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NOTICE.

Plastics and Orthopedics, by the same author, a volume of 400 pages, made up of three Reports made to the Illinois State Medical Society—revised and enlarged—is published by Messrs. Lindsay & Blakiston.

The last of these reports was rendered in 1871, noticing the important improvements made up to that time.

The following are some of the notices in the Medical Journals:

From the Philadelphia Medical and Surgical Reporter.

“The author is already quite well known by his contributions to other branches of surgery, and the present essay is calculated to favorably extend his reputation. * * * The details of several original operations are given, which reflect great credit on Dr. Prince.”

From the St. Louis Medical Reporter.

“In this work will be found a fund of information, which very few physicians have cared to seek, almost buried or concealed, as it has been, in journals and monographs not always easily accessible.”

From the New York Medical Record.

“Prepared with especial reference to the wants of the general practitioner, it is intended for a well-digested outline of all that is known of the cause, prevention, and cure of a very interesting and but little understood class of diseases. His descriptions are clear and concise, his views are tenable, and his deductions are eminently practical.”

From the Chicago Medical Journal.

“The very favorable manner in which the medical press generally have received this monograph, is an evidence that its author is very far from failing in his effort to produce an instructive and valuable work.”

From the Chicago Medical Examiner.

“We assure our readers that it is one of the best practical works on that subject that has been written either in this country or in Europe.”

From the American Journal of the Medical Sciences.

“This treatise upon Orthopedics has been prepared, the author states in his preface, with special reference to the wants of physicians engaged in general practice. He has succeeded admirably in preparing a work which will be of great assistance to men busily engaged in practice, who desire to quickly learn how deformities are most readily and surely to be prevented and remedied.

To such persons we recommend the treatise as, beyond all comparison, the best that we have seen.”

Letter from Prof. S. D. Gross, M.D., to the Publishers.

S.-E. Cor. 11th and Walnut Sts.,)
September 24th, 1866.)

“GENTLEMEN:

“I thank you for the copy of DR. PRINCE'S ORTHOPEDICS. The work is an excellent résumé of the existing state of the art and science of which it treats, and will, I doubt not, meet with the universal favor of the profession. The manner in which the treatise is gotten up, reflects credit upon your house. I am, gentlemen,

“Very respectfully, your friend,

“S. D. GROSS.

“MESSRS. LINDSAY & BLAKISTON,”

Galvano-Therapeutics

A REVISED REPRINT OF

A REPORT

MADE TO THE

ILLINOIS STATE MEDICAL SOCIETY,

1873.

by *David Prince.*

"Many recently discovered facts, seem to justify the conclusion, that very few chemical compounds can transmit a galvanic current, without at the same time being decomposed into their primitive constituents, all along the course or channel of that current."

MORGAN.



PHILADELPHIA:

LINDSAY AND BLAKISTON.

1873.

*Repr. from, Tr. Illinois
M. Soc., Chicago, 1873, XLIII,
131-183.*

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CHICAGO:

FERGUS PRINTING COMPANY.

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INTRODUCTION.

IN republishing the following Report, the writer is endeavoring to contribute something to the general fund of information, in exchange for what he is constantly deriving from other laborers in the same field. This essay is thus to be regarded as of temporary utility, like the clover which the farmer turns under, in order to enrich his field for the production of a final crop, which, once in the granary, will have an element of permanence.

Anything like a text-book on this subject, is at present out of the question. Such advances are making, that stereotyping present knowledge would embarrass the introduction of new and better views.

We know something compared with the ancients, who bathed their sick, in baths rendered stimulating by the presence of electric eels, up to the time of the invention of the electric machine: as compared with the first forty years of the knowledge of current electricity, from Galvani to Faraday, in 1831; and as compared with the next twenty years of the almost exclusive use of the induced current.

Our present return to the employment of the continuous current is very greatly due to Remak, of whom Græfe said, (according to Meyer) that "By introducing the constant current into the practice of medicine, he had enriched it with an invaluable treasure, whose aid in numerous, otherwise incurable cases, is incalculable."

Notwithstanding the fact established by Humboldt in the later years of the last century, that the galvanic current has great power over the secretions, and its previously known power over nervous sensibility and muscular contraction, the knowledge of its therapeutic applications, has exhibited a slow and fitful growth. So much extravagance has from

time to time been mixed, as chaff with the few grains of truth, that routine practitioners have turned with disgust from the whole subject.

Venturing, the other day, to recommend the galvanic current to a very scientific old gentleman, on account of a very troublesome chronic lameness, he replied, that he believed that all intelligent medical men had discarded the use of electricity as a humbug. This old man's notion is a type of the opinion entertained, in great part, by the scientific portion of physicians, up to a very recent period.

The present scientific interest in the medical application of electricity is, in great part, due to recent improvement in apparatus, rendering the agent more manageable. Some conception of the labor attending the employment of apparatus; the best that could be constructed, until within a very few years, will be derived from Dr. Moritz Meyer's remark, with regard to Remak:

"Besides, the application of the constant current, which Remak introduced into practical medicine, at a time when the incompleteness of the galvanic elements rendered a daily cleansing of the battery necessary, is, to-day, thanks to the improvements of Meidinger, Smee, Störher, and, above all, to Siemens and Halske, in the quality of the elements for the purpose of telegraphy—attended with far less difficulty, although a convenient, transportable battery remains a great necessity."

From the nature of the case, a convenient, constant current portable battery, of sufficient volume of current for its best therapeutic effects, will probably remain a desideratum for a long time.

The subject of diagnosis has been mentioned only incidentally in the following essay, and it requires too much length of detail to treat it as should be done in a complete treatise.

The importance of some knowledge of the subject is illustrated by Dr. J. Russell Reynolds, in his readable little book, ("Lectures on the Clinical Uses of Electricity.")

A gentleman had been injured in a railroad accident, and was supposed to be paralyzed on one side. The legal counsel for the Company claimed that the patient put on his apparent palsy.

Then came in the electrical test. A strong faradic current was applied to the sound side, and both arm and leg were thrown into violent convulsive movements.

On the injured side, however, only a very slight muscular quiver was induced.

The test was conclusive. The impossibility of controlling, by force of will, muscles, which are excited by the interruptions of a strong current, whether galvanic or faradic, enables us to distinguish differences of muscular conditions, as can be done by no other agent.

The mode in which the diagnosis is effected, is that also in which muscles are kept from wasting. It is an improvement upon passive motion, in which, by movement of a palsied limb by force foreign to it, the blood is invited into the muscles, very much as the skin is filled with blood by friction.

The electric muscular excitation results in a temporary restoration of the *function* of the muscle, and the increased circulation and consequent nutrition bears a close resemblance to that of the normal action. The *electrotonus*, attending rapid interruptions, in which there is no apparent motion, but only a swelling and hardening of the muscles within the circuit, is very much like the condition of the muscles of a person who temporarily braces himself in view of some impending danger. The balance of opposing muscles prevents any contraction, yet the muscles draw, and, in drawing, there is waste of substance, and a demand for nutriment to supply its place. The physiological experiment of paralyzing the limbs of a frog by division of the spine, and faradizing daily one side, leaving the other quiet, preserving the volume and density of the faradized side, while the limbs of the other side become small and flabby, illustrates the preservative power of this stimulant. While the cause of the palsy may be distant from the affected muscles, and beyond the restor-

ative power of this agent, the muscles keep their healthy capability, so that when the paralyzing cause is removed, the muscles are preserved, and fit for use, instead of having lost the contractile element of their constitution, through disuse.

There is great reason to expect that while the muscles are preserved by the interrupted current, the exudations in the nerves, central to the seat of the palsy, may become absorbed by the influence of the continuous current, including in the scope of its passage those results of the inflammation, effusion, or hemorrhage, which originally occasioned the palsy.

The full appreciation of the power of the galvanic current for this end, has not yet been settled, but enough is known to call for careful trials.

It is not the purpose of the following report to be more than fragmentary, and it is chiefly devoted to the influence of the continuous or galvanic current, employed in those cases in which the induced or faradic current has failed to establish satisfactory power.

To those who have not paid much attention to the medical use of electricity, an easy introduction will be found in the perusal of Reynold's "Clinical Use of Electricity." This may be followed by Beard & Rockwell's "Medical and Surgical Electricity," and by Dr. Moritz Meyer's "Medical Electricity," translated by Dr. William A. Hammond.

Duchenne's "Localized Electrization," translated from the French, by Tibbets, will be necessary to a full appreciation of the power of faradization.

Dr. William B. Neftel's "Galvano-Therapeutics," a publication of a few chapters of a larger work preparing, will repay perusal.

After having read these, the perusal of the little book of Dr. Herbert Tibbets, "A Hand-Book of Medical Electricity," and the little book of Dr. Allan McLane Hamilton, "Clinical Electro-Therapeutics," will not be found very necessary.

For the scientific understanding of the subject, the study of the elaborate work of Dr. Charles E. Morgan, "Electro-Physiology," is indispensable.

GALVANO-THERAPEUTICS.

The therapeutics of the galvanic current, which is the current directly produced by chemical decomposition, and which flows along the wires connected with the battery.

This subject is not so well understood as that of faradotherapeutics, *i.e.*, the therapeutics of the induced current, or the faradic current. The latter was discovered by Faraday about forty years ago, and the former by Galvani, eighty years ago. The child has outstripped the parent of twice its age.

The reason of this is easily explained. The faradic apparatus is cheap, light, and easily transportable, and its effects upon the nerves of sensation are very marked. The effects of this current upon the muscles, in a wasting condition, from the lack of nerve stimulation, is so obvious as to secure universal confidence. On the other hand, the galvanic current flowing without noise and without sensation, except in large current, and acting chiefly catalytically, and upon a different class of affections from those which are most benefited by the faradic current, requiring, at the same time, large and expensive apparatus, transported with difficulty, and easy to get out of order, (as ordinarily constructed) labors under the disadvantage of practical inaccessibility.

Attention is here chiefly invited to the subject of galvanization in its therapeutic relations.

This term therapeutic is employed to make a distinction from the mode of employing the current, in which by con-

centration or by length of time, the vitality and healthy chemical constitution of the tissues are impaired or destroyed.

Although there is some degree of electrolysis, or change of the constitution of tissue, in any part traversed by a galvanic current, the term electrolysis is reserved for the mode which is employed for surgical or destructive effects, while in the milder degree, or the more diffused scope, the current is employed for the therapeutic or conservative results.

The electrocautery application, or the employment of the heated platinum wire to take the place of the old actual cautery, and in many instances to take the place of the knife and the ligature, will be noticed very briefly.

The term electricity is employed to cover all the modes: 1st, galvanic, voltaic, current, contact or dynamic, 2d, faradic, induced, electro-magnetic or magneto-electric, and 3d, franklinic, static or frictional.

There are two modes of action in which electricity exerts its *therapeutic* power; one is through stimulation or agitation of nerves and muscles; and secondarily, such changes of circulation and nutrition as follow stimulation.

For the realization of this stimulation, static, or franklinic electricity, and induced or faradic electricity, are best adapted, being great in tension and small in quantity.

The other mode is primarily through a chemical or electrolytic action, the effect upon the nerves being secondary. The two influences are always combined, but as one or the other predominates, the minor effect is lost sight of. The action of a sharp induced current, which makes the surface tingle and the muscles contract, is very different from that of the current, which, without causing pain or contraction, changes the chemical constituents of both fluids and solids, causing oxygen and the acids to go to the positive-pole, while hydrogen and the alkalis go to the negative.

In the first instance, of the employment of a current of great tension and small quantity, there is very little effect upon the constitution of the parts—only a stimulation of the functions of sensibility and muscular contraction.

In the second instance, the current of little tension and great quantity affects first the chemical constitution of the parts, and the subsequent stimulation of the functions, is secondary to the effect of the current upon the essential constitution of the organ acted upon.

If the object is the removal of a morbid deposit, the electrolytic effect of a current of large quantity so changes the chemical or physiological constitution, as to favor the retrograde development of the morbid organism. The effects upon sensation and motion are here unnecessary and undesirable.

If, on the other hand, it is desired to restore sensation and motion by stimulating these functions, tension, and not quantity, is sought. The faradic, and not the galvanic current, is employed. If, however, there exists, at the same time, a hyperplasia in the nervous centres, resulting from previous hyperæmia, the absorption of which it is desired to stimulate, it is plain that the passage through these nerve-centres of a galvanic current must be more effective than the passage of a faradic current. The interruption of the galvanic current for the promotion of muscular motion and consequent muscular nutrition, can be effected by mechanism, at the same time that the electrolytic effects are secured in the seats of previous diseased action. It is thus easy to see how the galvanic current can always be substituted for the faradic, while the Faradic can be substituted for the galvanic, in only a portion of the cases.

Another distinction it may be well to refer to. If it is assumed that a wire of uniform size, and of the same quality throughout, passes from the copper extremity to the zinc extremity of the battery, the poles will be at a point in the centre of this wire. If, however, a medium is interposed (inter-called) at some point other than the centre, which is a poorer conductor, a resistance is afforded, and the poles are drawn away from the centre and brought to this medium of resistance. The side of the resisting medium next to the copper end of the battery is called the positive-pole, and the side next the zinc end of the battery, the negative pole. This re-

sisting medium being assumed to be a portion of animal substance, a decomposition goes on in the resisting parts which are within the scope of the current, oxygen, chlorine, iodine, and the acids going toward the positive-pole, or toward the surface to which the positive electrode is applied, while hydrogen, the alkalies, and other acidifiable bases go toward the negative electrode. If now, it is desired to act upon an organ in an inflammatory condition, in which we wish an antiphlogistic influence, the negative electrode is applied to this inflamed part. That is, the inflamed part is made to be the negative pole from which the oxygen and the acids are withdrawn, while hydrogen and the alkalies are accumulated.

If, however, we have to deal with a non-inflammatory growth of low vitality, though its increase of volume may be rapid, the part is made to be the positive pole by the application of the positive electrode.

In the treatment of pain which is not attended by swelling, it is found that the application of the positive-electrode, upon or near the seat of the pain, is most successful.

Assuming that non-inflammatory pain is attended by anæmia at the seat of pain, or of the nerves concerned, whether as cause or concomitant, we have a suggestion as to the mode of action. The augmentation of oxygen and acids in a diseased part is a phlogistic or stimulating treatment. The increase in the nutritive activity, and in the consequent amount of blood, may be supposed to raise the nerves in question, from the pathological and painful to the physiological and painless condition. The pain attending an inflammatory condition must be treated on a different principle; that of diminishing the nutritive activity of the part. As it is not enough to apply cold to an inflamed part without reference to its intensity, or to the grade of the inflammation, so it is easy to see that while the negative pole may be indicated, its application must require such skill as can only result from much experience.

The surface of the skin, which is made the negative pole, becomes reddened, showing an increase in the volume of the

vessels when the current is sufficient to produce any obvious effect, and this fact leads to the expectation that the current will be of limited applicability in inflammatory conditions.

In deep-seated pain, the distinction of poles cannot be recognized, and in practice it is found that the current may pass in either direction with equal effect.

The principle learned from experience, that the current descending, or in the direction of the nerves, is quieting, while the current ascending, or contrary to the direction of the nerves, the positive pole being peripheral, and the negative central, is disturbing, may receive a partial explanation by supposing that the whole length of the nerve involved assumes the condition of one pole or the other; that in the descending current the whole nerve is positive, and in the ascending current the whole nerve is negative.

In this view the neuralgic or the paretic nerve is brought to a condition of better nutrition when made the positive pole, but when it is made the negative pole, it is brought under the irritating influence of agents, which tend still further to impair a nutrition already defective. This reasoning applies to the continuous current, and not to the induced current, which produces its effect chiefly in the manner of a whip or other stimulant. So far, however, as the induced current exerts a chemical effect the distinction is the same; only the degree of difference is less. Whatever may be the explanation, the principle is well established, that the negative electrode has many times the power of stimulating a nerve to act upon its appropriate muscles, which is possessed by the positive pole. Hence, the direction given to apply the negative electrode over the nerve to be reached in the employment of faradization for the purpose of muscular excitation.

The battery with which the materials of most of this report have been worked out, is Hill's telegraphic battery, in which each cell, holding half a gallon, is filled first with water containing, in solution, a pound of sulphate of zinc.

On the bottom of the jar is laid a copper disk, and about two-thirds of the way up is suspended a disk of amalgamated

zinc. Through a hole in the disk of zinc, crystals of sulphate of copper are dropped from time to time. The blue solution of sulphate of copper which forms, is heavier than that of sulphate of zinc, and remains in the lower part of the jar. The copper is thus surrounded by sulphate of copper, and the zinc by sulphate of zinc.

The action is slow and constant, and the apparatus requires but little attention.

The copper is connected with the zinc of the next jar throughout the series.

My battery, obtained from the Galvano-Faradic Manufacturing Company, of New York, contains 120 cells, and is connected by sixteen wires, with Bartlett's regulator, which is in a room above.

This regulator enables the operator to employ, 2, 4, 6, 8, or 10 cells, and then increasing by tens, until the current of the whole battery is included.

A clock-work interrupter enables the current to be interrupted by turning a mill-headed revolver.

The accompanying cuts sufficiently illustrate the apparatus:

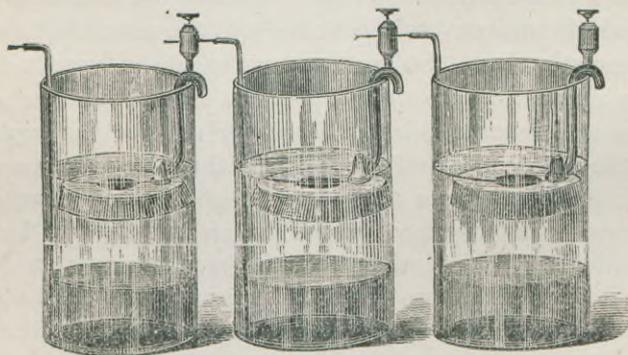


FIG. 1. Three cells in position, showing the relations of the electro-motor elements, and their connection from cell to cell. The heavier shading represents the blue sulphate of copper, and the light shading, the white sulphate of zinc. The inconvenience of porous diaphragm employed in the battery of Daniell is obviated. The connexions are such, that the parts are easily taken to pieces for cleaning.

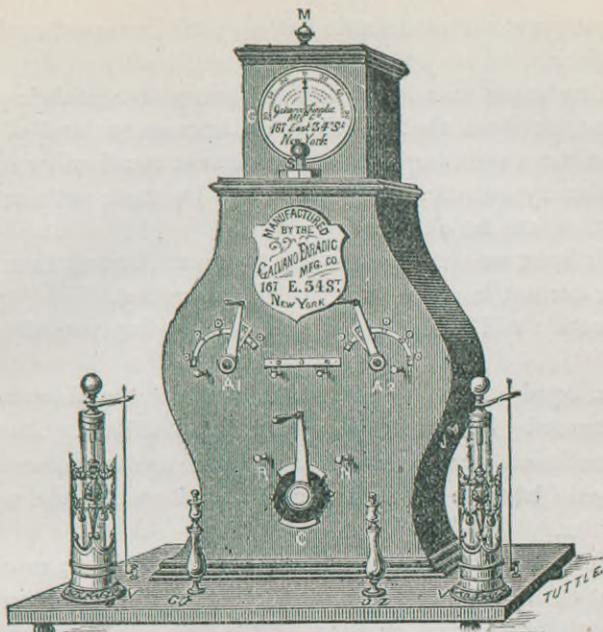


FIG. 2. Bartlett's Regulator, arranged for 60 cells, with current selectors, a current reverser, a galvanoscope, and Powell's clock-work interrupter.

To return to the subject of

PAIN:

It is found, by observation, that the most ready relief is afforded by the application of the positive pole of the battery to the seat of pain. If the pain is deep-seated, this is accomplished by applying the positive near the pain, and the negative, to some distant part.

The relief is sometimes more readily produced by interrupting the current, which can be done by rapidly breaking the connection by hand, or by means of a clock-work interrupter.

The better way, is to let the current run continuously some minutes, and, if the pain persists, to interrupt the current for a brief period.

Assuming, that in non-inflammatory pain, the nerves are anæmic, or in a state of retarded congestion, it at once appears that the positive or oxydating pole favors nutritive activity,

and consequent active disassimilation, with increased rapidity of circulation.

Whether or not this is the correct theory of neuralgic pain, in distinction from that which is inflammatory; and of the power of the oxydating pole of the current in affording relief, it may be hypothetically accepted, until a more satisfactory explanation can be obtained.

In this light we shall not be led to expect benefit from the galvanic current in cases of active inflammation.

Instruction will be derived from the following case of

LIGHTNING STROKE:

Davis, aged 22, in good health, was, in the forepart of April, struck by lightning, while standing in a barn. Insensibility continued for some minutes, and pain and tremor ensued.

The pain became severe through the chest and the upper extremities.

The tremor was chiefly in the upper extremities; more in the right than in the left arm, and most obvious on attempting to maintain a fixed position.

Under the charge of Dr. I. H. Brown, of Waverley, relief was chiefly secured by morphia.

May 2d and 3d, 1873. Three applications of the continuous current were made. The first application, through the arms from side to side, appeared to ameliorate the pain. The other applications, through the chest and abdomen, aggravated the suffering.

The feeling induced by the galvanic current made the patient averse to the repetition of the applications.

One-quarter grain doses of solid extract of aconite afforded some relief.

It is an interesting query why the pain in this case was aggravated by the same agent, which, in so many cases, affords relief.

One hypothesis explains the fact. If we classify pains as non-inflammatory and inflammatory, and assume that the galvanic current enlarges the vessels and increases the amount of blood in a part, we have a clue to the mode in which neu-

ralgia is relieved. An anæmic condition of the nerves affected being supposed to exist; the current secures an increased amount of blood in the painful nerves, and raises their nutrition so as to bring them to a painless physiological condition.

If, on the other hand, it is assumed that the central nerves, in this case of lightning stroke, were in an inflamed condition, having already too much blood in them, we can see why the galvanic application increasing the blood, at the same time increased the pain.

Analogy holds with the application of heat. Those cases of pain and discomfort in which the application of heat is beneficial, are likely to be benefited by the galvanic current. As the greatest heat is developed under the oxydizing or positive pole, this is the pole to be applied over the seat of pain, when the pain is supposed to be associated with an anæmic condition.

When, however, the current is employed in chronic inflammation, with redness of the part affected, as in chronic ophthalmia, proriasis, and other instances of sluggish circulation with full vessels, the negative pole is to be applied to the part affected. This result is worked out by experience, and the theoretic explanation corresponds with the practical result.

While we have the analogy with the application of heat, we have no analogy of the therapeutic action of galvanism with that of cold. Those cases in which the continuous application of cold is beneficial, are cases in which the galvanic current cannot be made profitable. Some heat is developed by the passage of the current under both electrodes, and hence the inapplicability to acute inflammation.

PREMONITION OF INFLAMMATION.

Our theory leads us to think that in the premonitory or painful stage of disease, the constant current may be beneficial in aborting the disease.

A SEVERE PAIN OF NINE DAYS' DURATION ARRESTED IN TEN MINUTES.

John Crump, aged about 16, had, several years ago, necrosis of the left thigh, occasioning some loss of bone, and result-

ing in permanent flexure of the leg upon the thigh. The limb was subsequently restored to its function.

April 27, 1872. Nine days ago, a severe pain attacked the same limb, extending the whole length of the thigh and including the knee-joint. The center of suffering was on the outer side of the thigh, at the junction of the middle and upper-thirds; not over the course of the sciatic nerve, and not in the old cicatrix, but anterior to it.

The sponge connecting the positive electrode was placed on the outside of the thigh over the seat of pain, the negative sponge being on the inner side.

The continuous current of 120 cells subdued the pain in 10 minutes. The current was allowed to run 10 minutes longer. In two hours, the pain began to return. After four hours, the current of the same power subdued the pain in 15 minutes. The current was allowed to run 15 minutes longer. There was then no pain whatever, but acute sensibility to pressure over a small space which had been the center of the most intense pain.

28th, Morning. The pain has not returned in its full force. Thinking that there must be an inflammation commencing under the periosteum, an incision was made to the bone in the seat of the greatest sensibility, and the periosteum extensively scarified.

The bistoury was made the negative pole of the battery, and the foam of hydrogen which escaped with the blood made it uncertain whether or not a small amount of pus was released from imprisonment.

No severe pain was felt afterward. The wound soon healed, and the patient then went to work upon his father's farm.

A case of necrosis was probably forestalled by the incision, and it is not probable that making the bistoury the negative pole of a strong current produced any difference in the result. The interest attending the case is in the fact, that the strong current subdued an inflammatory pain during the initiatory period of the inflammation. More instruction in relation to the power of the current would have attended the

case, if the trial of the galvanic current had been prolonged, and the incision postponed.

It is often a nice point to determine when an inflammation has so far passed from the acute to the chronic condition, that benefit will be derived from heat, friction, and movement in place of the cold and rest, which have previously been required. The same doubt will sometimes arise in the treatment (by galvanic currents) of chronic inflammation following injuries. The benumbing effect of the continuous current enables it to be useful in some cases, in which heat and friction cannot be borne.

Heat and friction must be applied primarily to the surface, but the galvanic current is applicable to deep parts. The direct diminution of sensibility is one of the advantages of galvanism over all other local forms of stimulation. In addition to the influence which galvanism has in common with heat and friction, there is an effect upon the composition of the interior tissues of the nature of catalysis, a loosening of the texture of new deposits, so that they are the more readily absorbed. When the tendency of action is right, this shaking of the tissues aids nature. When, however, the tendency is wrong, nothing short of the complete destruction of morbid deposits will aid a restoration to health.

Health is, therefore, important in aid of the good influence of galvanism as of other local applications. This requires the employment of tonic medicines and hygienic measures in cases of general prostration.

DEPRECIATION OF THE GANGLIONIC NERVOUS SYSTEMS.

This term may be employed to designate that condition, more common in women than in men, in which there is an inability to keep up an equable circulation, in which slight causes destroy its balance, resulting in congestions, local anemias, pains, and uneasinesses with various imitations of local diseases.

What this condition is, will not soon be determined by scalpel or microscope, for whatever molecular change there may be, this change must be more in the vital chemistry

than in that visible constitution, which remains the same after death as before. The condition seems to be one of action rather than of stasis, and the lesions which produce the morbid sensations, cease to exist the moment the machinery is brought to a stand still. The machine must move to demonstrate its irregularities; and this demonstration must be found in the result of action, rather than in the view of the parts as they are working together. We know the machinery works badly from the results, though we cannot, with pin or probe, point to the precise spot of derangement. The comparison is more accurate with a bank whose demands are beyond the funds at command, so that it is always hard run and strained to do its ordinary work, if its capital cannot be increased. What this bank needs is a quickening of collections, making disbursements possible. What a depreciated, nervous system needs, is such a stimulus as will increase its power of appropriating nutriment, and thus of performing work. A stimulant which, like thought and feeling, exhausts the nerves, must do harm to nerves already exhausted.

A stimulant, however, which aids the nutrition of the nerves in question, prepares them for responding to the call of exhausting stimulants—that is, nerves thus stimulated do the work of ordinary life without pain and fatigue, though without this aid the action is languid or irregular.

Many of the articles of medicine introduced into the alimentary canal, doubtless owe their efficacy as antispasmodics, to their direct influence upon the peripheral extremities of the ganglionic nerves.

Negatively or indirectly, the clearing of the alimentary canal of the irritating remains of imperfect digestion, by laxatives, produces a most marked effect upon hysterical symptoms.

The positive effects of valerian and assafœtida are best explained by their supposed action through the same system of nerves.

The calming and the pleasantly stimulating effect of the galvanic current through the body, so as to embrace the sym-

pathetic system within its scope, is best accounted for upon the supposition that numerous peripheral sensations depend upon a vitiated state of the sympathetic system, which condition is removed, for the time being, by the passage of the galvanic current. It may be easy to continue the current too long, when it may be considered an overdose.

By no kind of stimulant can nerve-nutrition and consequent nerve-function be indefinitely increased, whatever may be the explanation of the effects. The continuous current, carried from the back of the neck to the hypogastrium, arrests many of those uneasinesses which lead patients to think they have various organic diseases of lungs, heart, intestines, and uterus. The sense of relief begins with the flow of the current, and lasts for a long time after it ceases. Sometimes the feeling is simply one of relief; at others, there is a feeling of positive stimulation.

The *modus operandi* of the current may be supposed to consist in the increase of the molecular action by which material floating in the fluids is more rapidly appropriated by the tissues, resulting in a corresponding increase of the elimination of effete elements; an increase of transformation into and out of the organic active constitution, with an attendant increase of functional power; an exaltation of nerves above that condition of exhaustion, in which pain and uneasiness are indications of the existence of deficient nerve force. Upon the theoretic considerations already referred to, it would be expected that proximity to the extreme of resistance nearest the terminal electro-negative in the battery; *i. e.*, the positive pole, would be most stimulating on account of the elimination of oxygen, and this is found to accord with experience, but in deep parts it is impracticable to make this distinction. The equal development of oxygen and hydrogen in the tissues may be supposed to leave the oxygen to unite with other elements than the hydrogen, while the latter is an inert element which disappears in unison with the various excreted fluids.

For this healthy stimulation, the current flows toward the negative in the direction of the nerves, from their central ends,

while the current in the opposite direction is disturbing or irritating.

With regard to the sympathetic system, however, it is difficult to say what is central and what is peripheral, [and it is doubtful whether the same distinction exists between the effects of the current in the two directions. In the practical application of the current, other nerves than the ganglionic are always included in the scope of the current, and this constitutes a reason for the preference of the downward direction of the current in central galvanization.*

As a common method, therefore, the positive pole is applied to the upper part of the body, and the negative to the lower.

For the galvanization of the cervical portion of the sympathetic nerve, it is practically sufficient to place one sponge upon the base of the neck, anteriorly, and the other upon the back of the neck. If the quantity of the current is ample and the sponges large, it is not necessary to be careful about the localization, but if the quantity is small, requiring the use of small sponges, one may be placed upon the sixth or seventh cervical vertebra, and the other upon the inferior anterior triangle of the neck, where the pulsation of the carotid artery is most readily felt. It is not well settled whether the direction here is important. The conditions of the defective or perverted innervation of the head are influenced by the current through the neck, which ever way it may flow.

This subject will be illustrated by the introduction of the following case of

NEURALGIA WITH DIMNESS OF VISION AND HEADACHE.

April 30, 1873. Mrs. C. D., aged about 30 years, has, for a considerable time, suffered from headache and dimness of vision, being able to read or sew only for a very short time, without a visible congestion of the eyes.

Several sittings were had, with intervals of two or three days, the positive pole being applied to the back of the neck,

* The introduction of the term "central galvanization," "central electrization," and "central faridization," is claimed by Beard & Rockwell. See their book, "Medical and Surgical Electricity."

and the negative to the hypogastrium. No application was made to the head or to the eyes.

Very considerable improvement was noticed after the first sitting, and after the last sitting, the improvement remained permanent.

Citrate of iron and quinia, 5 grains, three times a day, was prescribed as a tonic.

In this case, the headache and dimness of vision had such relation to each other that they both vanished together, and both had such relation to the central ganglionic nervous system, that the stimulation of the central nerves removed the troublesome peripheral symptoms.

The removal of less peripheral pain and stiffness is illustrated in the following case :

CENTRAL NEURALGIA.

Mrs. J. W. K., aged about 60, had a course of fever several months ago, followed by pain and stiffness, which she has called rheumatism.

June 18, 1873. She has had seven sittings of half an hour each, taking the full strength of 120 cells. The pain and stiffness have been greatly ameliorated. She required to ride, now she walks.

June 27. She has had six more sittings, with great improvement, not only in the pain and lameness, but in all her functions. No medicine has been prescribed.

This case is a sample of numerous cases of pain and stiffness not well defined, capable of being relieved by a strong continuous galvanic current.

Lest it might seem that these cases were reported with the enthusiasm of an original discovery, it is thought proper to introduce Dr. Anstie, quoted by Dr. Wm. A. Hammond, in the *Journal of Psychological Medicine*, July, 1872; p. 576.

"I am now fully able to speak with far greater assurance of the positive value of electricity as a remedy for neuralgic pain. I shall make bold to say that nothing but the general ignorance of the facts can account for the extraordinary supineness of the mass of English practitioners, with regard to this question."

Hammond then says: "This is true of America. Many of our physicians know almost nothing of the great benefits to be gained by this agent, and have a groundless scepticism of all that is said in its favor. Faradic electricity is useless; the galvanic current is the one to be employed, but there must be as little variation of the tension as possible; the application should be made at regular intervals, at least once a-day, and the sittings should last from 5 to 10 minutes—not more than 15."

It will be seen from the narrative of my cases in this Report, that 30 minutes is no uncommon period for my sittings.

Another phase of central nervous depreciation will find its life picture sufficiently drawn by the next case.

GENERAL PROSTRATION.

Miss N., aged 19, attending school and expecting to graduate, was overtaken in the winter by a pulmonary inflammation which confined her to bed for weeks.

The convalescence was incomplete when she resumed her studies, and her graduation exercises were performed as if no interruption of health had occurred.

June 30. Exhaustion, palpitation, pain in the chest, headache, anorexia, constipation, and excessive menstrual flow are the heads of the case. The details may readily be imagined. The most grave apprehension of approaching consumption, was haunting the parents' anxieties.

Stethoscopic examination showed a slight catarrhal pulmonary complication, but no organic disease could be discovered.

Cathartics and tonics, including iron and quinine, had been taken with only temporary effect. Without change of the tonic medicine the galvanic current of 100 cells positive, to back of neck, and negative to hypogastrium, was employed continuously 20 minutes; then 90 cells interrupted 10 minutes. Next morning, the bowels moved without cathartic medicine. Several sittings, at intervals of 2 and 3 days, removed the troublesome symptoms, and improved the appetite, so that all medical treatment became unnecessary.

The primary influence in this case was the improvement of the function of the ganglionic nervous system.

The immediate result was the emptying of the colon, and the secretion of the gastric juice. With the grist well ground out below, and the hopper filling above, the working of the mill became all right. Good moral feelings and healthy intellectual action followed the physical improvement.

The portraiture of the following case of

CENTRAL NEURALGIA,

with three months' treatment, may afford more instruction than a narrative of success :

Mrs. M., widow, children dead, aged 28, figure symmetrical and moulded with the medium amount of fat, has been treated for heart disease and for consumption on account of the distress referred to heart and lungs, the palpitation and dyspnoea being extreme on very slight muscular exertion, or on the occurrence of emotional disturbance.

Sitting in repose, no disorder would be suspected, and the closest examination of the chest failed to reveal any disease.

The uterus was retroflexed with a dusky hue of the os, which was swollen. A moderate leucorrhœa existed. A probe entered only three-fourths of an inch, but a careful dilatation for several days, first with small slippery elm bark tents, and afterward sponge tents, enabled the cavity to be explored its whole length. A high back hard rubber bow pessary sufficed to diminish the pelvic discomfort. From time to time, application was made to the interior of the uterus, of citrine ointment combined with half its bulk of carbolic acid. This treatment improved the apparent condition of the uterus, with very little effect upon the general symptoms. A soreness, complained of in the left iliac region was less troublesome, as the uterine condition became more healthy.

The fundamental symptoms were vigilance and an indescribable distress in the head, with a presentiment of insanity. This distress in the head was always allayed for the time by the galvanic current.

The neuralgia travelled. Once in about six weeks the stom-

ach would retain nothing for several days, and the vomiting was distressing, with or without food. The abdomen and pelvis came in their turns for distress, and the cramps of the intestines, with flatulence, was, at times, very troublesome. Constipation was a permanent condition. The limbs were sometimes the seat of stiffness and soreness, but this was a minor symptom. The course of the spinous processes exhibited spots tender on pressure, but not always in the same locations.

Wandering spots, of excessive sensitiveness to the galvanic current, appeared upon the head chiefly, and less often upon the body. These places were only found upon the application of the electrode, and were not morbidly sensitive to pressure. One of these appeared early in the treatment upon the left temple, about an inch in diameter, which would not endure four cells without discomfort. The current from two cells was distinctly felt, and was not unpleasant. This hyperæsthesia disappeared in a few days. This was the only person who has been able to perceive the current of two cells, when applied to the skin. A characteristic of the case was, that the current applied through the body was always soothing; always anticipated with pleasure, and there seemed never to be an overdose.

The employment of the current through the limbs was never pleasant.

September 18, 1872. Twenty cells interrupted, the positive pole to the iliac region, the present seat of pain, for 15 minutes. During 10 minutes more the positive of 12 cells was applied, in a stroking manner, over the forehead, behind the head, and over the sympathetic at the base of the neck.

The applications were each day varied, in an experimental search for the best method.

The capability of enduring a stronger current increased, and there was this peculiarity, that a stronger current was endured interrupted than continuous. On stopping the interruption and permitting the current of the same strength to

flow continuously, a burning sensation would be complained of, which ceased with the starting of the interrupter. As the nervous condition improved, the continuous current was better borne, and as the nerves depreciated, the fondness for the interrupted current returned.

October 19th. One month from the commencement of the treatment. The current is employed morning and night, varying in strength, from 70 to 100 cells, interrupted, and in time from 40 to 60 minutes. The positive is applied to the upper dorsal region, and the negative to two or three places, dividing the current among the locations of greatest discomfort. If one of the electrodes conducts so as to produce too much sensation, it is intercalated by conveying the current through water, so as to increase the resistance and send more of the current over the other wires.

The feature of practical value in the treatment of this case is the alleviation of present suffering, without marked permanent improvement. In this respect the agent does not differ from others in obstinate diseases.

The medicines relied upon were pyrophosphate of iron, citrate of iron and quinia, the magnesian salts for the constipation, and the anti-spasmodics assafœtida and valerian.

Neither bromide of potassium nor iodide of potassium had any pleasant effects, and each time a trial was made a second dose was refused, on account of the discomfort following its use.

The treatment of this case continued a little over three months, terminating January 28th, 1873.

Quietude of nervous function and freedom from excessive pain seemed like success, coupled with a suspicion as to permanent improvement.

Two months later, the patient made a visit of a week, exhibiting marked improvement, which she attributed to treatment here.

The patient felt that the temporary relief was a sufficient reward to herself, without reference to any permanent result.

GALVANISM TO THE HEAD.

While an electrode is applied to the neck, either upon the spinous processes behind, or upon the region of the sympathetic nerve anteriorly, the other pole is applied to various parts of the head, and moved in a stroking manner from one part to the other. The strength employed is from 10 to 20 cells, and the relief from headache is often speedy and complete. It is not ascertained in which direction the current is most effective, but the general practice has been to place the positive electrode upon the head and the negative upon the neck.

When there is pain in one particular spot, it is in accordance with the uniform practice in the treatment of pain in other parts, to apply the positive electrode as near as practicable to the seat of pain.

The passages of the current through the base of the brain from one mastoid to the other generally occasions vertigo, and sometimes pain, and on this account, these localities are rarely selected for the application.

It is, however, found that in the majority of cases of pain in the head, that the removal of the pain can be accomplished by passing a current through the neck, including the sympathetic nerves in the scope of the current.

A much stronger current can be borne here without discomfort to the patient, and in the neck there is no danger of injury to the eyes or ears, by too strong a current. In all cases, however, in which the pain in the head is not relieved by the current passing through the spine and trunk, the head itself is made the seat of application of a weak current, and one or the other of these modes of employing the current succeeds in nearly all cases of non-inflammatory pain.

If the regions of the eyes are avoided, there can be very little danger of an overdose, if care is taken to apply the current very feebly at first, gradually increasing it, and refraining from increase as soon as pain or discomfort is experienced.

It is found in practice that there are, in some cases, spots

over the cranium which are very sensitive to the current, though there may, in these places, be no unusual sensitiveness to the pressure of the finger. The case just detailed is a good illustration.

The application of a very mild current to these sensitive spots usually removes the excessive sensitiveness in a few minutes. The unipolar method is generally employed—the negative being upon the front or back of the neck, or held in the hand.*

According to Dr. J. J. Mason, writing in the *N. Y. Medical Journal*, (June, 1873, p. 618), Prof. Cyon, of St. Petersburg, has taken position against the application to the head, on the ground that a current light enough to be safe, will so diffuse itself as to do no good in diseases of the central parts of the head. He assumes that the current is applied for the purpose of irritation, and in central cerebral disease the irritation intended is not obtained by the proceeding. It is difficult, however, to see how the central organ can escape from the scope of the current, and if only a weak current can be borne, and only a weak current is applied, it is impossible to say that the current is inoperative, unless we assume that only a strong current can produce any effect. It is difficult to see the reasonableness of the conclusion of Prof. Cyon, that "all direct treatment of the brain by electricity ought to be abandoned."

If the passage of the galvanic current through the head causes the patient to feel better, and no subsequent ill-effect follows; this is a sufficient test of the fitness of the measure.

A theoretic objection must be set aside by the favorable result of experience.

In further defense of galvanization to the brain, Dr. Moritz Mayer says, "There is no doubt that we can, by means of a constant current, even of tolerable strength, affect, through their bony coverings, the brain and spinal marrow.†

*The term *polar* or *unipolar* is employed when one pole is applied to the affected part, and the other pole to some distant part. *Bipolar* designates the placing of the two poles near together, so as to carry the current in the most direct manner through the part to be acted upon.

†Electricity in its Relations to Practical Medicine, p. 96; Hammond's translation.

LUMBAGO AND OTHER FORMS OF CENTRAL NEURALGIA.

No case of central non-inflammatory pain and accompanying lameness, which has been subjected to treatment, has failed to be benefited temporarily or permanently, and in the cases in which the result was imperfect, the benefit received was sufficient to make it probable that longer or more frequent treatment would have abolished the pain and consequent lameness. A sufficient number of cases have not come under observation to justify any more positive language.

One of the most gratifying features of this treatment is the immediate improvement. The patient coming in with a constrained posture and careful movements, and going out with careless posture and free movements. Whatever may be the pathological condition, the galvanic current has an immediate effect in ameliorating or removing the attendant pain and lameness.

The following case of chronic rheumatism may be sufficient for illustration:

Mrs. M., aged about 45; of careful mode of life, and full habit, has had, for many weeks, pain and lameness in her shoulders and arms. Restless nights, and inability to dress herself, kept her reminded of her disease.

November 22, 1872. The parts affected were traversed for half an hour by a current of 100 cells; sponges six inches in diameter being employed.

The pain and lameness were, for the time, entirely removed. The patient went away delighted with the result. The improvement was never wholly lost by the time of the next sitting, so that in a few days, the disease was entirely removed.

Dr. Wm. Stephenson, (quoted in the *Half-Yearly Abstract*, No. 57, p. 127, for July, 1873, from the Transactions of the Edinburgh Obstetrical Society, for 1872, p. 455,) speaking of pelvic pains, says, "The difficulty which we have hitherto had to contend with is, that we did not possess the means of acting directly and locally upon the weakened sacral nerves—the true cause of suffering," * * * * here, however, the constant current steps in. Its effect in alleviating pain affords

immediate relief, and, by its restorative influence, gradually removes the affection, while, in it, we have also the means of determining how far any local mischief is acting as an exciting cause. In some cases, where a cure cannot be looked for, great relief from suffering can be given, more quickly, and with better effect than by the use of anodynes." * * * *
 "What is wanted, is not a current of great intensity, but one of large quantity of electricity of low tension. Twenty-five Daniells' cells are sufficient for ordinary cases. "The mode of application I adopt, is by two large surface sponge conductors. One placed over the spine and the other on the iliac regions and inner side of the thighs. I have tried the direct application to the uterus by a vaginal conductor, but I have not found any well-marked advantage over the external method. Each application should last 5 or 10 minutes, and the direction of the current should be frequently changed, during the sitting."

SPRAINS.

The theory of action, which has been already entertained, is unfavorable to the expectation of benefit from the galvanic current during the period of acute excitement following sprains (subluxations) of joints, and other injuries liable to be followed by chronic swelling and lameness. In the latter condition, benefit should be anticipated, and is experienced.

Andrew Jackson, native citizen of African descent, a well-digger, sprained one of his little fingers.

Several weeks later, the man complained that he could not apply that finger to the handle of his pick or his shovel, and though an able-bodied man, he was kept idle by one little finger. One application of the current greatly benefited the finger, and a few applications made the finger fit the handle of the pick without pain.

The function of the little finger being restored, the whole man's working functions became operative. Chronic sprains are cases in which *bone-setters* have often gained fame over regular practitioners. Cold and rest are properly employed during the acute period, and the patient beginning very soon

to get about, calls upon a *bone-setter*, who applies friction with great benefit. Unmindful of the change of condition which permits the friction to be useful, the patient attributes his cure to superior skill.

It is in such cases that the galvanic current is useful, and it has this superiority to friction, that it affects the deep-seated parts equally with the surface. The action of the two agents in combination, or alternation, has this advantage, that the passage of a strong galvanic current is benumbing in its action upon the nerves of sensation, and friction is consequently better borne.

A more complicated condition, yet belonging to this class, is the following case:

Dysæsthesia with anæmia, following sprain of foot, of one year's duration. Pain referred to one place as the center of intensity, which was the last place to cease to be painful on pressure.

Patent enabled to walk without pain in one month from beginning of treatment.

September 3, 1872. Miss L. aged 15, received a sprain of one ankle a year ago, from which she recovered. Six months ago, the sprain was repeated in walking. Since this second sprain, the foot has been too sensitive to permit any weight to be borne upon it.

Much swelling was produced by the first injury, and reproduced by the second.

There is now a slight fulness over the internal plantar nerve, but no general swelling.

The tenderness on pressure precluded any full examination.

There is tenderness upon any movement of the tarsal bones, and upon pressure upon any of the tarsal joints.

The continuous current of 60 cells, for half an hour, diminished the pain occasioned by pressure and motion, and, without raising the apparent temperature, made the foot seem warm to the patient, in place of the coldness previously experienced.

Friction, for five minutes, increased the apparent temperature.

September 8. After five days of treatment by galvanization and friction twice a-day, all parts of the foot are free from pain on pressure, except the tract of the internal plantar nerve, which is thus proved to be the seat of disease. Severe pressure can be endured everywhere except in this tract.

From this time, the current was applied twice daily, for ten minutes each time—the continuous current alternated with the interrupted, and made alternately ascending and descending, with friction after each galvanization.

September 20. The interrupted current is found to be less unpleasant than the continuous.

There is a gradual narrowing of the scope of the hyper— or kakæsthesia, and a diminution of its intensity.

The crutches are left off, except when walking in the street. Plays croquet without crutches.

October 3. The patient went home, walking without lameness.

The only medicine employed, was elixir of pyrophosphate of iron, of which about half a tablespoonful was taken before meals.

This patient came by the recommendation of Dr. Goodbrake, of Clinton, who shares the gratification of seeing the recovery.

A letter, dated April 15, 1873, states that there have been a few attacks of slight lameness of short duration.

Sept. 1, 1873. A year has elapsed, and the recovery is complete.

BED SORES, and other ulcers dependent upon retarded circulation.

The treatment introduced by Dr. Wm. A. Hammond, following the suggestion of Crussel, of St. Petersburg, is coming into favorable appreciation. It consists in covering the ulcer with a plate of silver, from which a wire extends to a plate of zinc, held by adhesive plaster to the sound skin in the vicinity.

This action is hastened by interposing between the zinc and the skin, some lint, wet with vinegar, but the moisture and

saline exudations of the skin itself are sufficient to keep up a current.

The place of the zinc plate must be changed to another location, often enough to forestall the ulcerative effect of the salts of zinc upon the sound skin.

The tonic effect of the positive pole is well shown by a case of obdurate ulceration of one of the inferior extremities in which amputation would have been performed but for the opposition of the patient and friends, which is reported by Dr. Thomas W. Deering, of Leavenworth, (Kansas), in the *American Journal of the Medical Sciences*, for April, 1873, p. 419. The positive pole was applied to the foot, distal to the ulcers, and the negative to the spine. Fourteen Smee's cells (in Kidder's 36 cell battery) were employed daily during from ten to twenty minutes. The effect was so far soporific, as to obviate the necessity for hypnotics. The ulcers were all healed in about six weeks.

MENORRHAGIA.

The galvanic current increases uterine congestion, and consequent active uterine flow. It cannot, therefore, be a remedy for menorrhagia, unless the inner surface of the uterus is itself made the positive pole.

This is conveniently done by introducing a sponge tent, having a needle previously inserted into its axis. The needle having been threaded with a fine wire, can be attached to the positive electrode, while the negative electrode terminates in a large sponge, covering the sacrum, or is applied at any convenient place, or divided among any number of places. It is found, by experience, that the uterus is not very sensitive to the current, and that when the negative is divided among three or four large sponges, there is more sensation in each of these sponges than in the uterus, although a single current here balances all the others.

As the induction of inflammation is a remedy for passive capillary hemorrhage, we may entertain the expectation of benefit from the employment of the positive pole, with its coagulating and oxydating influence, in arresting passive

hemorrhages not only from the uterus, but from various other parts, as the nose, the gums, and the bladder.

The employment of the positive pole can be combined with pressure in all places which are accessible to this mechanical expedient. The subject is, however, too theoretical to offer more than a suggestion.

The positive pole has been employed in one case of persistent and repeated uterine hemorrhage with apparent benefit, but as the pressure of expanding sponge, and the styptic effect of chloride of iron were secured at the same time, it is impossible to analyze their effects and determine what belong to each expedient.

The good effect must be expected through the coagulation of the fluids, rather than through its effect upon those vital conditions, for the change of which the current is resorted to in such sub-involutions of the uterus as have been referred to as following injuries and inflammation in other parts.

SKIN DISEASES.

The value of galvanism, in cutaneous affections, is still in the experimental period. Enough is known, however, to warrant the expectation, that this agent will prove of more value than any other, in the removal of non-contagious affections of the skin.

Attention has been called to the subject by Beard & Rockwell,* and by Allan McLane Hamilton,† the latter of whom quotes Dr. E. L. Mann, of Brooklyn, (*Medical Record*, Oct. 1, 1872), by Dr. H. G. Piffard, of N. York, (*The Doctor*, Aug. 1, 1871), and by various investigators through the journal literature.

ECZEMA AND PSORIASIS.

Some trials have been made of the power of the galvanic current, in suppressing the eruption of psoriasis. At first there was nothing known, theoretically or practically, as to which electrode to employ. A few trials demonstrated that the positive pole aggravated the disease, and the negative

* A Practical Treatise on the Medical and Surgical Uses of Electricity.

† Clinical Electro-therapeutics.

ameliorated it. One obstinate case of eczema of the lower lip, and another of the cheeks, are controlled by the current, though not yet cured. Neither of these cases had been rendered even more comfortable by any remedy previously employed.

The determination of the real value of the remedy requires more experience.

CHRONIC OPHTHALMIA.

In one case of obstinate and recurring chronic ophthalmia, involving the general structures of the eye, the negative pole of from 10 to 15 cells, for one minute at a time, has been employed with very marked advantage. The application was continued several months, and finally discontinued, as the patient became able to engage in out-door farm work.

The method of application was the holding of the sponge termination of the positive electrode in the left hand, and the holding of the handle of the negative in the right hand by the patient, who applied the sponge to the closed lids, moving it at pleasure, and increasing the force of the current until slight flashes were perceived.

MORBID GROWTHS *in which there is a rapid production of cells.*

The knowledge of the means of changing the character of cell-growth, without their destruction, would be a valuable acquisition to science.

The view already explained of the oxydizing effect of the galvanic current at the positive pole, leads to the anticipation of good effects in epithelial growths, or growths composed in great part of cells of any kind. It may be conceived, that an agent capable of imparting to such a *growth*, the character of normal cell-*growth*, must diminish the rapidity of production.

If this change of vital character can be made sufficiently intense, the *growth* must diminish in size, and ultimately disappear. The discovery of such an agent need not be attended by invariable success. There are two forces—the morbid and the corrective. If the morbid force is the greater,

it will prevail, though retarded by the corrective force. If in some cases the corrective force is the greater, it will prevail; the disease will disappear, the cell-growth will become normal. This influence is distinct from that of the current when made destructively electrolytic by confinement of the current to a narrow scope, as is done by its introduction through needles.

The following case may serve to illustrate the *therapeutic* advantage of the galvanic in distinction from the electrolytic mode of application.

Case of infiltrated epithelial growth in the sub-parotideal region of two years' duration. Failure of dissection to remove the whole of the tumor. Growth under the influence of electrolyzation. Partial removal again by the knife. The current again employed with wide distribution, with rapid absorption of the infiltrated material.

May 28, 1872. Elijah A. Reynolds, aged 40, in May, 1870, perceived a small tumor under the angle of the right lower jaw, hard, but not sensitive to the touch. In August, it began to grow rapidly. In October, it diminished in size. In May,



FIG. 3. Elijah A. Reynolds previous to treatment.

1871, it began to grow again. In January, 1872, it began to be painful, and continues painful to the present time. It has grown perceptibly during the last month. A small additional tumor is perceptible under the jaw, near the median line.

The accompanying cut, Fig. 3, exhibits the appearance of the tumor previous to its dissection.

Operation under chloroform. The dissection was commenced from below, and the tumor was found to have no membranous enclosure, but to be incorporated with the tissues surrounding it. It broke up readily under the pressure of the finger, and its deep surface not only dipped into the muscles, but the muscles themselves were rendered hard and rigid by infiltration of the same material.

It was not thought prudent to attempt the complete removal of the morbid material, but to apply electrolysis after a few days. Under the glass, no caudate cells were discovered, and such cells as could be distinguished, had very much the appearance of those found in epithelial growths. The history of the tumor, and the appearance of its contents to the naked eye, were those of encephaloid disease.

The patient had been prepared for the operation by a cathartic the night before, and five grains of quinine in place of breakfast. A few hours after the operation, $\frac{1}{4}$ grain morphia and 30 grains hyd. chloral were given. The wound was left open, and kept covered with pieces of old muslin, saturated with a solution of carbolic acid of 4 grains to the ounce.

June 1. Wound cleaning out and granulating well; the patient kept upon the use of 7 grains of citrate of iron and quinine three times a day.

June 4. The seventh day from the operation, galvanization was commenced with a 32-cell platinum-zinc battery, obtained from Curt. W. Meyer, of New York.

The application was varied on different days, and averaged about 20 minutes, twice a day. The poles were interchanged, to see which was most agreeable to the patient. The flat metallic plate, covered with wet canton flannel, was soothing to the patient, producing sleep. The indurated tissue apparently softened and lessened in size.

June 29. One month subsequent to the operation. After employing the flat electrode for two weeks, the platinum needle (negative) was employed, to destroy a tubercle in the center of the open ulcer for several days, and some increase of thickness being discovered upon the upper and posterior margin, the needle was also introduced here. A rapid increase of volume followed the employment of the needle in the electrolytic way. It became evident that this mode of application was injurious. The patient became demoralized, and came near leaving in order to try somebody's cancer salve.

SECOND OPERATION.

The new growth upon the upper and posterior margin (just under the ear) was removed. This time again, no attempt was made to remove the whole of the morbid material. Several vessels were tied or acupressed.

A minute portion of the mass showed under the microscope only compressed epithelial cells. No caudate cells were discovered. From this time on, the galvanization was kept up through the application of a sponge to the wound connected

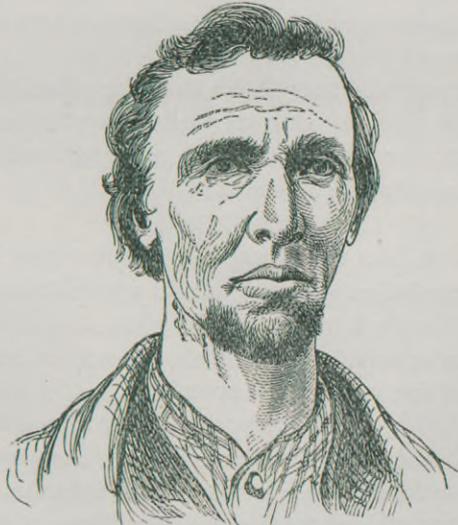


FIG. 4. Elijah A. Reynolds subsequent to treatment.

with the positive pole twice a-day, about half an hour. The tonic of quinine and iron was kept up. After about a month the galvanic current was applied twice a-week. A constant current 100-cell-battery was substituted for the 32-cell-battery previously employed. The full power of the battery was generally borne. Cicatrization went on rapidly, but a sinus remains open up to this time. Its surface has been occasionally stimulated by the application of carbolic acid. The painful condition soon disappeared after the second operation, and has never returned. The ulcer finally healed completely.

The cut, No. 4, illustrates the present appearance of the patient. He has, for a considerable time, performed his customary labor, as a farmer, and enjoys good health.

September, 1873. The health is good, with no return of the disease.

With regard to this case, it may be said, that if the growth was not cancerous, but scrofulous, or cachectic, the power of the galvanic current to arrest this last kind of morbid degeneration is at least vindicated. As far as the reproduction of a tumor is evidence of cancer, so far, any agent may be said to be a remedy for cancer, which has the power to arrest this secondary growth.

This history of this case shows that the power is not one of destruction, as the growth increased during the employment of the current for electrolysis, but an agent which directly promotes a more healthy nutrition.

ELECTROLYSIS.

In distinction from the therapeutic employment of the current, the electrolytic method is that in which the current is so concentrated in its introduction into the tissues by confinement to metallic needles, as to be injurious or destructive to the vitality of the parts acted upon.

Some morbid growths may be induced to disappear by any agent that causes a violent shock. Among them are ganglions or weeping sinews. A needle introduced through the little tumor which encloses the gelatinous accumulations around a tendon, and held there only a few seconds until

some apparent action has been induced, leads generally to a speedy disappearance of the tumor without slough, or suppuration.

Miss Miller, aged about 20. *Electrolysis* of ganglion or weeping sinew on one of the tendons of the extensor longus digitorum, upon the left wrist, of six months' duration, originally caused by a sprain.

December 13, 1872. A steel cambric needle was made to transfix the tumor, and was connected with the negative electrode. A sponge held in the hand was connected with the positive. The current of 100 cells was allowed to pass one minute, and the needle was then withdrawn. Intense pain was experienced about the needle, which ceased with the cessation of the current. There was a manifest immediate softening of the little tumor.

December 26. The surface is entirely smooth, though there is still some pain at the place of the ganglion.

Jan. 7, 1873. The swelling and lameness have entirely disappeared. In this case there was no sloughing, only sufficient action to produce absorption of the exuded material, and a return of the tissues to a healthy condition.

Little vascular tumors, which are reddish or blueish, and which are more apt to occur after 40 years of age than earlier, are very effectually destroyed by the negative current, introduced through a needle for a few seconds.

The galvano cautery is, however, more speedy, and it has the advantage of immediate and complete removal of the tumor.

Other growths which exhibit the appearance of malignancy, or which stand upon the disputed boundary between scrofula and cancer, are induced to disappear speedily, without inflammation or slough, by an electrolytic process of very short duration.

The following cases occupy this position of doubtful diagnosis, and serve to illustrate the effects of electrolysis:

John Ives, aged 21, living near Greenview. Lupus upon right cheek, first noticed six months ago. A dense scab grows

upon the surface, one-fourth of an inch in diameter, causing slight bleeding, as it is pulled from its rough base. Induration and thickening exist beneath the morbid surface, half an inch in diameter, situated half an inch behind the angle of the mouth.

December 14. Four small cambric needles, threaded with small iron wire and connected with the negative electrode, were inserted into the indurated tissue just beneath the surface. The positive connection was made by a sponge held in the hand. The current of 100 cells was permitted to pass during one minute. The pain of this application was very severe, but ceased the moment the circuit was broken.

December 31. Patient returned. The induration has nearly disappeared, and the ulcer has healed, leaving no mark. The application repeated with two needles. The patient has not since reported.

CHRONIC INDURATION.

Mrs. D. has had for several months an oblong enlargement upon the right cheek, elevated, smooth, brownish, and *cicatricial* in appearance, about one inch in length. Upon incision, there was found to be a very small amount of pus in the center, while the extremities of the elongated growth were solid. The existence of lancinating pains justified the fear of malignancy.

January 3d, 1873. Two cambric needles, connected with the negative electrode, were introduced, and a current of 100 cells allowed to run 30 seconds.

January 13th. Growth greatly diminished in extent. One needle introduced, with the same strength and duration of current.

February 3d. The size of the growth is still further diminished. One needle, with strength of 120 cells, during 30 seconds.

March. Only a slight induration remains. One needle, with 120 cells, 2 minutes.

The induration soon entirely disappeared, leaving only a very minute cicatrix on the same plane with the surrounding integument.

It is found, however, that some epithelial growths are liable to be stimulated to increased activity by a strength of current which is too great for the increase of physiological action, and too feeble, or of too short duration, for the destruction of the tissues.

When the growth is found to increase under the influence of needles, employed for brief periods, the method should be exchanged for the complete and immediate destruction of the mass by a longer continuance of the needles in the tumor, or the electrolytic method should be abandoned in favor of a different mode of employing the current, as was found necessary in Reynolds' case.

When the complete and immediate destruction of a part is determined upon, it is obvious, from a moment's consideration, that the more rapid the development of hydrogen, the less it will become diffused in the tissues beyond the boundary of the diseased structure.

As the patient must be etherized for the destruction of a mass of considerable size, on account of the painfulness of the process, it is evident that the stronger the current is, the larger will be the amount of substance which can be devitalized in a given time. The necessary duration of the anæsthesia is thus diminished to a corresponding extent.

In the *American Journal of the Medical Sciences*, for July, 1873, p. 260, Dr. Groh, Prof. of Surgery, in Olmutz, is quoted from the *London Medical Record*, for March 5, 1873, as having employed electrolyses in numerous tumors, with a powerful current for brief periods, under chloroform, and for long periods, without chloroform, with a weak current.

When he introduces the positive and the negative needle into the tumor, the positive is introduced first, in order that the oxydation may not retard the introduction. He connects with the positive electrode a zinc needle, in order that its oxydation may incorporate with the destroyed tissue a zinc compound, which is supposed to assist in hardening it; an effect similar to that which is produced by the application of chloride of zinc.

Case of Cancer (osteo-encephaloid) of the hand, reported in the Transactions of the American Medical Association, for 1872, by Dr. Wm. H. Mussey, of Cincinnati. The tumor upon the dorsum of the hand, of two years' duration, was removed by the knife, March 7. On the third day after the operation, encephaloid granulations were noticed.

The galvanic current was passed through the hand with apparent increase of the growth at first. From May to July the application was made every second day, resulting in cicatrization. The application was then made twice a week, till November.

The date of the report was two years after the close of treatment, and the disease had not returned.

The application was made by placing the bare metal (nickel plated) upon the wound. In this method there would be a destructive influence upon the surface, and beneath, there would be the same effect as if the surface had been protected by soft and wet material.

In the *N. Y. Medical Record*, No. 85, Sept. 1, 1859, a case is reported by Dr. Neftel, of New York, in which a tumor extending into the axilla, had been twice extirpated by the knife, and had returned after the second extirpation.

A complete cure was effected by the electrolytic process.

It may not be amiss to say, in this connection, that these brilliant successes ought not to lead to the expectation of curing all cases of cancer. It is enough to know that a remedy has been discovered which has a curative influence upon the disease.

AN UNSUCCESSFUL CASE.

March 13, 1873. Mr. William Smith, aged 72, of general good health, perceived, 2½ years ago, a movable tumor on the right cheek, which, a year and a-half ago, was excised by Dr. Sanford, of Keokuk. In a few months, the flaps, which had been made, began to thicken—a growth with a suppurating surface, gradually enlarged to be 2 inches in diameter, with a deep excavation in the center, like a rose in full bloom, having its elevated margin and depressed center.

The growth has been more rapid of late, projecting into the mouth, but not appearing to involve the bone, nor to reach the base of the tongue. The tumor has never been painful, and the discharge is not very offensive.

An operation by electrolysis, 18 needles being made to encircle the growth. The patient being etherized—6 needles received the current (negative) 2 minutes, when the current was transferred to the next 6, and then to the next 6, making 6 minutes—the duration of the proceeding. There was no other effect of the ether than fatigue and sleepiness. The subsequent effect was only some inflammation—no sloughing. The curative effect of the measure was negative.

The positive electrode was applied by means of a sponge to the tumor, of the strength of 100 cells, one hour, twice a-day.

Five grains of chlorate of iron and quinia, 3 times a-day.

April 21. Takes 120 twice a-day.

June 19. A tumor having developed under the jaw it was attached, by 3 needles, the current passing during 20 minutes.

July 30. For some time the ulcerated surface has been dressed with undiluted carbolic acid—a diarrhoea has set in, and the disease has increased with reduction of the patient's weight and strength.

For a few days, three settings a-day, of an hour each, with the full strength of 120 cells, have been permitted, at the request of the patient.

September 3. The tumor projecting into the mouth has entirely disappeared without sloughing, but a growth is projecting down the side of the neck—an extension of the tumor attached, and apparently destroyed by electrolysis on the 19th of June.

September 4. *Galvano-cautery:* Removing the skin and subjacent diseased tissue under the jaw. A small platinum wire was brought to such a degree of heat, that if exposed to the open air, it would melt. The wire was introduced by a pilot of needle and thread, as in the use of a silver wire for a suture.

Previous to the inhalation of ether, $\frac{1}{2}$ ounce of whiskey and $\frac{1}{3}$ grain of morphia, were taken. After the recovery from the sleep of ether, there was no vomiting, no pain, and no uneasiness.

September 8. The eschar is coming off, and the surface of the wound looks well. The general health is good.

September 13. The surfaces whence the sections were taken by the hot wire, are clean, with cicatrization around the margins.

From this time, the general health failed, without diarrhœa, or other obvious cause. The weight lessened rapidly, and the surface of the cauterized part lost its granulating covering, showing the distinct outline and convexity of the *sterno-cleido mastoideus*. The upper portion of the diseased surfaces, not cauterized, have not undergone any appreciable alteration.

Sept. 16. Went home despairing of any benefit, without any improvement in health.

This case may be set down as a failure, as cure of the cancer, but the relief of discomfort, by the passage of the galvanic current, has repaid the patient for the expense incurred. The disappearance, without sloughing, of the growth which projected into the mouth, leads to the inference that with younger and more vigorous life, the result would have been better.

To conclude this Report: It is hoped that the combination of success with failure may prove to be such as to make it valuable to those who are seeking to know the therapeutic value of the galvanic current.

Other cases of cancer to which I have applied the current prove nothing decisive, except in the relief of pain. For this purpose, the current is as effective as in cases of neuralgia. This effect sheds light upon the pathology, indicating that its position is among the lesions of vital depreciation.

Elephantiasis—failure. John Watt, aged 30; native of Edinburgh. When 20 years old he went to Australia. He had diarrahœa while there, and a development of elephantiasis arabum in the scrotum, and the left lower limb. At the end of three years, he returned to Edinburgh, and Prof. Syme removed his scrotum.

Four years later, or three years ago, Dr. Louis Bauer, of St. Louis, tied the femoral artery, without any permanent effect in diminishing the hypertrophy of the connective tissue.

The limb has sufficient strength, but walking produces a sense of fulness and weight, with pain in the ankle. The circumference of the affected limb is from three to four inches greater than that of the healthy side.

March 21, 1873. Electrolysis under ether during 55 minutes. Thirteen cambric needles were employed.

These needles were first, all inserted about a-quarter of an inch from each other, and were made to travel, by withdrawing and reinserting one after another, so that each needle held its position in one place about two minutes. The bubbling of hydrogen raised a distinct circle of foam around each needle.

Next day, the puncture marks were very plainly seen, but there was neither soreness nor lameness. The patient walked around his room.

March 23. The same process was repeated, with the same exemption from inflammatory results.

General galvanization was also resorted to for several days.

March 30. Ninety-four insertions—four needles inserted at a time—*i.e.*, four needles taking the current, and remaining two and a-half minutes.

Some inflammation followed this application, without any diminution in size.

The case was abandoned as a failure. It illustrates the safety of extensive galvano-puncture to the extent of large development of hydrogen in the tissues.

STRICTURE OF THE URETHRA.

Stricture of the urethra of 12 years' duration, extending from the bulb into the prostate.

G. D., aged about 30, of fine figure, and good health, contracted urethritis about 12 years ago. For several years, he has had great difficulty in urinating, and of late he has had to get up a dozen times in a night; only passing a very small quantity at a time. Occasionally the urine has dribbled

away upon his clothing, at the same time that he could not urinate by a voluntary effort.

OPERATION. *April 9, 1873.* The patient has frequently taken chloroform, and, at his request, chloroform was given in preference to ether.

I failed to pass any instrument into the bladder.

The bundle of filamentous whalebone bougies failed, only passing as far as the bulb.

The difficulty arose from the impracticability of giving the point of the most advanced filament the proper direction. Holt's railroad dilator was passed down into the membranous portion of the urethra, and would go no further. One of the followers was then passed down upon the track, between the two sides of the shaft, effecting dilatation of the first stricture.

This instrument was then withdrawn, and a steel bougie, No. 9, (one-eighth of an inch,) was introduced, without succeeding in getting it beyond the membranous portion.

Holt's dilator was then again introduced, and attached to the negative electrode with a strength of 30 cells, the positive electrode terminating in a large sponge upon the sacrum. Light, but steady, pressure was made upon the instrument by the forefinger of the right hand, while that of the left hand was in the rectum watching the point of the bougie. In eight minutes, the instrument passed into the bladder. The instrument was then withdrawn, and, with the current, increased to 50; bougies—9, 8, 6, 5, and 3—a range from $\frac{1}{8}$ to $\frac{1}{4}$ of an inch, were passed in succession. The whole time occupied by the electrolytic process was sixteen minutes. Eight minutes were consumed in the first entrance, leaving eight minutes for the next five introductions, making ninety-six seconds for each dilatation, minus the time taken for changing the bougies.

The left forefinger was kept in the rectum during each insertion, to guard against the possibility of making a false passage. The patient says, that in one of his own attempts to pass a small bougie, he entered the rectum, and, upon withdrawing the instrument, smelled the odor of feces upon the end of it.

April 12. Passed a No. 4 (3-16th of an inch) steel bougie in four minutes with a current of 70, without chloroform. More sensation was created upon the skin, over the sacrum, where the positive current entered by a sponge six inches in diameter, than in the urethra, or bladder, though the mucous membrane was subjected to the contact of a small surface of steel.

14th. The same size of bougie and strength of current passed, with very little sensation, and no blood.

From this time, No. 3 was passed daily. A little foam appeared upon the steel surface as it was withdrawn each time, after remaining as the conductor of the current for about two minutes.

April 25. After sixteen days' treatment, the patient went home, taking with him a No. 4 bougie, to use himself, in order to prevent a contraction of the urethra.

The patient has since remained free from trouble.

Stricture in the membranous portion of the urethra.

F. C., aged 22. Gleet from gonorrhœa of one years' duration; pain felt in the urethra; stream of urine not exceedingly small.

May 9th, 1873. A steel bougie, No. 6, smeared with citrine ointment, made the negative pole of 60 cells, passed in two minutes. The bougie was arrested at the place of the stricture, but passed with a jump, and entered the bladder without further stop.

10th. A bougie No. 4, passed as easily as a No. 6 yesterday.

11th. No. 4, repeated.

12th. No. 3, repeated.

13th. No. 2, repeated.

No. 2 passed into the bladder in 20 seconds, more easily than No. 3, the day before.

The treatment was practiced some time longer, for the purpose of confirming a cure.

It is more than a quarter of a century since a physician in St. Petersburg, reasoning upon the known disintegrating power of the galvanic current at the negative pole, conceived

the idea of employing this agent for resolving urethral strictures.

The *modus operandi* of the treatment seems to be the induction of the solvent action of the alkalies, and the disintegrating effects of diffused hydrogen, causing plastic deposits to yield more readily to mechanical force. This enables the bougie to pass on easily, without rupturing the urethra or drawing blood.

The perfection of treatment consists in so adjusting the size and force that no blood will be lost. A coarser proceeding, in which blood is lost, is, however, no more dangerous than the ordinary treatment by rupture, or by internal incision, in which a free flow of blood is produced.

This mode of treating stricture failed to attract much attention, until about six years ago. Mallez and Tripier, in France, followed by Brenner, in Germany, achieved several brilliant successes. In an account of five cases, reported by Mallez and Tripier, one death occurred.

From the encouragement afforded by these achievements, and those which have since been realized, this method of treating stricture of the urethra is rapidly coming into good repute.

The special danger in the treatment of stricture of the urethra, in bad constitutions, is the induction of diffused suppuration and sanious absorption.

The careless employment of the current so as to create a slough, or a cellular inflammation, would be liable to result in death in this manner.

According to an account of cases quoted by Beard & Rockwell, one case was lost in the employment of the galvanic current passed through a bougie. It cannot be pretended that this is an absolutely safe agent in bad constitutions. It must, however, be safer than rupture by the distension of the urethra, as in Holt's method, which must be the most dangerous of all. The internal incision commits less violence upon the parts, but is only applicable to the cases of moderate contraction. The external incision, by Syme's method, is applicable to the

worst cases, and the free exit for purulent discharge, is a protection against purulent infiltration.

In this view of the subject, the external incision for the worst cases, in bad constitutions, would be the safest. Electrolysis next, internal incision next, and rupture the least safe.

While this report is passing through the press, the little book of Dr. A. M. Hamilton (Clinical Electro-Therapeutics, page 154) comes to hand, in which the author says "The theory of the electrolysis of stricture is this: The slough produced where the negative pole touches, is such as that produced by an alkaline caustic. * * * An instrument insulated to its end, where it terminates in an olive-shaped bulb, is connected with one pole (the positive), and passed into the urethra, till it reaches the stricture. The other pole (negative) is held against some part of the body in the neighborhood. * * * * * From my own experience, I find that the only beneficial results that follow the use of electricity in these cases, are those that occur when the current is very mild (not so strong as to produce sloughs or cicatrices). A mild current undoubtedly has an electrolytic effect, which will eventually enlarge the point of structure."

This is an encouragement to read the rest of the book.

The misplacing of the words (positive) and (negative) is the result of hasty composition and careless proof reading.

The insulating of the bougie, except at the point, and making that point olive-shaped, must favor the production of a slough, which effect should be avoided.

Instead of enlarging the point of the conductor, it should be diminished in size, so as readily to insinuate itself into the yielding stricture.

The employment of a bougie not insulated, favors such a diffusion of the development of hydrogen, as to diminish the risk of the formation of a slough.

With the positive electrode upon the sacrum, the current crowds toward the point of the bougie sufficiently without insulation.

According to Dr. Moritz Meyer (Electricity in its Relation

to Practical Medicine, p. 474), Crussel, in 1847, was the first to employ the galvanic current for the removal of strictures and exudations, followed by Willebrand, Spencer Wells, Ciniselli; and lately the method has been revised by Scoutetten and Tripier.

The method has been employed by Tripier in overcoming the obliteration of the lachrymal sac, constriction of the Eustachian tube, and stricture of the urethra.

According to Dr. Meyer, Willebrand had good success in treating opacity of the cornea by applying a silver button upon the cornea, connected with the negative electrode, while the positive terminated by a metallic plate in the mouth of the patient. Meyer himself employed the electrolytic method, under the observation of Prof. Von Græfe, with satisfactory results. His method consisted in the application of a wet sponge (negative) to the closed lids, while another sponge (positive) was held in the hand—the duration of the current being from 10 to 15 minutes.

The electrolytic treatment has been attempted to be employed in enlarged prostate, and the urinary disabilities attendant, but with negative result.

The theory of creating absorption of overgrown parts, by the current, favors the expectation of success. A negative bougie, however, cannot be applied to the prostatic urethra for any length of time without danger of slough, and the oxidating and carbonizing action upon the positive electrode renders this inapplicable.

Nothing is left, therefore, but the therapeutic employment of the current, by bringing the prostate into the scope of a strong current, one pole being upon the sacrum, or in the rectum, and both poles being so spread out as not to endanger the formation of a slough. The effects of this method must be slow in development.

GALVANO-CAUTERY.

This addition to surgical art, said by Chas. E. Morgan, (*in Electro-Physiology and Therapeutics*), to have been first thoroughly studied by Middeldorp, of Germany, has been more

than 20 years theoretically known; but such has been the difficulty in constructing and keeping in order a battery which could be relied upon at all times for a prompt performance, that it has never come into very general use.

The beauty of this form of actual cautery lies in the ability to apply the metal cold, and to bring it while in position to a most intense heat—a heat sufficient to melt platinum, a metal most difficult of fusion.

Platinum is the metal chosen, on account of its heating readily, from being a bad conductor, the high degree of heat required to melt it, its tenacity, so that considerable force may be applied to a heated wire, and its resistance to oxidation. A small iron wire would do very well, only that when brought to a sufficient temperature, it takes fire and burns. The metal is always employed in the form of wire, generally round, to act like a ligature, or flattened to act like a knife. Sometimes the wire is made to form a loop for touching a wart, or other small substance which is to be destroyed. A projection, natural or morbid, is encircled by a platinum wire cold, and being in position, the wire is heated by the current, when it settles into the part. Once completely surrounded by damp tissue, the amount of the current is increased by dipping the plates of the battery deeper into the liquid, in order to counteract the cooling effect of the surrounding tissue. If the parts are very vascular, the wire is made to travel slowly, in order to form a thicker eschar, but if only slightly vascular, the operation may be accelerated.

If the wire cannot be made to encircle a part to be removed, it can be introduced by a needle, in the same way in which a silver wire is introduced for a suture.

There are quite complicated instruments for acting upon the wire, but all that is necessary is two metallic tubes, separated a-quarter or half inch, by the intervention of a piece of wood. The current is conducted through these tubes, and in passing the platinum loop, which is made by the closed portion of the wire projecting beyond the tubes and surrounding the substance to be acted upon, the loop becomes heated.

The free ends of the wire, projecting from the other ends of the tubes, are not in the circuit, and of course are not heated.

These free ends may be taken hold of by the right hand, while the tubes are held in the left, and there can thus be all the time an exact knowledge of the amount of traction.

The operator finds it most convenient to have an interrupter in a pedal, so that by his foot he can close or open the circuit, without any movement of his hands, and without any jostling of the apparatus by which the cauterization is managed.

The writer has recently employed this cautery in the removal of a section of the neck of the uterus in two cases, in which operation by incision had been previously practiced. In the first case, (operated upon by the knife three years ago), the patient was under the influence of ether.

There was no pain following the operation, and no bleeding: the eschar came off by particles, and the ulcer healed over rapidly.

In the other case of hypertrophy, the amputation by the knife having been made a year ago, and the growth having exceeded the size attained at the time of the incision; the operation was performed in the wakeful state, and with very satisfactory result.

The patient stated, after the operation was over, that there had been very little pain attending the process.

In these cases, the position was that upon the left side, with Eric's self-retaining modification of Sims' speculum. In this position, the uterus tends to recede from the operator, and the os needs to be held by toothed forceps. This probably accounts for the want of cupping of the surface of amputation, (as the uterus is viewed after the operation), described by Dr. J. Byrne, in his account of this operation, in recent numbers of the *American Obstetric Journal*.

Dr. Byrne places his patient in the position for lithotomy, and employs a speculum of his own construction, which is self-retaining by the divergence of the distal extremities of the blades, and is provided with the means of enlarging the proximal orifice as far as the vulva permits.

In this position the uterus crowds toward the operator, and hence the tendency of the wire in cutting straight across, (making a surface which is a plane in this position,) to make a surface which is cupped when seen afterward in Sims' position.

On this account, the lithotomy position is probably better for this proceeding than the position of Sims, it being desirable to secure such a surface as will facilitate cicatrization, the same principle applying here as in amputation of a limb.

The N. Y. Galvano-Faradic Manufacturing Company have furnished the writer with an apparatus which performs well, and promises to work when wanted.

It is not enough to have an apparatus which will heat a wire when on exhibition by the agent of a manufacturer. A surgeon will have something else to think of besides keeping his battery always in the best possible order.

It should have two or three times the apparent capacity necessary, in order to be always reliable on short notice.

APPENDIX.

Noticing, in the recent books upon Electro-therapeutics, a variety of statements with regard to the production of the induced interrupted currents, and the terms employed, it seems proper to append the following quotation from Dr. Charles E. Morgan's elaborate work on *Electro-Physiology and Therapeutics*, (p. 114).

This is believed to be the best authority in the English language, and may therefore be followed without hesitation.

"*Electro Induction* is a term applied to the production of a current in a closed circuit, by the mere presence or vicinity of a current-traversed circuit, under certain circumstances. Conceive, for instance, that of two parallel conducting wires, only one is traversed by a current. A galvanometer intercalated in the wire not traversed by the current, indicates no current action. Move, however, the first, or, as it is usually called, the primary or *inductive* coil, very rapidly toward the secondary or *inductive* coil; then there arises in the inductive coil, a secondary or induced current, having the same direc-

tion as the primary or inducing current, *i.e.*, a direct current. Then move the primary coil away from the secondary, and the secondary current is now inverse or contra-directed to the primary current. The greater the rapidity of this motion, the greater the intensity of the induced currents, which are immensely strengthened by using helices, instead of single coils. Instead, however, of moving the helices, we may place them along-side of each other, and suddenly interrupting the primary circuit, we get, in the secondary spiral, a direct current which at once disappears, and closing the circuit, an inverse current makes its appearance. Both these are so called instantaneous currents, lasting an exceedingly brief space of time, disappearing the instant the circuit is opened or closed. Their strength increases with the strength of the primary current, the closeness of the spirals to one another, and the number of coils in each spiral. Hence, in order to obtain the maximum, we form the secondary spiral of very many convolutions of fine, well insulated copper wire, while the primary spiral consists of comparatively few convolutions of a thick wire, in order that its resistance should not weaken too much the galvanic current traversing it, and for the same reason, large galvanic elements, or those of small internal resistance should be employed. Moreover, in order to lessen the inter-spiral distance, the spirals are hollow, so that the primary spiral can be placed inside the secondary.

"This action, however, is not confined to the interaction of two spirals, but also occurs between the coils of one and the same spiral. The intraspiral action, at the instant the circuit is opened, develops what is called the primary or opening extra current, and its direction is the same as that of the primary or inducing current, *i.e.*, it is direct; whereas the extra current, arising at the instant the accessory circuit is closed, the secondary extra current is inverse."

The effect of a soft iron core, usually composed of wires insulated by varnish, becoming magnetic during the passage of the current around the turns of the helix, is to augment the shock produced by the helix.

By the expedients of the helix and the soft iron magnet, a great intensity of impression is secured with a very weak primary galvanic current.

The object of the employment of the induced current, being chiefly the excitement of the nervous and muscular functions, and the secondary induced current, *i.e.*, the current in the helix of fine wire being of higher tension, producing a sharper physiological impression, the secondary current is usually employed, to the neglect of the primary induced current, *i.e.*, the extra current of the helix, in the coils of which the primary galvanic current flows. There is again this convenience in the employment of the secondary induced current, that by making the helices movable, the secondary helix sliding over the primary, like the finger of a glove upon the finger, the force of the current can be regulated by the amount of the secondary inductive helix brought within the inducing distance of the primary inductive helix.

In this way, the impression may be varied from the slightest to the most severe.

Aside from the durability of the mechanism, and the ease with which it can be mended, every faradic apparatus should have three points—the means of suspending the electromotive elements higher or lower in the liquid, the means of regulating the rapidity of the interruptions, and the means of varying the force of the current, in addition to the variation secured by the varying amount of the galvanic current which is dependent upon the depth of the elements in the liquid.

The importance of possessing the means of regulating the rapidity of the interruptions, will be appreciated when it is remembered, that slow interruptions favor muscular contractions, while rapid interruptions produce tonic contraction or tonicity of the muscle, without necessarily any visible effect, though under the touch, the muscle may become more dense.

The relations of varying rapidity of interruptions to the diagnosis of muscular power, and the consequent inferences with regard to the state of the nervous system, render plain

enough the necessity for having the mechanism arranged for this purpose.

In the employment of electricity for the diagnosis of muscular conditions, it may be well to remember this remark of Deuchenne (*Local Electrization*, p 196).

"I have sometimes found cases of paralysis, in which the muscles no longer responded to the distant intermissions of an induced current, but in which they contracted, more or less, under the distant intermissions of a strong galvanic current, after having been traversed from 60 to 80 seconds, by a constant continuous current."

* * * "It is a strange phenomenon, that the integrity of electro-muscular contractility is not essential to the performance of voluntary movements."

The instruments manufactured by Dr. Jerome Kidder, of New York, for the production of this current, *i.e.*, for faridization, have given general satisfaction, and recently a new device for making the interruptions, that is for closing and opening the circuit, has been adopted by the Galvano-Faradic Manufacturing Company of New York.

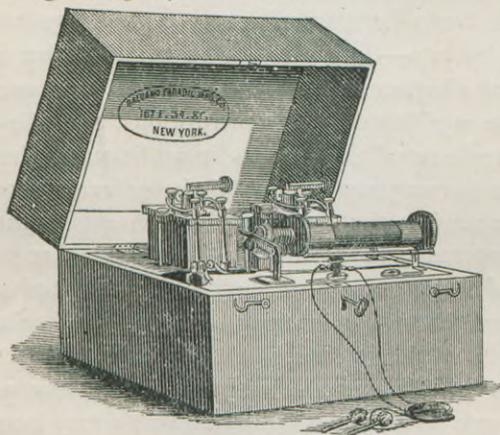


FIG. 5.

Fig. 5 is a view of the box opened, but it does not show the contrivance by which the interruptions are made, rapidly or slowly.

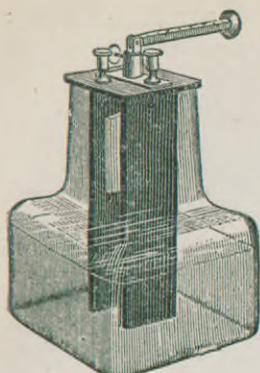


FIG. 6.

Fig. 6 affords a very good view of the cell with its zinc and carbon pair, elevated and sustained out of the fluid by a joint in the sustaining bar, connected with the zinc plate, and sustaining both zinc and carbon.

Carbon; a cheap carbonaceous compound of coal-tar and powdered coke, rendered dense by heat and pressure; introduced by Bunsen, of Heidelberg, Germany.

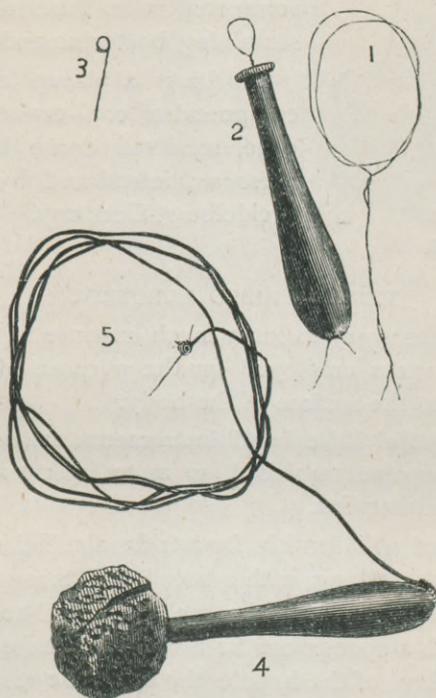
EXTEMPORIZED ELECTRODES.

It is not necessary to incur much expense in the purchase of the appliances employed for the purpose of introducing the current to the surface of the body:

Very beautiful little hand instruments are sold, but they very soon become tarnished, so as to look no better than extemporized handles.

Any turner will furnish, for a trifle, a sufficient number of handles, 6 inches long, with a hole bored through the center, through which a copper wire can be passed to form a loop, around which a sponge can be tied. To the free ends of the wire, at the heel of the handle, the electrode can be attached. This consists of the strand of small copper wires, with a woven covering, ordinarily sold, or of a copper wire covered with gutta-percha.

For conducting the current to large sponges, a loop of copper wire about 6 inches long, and attached to the insulated wire, is all that is necessary. When in use, the loop should be covered with wet, second-hand muslin, in order to prevent the incorporation of copper with the substance of the sponge, rendering it dense and inelastic. The muslin takes the copper from the wire, and holds it. A silver-plated copper wire would prevent this transfer of copper; which, however, is only an inconvenience.



Extemporized Electrodes.

Upper right hand figure (1)—a copper wire loop, to apply to a large sponge. The twisted shank can be insulated by wrapping it with a strip of oil cloth.

Central figure (2)—a wooden spool, 6 inches long, with wire passing through it, leaving a loop for the reception of a round sponge, as in the lower figure (4), which latter has an insulated wire (5) attached, terminated by a copper wire point, shown, also, in the upper left hand figure.

Something should have been said in this report upon the employment of *central* galvanization for epilepsy. The cases in which this agent has been tried, have been immediately benefited, but it is premature to report permanent cures.

ELECTRIC BATH.

As the salts of the body make it a better conductor than water, it is very easy to convey the current, whether galvanic or faradic, through the body, surrounded by water.

Very careful directions for the construction of the bathing tub, are given by Dr. Alexander Murray, in the number of the *New York Medical Journal* for October, 1872, page 375.

Any tub of painted wood, however, will do, and all that is necessary, is to drop two large sponges into the water, one connected by a gutta-percha covered wire, with the copper or carbon end of the battery, and the other with the zinc.

When these sponges are at the extreme ends of the tub, the whole body comes in the way of the current. By moving either of the sponges, the current can be localized, according to the fancy or the necessity of a particular case. If the administerer of the bath handles only one of the sponges, he will not take the current from the patient.

The faradic bath is exhilarating, and, if only continued a few minutes, it is safe. It is equal to rubbing inside, as well as out. The employment of the faradic bath would come into more general use, if it were known how simple the arrangement. A very convenient, portable bathing-trough is made in Ann Arbor, Michigan, of strong rubber cloth (the same which is used in diving-bells,) with a wooden rim round the top, which admirably fills the requirements of an electric bath.

The galvanic current, continuous or interrupted, can be used with the same appliances, or the two currents—galvanic and faradic—can be combined in one operation, as one may fancy.

To conclude this Report: It is hoped that the combination of success with failure may prove to be such as to make it valuable to those who are seeking to know the therapeutic value of the galvanic current.

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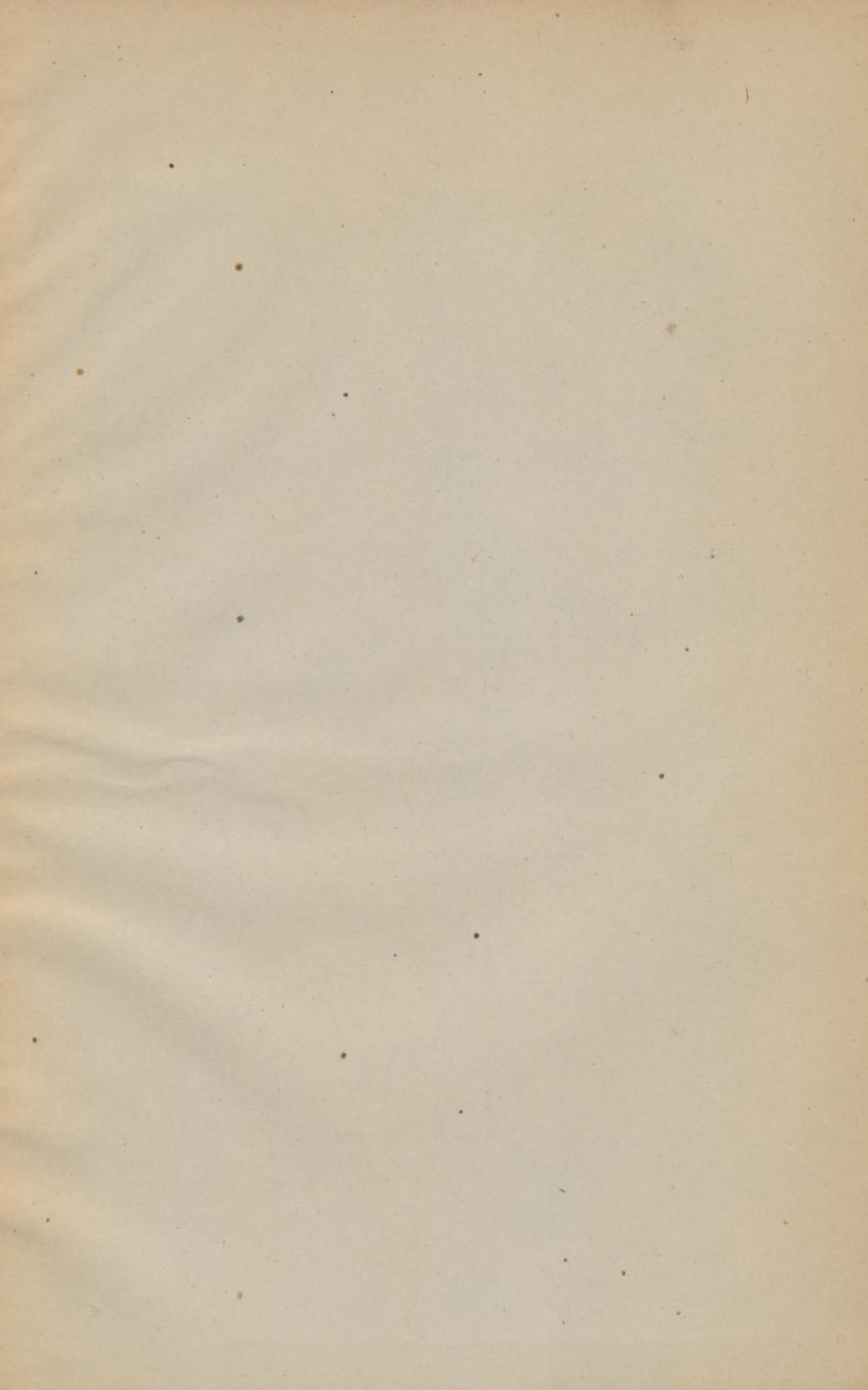
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