.	No benefit.	No improvement; had to stop treatment on account of "a chill." Patient did not return.
Ionisation—intra-uterine—and high-frequency.	Cured.	Only a drop of clear mucus at the os, after an interval of two months; no pelvic pain; no pessary required Report three years later: "Still no discharge at all, and no need for pessary."

Cases.	Complaints.	Brief Notes of Cases.
170.	Pelvic distress.	Married, age 52, no pregnancy; excessive dyspareunia at vaginal orifice; patch of erythema on left side of vulva causing a constant burning sensation; no relief whatever obtained from any previous treatment; galvanic cautery applied and the vacuum electrode afterwards.
171.	Metrorrhagia.	Single, age 37, metrorrhagia, very profuse in spite of drugs and rest in bed and after many intra-uterine applications; no evidence of tumour; uterine canal so narrow that copper electrode could not be passed; declined to be curetted.
172.	Septic endometritis.	Married, age 50, two children; frequent "waves of sickness" evidently due to uterine toxæmia; yellow inter-menstrual discharge.
173.	Pelvic distress.	Married, age 44, two children; prolapse of uterus; cystocele; whitish yellow inter-menstrual discharge. Pessary unsatisfactory; some bladder trouble.

Nature of Currents employed.	Results.	Remarks.
Various.	Much improved.	Burning sensation felt now only after urination; general health much improved. No special report as to the dyspareunia. Patient left for her home in South Africa at close of treatment.
Intra-uterine ionisation.	Cured.	First ionic application of fine copper wire into uterus arrested the hæmorrhage; "perfectly well now."
Intra-uterine ionisation.	Cured.	"In every way well." Speculum shows no discharge whatever around or within cervix.
Static induced only.	Great improvement.	"Very comfortable since treatment." Iodised phenol into cervix sufficed for the inter-menstrual discharge.

Cases.	Complaints.	Brief Notes of Cases.
174.	Septic endometritis; dysmenorrhœa.	Married, age 34, two children; menstruation painful; cervix torn; copious purulent discharge; unable to get regular treatment or to rest; pelvic distress; general health poor.
175.	Constipation	Married, chronic constipation for years.
176	Septic metritis; metrorrhagia.	Married for second time, age 45, three children; chronic metritis, uterine canal 4 ins., cavity dilated; metrorrhagia; cystocele.

Nature of Currents employed.	Results.	Remarks.
Ionisation—intra-uterine.	Practically cured.	Able now to do twelve hours' combined physical and intellectual work per day with little sensation of fatigue, but still some slight vaginal discharge. No consciousness of menstruation now till discharge seen. Report four years later: General health perfect; no pain and practically no inter-menstrual discharge: now pure mucus only around cervix, os small and clean.
Static induced.	Practically cured.	Her medical attendant reports the case "a success."
Intra-uterine ionisation; high-frequency.	Practically cured.	Practically no abnormal discharge now.

Cases.	Complaints.	Brief Notes of Cases.
177.	Menorrhagia; tubo-ovarian inflammation.	Same case as No. 108, membrane still "feathery" and present occasionally only; inter-menstrual pain in left side; leucorrhœa causing pruritus; some menorrhagia; evidence of tubo-ovarian disease on left side.
178.	Pruritus.	Single, age 55, severe pruritus of upper and outer part of left labium majus which is eczematous; eczema of inner portions of both thighs; boils on labium.
179	Septic endometritis; tubo-ovarian disease.	Married, age 30, two children; thickening in right broad ligament, right ovary prolapsed, pelvic pain; thick muco-pus around cervix; deep vascular injection of cervix.

Nature of Currents employed.	Results.	Remarks.
Intra-uterine ionisation; high-frequency.	Greatly benefited.	Less pelvic pain; no evidence of tubo-ovarian disease. Still some menorrhagia. Required to stop treatment owing to pain of intra-uterine application and fatigue from nursing a relative who was dangerously ill. Latest report: "Menstruation very much better; and, if any membrane, did not notice it. Less upset this time than for about two years."
High-frequency.	Greatly benefited, but temporarily only	Slight pruritus only, for 18 months after treatment; was 13 weeks in bed with articular rheumatism and pruritus returned accompanied by boils.
Intra-uterine ionisation.	Practically cured.	Practically no pain now; only a few minims of discharge round cervix, none in vagina; no evidence now of disease in right broad ligament; ovary can just be reached by examining finger. Latest report from husband—a medical man—$2\frac{1}{2}$ years after: "My wife is going on well."

Cases.	Complaints.	Brief Notes of Cases.
180.	Metrorrhagia.	Same case as No. 150. Hæmorrhagic patch within cervix after removal of cervical polypus, copious muco-pus exuding; usual applications, including ionic treatment, failed to bring about a healthy action, or to arrest the bleeding; suspicion of malignancy; finally cured by several applications of the galvanic cautery.
181.	Menorrhagia; inflammation in right broad ligament; mid-menstrual pain.	Single, age 40; mid-menstrual pain; enlargement and prolapse of right ovary; pessary worn for retroversion; erythema of posterior lip of os; menorrhagia; tenderness in right fornix on digital pressure.
182.	Tubo-ovarian disease—left side.	Same case as No. 15. Patient remained in fair health for ten years; afterwards enlargement and prolapse of *left* ovary and inflammatory induration in *left* fornix.

Nature of Currents employed.	Results.	Remarks.
Cervical ionisation and galvanic cautery.	Cured.	Absolutely no discharge around cervix; diseased patch perfectly healed; the "burning heat" on right side has at last disappeared.
Intra-uterine ionisation.	Practically cured.	Yellow discharge has gradually decreased since ionisation was begun; there is now none, only pure gelatinous mucus; less mid-time pain than for years; only sometimes slight menorrhagia; ovary cannot be felt now and there is no tenderness in right fornix.
Various.	Cured.	Left ovary has steadily become smaller and there is now no pain on pressure of left fornix. Later report: *Right* broad ligament normal: *left* ovary can with difficulty be reached, is apparently normal in size and consistence, quite mobile and free from pain on gentle pressure.

Cases.	Complaints.	Brief Notes of Cases.
183.	Pruritus vulvæ.	Single, age 55; intense chronic pruritus of vulva.
184.	Vaginal distress.	Single, age 17; pain at vaginal orifice, which is very tender to the touch.
185.	Hæmorrhoids.	Single, age 20; hæmorrhoids for years, pain *after* bowels move, probably from fissure.
186.	Pelvic inflammation; septic endocervicitis.	Single, age 28; pain in right iliac region; uterus fixed in retroversion; slight mucopurulent vaginal discharge, some erosion of os; marked induration and tenderness in right fornix.
187.	Septic vaginitis.	Same case as No. 126. Pelvic condition as at last report 4½ years ago. Has just returned from abroad, having worn a watch-spring pessary continuously for four months and had endemic intestinal trouble; offensive vaginal discharge; erythematous patches on cervix.

Nature of Currents employed.	Results.	Remarks.
High-frequency—vacuum electrode.	Cured.	A few applications sufficed.
High-frequency—vacuum electrode.	Practically cured.	"Practically well."
High-frequency—vacuum electrode.	Practically cured.	Little trouble from the anus since the treatment.
Intra-cervical ionisation; vaginal high-frequency.	Practically cured.	"Am all right, am perfectly well." Possibly some slight thickening in right fornix still.
Vaginal ionisation.	Cured.	Erythematous patches gone, no discharge in vagina; uterus only partially displaced. Later report two years after: "Still no vaginal discharge: pessary less frequently required."

Cases.	Complaints.	Brief Notes of Cases.
188.	Septic endocervicitis; salpingitis.	Married, age 30; copious mucopus around cervix, erosion of os; uterine canal dilated; right salpingitis.
189.	Septic endometritis; pelvic distress.	Single, age 32; inter-menstrual yellow discharge for five years following diphtheria; almost constant pelvic pain—probably a neuritis; "fearful itch" at vulva; frequent sickness.
190.	Dysmenorrhœa; metrorrhagia.	Same case as No. 123. Married since last report; no pregnancy; return of dysmenorrhœa after five years; inter-menstrual hæmorrhage for several months.
191.	Septic endometritis; pelvic pain.	Single, age 35; very copious yellow inter-menstrual discharge with pelvic pain for years; pruritus.
192.	Septic endocervicitis.	Single, age 27; copious mucopus from vagina; erosion of os.

Nature of Currents employed.	Results.	Remarks.
Intra-cervical ionisation.	Practically cured.	Eroded part is covered with epithelium; practically no discharge from cervix, uterine canal narrower; no evidence of salpingitis now.
Intra-uterine ionisation; vaginal high-frequency.	Practically cured.	"Very fit, very rarely have an ache."
Intra-uterine ionisation.	Treatment beneficial; but not cured.	Menstruation now irregular only; inter-menstrual discharge white; unable to have regular treatment. Has mucocolitis.
Intra-uterine ionisation; high-frequency.	Cured.	"The yellow discharge has disappeared; the other symptoms also."
Intra-cervical ionisation.	Cured.	Os perfectly normal, only slight clear mucus around cervix.

Cases.	Complaints.	Brief Notes of Cases.
193.	Dyspareunia; septic endocervicitis.	Married, age 26; dyspareunia and urethritis since operation for stenosis of vaginal orifice; erosion of cervix uteri.
194.	Irritability of bladder.	Single, age 29; frequent micturition, probably increased by atony of sphincter.
195.	Septic endometritis; pruritus.	Married, age 44; one child; muco-pus around cervix; pruritus—vulvar and anal—for two years, causing insomnia.
196.	Septic endometritis; pruritus vulvæ.	Single, age 30; pruritus vulvæ for seven years; uterus retroverted, fundus adherent to left fornix; muco-pus around cervix.
197.	Vulvar distress (apathy).	Re-married five months ago, age 37, one child; apathy; says vulva "dead."

Nature of Currents employed.	Results.	Remarks.
Intra-cervical ionisation and high-frequency.	Practically cured.	Slight white mucus only: practically no dyspareunia, vulva more normal in sensation.
Intra-vesical Faradisation.	Cured	No bladder trouble since treatment.
Ionisation—intra-uterine—and high-frequency.	Cured.	Her medical attendant says: "She keeps very well and seems to have no trouble."
Intra-uterine ionisation; high-frequency.	Cured.	Quite free from pruritus; discharge around cervix simply mucous.
Vulvo-vaginal high-frequency and Faradisation.	Cured.	"So well now." No further treatment required.

Cases.	Complaints.	Brief Notes of Cases.
198.	Hæmorrhoids.	Married, one child; hæmorrhoids, external and internal, "for a long time."
199.	Dysmenorrhœa; perimetritis.	Single, age 25; retroversion of uterus; perimetritis; dysmenorrhœa and menorrhagia.
200.	Septic endometritis; dyspareunia.	Married fifteen years, age 36, never been pregnant; dyspareunia continuous; vulva scalded from muco-purulent vaginal discharge; pruritus.
201.	Menorrhagia.	Married, age 35, one child aged 9 years; no miscarriage; menorrhagia, copious clots; if no flooding, discharge is "black and treacly."
202.	Pelvic distress; septic metritis; ovaritis.	Married, age 23, three children; dragging sensation in pelvis since first confinement, prolapse of vaginal walls; ovaritis, right side; vulva scalded; vaginal wall congested; cervix torn, everted, swollen and livid; metritis; frequent attacks of sickness.

Nature of Currents employed.	Results.	Remarks.
High-frequency.	Cured.	"Have been perfectly well ever since your treatment."
High-frequency.	Fairly well.	"Little pain and fairly well."
Intra-uterine ionisation; high-frequency.	Practically cured.	Only slight mucus; pelvic condition satisfactory.
Intra-uterine ionisation.	Cured.	No tendency to bleeding now.
Intra-uterine ionisation.	Great improvement.	Discharge "better in colour"; less sickness; cervix contracting, almost no eversion; less dragging sensation. Treatment stopped before complete recovery. Pregnancy followed.

Cases.	Complaints.	Brief Notes of Cases.
203.	Dysmenorrhœa.	Married three years, age 30, no pregnancy; severe dysmenorrhœa; advised in America to have the uterus removed for this; uterus small and anteflexed; general health very poor.
204.	Pruritus vulvæ; endometritis.	Single, age 30; pruritus vulvæ for four years, practically continuous. Has tried many remedies; uterus retroverted; endometritis; some eczema on right labium majus. Was told by her medical adviser that her disease was incurable and that such cases generally ended in an asylum. Excision of affected portions of vulva had been advocated.
205.	Metritis; menorrhagia.	Married, age 32, one child, no miscarriage; menorrhagia, was curetted $3\frac{1}{2}$ years ago with no benefit; intermenstrual pain; uterus soft and anteflexed.

Nature of Currents employed.	Results.	Remarks.
High-frequency.	Practically cured.	"No pain worth talking about" during menstruation; general health much improved. Letter from husband in America seven months after cessation of treatment. "Menstruation has not been painful till this month."
High-frequency; ionisation—intra-cervical.	Cured.	Letter from patient: "I feel very much better indeed in every way." One month's treatment had been given. Report several months later: "Very well."
Intra-uterine ionisation.	Practically cured.	Menstruation practically normal; only one clot on each of last three occasions.

Cases.	Complaints.	Brief Notes of Cases.
206.	Septic endocervicitis.	Single, age 23; copious muco-pus around cervix; os pouting and granular; anæmia.
207.	Septic endometritis; pelvic inflammation.	Married, age 32; never pregnant; dysmenorrhœa, always; excessive yellow discharge for years; scalding and pruritus of vulva; uterus acutely retroverted; hypogastric pain.
208.	Septic endocervicitis.	Married, age 53, one stillbirth; uterus normal in size, but hard; os excoriated, muco-pus around cervix; patient "weak and nervous."
209.	Septic endometritis; pelvic inflammation.	Married, age 38, five children; menstruation frequent and copious; intermenstrual yellow discharge since first confinement, getting worse of late. Was curetted seven months ago, has been worse since; probably inflammation of both broad ligaments; tenderness in the neighbourhood of both tubes is so great that a full examination cannot be made; insomnia.

Nature of Currents employed.	Results.	Remarks.
Intra-cervical ionisation.	Cured.	Only a trace of white mucus around cervix. General health improved.
Intra-uterine ionisation.	Practically cured.	"Am now nearly all right, and am suffering no pain."
Intra-cervical ionisation.	Cured.	"No return of the discharge; am feeling stronger and better."
Ionisation—vaginal and intra-uterine—and high-frequency.	Cured.	Specks of gelatinous mucus only, in lumen of speculum, now; tubes easily explored bimanually, no evidence of inflammation there. Feeling stronger and getting more sleep. Extract from letter: "I am wonderfully well." There was no improvement in the amount of septic discharge under zinc intra-uterine ionisation; but an immediate improvement after the copper electrode was employed.

Cases.	Complaints.	Brief Notes of Cases.
210.	Pelvic neuritis.	Single, age 40; pain in left iliac fossa, due to pelvic neuritis; more or less constant for several months.
211.	Septic endocervicitis; cellulitis.	Married, age 30, one child, age two years; cervix lacerated, left side; induration along base of left broad ligament; no tubal disease or ovaritis; ectropion; muco-pus around cervix.
212.	Septic endometritis.	Married, age 44; three children; copious muco-pus from gaping os; length of uterine canal 3½ ins.; disorders of digestion from toxæmia.

Nature of Currents employed.	Results.	Remarks.
High-frequency.	Practically cured.	"My pain has gradually disappeared and I am feeling much better." Had time for three applications only. Later report: Pain returned on account of fatigue, but disappeared after a period of rest.
Intra-cervical ionisation.	Cured.	Latest report: "Quite well." No discharge now around cervix; ectropion has disappeared: no evidence of cellulitis before close of treatment. Is gaining in weight.
Intra-uterine ionisation.	Cured.	No muco-pus around cervix; os and uterine canal now normally contracted. "Am remarkably well. My digestive troubles have all gone."

SUMMARIES AND COMMENTS

Some important omissions may be noted from the list of ailments treated by electrical methods.

All purely and indisputably surgical cases are excluded.

Displacements *per se* are omitted; although it will be seen from the notes that a large number of the cases in the list had retro-displacement. This, though sometimes of considerable importance as evidenced by the great comfort derived from a properly fitting pessary, does not of itself require mention here; since, when uncomplicated by inflammatory conditions in the pelvis, or by enlargement of the uterus, uterine displacement cannot always be considered a pathological condition. Yet its accompaniments, which are often its cause also, may be treated electrically, through removal of inflammatory exudations and by tonic applications to the uterine supports. See, as illustrations, cases 42, 169 and 187.

I have also omitted cases treated by the galvanic cautery only, since the effect is caustic and not electro-therapeutic in the ordinary sense of the term.

Lastly, every gynæcological case in my practice which seemed not obstinate enough to require electrical treatment has been treated by the ordinary methods familiar to gynæcologists: so that all the cases in the list may be taken to have been, what they have been called: "Obstinate Cases of Pelvic Disease."

Under "Results," the terms employed are those which seemed most appropriate at the time. In order, however, to form a proper estimate of the results as a whole I have divided them into four classes, thus—

(i) "Cured," absolutely or practically; that is, the result was a cure, in the sense that all the symptoms and signs of the pre-existing disease have disappeared or are disappearing, and the benefit derived gives promise of being lasting, since it has continued till the time of writing. Many of these cases have been under observation for years : some of them for months only ; whilst some have been lost sight of since the last favourable report was received. Latest reports are always given unless when these merely confirm the previous ones.

(ii) " Greatly benefited," that is practically cured, but afterwards relapsing somewhat ; or considerable and lasting improvement, but not a cure in the sense indicated when describing class (i).

(iii) " Slightly benefited," in the sense of some improvement only, or improvement of very limited duration.

(iv) " Not benefited " at conclusion of treatment.

It will be observed, from an examination of the following tables, that the least favourable results are obtained when a combination of electric methods has been employed or required. The reason for this is obvious. When one form fails, another and still another electrical method has been tried, often without success. Sometimes, however, such cases, little influenced by any one form of application, have, in the end, yielded to a combination of methods.

Pruritus

The first in the list of ailments is Pruritus—a distressing complaint, frequently very chronic and very resistant to treatment. When special treatment was necessary this was carried out with the high-frequency current by means of the vacuum electrode ; and, looking back on some cases of pruritus vulvæ in my practice before I knew of electric methods of treating disease, I often wish I had then had such effective means for their cure. No case has resisted this treatment, with the exception of one—case 56—which was temporarily benefited only on each occasion ; although all forms of electrical treatment were tried. Even a case of diabetic pruritus—No. 118—yielded to this treatment. Although not absolutely cured, the trouble became very slight, and was easily kept under by moderate attention to diet.

TABLE (*a*).—Pruritus, vulvar and anal.

Treated by		Cured.	Greatly Benefited.	Slightly Benefited.
High-frequency . . .	12	11	1	
Various forms of current	1			1
Totals . . .	13	11	1	1

Only otherwise incurable cases of pruritus which had resisted the usual remedies were treated electrically. In most of the other cases the treatment of the septic discharge was sufficient to cure the pruritus.

The electrical treatment, in the cases of pruritus, was given daily or on alternate days; and the total number of applications in each case varied from three or four to about twelve, which an obstinate case would probably require.

PELVIC DISTRESS

In the next table have been placed all cases of indefinite Abnormal Sensations in the Pelvis, including pain unaccountable unless from a neuritis. These abnormal sensations—neuroses of the pelvis—may be defined by the patient as "a bearing-down sensation," "a fulness," "a feeling of looseness," "a wearied sensation," "an aching feeling at the vulva," etc. Two were cases of severe orgasms, causing great distress and consequent nerve prostration. In the cases of neuritis, there was generally a tenderness on gentle pressure over the whole of the pelvic walls and over the bodies of the lumbar vertebræ. I believe that in these cases the cause is mainly a constitutional one. The affections in this group are often greatly benefited by electro-therapy; whilst they are, as a rule, in no way benefited by any other form of treatment. Generally no satisfactory cause can be found to account for them.

When the cause of the distress was ascertainable, the correct form of electro-therapy to employ was easy to determine; whereas, for indefinable and unaccountable sensations, one form of electric treatment after another had sometimes to be tried.

TABLE (*b*).—Pelvic distress.

Treated by		Cured.	Greatly Benefited.	Slightly Benefited.	Not Benefited or result unknown.
Galvanisation . .	3	1	1	1	
Faradisation . .	13	7	3	1	2
Ionisation . . .	4	3	1		
High-frequency . .	5	3	1		1
Galvanisation and Faradisation . .	4	1	2		1
Ionisation and High-frequency . . .	7	6	1		
Faradisation and High-frequency .	1	1			
Static induced . .	1		1		
Ionisation and Static induced . . .	1	1			
Various forms . .	1			1	
Totals . . .	40	23	10	3	4

The proportion here benefited is, under the circumstances, considerable. There is often present, as has been said, a constitutional taint. Two of the patients were epileptics. These, as might have been expected, appear amongst the seven unbenefited.

DYSMENORRHŒA

The next ailment in the list is Dysmenorrhœa, simply as a symptom: no attempt being made here to differentiate between various forms of this affection. In some of the cases there was associated septic endometritis, and in others inflammatory affections of the pelvis; but as these may be present with no dysmenorrhœa properly so-called, I am dealing purposely with painful menstruation, only in so far as I have treated this symptom specially by electric methods.

In a large number of cases of dysmenorrhœa general electric treatment, by auto-condensation, is more suitable than local. In purely neurotic cases it is likely to be of more service. Case 139 was distinctly one for this treatment, and no local applications were made.

TABLE (c).—Dysmenorrhœa.

Treated by		Cured.	Greatly Benefited.	Slightly Benefited.	Not Benefited.
Galvanisation [1] . . .	3	2	1		
Faradisation . . .	6	3	2	1	
Galvanisation and Faradisation	4	3			1
Ionisation	8	7	1		
High-frequency . . .	4	2	2		
Ionisation and High-frequency	1	1			
Totals . . .	26	18	6	1	1

As a rule, no *immediate* benefit was derived from the local applications. The number required depended on the state of the general health of the patient; and this, as has been shown, can be greatly benefited by electrotherapy.

SUBINVOLUTION

In Class (*d*)—Subinvolution—there were five cases. I have made these into a separate class because the cases

TABLE (*d*).—Subinvolution.

Treated by		Cured.
Galvanisation . . .	3	3
Galvanisation and Faradisation	2	2
Totals . . .	5	5

[1] The term "Galvanisation" in these tables includes "Electrolysis" in the sense in which this word is employed in column 4 in the list of cases. For the relative meanings attached to these terms in this work see p. 35.

in it were unaccompanied by menorrhagia or metrorrhagia or with septic infection of the endometrium. The patients usually complained of pain or other pelvic distress, and their general health was poor. The enlargement of the uterus probably arises in such cases from an inflammation of its substance.

The electrical treatment of subinvolution was continued till all subjective symptoms had disappeared; leaving the reduction of the bulk of the uterus to follow from the improved health of the patient.

Hæmorrhage

Regarding Hæmorrhages apart from fibroids, the results were very satisfactory: there having been in this group no failure, whilst no case required after-curettage.

Table (e).—Hæmorrhage.

Treated by		Cured.	Greatly Benefited.
Galvanisation . . .	4	4	
Faradisation	1	1	
Ionisation	12	9	3
Galvanisation and Faradisation	1	1	
Ionisation and High-frequency	2	2	
Totals . . .	20	17	3

In this list, one—No. 115—was not treated locally, but with dorso-abdominal applications of the alternating current; the benefit derived being probably due to an improvement in the tone of the circulation in the abdomen and the pelvis.

Occasionally one or two intra-uterine applications—especially in the case of copper ionisation—succeeded in arresting the bleeding in metrorrhagia. On the other hand, cases of long-continued menorrhagia, which had resisted all other methods of treatment, required at least two months of intra-uterine applications.

Septic Infection of the Genital Tract

As might have been expected, class (*f*) contains by far the largest number of cases: being in all eighty-four. Sepsis is the cause of most of the pelvic complaints of women, and it is often the despair of the physician. I have referred in a previous chapter to the hopelessness of ordinary treatment in such cases. In many of the septic cases in the following table curettage had been previously performed without relief, and in some of these cases this operation had been done several times.

Table (*f*).—Septic Affections of the Pelvis.

Treated by		Cured.	Greatly Benefited.	Slightly Benefited.	Not Benefited or result unknown.
Galvanisation . .	8	4	4		
Faradisation . .	7	1	3	1	2
Ionisation . . .	64	58	3	2	1
High-frequency .	1				1
Galvanisation and Faradisation . .	4			1	3
Totals. . .	84	63	10	4	7

Several deductions may be drawn from the above table, and some questions suggest themselves.

That so many of the cases in which galvanisation was employed were successful is not to be wondered at; for the action of the intra-uterine electrode in electrolysis is antiseptic, if not caustic also. In the cases in which galvanisation failed and faradisation was subsequently employed the results were all unfavourable. This was evidently due to the fact that, if electrolysis should fail, no antiseptic action is to be expected from the faradic current. That faradisation alone should have succeeded at all requires some explanation. I find that in one of the cases—No. 45—the septic condition was cured by local antiseptic applications and douches; but, in spite of this improvement and of the benefit derived from general treatment, the faradic current was required for the pelvic pain: so that in this case perhaps little, if any, credit should be given to electro-therapy for the removal of the sepsis. Case 48 was also treated by antiseptics, with much the same result as in case 45, the faradic current acting mainly as a pelvic tonic. Case 50 derived little benefit from any treatment, including curettage. Case 64 was also curetted on account of the continuance of the septic discharge. The faradic current, however, sufficed to reduce materially the pelvic inflammation. Case 66 received decided benefit generally, but there was no improvement in the septic condition. In case 74 the current was employed after a third curettage, and was necessary for the treatment of the dysmenorrhœa; the sepsis having probably been cured by the last curettage. It is, therefore, probable that the faradic current is of little, if any, service in cases of uncomplicated sepsis. This might be inferred, but these cases seem to confirm the fact.

All the cases treated by the ionic method have done well, with three exceptions. In one case—No. 141—the patient was sent to me after three operations for curettage had failed. Pus was welling out of the vagina, and there seemed no hope of cure except from hysterectomy, the septic process having penetrated deeply into the walls of the uterus. After two months' treatment the discharge became scanty and was composed of pure mucus only. The patient now, however, began to grow tired of the treatment. She frequently came for it in a state of fatigue, in consequence of a long railway journey in cold and wet weather. The treatment, therefore, was less thoroughly applied and the discharge gradually returned. I advised either thorough treatment or none, and the patient said she would consider the matter. She did not return.

In case 166 the patient is noted as "unsatisfactory," and as having stopped attendance; whilst, in the third case—168—the patient had to stop treatment owing to "a chill."

Thus, out of sixty-four cases of septic infection of the genital tract treated by electro-chemical methods, fifty-eight cases were cured, whilst three are recorded as having been greatly benefited; so that in only three out of the sixty-four was the treatment a failure. Many of these cases had had curettage performed previously without a cure. No douching was permitted or required during the treatment, and there was no necessity for any change in the patient's habits; moreover, the duration of the treatment was less than that of antiseptic and caustic applications to the uterine canal in the usual manner. That the case treated by high-frequency currents alone—No. 112—failed is possibly due to the fact that the applications were vaginal only, not intra-uterine.

The average total number of ionic applications required for the removal of sepsis was probably under twelve. The minimum number, where the results were permanent, was seven. The treatment was given, as a rule, at intervals of three or four days.

Pelvic Inflammations

The affections included under this heading vary considerably in their nature and in the degree of their severity. Whilst cases of sepsis may be obstinate, those arising from pelvic inflammations, including parametritis, perimetritis, salpingitis and ovaritis, singly or in combination, are often quite hopeless if treated by the ordinary non-operative methods. Treatment seems to relieve, but only till a slight chill or a little fatigue reminds the patient that the cause of her aching pain is still there.

Displacements of the womb complicate matters; pessaries being often tried, only to find that they make matters worse. These pelvic inflammations are the consequence of sepsis, although no vaginal discharge may be observed. The following table indicates the results of the electric methods of treating them.

TABLE (*g*).—Pelvic Inflammations.

Treated by		Cured.	Greatly Benefited	Slightly Benefited.	Not Benefited or result unknown.
Galvanisation . .	9	8		1	
Faradisation . .	13	8	2	2	1
Ionisation . . .	9	6	1	1	1
High-frequency .	7	4	3		
Galvanisation and Faradisation .	6	4	2		
Faradisation and Ionisation . .	1	1			
Ionisation and High-frequency	4	4			
Various forms .	4	2			2
Totals . .	53	37	8	4	4

These results seem at first sight incredible even to myself. I have gone over every case, however, more than once, and I see no reason to change the figures. True, in many of them a few of the ordinary therapeutic measures were occasionally employed, in addition to electro-therapy, whenever these seemed to me serviceable; but, from my previous experience of these and my limited use of them now, I feel convinced that the good results are in a special degree due to the electric measures. Indeed, I do not believe that such results could be obtained without the help of electro-therapeutics.

Case 43 is an interesting one. There had been an inflammatory mass in the left fornix. The last record says: "There is still great pain, but a careful examination can detect nothing except tenderness on pressure of the uterus, the broad ligaments, and the pelvic wall at the sides and posteriorly. There is great tenderness also over the lumbar vertebræ." A gynæcological surgeon was appealed to and his diagnosis was "neuralgia." This case has been put down as a failure from the point of view of the continuance of the pain; although the inflammatory condition had disappeared—at least, there was no evidence of its presence.

Of the thirteen cases noted in the table as having been treated by faradisation alone 23 per cent. were failures; whereas, in the remaining forty, the failures were 12·5 per cent. only. As was previously mentioned, the faradic current seems to have little, if any, antiseptic action; so this may partly account for its comparative failure in tubo-ovarian disease.

A *short* course of electric treatment in cases of pelvic inflammation is of very little service, unless for the relief of pain. Some of the cases in table (*g*) were long under treatment, but this was compensated for by the fact that, in not more than two cases, so far as I know—case 155 certainly, and case 166 probably—was an abdominal operation required.

I had a case early in my electro-therapeutic practice, in addition to these, in which faradisation was tried, along with other measures, for ovarian pain without success. An abdominal operation was performed and a cystic ovary removed (see p. 172).

Case 42 had medical treatment as well as various forms of electric treatment by myself for years; but a practical cure was effected only after a course of ionic medication. The final result in this case was, in the language of the patient, "marvellous." Her letter in reply to my inquiry, a considerable time after cessation of treatment, was a most satisfactory one, and fully confirmed the truth of the remark recorded in my notes on the occasion of her final visit to me, that "improvement will probably continue without further treatment."

Uterine Fibroids

No case of Fibroid Tumour was treated by electricity, unless for bleeding or pain. The following are the results—

Table (*h*).—Fibroids.

Treated by		Greatly Benefited.	Not Benefited.
Galvanisation	4	3	1
Faradisation	2	1	1
Galvanisation and Faradisation	2	1	1
Galvanisation, Faradisation and High-frequency	1	1	
Totals	9	6	3

This record, though a small one, is not unfavourable to the employment of electricity in cases of fibroids, where these are causing bleeding or distress. Out of a total of nine, six cases showed considerable improvement. Of the unsuccessful cases, one—No. 30—suffered mainly from pain. She was an epileptic, and was so frightened by the current that the treatment had little chance. In another case—No. 24—where there was pain and hæmorrhage, absolutely no good resulted from the electricity or from a course of treatment which she had obtained in a hospital. In case No. 51 the patient died from a sudden attack of hæmorrhage two weeks after her last treatment. This patient was too weak to have made an operation safe. The report, one month before the fatal hæmorrhage, was: "Perhaps fully more than half as much blood lost now as was the case a year ago; the general health, compared to one year ago, is now decidedly better." Of the successful cases, the result was in some instances most satisfactory. As an example, in case 13, two months after treatment commenced, the length of the uterine canal fell from "4½ ins. at least," to 4 ins.; whilst two months after the cessation of the treatment, the patient's husband wrote to me thus: "My wife has been improving so rapidly that time has passed unknown to me. I am sure you would be quite pleased if you could see how well she looks. She is quite well after her period is over, and the pain is now gone."

In galvanisation of the interior of the uterus—simple electrolysis—in the treatment of fibroids, the intra-uterine electrode employed was the Apostoli platinum sound, attached, of course, to the positive pole, since control of the hæmorrhage was the object of the treatment. The negative pole attachment would almost certainly cause an increase of the bleeding through the deposition of caustic soda on the bleeding surface (see p. 35, sect. 3). The number of applications varied with the nature and severity of the case.

Sterility

Where Sterility was prolonged and had become a source of mental distress to the patient the results were as follow—

Table (*i*).—Sterility.

Treated by		Successful.	Unsuccessful.
Galvanisation	2	2	
Ionisation	1	1	
Galvanisation and Faradisation	2	1	1
Ionisation and High-frequency	3	1	2
Ionisation and Static induced	1		1
High-frequency and Static induced	1	1	
Totals	10	6	4

Treatment, in cases of sterility, was mainly directed towards the removal of all existing morbid conditions and improving the tone of the pelvic organs. Case No. 134 is an illustrative one. This patient came to me suffering from toxæmia due to septic endometritis. She complained of general weakness and pelvic pain, but especially of sterility. She was twenty-nine years of age and her previous confinement had been three years before. She came to me with the expectation that I would curette her with the object of removing the sterility, but I asked her to permit me to treat her without operation. After eleven applications of ionic medication her general health was completely restored, and she had lost her pelvic distress; whilst the uterus and cervix had become perfectly aseptic. She returned a few months after, still perfectly well in every way; but disappointed at not having become pregnant. I then administered on five occasions intra-uterine mono-polar high-frequency treatment as a uterine tonic; after which I dismissed her, stating that she required no further treatment. Six weeks later she became pregnant. Writing to inform me of this, she added: "I am very well indeed, and have felt ever so much better since the first course of electricity I had."

Although case No. 55 is labelled as a success, it may be open to question whether the pregnancy was, in any way, due to the treatment, seeing that there had been sterility for fifteen months only when the treatment was begun. Nevertheless there was evidence, in the experience of the patient, that the electric treatment had acted as a stimulant to the pelvic organs; so that the electric applications had, in all probability, no little influence on the successful result.

Irritability of the Bladder

The results in the cases treated for this affection are as follow—

Table (*j*).—Irritability of Bladder.

Treated by		Cured.	Greatly Benefited.
Intra-vesical Faradisation.	4	3	1

In no case was prolonged electric treatment required.

Incontinence of Urine

Cases of this complaint are not dangerous, but they are sufficiently annoying to make the patient grateful for their cure. My list contains five of these. They were all treated by the primary faradic current and were all benefited. All of them occurred in married women. In three of them the cause was evidently due to parturition; in the remaining two it had followed chronic cystitis.

Table (*k*).—Incontinence of Urine.

Treated by		Cured.	Greatly Benefited.
Intra-vesical Faradisation (Primary Current) . .	5	4	1

In these cases the urine would escape when the patient was hurrying, golfing, laughing, lifting a weight, etc., so that the ability to dance "with no discomfort whatever," as one of them expressed it at the close of the treatment, must have been a source of satisfaction.

When there was vesical pain the secondary current was employed till the pain had subsided; about three or four such applications being required. Treatment by the primary current was given every second or third day for about eight or ten times.

Nocturnal Incontinence

In the whole list there are two cases only of Nocturnal Incontinence. One of these was treated by the faradic current alone, but with no benefit. The girl was mentally defective, and the trouble had lasted nearly all her life. Faradism was applied locally by me, and for a long time the galvanic current was applied to the spine by the girl's mother at home. As might have been expected, however, no benefit resulted. The other case was practically cured by applications of faradisation to the spine, followed by some mono-polar high-frequency treatment to the sacral and hypogastric regions.

TABLE (*l*).—Nocturnal Incontinence.

Treated by		Greatly Benefited.	Not Benefited.
Faradisation	1		1
Faradisation and High-frequency	1	1	
Totals	2	1	1

Cystitis

Those belonging to this group—Cystitis—constitute a troublesome class under ordinary modes of treatment. I have not found them so, however, when treated by faradisation. The list contains six cases. One of them was more a case of bacteriuria than of ordinary cystitis. It proved, however, the most obstinate of them all; though it was finally practically cured by ionic treatment. Another—case 127—was rather a case of urethritis than cystitis, and it also was practically cured by ionic medication. The remaining four were cases of cystitis, with the usual symptoms—namely, frequent micturition, pain, and pyuria. The treatment in all the cases was effective. One of the severest of them required ten applications.

TABLE (*m*).—Cystitis.

Treated by		Cured.	Greatly Benefited.
Intra-vesical Faradisation .	3	3	
Ionisation	2	1	1
High-frequency	1	1	
Totals	6	5	1

In case 137 there was great nervousness due to pain and want of sleep, and the urethra especially was exquisitely tender; so that it was with difficulty the bi-polar electrode could be introduced. The treatment, however, at once began to tell. After three applications of the faradic current, the electrode could be passed in without pain, ordinary diet could be taken, and the urine became perfectly clear. Ten applications in all were given; and what impressed the patient most was her increase in strength and her difficulty in keeping awake, after the prolonged sleeplessness which had preceded the treatment.

Hæmorrhoids

This is a complaint common in men also, but in my experience vastly more common in women; and so I have included it in the list of gynæcological affections.

Table (*n*).—Hæmorrhoids.

Treated by		Practically Cured.
High-frequency . . .	8	8

In few of these cases was a return for treatment necessary. They were all severe, and some of them would certainly have required operation. The result of this mode of treatment in my experience has been so good that I would not advise operation, even in apparently hopeless cases, till high-frequency applications had been tried. In one of the cases zinc electrolysis was required for a fissure of the anus; two applications sufficing to effect a cure. The improvement in the general health due to the treatment was often most marked. In mild cases six applications sufficed; but, as a rule, twelve or fifteen were required.

Constipation

In no case in all my practice have I seen this affection so obstinate in men as in some of those I have treated electrically in women. In two of them the constipation was *absolute*. Aperients had no effect, enemata had no effect; only by resorting to mechanical measures could the rectum be emptied.

TABLE (*o*).—Obstinate Constipation.

Treated by		Cured.
Static induced	5	5
High-frequency and Static induced	2	2
Totals	7	7

The result of the treatment in these cases was a revelation to some of the patients. In one of them, the worst I have ever known, the complaint had followed an operation for piles. In a letter received from this patient ten months after the cessation of the treatment, she says: "I can honestly say I never felt better than I do now."

Some additional cases of severe constipation, which are not mentioned in this table, were also treated by the static-induced current; but I have not recorded them because they were treated for a few times only. In these cases the improvement derived was generally in proportion to the number of applications made. From ten to twenty, according to the duration of the obstinate constipation, may be reckoned as the requisite number for a lasting cure.

A point worthy of notice, in the order of the electric methods employed throughout the list of cases, is that the early ones were treated only by galvanisation or faradisation or both. Later on the treatment was largely confined to high-frequency applications; and afterwards mainly to ionic medication.

This is the order in which electro-therapeutic methods were introduced to the profession, and it became, therefore, the order which was followed in practice: the old methods being temporarily neglected to give place to the new. New methods excite more enthusiasm, and are apt to be employed on all possible occasions, in order that one may test by experience the theory upon which their employment in treatment is based, and thus be able correctly to estimate their value, and judge as to the cases for which each method is best suited.

As an illustration of a case requiring more than one form of electric energy in the course of the treatment, let me relate the following one: The patient complained that, since her confinement, "the womb came out of the passage," as she expressed it; there was a general sense of pelvic discomfort, the menstrual periods were too frequent, and the flow was excessive; whilst there was a constant yellow discharge between the menstrual periods. On making an examination I found that the anterior wall of the vagina was prolapsed, the uterus was enlarged and its cavity was dilated throughout; whilst the os was gaping and excoriated. She had at first vaginal and intra-uterine ionic treatment, then vagino-hypogastric static-induced applications; and, finally—since, though the discharge had ceased to be yellow, there was an excess of mucus from the vagina—some intra-uterine mono-polar high-frequency applications. Under the last form of treatment—the high-frequency—the mucous discharge from the vagina became only a quarter of what it had previously been. Throughout the whole of the treatment no douching was done, no extra rest ordered, and, with the exception of an occasional tablet of styptol, on account of some bleeding following the intra-uterine ionic medications, no drugs were ordered or taken. Eight months after the close of the treatment she reported to me as follows: "I am still very well, feel quite firm, and have practically no discharge of any sort."

To determine the best form of electric energy to apply at the beginning of each case, and on each occasion during the course of treatment, can be learnt from experience only.

INDEX

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