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THE

MEDICAL APPLICATION

OF

ELECTRICITY,

BY

WILLIAM F. CHANNING, M. D.

SIXTH AND ENLARGED EDITION.

PUBLISHED BY THOMAS HALL,
ELECTRICIAN,
AND MANUFACTURER OF ELECTRO MEDICAL INSTRUMENTS,
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THIS treatise is respectfully inscribed to those Members of the Medical Profession who wish to avail themselves in their practice of a principle of nature, which occupies a central position, both in regard to organized and unorganized matter, — which has already accomplished something for medical science, but which is still undeveloped in its most important relations to physiology. The only value claimed for these pages is in their connection with present experience. They are intended simply to facilitate the application of electricity to disease in the existing state of our knowledge, and, if it may be, to aid others, especially American practitioners, in advancing a high department of physiological science.

The instruments here described, and which this book is intended to accompany, are those prepared by MR. THOMAS HALL, successor to DANIEL DAVIS, well known as the earliest manufacturer of electro-magnetic apparatus in this country; to whose liberality in experiment, and ingenuity in construction, the present form of electro-magnetic instruments, of all descriptions, here and elsewhere, is due, probably, more than to any other person.

MEDICAL APPLICATION

OF

ELECTRICITY

The introduction of electricity into medical practice has been made the subject, within a few years, of many empirical treatises. Original and valuable sources of information have at the same time been multiplied, and the European journals, after a long interval, are again filled with cases of the successful application of this agent. Professor Wisgrill, in addressing the Medical Association of Vienna,* remarks that a revolution has now taken place in favor of electricity, which, after its wide celebrity at the commencement of the present century, had fallen into disuse, not from the inefficacy of the means, but from the mode in which they were employed. The object of this work is to present, in a reliable form, the results of experience in this revival of electro-medical application, to arrive at general principles, as far as these can be correctly deduced, and to place the materials

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* Brit. and For. Med. Rev. April. 1845.

of practice or investigation in the hands of all who look with hope to the development of this principle, now receiving so general attention abroad, which is so fertile in its applications, so immediate and so safe in its operation.

The subject will be divided into the following heads: I. Physiological Relations of Electricity. II. Forms of Medical Electricity. III. Means of Application. IV. General Application to Disease. V. Special Application to Disease. In treating the last division, the effort will be made to give as full a statement as possible of applications heretofore attempted, whether experimental in their character, or established as modes of practice. The propriety of this course will be acknowledged when it is considered that the use of electricity is comparatively recent; that it is acquiring an important place in scientific regard; and that the extent of its agency, standing alone, as it does, in relation to vitality, can hardly be anticipated.

I. — PHYSIOLOGICAL RELATIONS OF ELECTRICITY.

1. The principle of vitality, in its highest relations, has hitherto escaped analysis. All its functions, however, in the animal system, are performed through the intervention of physical agents, and in strict accordance with the laws of chemical affinity and material force. Thus, though Life stands alone as an immaterial and an organic principle, it has also, distinctly, a material side and relations in which it must be studied like any other branch of natural philosophy. The physical agents by which the animal organization accomplishes its results are of two kinds: first, principles and affinities which are common also to unorganized matter; second, a force which is peculiar to living structures — the special agent or material principle of vitality. This is manifested in two distinct forms — in the nervous system, and in the life of the tissues. In the former, its action may be spoken of as between organized masses; in the latter, between organized atoms. In both cases it is associated with a physical organization, and reacts with other physical agents. Its precise connection with these will now be more especially considered. The following extract from Faraday, on the nature of the nervous influence, treated in connection

with the electrical endowments of the gymnotus,* will serve as a fitting introduction to this subject.

2. "The anatomical relation of the nervous system to the electric organs; the evident exhaustion of the nervous energy during the production of electricity in that organ; the apparently equivalent production of electricity, in proportion to the quantity of the nervous force consumed; the constant direction of the current produced, with its relation to what we may believe to be an equally constant direction of the nervous energy thrown into action at the same time — all induce me to believe that it is not impossible but that, on passing electricity per force through the organ, a reaction back upon the nervous system belonging to it might take place, and that a restoration, to a greater or smaller degree, of that which the animal expends in the act of exciting a current, might, perhaps, be effected. . . . . So, perhaps, in these organs, where nature has provided the apparatus by means of which the animal can exert and convert nervous into electric force, we may be able, possessing, in that point of view, a power far beyond that of the fish itself, to reconvert the electric into the nervous force.

3. "With respect to the nature of nervous power, that exertion of it which is conveyed along the nerves to the various organs which they excite into action, is not the direct principle of *life;* and therefore I see no natural reason why we should not be

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* Experimental Researches. Series XV. Nov. 1838.

allowed, in certain cases, to determine, as well as to observe its course. Many philosophers think the power is electricity. Priestley put forth this view in 1774, in a very striking and distinct form, both as regards ordinary animals and those which are electric, like the torpedo. Dr. Wilson Philip considers that the agent is electricity modified by vital action.* . . . Now, though I am not as yet convinced by the facts, that the nervous fluid is only electricity, still I think that the agent in the nervous system may be an inorganic force; and, if there be reason for supposing that magnetism is a higher relation of force than electricity, so it may well be imagined that the nervous power may be of a still more exalted character, and yet within the reach of experiment."

4. The physical agent residing in the nervous system, and also in the tissues, bears a remarkable analogy to electricity in its three principal characteristics, — the exertion of attractive force, the control of chemical affinity, and the rapid transmission of impulses. It will be observed that these analogies are much more striking and fundamental than any offered by magnetism or chemical affinity, where electricity

* "Dr. Wilson Philip is of opinion that the nerves which excite the muscles and effect the chemical changes of the vital functions, operate by the electric power supplied by the brain and spinal marrow, in its effects modified by the vital powers of the living animal, because he found, as he informed me, as early as 1815, that while the vital powers remain, all these functions can be as well performed by voltaic electricity, after the removal of the nervous influence, as by that influence itself."

exists in other and undisputed combinations with matter. The impulses connected with volition and sensation are propagated along the nervous cords with the same dependence on the integrity of conductors as in the case of galvanism, though with a modified law of conduction. The chemical changes effected by vital force take place under an affinity like that in nature, alone supplied by electricity. We not only find this exerted by the ultimate particles of the tissues, but we have an example of the polar decomposition of common salt (chloride of sodium) taking place between the secreting organs of the stomach and liver, muriatic acid appearing at the one, and soda at the other, in the course of their natural functions. This correlation of electro-chemical powers in different organs is evidently due, not to the vital force in the tissues of those organs, but to the agency of the nerves, supplying them, and uniting their functions. The vital force, therefore, in both its manifestations of the nervous system and of the living tissues, modifies existing electro-chemical affinities as by the power of electricity itself.

5. The attractive force, developed in muscular and other living tissues, producing the effect of motion, bears a close analogy to the attractive force so suddenly communicated to, and withdrawn from, the particles of magnetizable bodies by electricity. The mode of production, however, of this force in the muscular fibres, which has been so recently and so ably discussed by Liebig, furnishes the final and most conclusive analogy between the agents under consid-

eration. This is concisely presented in the following statement by Carpenter.

6. "A great variety of evidence has been for some time conducting physiologists to the opinion that every act of muscular contraction necessarily involves the death and disintegration of a certain amount of muscular tissue, and it has recently been argued by Liebig, that this disintegration, resulting from the action of oxygen upon the elements of which the tissue is composed, is the real source of the mechanical power; by setting at liberty (so to speak) the vital force, which was previously employed in a *latent* manner in holding together the components of the structure. Certain it is that the amount of muscular power exercised by an animal, bears a very close resemblance (other things being equal) on the one hand, to the measure of oxygen introduced into the system by the lungs, and on the other to the amount of those excretions which seem especially produced by this metamorphosis. . . . This doctrine may probably be extended from the muscular system, in regard to which alone it has been urged by Liebig, to the nervous, as well as to the various organs of nutrition. Many circumstances lead to the belief that the nervous tissue, when in a state of functional activity, undergoes a rapid waste or disintegration, and a corresponding renewal." *

7. Not only then the exertion of muscular power, but every exertion of vital power, follows the law of elimination of material forces, the development of

* Human Physiology, §§ 377 and 77.

which, from latent conditions, is inseparably attended by a change of form in the associated matter. An illustration of this principle, and of the particular development of muscular energy, may be found in Smee's battery, described hereafter, (§ 17,) where the chemical affinities are present, but held in abeyance till the circuit is closed, when oxidation and the electrical discharge take place. In the case of muscular contraction, according to Liebig, the blood, replete with oxygen, is present in the muscle, but remains ineffective until the volition, or nervous communication, as it were, closes the circuit, permits oxidation, and eliminates the attractive force; or, in a different form of the same theory, discharges the agent previously existing as a repulsive force between the atoms. It will be remembered that the contractile power of the muscular tissue depends upon the arterial condition of the blood.

8. It has thus been shown that electricity is characterized by its ready assumption of peculiar forms, in association with matter, and by a class of widely different properties; and it has also been found that the vital force is characterized by this same series of remarkable properties and energies. This identity of action would make the conclusion not unphilosophical, that these principles were fundamentally the same. This conclusion, however, is not an essential one to our subject, and, as recently shown by Matteucci, is unsubstantiated by any positive evidence. The analogy which has been pointed out has its important applications; but, beyond this, even if the

vital force should be a form of electricity, we are at present wholly ignorant of the nature of its modification, and any control which we may succeed in exercising over it must still be the work of experiment.

9. After what has been said of the relation of these principles, it will be readily conceived that electricity has a positive reaction upon the vital force; and in this fact consists its medical application. Wilson Philip states, "We have seen that galvanism is capable of performing all the functions of the nervous power, properly so called." * That is to say, galvanism can stimulate the muscular movements of animal and organic life, promote secretion and absorption in the proper organs, affect nutrition, and influence the capillary circulation, besides exciting all other functions to the full extent of their dependence on the nervous system. The same writer supplies the following illustration, in his remarks on the application of galvanism to the digestive organs and liver: "I have repeatedly seen from it the same effect on the biliary system which arises from calomel; a copious bilious discharge from the bowels coming on a few hours after its employment." Another remarkable illustration of functional excitement, by galvanism, is furnished by the nerves of special sensation. If a current be sent in the course of the nerves connected with vision, hearing, or taste, these sensations are strongly excited; a flash of light, a noise, or a metallic flavor, is at once perceived. The impulses of special

* Vital Functions.

sensation in the appropriate nerves are thus imitated, or excited, by the electric current, the impression varying in *tone* with the nature of the current, and receiving its character, as a sensation, from the organ to which it is conveyed.

10. A more precise view of the relations of electricity to the nervous system is furnished by Matteucci, in the following comparative statement.* He observes, that electricity differs from any other nervous stimulant, 1st, in that it excites sensation at one time, and contraction at another, according to the direction in which it traverses a nerve ; 2d, in that it does not excite a nerve when passing through it transversely ; 3d, in that neither contraction nor sensation are produced when its influence upon a nerve is prolonged ; 4th, in that it alone has the property of increasing or diminishing the excitability of a nerve according to the direction in which it is made to flow ; 5th, in that it has the power of awakening the excitability of a nerve after all other stimulants have ceased to act. Beyond this, however, as might be anticipated, electricity reacts with the vital agent of the tissues, as well as of the nervous system. Thus, when a galvanic current is sent through a limb, in the opposite direction to the motor nervous current, a muscular contraction takes place, which Marianini has called *idiopathic*, or the result of the immediate stimulus of galvanism on the muscular tissue ; but, when the current is sent in the direction of the ramification of the nerves, a stronger, or *sympathic* contraction takes

* London Lancet. September 1847.

place, which is the product of both the electric and nervous stimulus. Thus, when the nerve of a frog is exposed, contractions of the muscles supplied by it, are only produced when the current flows through the nerve in the direction of its ramifications; but they are produced in a muscle, in whatever direction the current flows through its tissue.* The production of the bilious secretion, in the experiment already quoted from Wilson Philip, is more properly, perhaps, an example of the influence of electricity immediately on a secreting organ. It will be found, indeed, hereafter, that the organs of secretion are, in many cases, excited by the immediate application of electricity to their tissues, without the intermediate stimulus of the nerves supplying them. Thus, in the whole action of vitalized particles, in the secreting tissues, in the capillaries where the process of nutrition goes on, in the blood itself, a new influence and new affinities are introduced with the electric agency. The property of electricity alluded to by Müller, and on which one of its surgical applications is founded, — that of coagulating the blood, — is a significant one in this connection.

11. In addition to the vital agencies employed in the system, it is worthy of remark, that there are constant electric currents necessarily taking place, or tending to take place, between organs differing in chemical constitution and in temperature. These currents, between the superficial and deep-seated muscles and local currents elsewhere, have been

* Lond. Med. Gaz. April, 1830.—Braithewaite's Retrospect, No. XV.

observed, and are now admitted facts in physiology. They cannot but exercise an important function in the stimulation of the system. In the organs of secretion, where different fluids are separated from each other by a membrane, all the elements of a galvanic current, of some energy, are present; and this must necessarily modify the nature of the secretion, or react distinctly with the controlling vital force. These considerations are adduced as showing the extent of the relations of electricity to life, and the rational ground which exists for its application to disease.

II. — FORMS OF MEDICAL ELECTRICITY.

12. Currents of electricity are to be considered chiefly in relation to their quantity and intensity, — two elements which may be associated in infinitely variable proportions. Thus the electricity from the electrical machine has extreme tension, but almost inappreciable quantity, while the electricity from a single galvanic pair has great quantity, but so little intensity that it will hardly pass to an appreciable extent through the animal system interposed in its circuit. Between these extremes, currents can be obtained, in which the quantity and intensity exist in any desired proportion. These properties have different physiological effects, and this, therefore, is one of the conditions to be attended to in the construction and use of apparatus. Currents also may be contin-

uous, or consist of intermittent shocks, of greater or less rapidity. This modulation also exerts an important physiological influence, and must be provided for in the construction of instruments. The current of the galvanic battery, and induced electrical currents, do not consist of free electricity, but electricity modified in its action by intimate association with the matter, organized or unorganized, which it is made to traverse. This gives it, in many respects, apparently a greater physiological efficiency than the same quantity of electricity derived from the machine.

13. The common electrical machine has been very nearly dismissed from medical practice, on the ground of the deficiency of its product and the disproportion between its quantity and intensity; the former, its quantity, being sufficient only to produce comparatively slight vital changes, while the latter, especially when accumulated in the Leyden jar, is almost disorganizing in its energy. The great success, however, which has attended its use in Guy's Hospital, in the hands of Dr. Golding Bird, in cases of chorea and amenorrhœa, will not now, with propriety, allow it to be thus summarily disposed of. In some diseases, in which the nervous system is chiefly at fault, machine electricity has peculiar applications, which should not be overlooked among the numerous, and often more efficient forms in which this agent may be employed. The first mode of application of machine electricity is by electrifying the patient while seated on the insulating stool, and allowing a silent and insen-

sible discharge, which, in the dark, is luminous at prominent points, to take place from the surface of the body to the surrounding air. Of this, Dr. Bird holds the following language: "During this discharge, heat is evolved, the circulation becomes quickened, the secretions generally become more active, and perspiration breaks out. A person thus situated is said to be in an *electric bath;* and it is by no means improbable that this might be frequently employed with advantage in certain affections in which the functions of the skin and nervous membranes are deficient."* To concentrate this discharge upon a single point, as upon the eye, or the surface of an ulcer, a pointed conductor, connected with the rubber of the machine, may be held a short distance from the organ, or spot to be influenced. The second mode of application is by drawing sparks from the person so situated, by means of a knob attached to a rod, and connected, as before, with the chain from the rubber. Dr. Bird was accustomed, in this way, to draw sparks from the spine of a patient until a papular eruption was produced, which he considered as aiding in the effect. At the moment preceding the passage of the spark, a powerful concentration of electricity takes place on the part, and to this may be ascribed its efficiency. The third application is that of the shock which is made by means of the graduated jar. In this, the conductors are placed in contact with the body, and the discharge

* Guy's Hosp. Reports. April, 1841

takes place between two balls, attached to the jar, whose distance from each other, upon which the strength of the shock depends, can readily be adjusted. The shock, unlike that of the battery, or electro-magnetic apparatus, is almost necessarily painful, and will not often be resorted to. It has proved efficient from its very intensity, in suspended animation, and also by its passage across the pelvis in amenorrhœa.

14. The most powerful electrical agency which can be brought to bear upon the human system, is, undoubtedly, the direct current of the galvanic battery, in which the quantity is proportioned to the size of the plates, and the intensity to the number employed. In hospitals and large establishments the battery should always have a place, as the full power of electricity, in producing any physiological change, cannot be tried without it. The primary, uniform current of the battery is, upon the whole, less of a mere stimulant, more of a re-agent with the vital powers and living tissues, than any substitute that can be offered for it.

15. The electro-magnetic apparatus, which has almost superseded the battery, is generally sufficient in those cases where stimulation of the nervous function is the object to be attained. The influence of the nervous system has been extended by recent observations in physiology so as to embrace even processes which seem to have the least relation to vitality. Vital changes can therefore be effected by the practitioner, in a large class of cases, by coöperating with the nervous power. But beyond

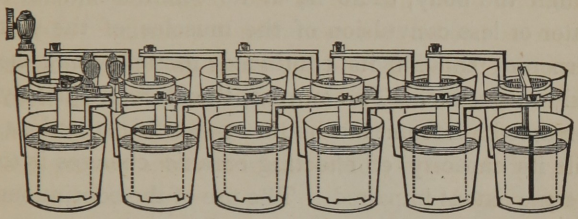
this, the life of the tissues remains, involving chemical changes, and the exertion of organizing power, which, like all other physical agencies, requires, for reaction, a definite quantity of electricity. This is a simple application of the law of electro-chemical equivalents to physiology. To act, therefore, directly upon secreting organs, to affect the vital condition of the blood, to influence nutrition at its source, to produce structural change, in the nerve-centres and fibres themselves, as well as elsewhere, in fine, to act directly upon the life of the organized atoms, a relation is needed between the "quantity" of the electricity employed, and the effect to be produced. In such cases, where something more is wanted than the mere stimulation of the life, which is actually in a part, by the supply of artificial nervous power, the battery is needed.

16. Many of the failures which have attended the application of electricity, especially since the introduction of the electro-magnetic apparatus, are to be ascribed to the want of a proper distinction between reaction with the life of the nervous system, and reaction with the life of the tissues. Even in influencing the nervous system, the battery is, occasionally, more efficient than the electro-magnetic agency; some cases of paralysis, for example, without structural derangement, yielding to the former which resist the latter. We have hence the rule, that the battery should be resorted to after the trial of electro-magnetism, before abandoning any case of disease in which electricity is known to be beneficial.

Having spoken thus of the superiority of the battery, in many conditions of disease, it is necessary to state its disadvantages to the common practitioner. It is more expensive than the electro-magnetic apparatus. It is with difficulty portable. It requires frequent attention, and renewal of solutions.

17. The recent improvements in the battery have done something to remove these objections to its use. The figure represents a Smee's battery, consisting

Fig. 1.



of twelve pairs of platinum and amalgamated zinc, arranged in the same number of heavy glass tumblers. The solution used to excite the battery is sulphuric acid, diluted with ten or twelve parts of water, or, where a less quantity of current is desired, with twenty parts of water. The zinc plate, so long as it is well amalgamated, is not acted upon at all, except when the galvanic circuit is complete, and the instrument in operation. It is, consequently, always ready for use. For many applications, a series of twelve pairs, enclosed in a box, will be sufficient; but where an intense current is required, two or more such, in conjunction, may be needed. The elements of this bat-

tery are more efficient than those generally referred to in the cases hereafter recorded; and half the number will frequently produce an equal effect. The wires conveying the electricity are connected by screw-cups with the terminal plates of platinum and zinc, or they may be connected with a less number of pairs, at pleasure. The wire connected with the platinum plate constitutes the positive or delivering pole of the battery; that from the zinc, the negative pole.

18. When the battery current is made to flow through the body, there is, at its commencement, a greater or less convulsion of the muscles of the part interposed, though its continued passage may be nearly insensible. The current, therefore, frequently interrupted, becomes a more powerful stimulant, while its capacity of effecting organic changes is to the same extent impaired. The use of the continuous current of the battery, in cases of irregular nervous action, and in some surgical applications, is indispensable.

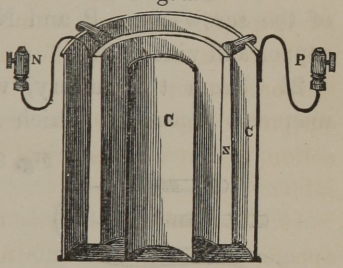
19. The current obtained from the electro-magnetic apparatus, to which attention will now be more particularly directed, is one of high intensity and small quantity, induced by another current, its opposite in these respects, the product of a single galvanic pair. The theory and facts of electrical induction will be found elsewhere,* but cannot here be dwelt upon. The convenience of this form of apparatus, its compactness and cheapness, and its efficiency in a large class of cases, have introduced it into general

* Davis's Manual of Magnetism, 2d edition.

practice ; but its disadvantage consists in the fact that a large proportion of the quantity of the battery has to be sacrificed to obtain the requisite intensity. The current of a single galvanic pair, as already stated, though large in quantity, is too inert to pass, to a sensible extent, through an indifferent conductor, like the human body, but it may be made to induce a secondary current, less in quantity, but of any required intensity.

20. The form of the single galvanic pair, most conveniently used in connection with the electro-magnetic apparatus, is the cylinder battery, a vertical section of which is represented in Fig. 2. C, C, is a double cylinder of copper, with a bottom of the same metal, which answers the purpose of a galvanic plate, and forms also the containing vessel, for the exciting solution. There is a movable cylinder of zinc, Z, which is to be let down into the solution, whenever the battery is to be put in action. It is, of course, intermediate in size, as well as in position, to the two copper cylinders, and is made to rest upon the exterior one, by means of three insulating supports. The exciting solution used is one of sulphate of copper, (blue vitriol,) containing about two ounces of the blue vitriol to a pint of water. The copper in the solution is deposited while the battery is in action, so that it

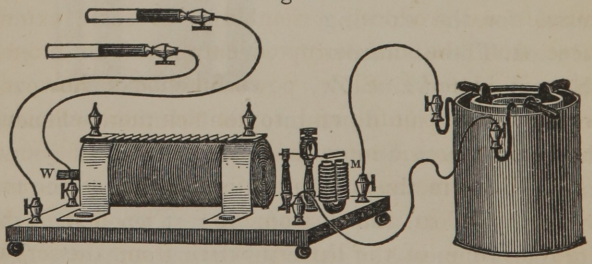
Fig. 2.



is necessary, occasionally, to add more of the blue vitriol to the solution, or to renew it. The solution may conveniently remain in the copper vessel, while the battery is out of action. The zinc plate becomes coated in the battery, so that it is necessary to clean it, after using it, with the wire brush, whenever the metal has become thickly furred. The coating should be removed, so as to expose again the bright surface of the zinc. When the plate is only tarnished, or slightly coated, it will be found difficult to effect the removal of the deposit, and it may be allowed to remain, without cleaning, until further use. The wires which convey the current to the electro-magnetic apparatus, are connected, by means of the screw-cups, P and N, respectively, with the copper and zinc plates.

21. From the battery, we pass to the electro-magnetic apparatus, which is shown in connection

Fig. 3.



with the battery in Fig. 3. It consists, in its simplest form, of two concentric helices of wire, and in the axis of both, a rod of soft iron, or a number of iron wires. The current from the battery passes

through the inner helix, which is of coarse, insulated copper wire; and by so doing, it magnetizes the iron rod or wires in the centre.

22. When this current is interrupted by breaking the circuit, and the rod or wires within lose their magnetism, a momentary reactive current is excited in the outer helix, which is of fine wire, and wholly distinct from the inner. This current possesses the intensity requisite for medical application. The condition of its existence is the interruption of the primary current. An important object of the apparatus, therefore, is to provide means for breaking and renewing the battery circuit, with whatever rapidity may be required. When the battery circuit is broken slowly, the secondary current has the effect of distinct shocks, or convulsions of the system. When the battery current, on the other hand, is broken with extreme rapidity, the separate impulses almost cease to be distinguished, and tonic contractions of the muscles are produced, resembling, to some extent, those from the uninterrupted current of an intense galvanic battery. Slow, powerful shocks, however, are often less painful, and sometimes more efficient, than a weaker and more rapid succession.

23. Two methods of breaking the battery circuit are provided in the instrument. The first is by removing one of the battery wires from the screw-cup, in which it is inserted, on the base-board of the electro-magnetic apparatus, and drawing it over the rasp, or break-piece, which is seen attached to the top of the double helix. As the wire leaps from

tooth to tooth of the rasp, the battery circuit is each time renewed and broken; and when the bundle of iron wires occupy their place in the centre of the helix, vivid scintillations occur, at the moment of interruption, and powerful shocks are obtained from the handles which are seen in the figure, connected with the cups of the fine-wire helix. It will readily be found, by experiment, from which screw-cup it is necessary to withdraw the battery wire, to obtain the shocks and scintillations. On account of the connections of the machine, it is the wire only from one screw-cup, which will produce the result. It will be observed that the screw-cups with which the battery wires are connected, are made, for the sake of distinction, higher, and with larger head, than those with which the handles are connected. The wires, or *poles*, as they are often called, connecting the battery with the electro-magnetic apparatus, are of necessity larger than those connecting the electro-magnetic apparatus with the handles, because they convey a less intense current. This should be remembered in making the connections, when the wires furnished with the instrument are of different sizes.

24. The second method of breaking the circuit is the one of chief importance. This is effected by the vibration of a little armature, or piece of iron, which is seen supported by a slender spring, over the poles of the electro-magnet, M. When the two wires from the battery are inserted in their screw-cups, on the board, the electro-magnet, M, attracts the armature

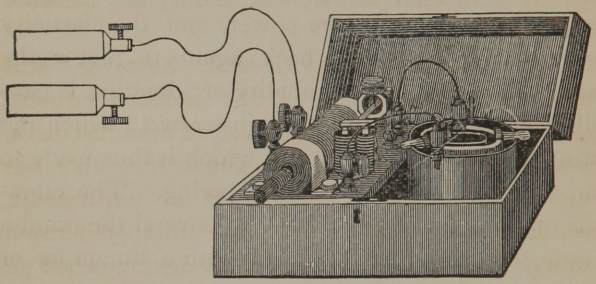
down to itself, and, in so doing, a little platinum surface on the spring is separated from the platinum point of the thumb-screw immediately above it, and the battery current, which is made to traverse these, is consequently interrupted. The electro-magnet instantly loses its attractive power, and the elasticity of the spring carries it back again to renew the contact, as before. The rapidity of vibration is controlled at pleasure, by the thumb-screw to which the platinum point is attached, and which is thus made to bear, more or less lightly, on the spring. The vibrations may be made to amount to several thousand a minute, and are then attended with a humming or musical sound.

25. The bundle of iron wires in the centre of the helix have been referred to, and will be seen at W, in the figure. The induced current, in the outer coil, results in part, or indeed chiefly, from the change in the magnetic state of these wires. It therefore follows that, by withdrawing the bundle of wires partially from the helix, or by withdrawing a part of them wholly from the helix, the shock may be graduated at pleasure, from one entirely insensible, to one insupportable to most nerves. This is another very important provision of the apparatus, without which it would be impossible to apply it in a manner at once safe and agreeable to the great variety of diseased conditions.

26. A compact form of medical electro-magnetic apparatus is exhibited in Fig. 4, in which the battery and helices are arranged in a small box. When the

instrument is transported, the solution must either be carried in another vessel, or prepared at the time of use by dissolving the sulphate of copper.

Fig. 4.



27. The relative quantity and intensity of an induced current remains always the same from the same coil. As the intensity of the shock diminishes by removing the wires, the quantity diminishes also. To obtain, therefore, a current of very considerable quantity and low intensity, it is necessary to resort to the battery. A slight modulation, in this respect, can be exerted, however, in the construction of the electro-magnetic coil, by employing a secondary helix, of coarser wire, and of copper, which is a better conducting material than the iron wire generally employed. Where, however, mere nervous stimulation is required, — the principal object of the electro-magnetic apparatus, — the ordinary form will answer almost equally well. It may be observed here, in connection with the use of the quantity current, that the muscular disturbance and agitation, produced by

electricity, depend chiefly upon its intensity, and the interruption of the current, and that a much larger quantity of electricity, of low intensity, from the battery, may be conveyed through the system, to coöperate with vital action, with hardly any sensible excitement.

28. It must be acknowledged, however, still further, that the quantity of the induced current, passing through the body, is, under all circumstances, exceedingly small. I do not know that this has heretofore been made the subject of experiment. There has, at any rate, been some misapprehension on this point, even on the part of so distinguished an electrician as Dr. Golding Bird, who recommends the electro-magnetic apparatus as furnishing a current in some sort equivalent in quantity to that from the battery.* The wave of the induced current encounters great retardation, from passing through an imperfect conductor; and however great its quantity may be, when conveyed by a wire to the galvanometer, its effect is inappreciable by this test, when passed through the body. Thus the galvanometer needle was deflected 24°, in one instance, by the secondary current; but the body being interposed in the circuit, no motion could be perceived in the needle, observed by a microscope, although the shock was powerfully felt. On employing a delicate decomposing apparatus, a single wave of the induced current gave a bulky precipitate of iodide of starch, adhering

* Guy's Hospital Reports, April, 1841.

to the little platinum discs of the instrument; but, when passed through the body, it required fifteen shocks, as strong as could be borne, to discolor one of the discs as much as the electricity generated by thirteen turns of a small plate machine, being the amount required to charge a quart Leyden jar of sixty-five inches coated surface. Here is a comparison by which the quantity of the induced current, passing through the body, is made actually less than that from the common electrical machine. Although the intensity, as well as the quantity, is less than in machine electricity, it will be observed, that its physiological effect, estimated by the number of shocks, is vastly greater; and this difference, inherent, probably, in the peculiar character of the galvanic and induced currents, (§ 12,) explains the beneficial agency of electro-magnetism in those cases where nervous stimulation alone is required, and where free electricity, from the machine, is yet comparatively inefficient. The result of the battery current, tested in the same way, is widely different. The current from a Smee's battery of twelve pairs, passed through the body, deflected the galvanometer needle 48°, and this deflection was not momentary, the result of a single electrical wave, as in the case of the electro-magnetic apparatus, but permanent, the record of an almost infinite succession of similar waves. The current from a Smee's battery of twenty-four pairs, in like manner passed through the body, deflected the galvanometer 70°. The quantity of electricity, in these cases, is immensely dispropor-

tioned to the electro-magnetic shock; and yet, during the continuance of the current, no sensation, except one of warmth, could be perceived. At the commencement of the current, a slight shock was experienced.

29. The following practical directions may be found of use in case of derangement, or other cause of failure, in the electro-magnetic apparatus. It is necessary that the conducting wires should always be denuded of their cotton insulating covering where they screw into the cups or handles. They should also be screwed in tightly, so that there may be good metallic contact. Where they happen to cross one another, if the wires are *bare*, they must not be allowed to touch, as otherwise the current would flow across, instead of making the circuit of the instrument. If the electro-magnetic apparatus will not operate, see, first, if any spark is perceptible on rubbing the extremities of the wires from the battery together. If not, the battery is in fault. This may be owing to a sediment of copper at the bottom of the battery, making a connection between the zinc and copper, or to the zinc being somewhere in metallic contact with the copper; or it may be owing to the foulness of the zinc plate, or to the weakness of the copper solution, which, in that case, will have lost its color.

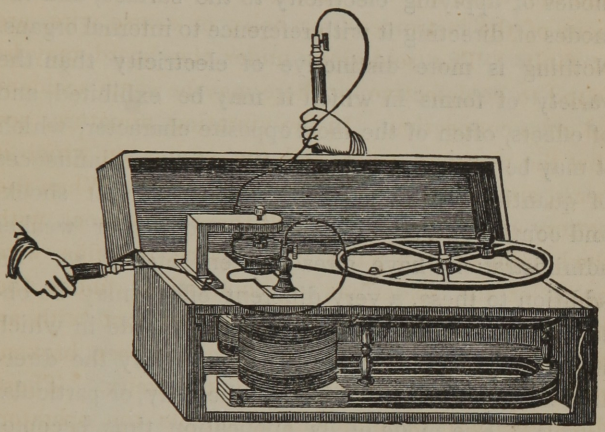
30. If the battery is in action, see next if there is any spark when the electro-magnetic instrument is included in the circuit of the battery. This is done, when one wire from the battery is in its place, by

drawing the other over the break-piece, as in Fig. 2, or over its own screw-cup, making and breaking contact. It may also be observed, if the bundle of iron wires is magnetized, while the battery is connected with the instrument. If there is no spark, and the wires are not magnetized, then the connections of the instrument, or helix of coarse wire, are at fault. The solderings under the board may be found to be defective, or there may be some accidental cross connection. In the vibrating armature, see that the platinum point, and the spring on which it bears, are bright at the place of contact. When the battery current passes, but still there is no shock with the bundle of iron wires in its place, the fine wire helix, or the solderings or connections under the board, are at fault. If the helix has met with an accident, observe if the fine wire has been broken, on any part of the surface of the helix. These directions will be sufficient to enable the operator, especially when at a distance from the constructor of the apparatus, to obviate any slight difficulties which may occur, without further trouble.

31. Another form of instrument, sometimes used for medical application, is the magneto-electric machine, (Fig. 5.) In this, the source of power is a permanent steel magnet. The current is obtained by revolving a pair of armatures, surrounded by a helix of wire, between the poles of the U-magnets, seen in the figure. This is accomplished by means of the multiplying wheel. Shocks are experienced whenever the induced current is broken by a little

apparatus on the axis. The strength of shock depends on the power of the magnet, and the rapidity of the mechanical motion. Consequently, by neutralizing the magnets, by placing small detached

Fig. 5.



armatures over their extremities, or by turning the handle slowly, the current is proportionally diminished.

32. The quantity of the electricity from this apparatus is rather greater than that from the electro-magnetic apparatus. It is also always ready for use, and requires no battery or solutions. On the other hand, it is less easily modulated ; it is more expensive, and less portable, from its weight and size. It will be found, in the following pages, to be sometimes employed by the most skilful European practitioners.

III. — MODES OF APPLICATION.

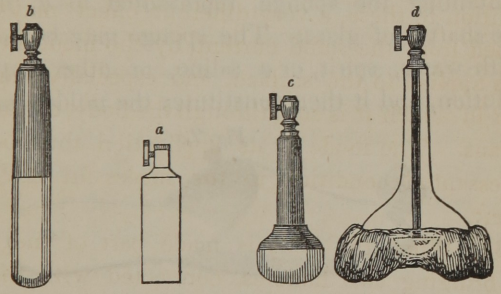
33. This subject naturally divides itself into the modes of applying electricity to the surface, and the modes of directing it with reference to internal organs. Nothing is more distinctive of electricity than the variety of forms in which it may be exhibited, and of effects, often of the most opposite character, which it may be made to produce. The different influences of quantity and intensity, of the intermittent shock, and continued current, and of a stronger or weaker administration, have already been referred to. In addition to these, a very different effect may be obtained from the same current, by the mode in which it is applied to the surface, and especially the direction in which it is sent through the body, or particular organs. The mode of its application thus becomes an essential condition to the successful use of the agent.

34. When the body is made part of the circuit, by bringing two handles, connected with the poles of the electric apparatus, in contact with the skin, the current always flows, by the shortest route, between its point of entrance and departure. It is not, however, confined to a single line, but is diffused so as to embrace the organs immediately around the axis of transmission. By regarding, therefore, the course of the nerves, and the anatomical position of the organs, the current may easily be directed so as

to include them in its circuit, and to subject them to the influences attending its passage.

35. The handles, or conductors used as the medium of communication, are so constructed as to bring a considerable metallic, or other conducting surface, in contact with the skin. This is rendered necessary by the poor conducting power of the latter, especially in a dry condition. The skin is sometimes, also, artificially moistened, to increase its conduction, and also to diffuse the electricity, which would be painful if concentrated on a single point of the surface. Several forms of handles used for different purposes, are represented in Fig. 6. The simple

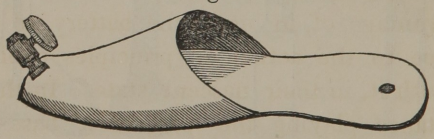
Fig. 6.



cylindrical handle, of German silver, is shown at *a*. When it is desired to produce the most general effect upon the system, the cylinder handles may be grasped by the patient, the current then traversing the arms and chest, from side to side, stimulating the organs of respiration, and, to a greater or less extent, the nerves supplying the principal vital organs. Another form is represented in *b*, where the upper

part of the cylinder consists of rosewood, which insulates the metallic portion from the hand of the operator, who may wish to direct it. It may be grasped in the hands, or its rounded metallic extremity may be placed in contact with any portion of the body of the patient, the skin being previously moistened, or, what is preferable, a moistened cloth being interposed. A form of handle exclusively for surface application, is seen at *c*, in which the shaft is of rosewood, insulating it from the hands of the operator, and the extremity, a plated, hemispherical disc, which may be applied either to the moistened skin, or covered itself with moistened cloth or leather. Another handle, for surface application, is that containing the sponge, represented in *d*, in which the shaft is of glass. The sponge may be moistened with water, spirit, or a saline, or other appropriate solution, and it then constitutes the mildest and most

Fig. 7.



grateful form of application. The slipper, with a metallic sole, is represented in Fig. 7. In this case, the sole of the stocking may be moistened with spirit, or cologne, and thus complete conduction, without withdrawing it from the foot. Where two slippers are used, the current passes up one limb and down the other. Where a cylinder handle and slipper are used, on the same side of the body, the

current passes up or down that side. Handles, or conductors, of a peculiar shape, may sometimes be required, as for the ear or vagina, which will be described in their connection hereafter.

36. In using the sponge handle, spirit or cologne will generally be preferred to water, for moistening the surface, as counteracting, by their stimulus, any exposure to cold. The solutions may sometimes be made to answer an independent purpose, such being employed in sponging a part as will have a positively beneficial action. Thus, in cutaneous diseases, the skin may be sponged with a solution of acetate of ammonia (spirit of Mindererus), or other cooling salt. So, also, in producing reaction of the skin, or excitement of the capillary circulation, water or spirit of ammonia may be used. Metallic salts, which would be decomposed by the current, should be generally avoided, though the decomposition of powerful chemical agents may, at other times, be taken advantage of, in using the battery, to subject the surface to the action of principles evolved in contact with it, in their nascent state. In this case, the substance playing the part of a base in the combination is evolved at the surface under the positive pole, and that playing the part of an acid, at the surface under the negative pole. An illustration of this will be found, in the present section, in the insensible moxa of Dr. Golding Bird. When the object of application is the skin, the handles are usually kept in motion, to distribute the influence. This mode of application, — that of changing the

position of the handles and the direction of the current — is also frequently employed in acting upon internal organs, or in stimulating associated nerves.

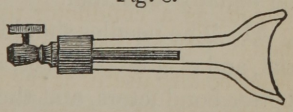
37. A mode of application used by Wilson Philip, and particularly adapted to the battery, is, to place two thin plates of metal, two or three inches in diameter, upon the surface of the body, where it is desired to make electrical communication. The wires of the battery are brought in contact with these plates, and constantly moved over them, especially the negative wire, to avoid injury to the cuticle beneath. The plates are previously dipped in water, or solution of common salt, as should generally be done, in using the battery, to aid the diffusion of the electricity. Some irritation of the skin is, at any rate, produced, especially if the wires are kept stationary.

38. Application by the hand of the operator is frequently an advantageous one, admitting all the precision of touch. In this case, the operator, holding one handle, himself becomes the medium of electrical communication, and uses the hand which is disengaged, as a conductor to the surface of the patient's body. The other handle is held by the patient. This is especially useful as regards the face and extremities. In the case of a sprain, in its latter stages, the fingers of the operator may thus be employed, to exercise, or cause to contract, successively, the different muscles connected with the injured articulation.

39. The general or local bath is one of the most useful and elegant modes of application. In this

case, the water being wholly, or in part, the conductor to the surface, the electrical influence is diffused, so as to constitute a most equable and mild form of administration. Where the water is to be made wholly the conductor, the two handles are immersed, so as to include the limb or body of the patient in the straight line between them. A large portion of the current then passes through the intervening member, from the fact that the body is a better conductor for electricity than the surrounding water. Where the current is only partially to be conducted by the water, the patient may hold one of the handles, and the other may be placed in the bath. In this case, those parts in the bath nearest to the handle receive the greatest amount of electricity. Examples of the local bath may be found in the foot bath, for ulcerations of the foot; the hip bath, for diseases of menstruation; and a very delicate application in the eye-glass, for amaurosis, and other diseases of that organ. The electrical eye-glass, or bath, is represented in Fig. 8. I have caused this instrument to be constructed, as a means of distributing the electrical current, in its application to the eye, in which case, a very powerful administration may be resorted to without injury. The bowl and shaft are of glass. A screw-cup is adapted below, for connection with the conducting wire. Rose-water, or other appropriate solution, may be employed, and either the electro-magnetic or battery current may be used.

Fig. 8.



40. Electro-Puncture — Galvano-Puncture. — The surgical application of electro or galvano-puncture is accredited to M. Berlioz, in 1816, but was introduced, only some years later, in the Hospital de la Pitié. It is now very extensively used on the continent. "This mode of applying electricity," says Becquerel, "is the most efficacious of all those that have been employed, since it permits us to act directly on the diseased part."* In this case, one or both of the conductors consist of gold, silver, or platinum acu-puncture needles (never of steel), which are thrust under the skin, or into deep-seated parts, and made the medium of the galvanic discharge. The primary current of the battery is here indicated, as the shocks of the electro-magnetic apparatus would be in most cases intolerable, except under the influence of ether. In aneurism, where coagulation of the blood is to be effected by this means, the quantity current of the battery is essential. The severity of this application will prevent its use, except for local influence, where a current of electricity, passed through the same parts from the surface, would not be equally effectual.

41. The needles should be of an unoxidizable material, and of gold or silver, in preference to platinum, as better conductors, and therefore less liable to be heated during the transmission of the current. Attempts have been made to varnish the needles, excepting at the extremity, to prevent the destruction of the flesh

* Braithewaite's Retrospect, Part XV.

in contact with them. This, if it could be effected by japanning, or any other process, would be desirable. The negative needle is the one which exercises the greatest local influence. Magendie directs that the insertion of the needles should be accomplished by a sudden plunge, rather than by drilling. Care must be taken that they do not touch each other, while conducting the current, as they would become ignited, and destroy the surrounding tissue. These needles should be ordered by the surgeon, of the proper length and fineness, and may then be mounted with a slender wooden insulating handle, having a delicate screw-cup, or sliding vice, on the end, for the battery wires; or they may be made with eyes, into which the wires can be threaded. The current from the battery may be modulated, to avoid too powerful action, by using a very dilute solution, or only partially filling the cups.

42. Dr. Shuster, in a paper read, on this subject, before the French Academy, in January, 1843,* takes the ground that electricity is only useful as a therapeutic agent, when introduced into the substance of the affected organs, by means of electro-puncture, and that it then constitutes one of the most powerful and inoffensive medicinal agents we possess. He says, "Electro-puncture, applied to the treatment of diseases, acts in several ways, viz.: First, as a direct stimulant of sensible contractility and absorption. Second, by causing small eschars, thus, as it were,

* Rev. Med. January, 1843. — Lond. and Ed. Monthly Jour. of Med. Science. June, 1844. — Braithewaite, Part X.

cauterizing, and destroying in detail, a portion of the tumor. Third, by decomposing the aqueous portion of tumors. Fourth, by forming, at the will of the operator, minute openings for the exit of the fluid part of the tumors. Fifth, by producing in the wall of the cyst, or other cavity, such a degree of inflammation as will cause obliteration by adhesion, without giving rise to any inconvenience, if the patient be kept under strict surveillance. Sixth, by coagulating the blood, and causing effusion of little masses of plastic lymph into the cellular tissue. Electro-puncture, properly applied, is, in the majority of cases, attended with slight pain only, is free from inconvenience and danger to the patient, and frequently accomplishes a cure, when all other means have failed."

43. Galvanic Moxa. — Another surgical application, possessed of very peculiar properties, the instantaneous or deep moxa, was apparently first brought forward by M. Fabré Palaprat, at a sitting of the French Academy, in February, 1831. It consists in galvano-puncture, with fine platinum needles, connected with a battery of large plates. The circuit is completed by thrusting the needles into the flesh, when they immediately become incandescent, causing a pipe of destroyed tissue to separate and fall out in a few days. The lesion here is strictly local, and instantaneously produced, a powerful stimulus being given at the same time to surrounding parts. It has been used in arthritic inflammations and tumors, and has been proposed as a means of destroying diseased tissues.

A battery of some intensity would be required to ignite the platinum needles, if merely thrust into the flesh, without being brought into contact with each other. If, however, the needles are made to touch each other, they can be readily brought to incandescence by a battery of two or three pairs of large size. In the case of tumors which can be readily transfixed by a single needle, this may be readily ignited by being made the medium of a galvanic discharge, the poles of the battery being made to touch its two extremities.

44. Insensible Moxa. — A simple form of galvanic apparatus has been lately recommended by Dr. Golding Bird,* as the means of producing an insensible moxa. The same fact has also been observed by Humboldt.† Dr. Bird produces two blisters, the size of a shilling, on the surface. He covers one with zinc foil, the other with a silver plate, and connects these with a wire. The whole is then covered with a water dressing and oiled silk. The surface under the zinc plate becomes white, and in forty-eight hours a decided eschar will appear, which will begin to separate at the edges in four or five days. The plates being then removed, the surface under the silver will be found healed. A common poultice applied to the part will leave a healthy, granulating sore, freely discharging pus. If any pain is felt during the process, it will be referred to the silver plate. Dr. Bird knows of no other way by which an equally effective dis-

* Lond. Med. Gaz. June, 1847.

† Lond. Med. Gaz. May, 1847.

charge can be obtained, except by the moxa, or actual cautery. The effect is ascribed by him, whether correctly or not, to the corrosive action of chloride of zinc, in its nascent state, while forming under the influence of galvano-decomposition. When the surfaces are not blistered, the zinc and silver plates form a galvanic arrangement, which depends for its activity upon the moisture of the skin. This use of the insensible current, from a single galvanic pair, may be considered the prototype of a recent form of quackery, the "galvanic belts," which are so constructed, however, as to fail in the production even of an insensible current.

45. Electricity with Etherization. — The use of etherization, in connection with galvanic application, has not yet received attention. The most obvious action of electricity, during etherization, is to rouse the nerves from insensibility. From experiments with a rabbit, however, I am satisfied that electro-puncture may be resorted to when the current does not traverse any important nerve, without terminating the state of general unconsciousness. Whether the nerves of the part may not, in this case, be quickened, so as to communicate impressions of pain, which there may be no power of expressing, cannot, perhaps, well be determined, without repeating the experiment on a human subject. In the galvanic moxa, where the current is merely made to traverse a conductor passing through the flesh, there can be no interference with the condition of insensibility. Whether electricity would be applicable to

the excitement of uterine contraction, during the administration of ether, remains a subject for experiment.

46. It has been stated, (§ 10,) that the positive electrical current, flowing in the direction of the ramifications of the nerves, produces stronger muscular contractions, than when flowing in the opposite direction. For instance, if the cylinder handles be held one in each hand, the sensation will usually be much stronger in one wrist than the other, owing to the spasmodic contraction of the muscles of that arm. This is the arm by which the current leaves the system, and this indication constitutes the best method in the case of the electro-magnetic apparatus, by which the practitioner can ascertain the direction of the current, — an object, sometimes, as will be seen, of considerable importance. The handle, then, held in connection with the wrist in which there is *least sensation*, is the *positive* handle, at which the electricity enters; the handle held in connection with the wrist in which there is *most sensation*, is the *negative* handle, by which the electricity leaves the system.

47. Becquerel, in speaking of the battery, observes that, when currents of no great intensity travel in the direction of the nervous ramifications, muscular contraction ensues; when in the opposite direction, pain. The generalization from this is very simple. In the first case, the function of the nerves of motion is excited; in the second, of sensation; each being stimulated when the direction of the galvanic cur-

rent coincides with that of their own proper impulses. Marianini's experiment with the frog has already been referred to (§ 10). Matteucci and Lauget have shown that nerves of sensation and motion may be conveniently distinguished by the different reaction which electricity, made to traverse them, exerts upon the connected muscles. Dr. Golding Bird remarks, in his recent lectures on physiological electricity,* "It seems quite certain that, *cæteris paribus*, nerves only convey the influence of a current in a given and definite direction." This fact, of the propagation of electrical influence by a nerve, in accordance with its function, whether of motion or of sensation, will constantly appear in the cases which are given hereafter, and is an important consideration in directing a current for the purpose of reaction, with a particular class of nerves, or with particular parts of individual nerves, as the nerve centres or extremities.

48. Becquerel has also remarked that, to rouse or stimulate an organ, the current should be sent in the opposite direction to the ramifications of the nerves. This may, probably, be referred to the influence exerted on the nerve centres of the organic nerves, towards which the impulse of the current is, in that case, directed, and from which a vital reaction to the organ ensues. To produce the temporary stimulation of a function, the current should coincide with that of the nervous current of the organ. It would appear that a different direction of current should be em-

* Lond. Med. Gaz., May, 1847.

ployed to influence directly nerves of sensation and nerves of motion; but in mixed nerves, the reflex action of one series upon the other will frequently render the law of direction uniform, whichever function is to be excited. These considerations have an immediate application in paralysis. The sympathy here is so general that in many cases, which will hereafter be specified, it is not only allowable, but desirable to send the current in both directions. It is sometimes, however, an object to act only upon the muscles; at others, to act upon the nerve conductors; and at others, to act upon the spinal cord, or to direct action principally to the brain. Where a special function, such as the peristaltic action of the intestines, is to be excited, it will be found desirable to send the current in the direction from the nerve centres toward the nerve extremities. So, to stimulate the capillary circulation, by coöperating with the organic nerves, the current should be sent in a direction coincident with the nervous. It will be observed that the reaction of the electrical current with the nervous current, dependent on their reciprocal directions, is a physical reaction, as distinct as that of the electric current with the magnetic needle, where the position of the latter is always in strict relation to the direction of the former.

49. Another mode of action, less dependent on the nervous system, is the direct application of electricity to the organs. It has been stated that muscular contraction could be produced by the immediate stimulus of electricity upon muscular tissue,

and also that vital changes in the tissues, could be effected by the immediate influence of a quantity current. In this mode of administration, electricity may be sent through an organ in different directions, either without reference to the nerves, or coöperating with them to a greater or less extent.

50. The effect of currents of different descriptions has been alluded to. The current from the battery will be found necessary to produce immediate, vital or organic changes in the tissues; and its power, in this respect, leads to a necessary caution. The influence of a quantity current is to produce increased action in a part, and this without the intermediate influence of the nervous system. Consequently, Wilson Philip states that he has known inflammation of the lungs produced in an animal by continuing the passage of a powerful current beyond a moderate length of time. Hence the battery current cannot be properly applied to many cases of inflammation in which, on the other hand, electro-magnetism, which acts as a simple stimulant and alterative, may be employed with benefit. To effect nervous stimulation, the electro-magnetic current is generally sufficient; but to effect any organic change in the nervous tissue, as well as in other organs, the battery must be resorted to. The different kinds of shock of induced electricity will be found all to have their application. Thus the separate shocks, whose influence is to arouse the system, would be used in suspended animation, — the rapid succession of shocks, producing tonic muscular contractions, in some conditions of the uterus during parturition.

51. The strength of the shock to be administered, or the amount of the continuous current, must depend upon the temperament of the patient, upon the seat of the disease, and the object to be accomplished. Different parts of the body differ exceedingly in their sensibility to electricity. The hands and the face are very sensitive, while the back part of the neck, which, as a great nervous centre, is frequently used as the entering point for the current, has hardly any sensibility. Individual sensibility also differs exceedingly, both in healthy and diseased conditions. The first rule to be adopted, is to begin gradually, and continue the application but a short time. Five minutes may be sufficient for a first application, to be increased in a week to twenty or thirty minutes. Electricity may also at first be applied, once a day, or every other day, and subsequently, perhaps, more frequently. In paralysis, where sensation is deficient, no such caution would generally be necessary, and the highest powers of the apparatus might be early called into use. Another rule should be, to graduate the shock to the sensations of the patient, letting the application be agreeable wherever it is possible. Over-stimulation by electricity, as by any other agency, produces subsequent exhaustion, and this must, therefore, be carefully avoided. One case of extreme nervous sensibility has come under my notice, in which it seemed impossible to graduate the electric power sufficiently low to avoid reaction. In this case, the previous exhaustion of nervous energy was so complete as to afford no basis for stimulation.

The application of a feeble primary current from the battery might have given a better result. Another rule is, to use patience in continuing the application. The restoration of vital power is frequently a slow process, and though the results are sometimes sudden and unexpected, yet the practitioner must be encouraged if he finds steady, though not rapid progress. Finally, in diseases such as paralysis, in which electricity is known to be beneficial, no case should be abandoned on the failure of electro-magnetism, without resorting to the battery. In the Dublin Quarterly Journal of Medical Science, for February, 1847, a case is quoted by Dr. Donovan, in which paralysis of four years' standing was relieved by the use of a powerful battery, while a lesser degree of strength produced no effect.

IV. — GENERAL APPLICATION TO DISEASE.

52. Electrical Diagnosis. — Attempts have been made to employ the sensations produced by electricity, in traversing diseased parts, as a means of diagnosis. Although nothing reliable has been accomplished in this direction, the subject yet deserves notice in a treatise like the present, which seeks to embrace all applications which hold out any promise of usefulness. The fact is well known, that tissues and nerves which are inflamed, or otherwise diseased, are often more sensitive to the passage of electricity than those in a healthy state. Some discrimination

may also probably be made as to the character of sensation in different conditions of disease. This has suggested the idea of determining the position and nature of internal lesions, by the electrical current. Diseases of the spine and of the lungs are examples of cases in which this experiment has been tried. The idea of thus probing deep-seated organs is one of interest, and calculated to awaken inquiry. In some cases, the rapid administration of electro-magnetism would be available for this purpose but for nice distinctions, the continued current of the battery would obviously be preferable.

53. Vitalizing Power.—One of the most common objects of electrical application is, to coöperate with vitality. This may indeed be considered the central principle in the medical use of electricity. In the nervous system, it is illustrated in cases of exhaustion, prostration, enervation, and paralysis; in the tissues, in gangrene, erysipelas, indolent sores, and deficient nutrition. It will be found, indeed, to enter, more or less directly, into every case of electrical application. The idea will be frequently suggested to the practitioner, by his own observation, that the agent electricity works in the direction of health, even in the most opposite affections. This is explained simply by the fact, that its operation is to quicken the vital powers and natural functions of the part to which it is applied. Diseased action, when local, is perhaps especially controlled by the supply of nervous power, previously deficient, which is brought into action, connecting and harmonizing functions.

54. Reactive Power. — Electricity constitutes the most powerful means of effecting vital reaction, in the hands of the medical practitioner. According to Matteucci, the nervous system responds to electricity after all other stimulants have ceased to act. Thus it has a very important application in suspended animation, narcotism, and stupor. Another equally important application, which has only begun to receive attention, is that to collapse and the sinking stages of disease.

55. Alterative Action. — An influence frequently exerted by electricity is to change the action of an organ, or the general tone of the system, thereby interrupting a diseased condition. The application of electricity by the sponge handle, in cutaneous diseases, is perhaps founded on this principle, causing the skin to take on a new action. So also in some nervous affections, and perhaps in applications to the brain. As a simple alterative, electro-magnetism is most generally applied.

56. Sedative Action. — The continuous current of the battery exerts often a tranquillizing influence, harmonizing irregular action of the nervous system, at the same time that it adds to its power. Thus convulsions are quieted by the steady current, though increased by the intermittent or electro-magnetic shock.

57. Promotion of Nutrition. — In deficient nutrition, electricity may coöperate in the vital transformation and organization of the nutritive matter, by means of the nervous system, or by direct action

on the tissues of a part. To produce increased action in the latter case, the battery must be used. This will be done whenever a part needs to be nourished, or the waste of any organ to be replaced. As a general rule, the battery current should be feeble, and the application long continued and frequent.

58. Promotion of Secretion. — Wilson Philip says, "I cannot help regarding it as almost ascertained, that in those diseases in which the derangement is in the nervous power alone, where the sensorial functions are entire, and the vessels healthy, and merely the power of secretion, which seems immediately to depend on the nervous system, is at fault, galvanism will often prove a valuable means of relief." * The immediate influence of galvanism on the tissue of secreting organs will also appear hereafter. The battery current is most efficient for this application, but nervous stimulation may be effected also by electro-magnetism. The current should be sent along the nerves supplying the organ in the direction from the nerve centre toward the nerve extremities, where it is desired to produce an immediate stimulation of the function, and in the opposite direction where it is desired to produce gradual and permanent stimulation. It may also be sent through and through the organ in different directions. The strength and stimulating character of the application will vary with the organ. In deficient secretion from the mucous membrane of the lungs, a gentle and diffused current will be indicated.

* Vital Functions, 2d ed. p. 331.

59. Promotion of Absorption. — In effusion of serum or lymph, in some forms of hypertrophy, in bony deposits, rheumatic enlargements, and every undue organic development, with the exception, perhaps, of some malignant growths, the power of the absorbents needs to be quickened, and this may often be effected by electrical action. In this case, the application is usually made directly to the organ, though the rule still prevails, in acting through the nervous system, that the vital stimulus, artificially supplied, directs itself to, or is principally perceived in, that function whose efficiency is suspended. In other words, the tendency of the nervous influence seems to be, to harmonize the various vital functions, disproportionate action appearing thus to proceed from causes acting originally on the life of the tissues. In serous effusion, accompanied with inflammation, the battery cannot be used, but a cautious and gentle application of the electro-magnetic current may be effectual. In other cases of effusion, the battery will be most efficient.

60. Capillary Circulation. — The increase of the capillary circulation, under the influence of the current, has been referred to. This takes place in a very striking manner, when the sponge handles are used in connection with the battery. The skin, in a short time after the application, becomes warm and red, especially under the negative handle, where the current passes out in the direction of the nervous organic current. The excitement of the functions of the skin may be spoken of in this connection.

It wi.l be seen hereafter, that perspiration frequently breaks out, and warmth is established in a part subjected to the influence of the battery. This takes place also, though not so efficiently, under the use of electro-magnetism. The arterial action is probably increased by all modes of application, and is especially quickened in the smaller vessels, as may be presumed, by the convulsion of the shock.

61. Digestion and Menstruation. — The functions of digestion and menstruation are peculiarly under the influence of galvanism. They will be treated of in connection with their diseases. The application, in the case of the diseases of women, is so simple that it can generally be made by the patient without assistance. Otherwise, as a general rule, it may be committed to a female attendant.

62. Use in Inflammation. — The tendency of the battery current is to produce increased organic action; the tendency of a feeble electro-magnetic current is hardly more than an alterative stimulant. Still the application of electricity is contra-indicated by active and progressive inflammation, except in a few rare cases. Dr. Wilson Philip states, as a result of microscopic observation,* that the condition of the capillaries in inflammation is one of distention and debility, while the arterial action is increased. Stimulation of the capillaries, therefore, in such cases, may relieve inflammation, especially when of a passive character. This power of stimulating the capil-

* Vital Functions, 2d ed. p. 279.

laries on the surface of the body is peculiarly within the province of electricity. In an advanced stage of inflammation, when the capillaries are so burdened as to stop the circulation, an increase of vital power, determined by electricity, may be of important service. So, also, electricity may be summoned to terminate a condition of things consequent upon inflammation, which is only continued from want of reactive power.

63. Use in Congestion. — The application of electricity to an organ in the early stages of congestion would be inadmissible. In the later stages, it may prove beneficial, aiding the vital powers in the resumption of the natural function of the organ. The electro-magnetic current alone is indicated here, and great caution, as in the case of inflammation, would be required.

64. Counter Irritation, Revulsion. — An organ which is inflamed or congested may sometimes be relieved by stimulating another organ connected with it by position or nervous association. It frequently happens in the inflammation of one organ, that neighboring organs are torpid. A double relief can therefore be obtained, where it is possible to stimulate the latter without acting upon the former. Electricity, in most of its surface applications, is easily capable of being converted into a rubefacient or irritant, with the advantage of stimulating into activity all the functions of the skin. It can also be directed so as to excite specific internal organs. For irritating the skin, the sponge or metallic han-

dles may be used with the battery, being kept near each other, and moved over the surface; or the metallic plates of Wilson Philip (§ 37) may be employed. With electro-magnetism, a metallic handle, more or less dry, and presenting a comparatively small surface to the skin, may be used. Sparks may also be drawn from the patient, on the insulating stool. It has been stated that suppressed eruptions have been brought out by this mode of revulsion.

65. Organic Contraction. — An influence of electricity, capable of important applications, is the restoration of organic contractility or tension in relaxed tissues. This applies not only to muscular tissue, but especially to the ligamentous system, including fibrous and capsular ligaments. Examples of this will be given hereafter.

66. Muscular Exercise. — Much advantage, at times, is derived from the effect of muscular contraction induced by electricity, in moving organs upon one another, and very probably in old inflammations, such as sprains, in breaking up adhesions. Single muscles on the surface of the body can be made to contract independently of those surrounding them, and the fullest play of the parts is thus secured. In the application of an interrupted current to the abdomen, the parietes are contracted in a variety of directions, as well as the muscular fibres of all the included organs, thus producing a thorough movement, which, in some forms of dyspepsia, is perhaps one of the most favorable influences. In

paralysis, the exercise given to the muscles is of great importance in preserving the contractility of the tissue, and in preventing the loss of organization and waste of substance. Electro-magnetism is most applicable for this purpose.

V.—SPECIAL APPLICATION TO DISEASE.

67. In the present section, the principles already laid down will be applied to the treatment of disease. Upon the correct understanding of the general laws which govern application, and upon the skill and resource of the practitioner, the successful use of electricity, as a remedial agent, must very much depend. A writer in the *Revue Medico-Chirurgicale* speaks of electricity as a principle whose direction and activity are wholly at the control of the operator, and which can be graduated in a hundred ways. This fertility of application, and the constant correspondence of electricity to vital states, must be considered as the groundwork of its medical use. It will be frequently seen, even in successful cases, quoted hereafter, that the nature of the agent and the laws of application have been imperfectly understood; and many of the failures which have occurred must be ascribed to this source.

68. No claim will be made for electricity as an exclusive medical agent. It is not to supersede, but to coöperate with other treatment. It is to be

introduced into practice with discretion, and to be expected to fail under the same conditions with other remedies, either from its own inapplicability, or the want of knowledge and adaptation in the operator.

69. The outline of a large number of cases will be given in connection with the various diseases to which electricity has been applied. Although the objection has been felt of omitting many of the useful details of cases, which could not be included within our limits, it has been still considered advisable to present such sketches as could be recognized, and which could, where desirable, be sought out by the practitioner for himself. It may here be repeated, that many of the applications presented are to be considered experimental, rather than as confirmed modes of practice. These will be readily distinguished.

70. As the direction of the current is one of the important considerations, it will be remembered that, with the battery, the pole or handle connected with the platinum plate is the positive pole, or the entering pole, of the current, as regards the body of the patient, and the handle connected with the zinc plate, the negative pole. With the electro-magnetic apparatus, the positive pole is that which produces least sensation when applied to an equally sensitive part of the body with the negative. The handles may be conveniently distinguished by holding them in different hands, when the most pain and contraction will be felt in the wrist of the hand grasping the negative handle.

71. No attempt has been made, in this section, to group the diseases in a natural order. They are simply arranged according to the direction and character of the treatment. An index will be furnished at the end, by which reference can readily be made to any special subject. The word "electro-magnetism," frequently used, will be understood as equivalent to the expression "electricity from the electro-magnetic apparatus."

NERVOUS SYSTEM.

72. Paralysis. — The application of electricity to paralysis, which was one of the earliest, is also one of the most important. Its remarkable efficiency in this disease has been limited by a want of discrimination and resource, which we can as yet only imperfectly supply. Dr. Golding Bird has recently mentioned the following forms of paralysis as those in which he has used electro-magnetism with decided success:* 1. Partial paralysis from organic congestion or effusion, which has been removed. 2. Paralysis of the portio dura of the seventh pair, from exposure to cold. 3. Paralysis of a limb from the same cause. 4. Paralysis of one side of the body, or a single limb, from exhaustion, as from lactation, flooding, &c. 5. Rheumatic paraplegia. 6. Paraplegia from enervation, as in the case of the seamstresses of London. Dr. Bird remarks, that electricity, though not universally successful, is the

* London Lancet. June, 1846.

actual curative agent in some of these forms, that in all it expedites the cure, and in none is it injurious. *Cæteris paribus*, he finds it most successful in proportion to the acuteness of the case. In chronic cases, the new muscular tissue deposited does not stand in active relation to the nervous system, and time is required to establish its function. Other forms of paralysis, besides those specified, as that from lead colic, will be found to have yielded to electricity, in the cases hereafter quoted by Dr. Bird.

73. All practitioners have borne testimony to the uselessness of electricity during the existence of structural lesions, from which paralysis, in any case, proceeds. Dr. Bird cautions against its employment in recent or even persistent organic lesions,* stating that he has known fatal apoplexy to follow the use of electricity in cases of ramollissement of the brain, or where rigid arteries existed. Medical treatment, in such cases, should be directed to the original cause of the paralysis, and the effect may then often be rapidly dissipated by electricity.

74. Dr. Bird states that he has never seen electricity do any good in cases of rigid flexure of the thumb or fingers. Under other modes of electrical application, we find, however, that paralytic contraction has been successfully combated. This is illustrated in the following case, together with the necessity, in the last resort, to employ the higher powers of the galvanic battery. A young lady, under the care of

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* Lond. Med. Gaz. June, 1847.

Dr. Grapengiesser,* was attacked with apoplexy, succeeded by paralysis of the right side and loss of speech. Within four years, she recovered the use of her foot, and the power of utterance; but the arm remained contracted, and the fingers firmly closed. "Whenever galvanism was employed, this stiffness of the elbows and fingers disappeared in a moment, and she could with ease stretch the fingers and arm; but in order to produce this effect, *a battery of one hundred pairs was required.*" The application being continued for a short time, recovery, though not perfect, took place.

75. It must not be supposed, from this case, that an overpowering application of electricity is required, or allowable, in paralysis. The application should be made with care, in the first instance, to avoid exhaustion, and be increased, according to the sensibility of the patient and the demands of the case. Where the battery is used, the tendency is to increase the general action of the system, and depletion must sometimes be resorted to, in connection with it. Matteucci recommends commencing always with a feeble current, which should be frequently interrupted, and the administration not too much prolonged, the patient resting after twenty or thirty shocks. He approves the use of electro-magnetism, and regards the interrupted current of the battery as more efficient as a stimulant than the continued current.

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* Dub. Quart. J. of Med. Sc. Feb. 1847.—Braithewaite, Part XV

76. Matteucci has shown, as the result of experiment,* that the electric current, passed through a nerve in the direction of its ramifications, rapidly exhausts its excitability, whilst the inverse current increases it. An exhaustion of contractile power, amounting to temporary paralysis, may be occasioned in the frog, by the persistent use of the direct current of the battery. Regarding some cases of paralysis as a similar exhaustion of nervous power, the employment of the inverse current is therefore indicated. This is fully borne out by experience. The direction of the current in different conditions of paralysis, as in nerves of motion or sensation, or in the origin, course, or expansion of the same nerve, still, however, requires much additional investigation.

77. It has been stated, inferentially, that a nerve propagates the influence of an electric current only in the direction of its own nervous current (§ 47). Hence the impression of an electric current, sent in the direction of the brain, or the nerve centre of any nerve, is transmitted by the nerves of sensation, while the influence of an electric current, sent toward the extremities or surface of the body, is transmitted by the nerves of motion, or corresponding organic nerves. Nevertheless, the nerves of motion are, as a general rule, more permanently stimulated in their functions by sending a current in the inverse direction toward the nerve centre. This is apparently an excito-motory influence through the stimulus propa-

* Medico-Chirurg. Rev. April, 1845. — London Lancet. Aug. 1847.

gated to the nerve centre, and thence reacting on the associated nerves of motion. It would, therefore, in cases of organic lesion, inflammation, or irritation of the nerve centres, be especially improper to send the current in their direction. On the other hand, in passive conditions of the nerve centres, after lesions already cured, the electric current should be directed toward them, through the paralyzed parts. A current passed, for a short distance, through a nerve, is sufficient to propagate its impression through the whole extent of the nerve. Thus, in the little finger, if a shock be passed through a single joint, it is felt to the shoulder, and occasions contraction through the whole arm.

78. Dr. Dewees, in the New York Journal of Medicine,* states, as the result of his experience, that in paralysis resulting from the lesion of organic nerves, or when nutrition is deficient, the current of the battery, which he prefers, in all cases, should be sent in the direction opposite to the ramification of the nerves, but that, in "muscular paralysis," it should be sent in the same direction with the ramifications of the nerves. He recommends the continued battery current, where it is desirable to exercise an organizing power over the muscles, and a resort to the interrupted current, when stimulation and exercise of the nerve and muscle are desired.

79. Dr. J. Reid has recently made experiments† to show the effect of muscular exercise in preserving

* N. Y. Jour. of Med. May, 1847.

† Ed. Month. Jour. of Med. Sc. May, 1841.

the nutrition and excitability of a paralyzed limb. The spinal nerves of a frog were cut across so as to paralyze the posterior extremities. The muscles of one of these were daily exercised by a weak battery, while those of the other remained quiescent. The exercised limb, at the end of two months, remained of its original size and firmness, contracting vigorously, while the other limb had shrunk to one half of its previous size, still preserving, however, some contractility. Dr. Bird remarks, "From want of exercise, the muscles of the affected limb become atrophied." Before this takes place, "the power of electricity is very remarkable, frequently restoring power to the paralyzed muscles in a very short time."* Not less efficient, however, is electricity, as we have seen above, in giving the required exercise, and preserving the organization of the paralyzed muscle. For this purpose, the electro-magnetic shocks are best adapted. The hand of the operator may be used as one conductor (§ 38), and the contraction of each individual muscle will follow the touch of the finger to the surface of the affected limb.

80. Dr. Marshall Hall has stated that the electric excitability of muscles in paralysis from cerebral lesions is increased, but that in paralysis from spinal lesions it is diminished. This has been recently denied by Dr. Todd, in a paper in the Medico-Chirurgical Transactions of 1847, who, from a large number of observations, arrives at the following

* Guy's Hospital Reports. 1841.

conclusions: 1. The irritability of paralyzed muscles is in direct relation to their state of nutrition. 2. It varies with the condition of their nerves more than with that of the muscles themselves. 3. In a majority of cases of cerebral palsy, the contractility of the paralyzed muscles is less than that of the muscles of the sound side, on account of diminished nutrition. 4. No diagnostic mark to distinguish cerebral from spinal paralysis can be based on any difference in the irritability of the muscles. 5. The irritability of paralyzed muscles, under the influence of galvanism, is an index to the state of their nerves.

81. Mr. John Grantham, in a work recently published in England,* gives the following, among other conclusions: The galvanic influence will be most active in the paralyzed limb, when passed along the spine. It restores diminished temperature, decreased circulation, and lost muscular action, in the order in which they are here written. It has no effect in disease that alters the structure of nerves. It is assisted by immersion of the affected limb in a warm bath, into which one of the poles is plunged. It is injurious when much pain is caused in the muscles by its application. It may be carried to an undue extent, so as to produce congestion of the brain.

82. In the valuable report on the use of electricity in Guy's Hospital,† Dr. Golding Bird cites a large number of cases of paralysis treated by this agent. In these, machine electricity, in the form of the spark

* Medico-Chirurg. Rev. Jan. 1845.

† Guy's Hospital Reports. April, 1841.

and shock (§ 13), was for the most part employed. Dr. Bird, however, in his concluding remarks, gives the decided preference, in paralysis, especially in chronic cases, to electro-magnetism. The interesting results, from the use of the spark, still deserve attention. Dr. Bird makes the general remark, that in paralysis from rheumatism or cold, from functional affections, or the effect of lesions previously cured, he has found the application of electricity most successful; but that he has found it of no effect in cases of persistent structural lesions. Many cases in which electricity had been found useless, were submitted to post mortem examination, and, in all, permanent causes of paralysis were discovered.

83. *Dropped Hands.* — Eleven cases are given, by Dr. Bird, of dropped hands, mostly connected with *colica pictonum*, in which five were cured, three were relieved, one improved, and two received no benefit. Sparks were generally drawn from the upper part of the spine, while the patient was seated on the insulating stool, in order to influence the axillary plexus. Medical treatment was also directed to associated complaints of the patients. The details of four of these may be summed up as follows: —

I. A compositor, aged 19. Paralysis of extensors of both hands, with amaurosis, preceded by an attack of lead colic. After four months of interrupted treatment, the paralysis was cured, but the amaurosis remained, though the pupils, previously nearly insensible, contracted and dilated readily.

II. A cooper, aged 29, with recent and complete

paralysis of extensors. Weak shocks, from the spine down the arm. Within a month, able to resume his work.

III. A painter, aged 27. Complete paralysis of extensors. In fifteen days discharged, well.

IV. A plumber, aged 36, with total paralysis of the extensors, of a year's standing. Shocks down the arms on alternate days. No improvement after twenty days. Sparks ordered to be drawn from the spine. In sixteen days, great improvement, and soon able to resume work.

Dr. Bird states that in *chronic* cases of this form of paralysis, sparks from the spine are very often effectual, when shocks to the arms are of no avail.

84. *Rheumatic Paralysis.* — In paralysis from rheumatism or exposure to cold, Dr. Bird speaks of the remarkable influence of electricity, before wasting of the muscles has taken place. In ten cases given by him, five were cured, three improved, and in two there was no relief. Those reported in detail may be summed up as follows: —

I. A boy, of 15 years, with paralysis of motion of right arm, preceded by pain and swelling of neck. Medical treatment for nine months, without benefit. Twelve shocks daily, from the Leyden jar, to be passed from the cervical vertebræ to the fingers. In two months discharged, cured.

II. A sailor, aged 32. Paralysis of right arm and both hands, from *cold affusion* in fever. Sparks to be drawn from spine and paralyzed muscles thrice a week. In seven weeks discharged, cured

III. A man, aged 38, with entire paralysis of motion of right leg, following rheumatism. Sparks alternate days, from the lumbar vertebræ and limb. In six weeks discharged, cured.

IV. A man, aged 30, with paralysis of motion of both hands, from effects of cold water. Sparks from spine and hands. After a few applications, returned to his work.

85. *Paralysis from various Causes.* — Dr. Bird groups together twelve cases of paraplegia, hemiplegia, and partial paralysis, from various causes, treated in Guy's Hospital, excluding those with coëxistent structural lesions. The result was, no relief in four cases, relief in two, cure in six. Details of seven of these cases may be condensed as follows : —

I. A man, aged 30, with hemiplegia of right side, of nine months' standing, from a fall, in which he struck his head. Paralysis partial. Dec. 1837, shocks to be passed twice a week from spine down leg and arm. April 3, 1838, cured.

II. A woman, aged 26, with paraplegia, following a recent apoplectic attack. After several months' medical treatment, condition improved. Sparks ordered from the lumbar vertebræ and legs. Rapid recovery ensued.

III. A woman, aged 52, with partial paralysis of motion and feeling of right arm. Under common treatment for three months, sensation had improved. Dec. 20, electro-magnetic current ordered from neck to fingers thrice a week. Jan. 20, 1840, motion much improved. Feb. 20, completely well.

IV. A waiter, aged 46, with paralysis of motion of right half of the body, with some loss of sensation, of three months' standing. Sept. 22, twelve shocks, on alternate days, down back and limbs. Oct. 31, numbness of only one finger remaining. Returned to his work.

V. A boy, of 11 years, with complete paralysis of motion on the right side, of seven weeks' standing. Sparks were drawn from spine and limbs. After first application, walked back into the ward with the aid of a stick. In a few days, completely cured.

VI. A smith, aged 22, with recent complete paralysis of motion of right arm. Aug. 4, sparks to be drawn from the upper part of the spine and arm. Sept. 1, cured.

VII. A coal porter, with paralysis of right arm and face. Nov. 29, sparks from spine, face, and arm. Dec. 24, arm cured. Electro-magnetic shocks to face in direction of branches of fifth pair. Jan. 10, much improved, and returned to work.

86. *Paralysis from Local Injury.* — Dr. Bird relates four cases, in two of which there was structural lesion of the nerves, and no benefit resulted from electricity. The other two are as follows: —

I. A shoemaker, aged 50, fell with his left arm bent under him. Complete paralysis of sensation and motion ensued. After three weeks, on June 27, feeble shocks were ordered from the neck to the fingers. July 13, upper part of the arm restored; numbness still in the fore-arm. July 17, sufficiently recovered to resume work.

11. A muscular man, of 60, with partia. paralysis of left arm from a fall, injuring the shoulder, six weeks before. Nov. 12, sparks ordered from the shoulder. Dec. 3, considerably improved, and ceased to attend.

87. *Limited Paralysis.* — In these cases, Dr. Bird has found electricity generally successful. A gentleman, aged about 40, applied to him on account of gradual loss of power in the flexors of the left forearm. He found the biceps remarkably atrophied, but the brachialis antichus in its usual condition. Strychnia was applied to a blistered surface over the muscle with very little spasmodic excitement. Electromagnetic shocks were then passed from the cervical vertebræ to the belly of the muscle. During several weeks, power gradually returned to the muscle, and the arm was restored ultimately to its original strength.

88. *Hysterical Paralysis.* — In this affection, in which it is difficult always to separate simulated from actual paralysis, Dr. Bird has yet seen recovery, under electrical treatment, in undoubted cases, of which the following is an example: A girl, aged 15, of florid appearance, with complete paralysis of the lower extremities, following an hysteric attack. After six months, when admitted, she had regained slight power of motion of the toes. Menstruation regular, but painful. Oct. 6, shocks were ordered from the sacrum to the toes daily. Oct. 18, no remains of paralysis. Oct. 23, presented cured.

89. Dr. Addison furnishes another case of a girl,

aged 16, at Guy's Hospital,* who, as a consequence of suppression of the catamenia, was attacked with an hysterical paroxysm terminating in coldness and paralysis of the left side, involving amaurosis of the left eye. After sparks were drawn for the first time from the spinal column, she could bend the fingers of her left hand. In ten days, she could walk without difficulty. Shocks were also passed through the pelvis. In seven weeks, the catamenia reappeared, and her general health was restored, but the eye remained amaurotic.

90. In hysterical paralysis, where there is any tendency to spasm, as in other spasmodic affections, electricity, in the form of the shock, may produce excitement and irregular action, as the writer has had occasion, in a single case, to observe. The uninterrupted current from the battery, or the spark, though the latter is generally less efficient, should be resorted to under such circumstances.

91. Mr. John Grantham, in two papers† giving some general views of the action of galvanism, relates the following cases of paralysis and nervous atony, subjected to that agent.

I. A block printer, aged 52, with partial paralysis and neuralgia of the right fore-arm. Galvanism, from a battery of forty pairs, was passed through the arm, a flannel roller applied from the wrist to the shoulder, and the patient was directed frequently to swing a six-pound weight in the hand. Heat and

* Guy's Hospital Reports. Oct. 1837.

† Lon. Med. Gaz. Apr. 1837. and Dec. 1838.

sensibility increased daily during the action of the galvanism. In five or six weeks he was cured. Stimulants and other treatment had been previously tried ineffectually. A similar case is given where a cure was obtained simply by medical treatment and exercise of the arm, as above.

II. A shoemaker, aged 47, with paralysis of the extensor muscles of the fore-arm, attended with coldness and neuralgic pains. Stimulants were found of no avail. Ptyalism gave some relief to the pain, but none to the paralysis. Galvanism from twenty-four pairs, directed from the shoulder to the hand for three weeks, effected a cure, with the exception of numbness of the tip of the middle finger.

III. A woman, aged 36, with health generally deranged, — painful sensibility to light, eyelids in constant action, conjunctiva inflamed, iris nearly immovable, bowels torpid, secretions deficient, skin cold and dry. The cerebral and digestive derangements yielded to mercurial treatment, and in five weeks, under the use of galvanism from eighteen pairs, passed from the back of the head to the exit of the orbitar nerves; the affection of the eye, and the coldness of the surface, were essentially removed, so that the patient returned to her occupation.

IV. A woman, aged 29, was attacked, in 1835, with hemiplegia of the left side, and partially relieved under a depletory and mercurial treatment. She was seized again, in 1837, with a painful spasmodic action of the left arm, which was relieved by medical treatment, but subsided into paralysis. Galvanism, being

applied to the arm, produced cerebral congestion, and was abandoned. A further attack took place in 1838, accompanied with menorrhagia, which latter yielded to the usual remedies. Electricity from twelve galvanic pairs, again resorted to, and passed through the arm, proved very irregular in its effects. The current was then passed from the lumbar vertebræ to the left foot, by means of a hot foot-bath. A very powerful effect was thus produced on the left arm, through the medium, as Dr. Grantham conjectures, of the grand sympathetic nerve. Mercury and carbonate of iron were given at the same time, under which treatment she shortly recovered the use of the arm, though only partially of the fingers.

V. A clerk of the ordnance department, with hemiplegia, the result of rupture of the tendo achillis and subsequent treatment several years before. Pulse in right radial artery, eighty-six; in left radial artery, seventy-four. By depletion and mercurial action, the general health was improved. Galvanism from forty-eight pairs was then passed from the head, neck, and spine, to the left foot in the bath. In ten days, the warmth of the surface gradually returned; the pulse then rose. On the thirteenth day, muscular action was rapidly developed. Later, some cerebral congestion occurred, which was relieved by depletion. In one month, galvanism was suspended, the patient being able to walk with a cane and crutch; and two months later, he returned to his occupation, still with some slight deficiency in the muscular power of the arm and leg.

92. M. Marianini reports several cases of paralysis* treated by the battery in the following way: The first, a young lady, was suddenly seized with paralysis of both lower extremities. After fifty days of ineffectual medical treatment, galvanism was resorted to. The positive conducting wire, from a battery of fifty-eight small pairs of copper and zinc, was carried round one of the paralyzed limbs, and the negative was brought in contact with tin foil, placed on the instep. One hundred and fifty contacts, occasioning slight shocks, were administered to each limb; and also the constant current was allowed to flow for some minutes. One of the wires was also touched to the skin, at particular points, occasioning a prickling sensation — the first which had been perceived. After three days, the number of pairs was increased to seventy-five, and afterwards to a hundred pairs of feeble strength. After twelve sittings, decided improvement appeared, and in six more there was a perfect cure. The second case was a woman, aged 29, who had suffered, for four years, from partial paralysis of the left side. She was electrified forty times, in the course of two months, with some improvement, which continued without further use of the agent, so that, twenty months after, both sides were equally strong. Five other cases are referred to, in which the same treatment proved successful.

93. *Local Paralysis.* — Dr. J. M. Neligan,† who has

* Revue Med. (Jan. 1833,) from An. Univ. di Med. di Milano.

† Month. J. of Med. Sc. Apr. 1846. — Braithewaite, Part XIII.

recently used electro-magnetism, states that he has found no benefit in paralysis referable to the brain or spinal marrow, but great advantage in local paralysis, as from the action of lead, from exposure to cold, or from pressure upon a nerve. The following cases are given: —

I. A girl, of 9 years, with paralysis of the right sterno-mastoid muscle, from inflammation of the cervical fascia, causing wry neck. After three weeks' treatment with iron, directed to the general health, electro-magnetism was applied to the paralyzed muscle. After three or four applications, a decided amendment was visible; the muscle regained its power, and the head gradually assumed its natural position, the application being continued from December, 1843, to May, 1844.

II. A case of painter's colic, succeeded by almost complete paralysis of the muscles of both fore-arms. On the first application, the hands of the patient immediately closed on the conductor. In four weeks of daily application of half an hour each time, he was completely cured.

III. A sailor, with paralysis of "the right shoulder," from the effects of damp. Blisters and moxas had been applied without benefit. After ten days' application of electricity, he could use the arm nearly as well as ever. Dr. Neligan adds that, in some apoplectic cases, he has found electricity prove absolutely injurious by its effects in hastening the circulation.

94. *Partial Paralysis of the Face.* — H Montault,

in the *Revue Medicale* of January, 1830, gives an account of paralysis of the portio dura of the right side of the face, with which he had been afflicted. Active treatment was immediately resorted to — depletion, local irritants, &c. In a week, the symptoms had aggravated, pronunciation and deglutition being almost impossible. Electricity was then administered by MM. Sarlandiere and Pictionniere. The sparks, brush, and shock of the machine were employed, followed by galvano-puncture, several needles being passed into the face, and the current transmitted in the course of the facial nerve and its branches. Thirty pairs were employed for the space of twenty to thirty minutes each time. The right eye commenced to close after the second application, and a cure was effected by the sixth, eleven days from the commencement.

95. A writer in the *Revue Medico-Chirurgicale* of December, 1847,* referring to a number of failures in the use of electricity for paralysis, of which the details are not given, calls attention to the agent, not for its general efficacy, but for its remarkable action in some cases where other remedies are insufficient. He details a case of facial paralysis successfully treated by galvano-puncture, and apparently similar to another case in which the same treatment had no effect. A young woman, of 20, was affected with paralysis of the right side of the face, as a consequence of fright, to the extent of unconsciousness.

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* Nouv. Encyclog. des Sc. Med. Dec. 1847.

She was unable to shut the right eyelid, and suffered the usual distortions, the saliva escaping involuntarily from the mouth. For several months, every variety of treatment was resorted to without result. At length, acu-puncture, with from thirty to forty-five small pairs, was employed, at first daily; afterwards every two days. The needles were inserted in different parts of the face. Severe pain, contractions, secretion of tears, and suffusion and perspiration of parts traversed by the current, ensued. This was continued for three months, at the end of which time the patient retained hardly a trace of the disorder. It may be remarked, that this application seems to have been unnecessarily severe, and that over-stimulation, from so many pairs, may have retarded the cure. It may also be observed, that the cases referred to as unamenable to electricity may have depended upon persistent organic lesions.

96. *Paraplegia.* — Dr. Turtelli relates a case of paraplegia,* following six months after cerebral inflammation. Energetic diuretics were administered, also nux vomica, but without success. The shock from thirty pairs of plates was passed from the hand to the foot of the patient. The intensity being too great, and causing pain in the head, thirst, and anxiety, the number of plates was reduced to twenty. Contact was made thirty times. Improvement manifested itself at the second application; and by the seventh, the paralysis had entirely disappeared.

* Revue Med. May, 1825.

97. In the *Gazette Medicale de Paris* of 1848,* Dr. Constantin James gives the details of a very interesting case of paraplegia, occasioned by the patient, a girl of 17, falling forwards at full length, while walking in a corridor. She first complained of pain in the knees, and subsequent weakness. Local and general treatment was resorted to without effect, and then the waters of Néris were prescribed, at which place she remained for six months. Complete paraplegia ensued. On her return to Paris, powerful treatment was addressed to the vertebral column, but with slight benefit. At length, after three years from the first accident, M. James recommended electro-magnetism. At this time, the lower extremities could not be raised from the bed, and were sensibly wasted, without, however, muscular atrophy. The first application was made very cautiously; the negative handle being placed over the first of the lumbar vertebræ, the positive handle over the head of the tibia, successively, of both limbs. At the end of eight applications, there was a notable improvement. Electro-puncture was then resorted to, by introducing a needle, which was connected with the negative conductor, sufficiently deep into the middle and posterior part of the lumbar region. At the twentieth application, the patient was able to take some steps, with the use of a cane. A needle was subsequently inserted in each limb, a little below the head of the tibia. During the menstrual periods, and in case of any

* Nouv. Encyclog. des Sc. Med. (March, 1848,) from Gaz. Med. de Paris. 1848.

nervous excitement, the application was interrupted. In four months the cure was completed, and the treatment discontinued. The patient, since married, has remained permanently well.

98. The author remarks, that application of electricity should not be made during existing lesions of the spinal column. In doubtful cases it should be employed. One of his associates, Dr. A., was attacked with all the symptoms of spinal lesion, complete paraplegia existing, incontractility of sphincters, partial paralysis of upper extremities, irregular action of the muscles of respiration and of the throat, and perceptible strabismus. Cauteries applied to the spine were ineffectual. The third application of electricity, however, produced amelioration, and in a few months the patient was convalescent.

99. M. James guards against too rapidly reversing the direction of the current, as producing too great commotion, without benefiting the patient. This mode of application would have a place, however, in cases of great inaction. He objects to using a continuous application, and prefers the intermittent mode of administration, particularly avoiding an excessive use of the agent. Matteucci has pointed out the entire exhaustion of nervous power, similar to paralysis, resulting from an excessive use of electricity. If the improvement appears to come to an end, M. James recommends the discontinuance of the agent for a week or two. The progress is then usually renewed. During the treatment, the patient should be placed upon a strengthening regimen, with tonics, friction,

exercise to the muscles, &c. Cold should be guarded against.

100. The time of cure of facial paralysis, with M. James, is stated to have been sometimes eight or ten days, or even in so short a space as five; but paraplegia was rarely cured before several weeks.

101. *Hemiplegia.* — A young woman, in the care of M. Hoering, of Heilbronn,* was affected with hemiplegia and difficult utterance, as a consequence of apoplexy. A galvanic current was passed through the larynx, from side to side, and also through the cervical vertebræ and the tongue. Speech, and also motion of the paralyzed limbs, were soon essentially benefited.

102. M. Bermond, of Bourdeaux,† relates a case of hemiplegia, following apoplexy, in a lady, aged 26, in which the Leyden jar was successfully employed. After three months' medical treatment, the hemiplegia remained nearly complete. The memory was slightly impaired, and there was unusual nervous irritability. At the first sitting, shocks from the jar were passed from the hand to the foot of the affected side. After fifty moderate shocks, considerable improvement manifested itself. After the fourth sitting, twelve days later, the patient took some steps. At the tenth sitting, seven weeks from the commencement, the patient walked to the office of M. Bermond. After the eleventh application, a week later, the cure might be considered as almost complete.

* Encyclog. des Sc. Med. June, 1847.

† Revue Med. (June, 1831,) from Jour. de Med. de Bourdeaux.

The shocks were increased in number, towards the close, and directed sometimes to a single limb, or to the tongue. This case, of which the details are given, would seem to have been one of unusual discouragement.

103. Madame B.,* aged 56, in full health, was attacked with apoplexy, resulting in hemiplegia of the left side, which remained after relief of the primary disease. Speech was difficult, the saliva constantly escaping from the corner of the mouth. Taste and hearing were slightly affected, deglutition difficult, the bladder distended, constipation at first obstinate, cramps in the paralyzed limbs frequent for the first fifteen days. Œdema at length appeared throughout the left side. After a month, a slight improvement had taken place in other respects, when electricity was applied by M. Bermond. After the first application, Madame B. was able to stand, and even to stoop slightly and recover the erect position. On the following day, the features had become more regular, the hearing had improved, the œdema diminished, and an abundant perspiration had visited the limbs on the left side. The application was then repeated. The circulation increased in force, and the third application, which took place two days later, was followed by rapid increase of pulse and plethoric symptoms, which yielded readily to active treatment. After twenty applications, the patient had essentially recovered, and, in the opinion of M.

* Revue Med. (Nov. 1834,) from Bul. Med. de Bourdeaux.

Bermond, would in two weeks longer have been relieved from every trace of disease. She, however, left Bourdeaux.

104. Dr. W. M. Cornell * relates the case of a journeyman bootmaker, who was affected with partial paralysis of the left side, accompanied with occasional twitchings. After four or five months' medical treatment, Dr. C. prescribed galvanism, which the patient used, every other day, for six weeks, at the end of which time he had been apparently free from the affection for a fortnight. The current was sent in various directions, through the extremities, head, and trunk, the time of application being about fifteen minutes. Dr. Cornell states that he has found galvanism more useful in cases of some weeks' standing, which have been treated with other remedies, than in very recent ones.

105. *Dropped Hands.* — Dr. Elliotson, in the clinical department of St. Thomas's Hospital,† related the case of a manufacturer of white lead, with dropped hands, who used to assist when other persons were electrified by the machine. The hand which was most exposed to electricity, and also which received the sparks, recovered much the most rapidly. The patient, attributing it to the sparks, requested that the application might be made in that form to both hands, and, under these circumstances, recovered in a short time.

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* Br. Med. and Surg. Jour. 1847

† Lancet. Feb. 1831.

106. Dr. Elliotson also reports the case of a painter,* aged 58, with paralysis of the hands, from the effects of lead. Shocks were passed through the hands three times a day, and strychnia also ordered, in small doses. The improvement was very rapid, although none of the usual effects of strychnia were perceptible, and its administration was suspended after ten days. Progress continued, and in about five weeks, the patient was discharged from St. Thomas's Hospital, cured.

107. M. Heller, of Stuttgard,† gives the case of a carpenter, who, in the autumn of 1845, fell on his back, principally on the cervical vertebræ, from the roof of a cottage. There was no external injury, but paralysis and tumefaction of the right leg, paralysis of the bladder, partial paralysis of the rectum, contraction of the fingers of both hands, and inability to change his position. This remained for fifteen days, notwithstanding the use of calomel, arnica, and nitre. M. Heller then had recourse to electro-magnetism, applying it to the hands, neck, bladder, sacral region, and right foot. The application to the bladder, made from three to six minutes, every other day, by means of an insulating catheter, with a metallic stilette, completely restored voluntary power, in seven applications. The pulse, which had fallen to thirty and thirty-six, became normal, after the sixth general application. After the seventeenth application, he

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* Lond. Med. Gaz. Nov. 1830.

† Nouv. Encyclog. des Sc. Med. Aug. 1846. — Med. Cor. Blatt.

could be considered cured, and in the spring returned to his lumber-yard.

108. *Paralysis of the Bladder.* — An instance of the relief of this affection has just been given. The following case is related by M. Hoering.* A woman, aged 60, suffering from prolapsus uteri, was attacked with paralysis of the bladder. Eight applications were made, resulting in a perfect cure; one of the conductors being introduced into the bladder, enclosed in a caoutchouc catheter.

109. Dr. Thomas Radford, in a lecture delivered in 1844,† reports the case of a lady, under the care of himself and Dr. Goodwin, who recovered, after protracted labor, with inability to pass her urine. The first application of galvanism to the bladder gave permanent relief.

110. *Incontinence of Urine.* — M. Froriep relates several cases of cure of this affection,‡ by passing electricity into the bladder by means of a metallic stylet with a button point, enclosed in a gum catheter. The other pole was applied to the pubes. The application was continued fifteen minutes, and was frequently beneficial the first day. The weakness occasioning the enuresis of children may be treated in the same way.

111. *Paralysis of the Bowels.* — MM. Emery, Cloquet, and Dubois, in their report to the French Academy, in May, 1826,§ state that the passage of a

* Encyclog. des Sc. Med. June, 1847.

† Prov. Med. Jour. Dec. 1844. — Ranking's Abstract, Part I.

‡ Ed. Med. and Surg. Jour. (1844,) from Froriep's Notizen.

§ Revue Med. July, 1826.

battery current of twenty-five pairs, from the mouth to the anus, is attended with a sensation of heat, at both extremes, flashing before the eyes, and motion of the whole intestinal canal, which continues, after the cessation of the current, and terminates, in a few minutes, with evacuation. This took place, in one experiment, after only momentary contact. M. Magendie had also made similar experiments.

112. Aldini, by a single zinc and silver plate, connected by a wire, and placed respectively in the anus and mouth of an ox, recently killed, produced convulsion of the abdominal muscles, and a discharge of fæces.* Achard, of Berlin, obtained a similar result, in repeating the experiment on himself.

113. The excitement of the peristaltic action of the intestines has been produced, in numerous cases of paralysis, both by the electro-magnetic shocks and the galvanic current. Mr. Clarke, of Dublin,† states that he has found galvanism more efficient than electro-magnetism, in exciting the vermicular motion of the intestines, as well as the action of the heart, after these functions had ceased, from asphyxia, in the case of animals subjected to the experiment. This result also agrees with observation in the case of the living subject. The current may be sent from the back of the neck, by means of a surface handle, and with less inconvenience to the patient, than by contact with the tongue, though an acid or pungent taste will still be perceived in the mouth. It is most

* Golding Bird. — Lond. Med. Gaz. May, 1847.

† Dub. Hosp. Gaz. — Braithewaite, Part XIII.

efficient when the negative conductor is introduced within the rectum, though a sponge handle may be applied superficially. In a majority of cases, perhaps, the electro-magnetic apparatus will answer the purpose. A movement in the bowels is generally felt, in a few moments, and an evacuation follows, in a period dependent on the position of the fæcal matter in the intestines. In cases of obstinate paralysis, it might be necessary to continue a feeble galvanic current, until an evacuation was effected. A silver plate, placed in the mouth, and connected by a wire with a conductor of zinc, introduced into the rectum, may prove a useful expedient in such cases.

114. *Colica Pictonum.* — This disease, which may be considered a painful paralysis of the bowels, extending also to the limbs, may with propriety be treated with galvanism, from the outset, both for the paralysis and the pain, especially if of a spasmodic character. Galvanism would be preferable to electro-magnetism.

115. *Aphonia.* — A case is reported in the Lancet,* of a criminal, who was attacked with aphonia, accompanied with a swelling of the throat and fauces, after a fit of epilepsy. This was persistent, after sixteen months of medical treatment, directed to the mouth and throat. A battery of from fifty to seventy pairs was then applied, from two to four hundred shocks being given, or contacts made, on each day. No effect was produced till the third application,

* Lancet. May, 1843. — Braithewaite, Part VIII.

when seventy pairs were used, which produced fainting and some agitation. This, with some overaction of the system, was relieved, subsequently, by bleeding, and in five days the application was renewed. After the twelfth application, the patient had completely recovered.

116. M. Magendie presented to the French Academy, at its sitting in December, 1837,* a cavalry officer, who had lost his voice and hearing, in consequence of a fall from his horse. The hearing had been restored by means of electro-puncture. The aphonia, which had at first been complete, had given way, so that vocal sounds could be produced, but articulation was still deficient. He was improving daily. The treatment had been continued for a year.

117. Dr. Donovan, of Dublin, quotes from Dr. Grapengiesser,† a case of restoration of voice, by means of a plate of zinc, the size of a shilling, and a small plate of silver, connected by a wire, and applied respectively to surfaces blistered for the occasion, one on each side of the larynx. Convulsive movements of the larynx were occasioned, and in half an hour the apparatus was removed. Some benefit ensued. Five days afterwards, it was applied again, and allowed to remain all night, effecting a permanent cure.

118. *Paralytic Contraction.* — A case has already been quoted (§ 74) of the partial cure of paralytic contraction of the arm and fingers. Where this indi-

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* Revue Med. Jan. 1838.

† Dub. Quart. Jour. Med. Sc. Feb. 1847. — Am. Jour. Med. Sc. 1847

cates nervous irritation, the battery alone should be employed, and frequently the higher powers will be required. A case is reported by M. Breschet,* at the Hotel Dieu, of spasmodic and permanent contraction of the flexors of the fingers from a lancet incision. This was treated by galvano-puncture with twenty-five or thirty pairs, one needle being inserted near the origin of the flexors, the other in the annular ligament of the wrist. The fingers gradually unclosed, and, after twelve applications, a permanent cure was effected.

119. *Anæsthesia.* — A case of anæsthesia, or insensibility, approaching paralysis, is given by Dr. Christophers, of London.† The subject was a woman, who, from the use of the cold hip-bath, twenty minutes at a time, for twelve days in succession, had lost all sensibility of the surface from the line round the body reached by the water to the toes. The sphincters of the rectum and bladder were also slightly impaired in their functions. Stimulating frictions were applied, during a fortnight, to the surface and spine, and leeches, to remove a local tenderness over the dorsal vertebræ, but without giving relief. The electro-magnetic shocks were then administered, at twenty-two sittings, of an hour and a half to two hours each, at the end of which time the cure was complete. Improvement commenced on the second application. The rectum and bladder were first

* Braithewaite, Part IV. from Jour. des Con. Med.

† Lancet. Aug. 1846.

restored, then the sensibility of the thighs and legs, and, lastly, of the feet and abdomen. The current was passed successively down the course of the spine, — from the sacrum down each limb, — and from the spine to the abdomen.

120. General Debility. Atonic States. — A condition of nervous prostration frequently exists, which is capable of being benefited by electricity. In these cases, electro-magnetism, or galvanism, may be passed through the arms, and across the body, by means of the cylinders held in each hand for several minutes at a time; or they may be passed from one hand to the foot; or, lastly, they may be passed down the spine. The application of electricity to the brain also deserves attention in this connection. The nervous exhaustion of the young is one of the affections to which this treatment is applicable. Weakness, or atonic condition of the throat, may be treated in the same way as aphonia.

121. Coldness of Extremities. — When this exists as a primary affection, or symptomatic of others, the capillary circulation may be excited, and the nervous power of the part temporarily increased, by the application of galvanism or electro-magnetism. Increased warmth is one of the first effects of electrical action. The sponge handles, moistened with spirit, may be moved over the skin near each other, or be separated widely apart. The feet or hands may also be placed in separate vessels of warm water, and one conductor be put in each. As a means of reaction, this is sometimes of value. The battery will be found most powerful in producing this effect.

122. Paralysis of Special Sensation. *Amaurosis.* — This is one of the most formidable affections to which electricity has been applied. Dr. Bird obtained no conclusive or satisfactory results at Guy's Hospital * with the mode of treatment, principally by the machine, there employed: in a majority of cases no good was done; in a few there was apparently relief, but no cure. Dr. Usiglio, of Corfu, states that he has found no advantage from the use of electricity in this disease.† He relates the case of a sailor, aged 56, with amaurosis following chronic inflammation, in which a battery of twenty to sixty pairs was employed unsuccessfully. The positive pole was placed over the closed eyelid, and the negative on the tongue. More patient and more efficient modes of treatment, however, have given important results in the hands of other practitioners. Dr. Finella reported many cases of amaurosis, which he had treated successfully by electricity, to the sixth and seventh Scientific Congresses of Italy.‡ It remains only to say, with Magendie, in introduction to the following cases, that the name *amaurosis* probably includes several different diseases; that complete amaurosis is with difficulty cured; and that it requires for its treatment the powerful and prolonged exhibition of electricity.

123. M. Magendie reported to the French Academy, at its sitting of June 19, 1826,§ several cases of

* Guy's Hospital Reports. April, 1841.

† Revue Med. March, 1844.

‡ Nouv. Encyclog. des.Sc. Med. April, 1847.

§ Revue Med. July, 1826.

incomplete amaurosis benefited or cured by electro-puncture. These cases, easily influenced, he considered to be due to alteration of the ophthalmic branch of the fifth pair, and not of the optic nerve. He accordingly attacked the frontal and suborbital branches by means of electro-puncture needles. In the case of a young man of 18, he even assailed the frontal nerve within the orbit, and the lachrymal nerve, occasioning an abundant secretion of tears. Twelve feeble pairs were employed. Considerable improvement had taken place in fifteen applications. In other cases, a highly satisfactory result had been obtained, and in a lady aged sixty, a complete cure after three months' treatment.

124. In his lectures before the College of France,* M. Magendie also recommends acting upon the branches of the fifth pair in treating amaurosis, as the most expeditious and efficient method, especially in the incipient disease. He prefers electro-puncture, transfixing the nerve with the needles — a process which he declares to be entirely safe. In complete amaurosis, M. Magendie, in 1836, had never obtained a cure; but where some perception of light remained, he had been entirely successful.

125. Becquerel related to the French Academy, in December, 1837,† the case of a man affected with almost complete amaurosis, who had been treated by electro-puncture. The current was made to pass along the frontal and suborbital nerves, "which

* Lancet. May, 1837.

† Revue Med. Jan. 1838.

react with the nerve of special sensation." In three months, a notable improvement in the sensibility of the eyes had taken place, and the treatment was confided to the wife of the patient, in whose hands he had progressed so far, that, at that time, he was able to walk in the streets without a guide.

126. Dr. H. Schlesinger gives a full report* of the case of a young man, who, from a blow upon the back of the head, experienced severe pain, terminating in unconsciousness, from which he recovered with entire loss of sight; the iris being immovable, and the pupil undilatable. Stimulants were applied for several days without success. He then applied electro-magnetism, by means of sponge or metallic conductors to the superior and inferior orbital foramina, to the maxillary fossa, and the gums of the canine and molar teeth, continuing the external application of an infusion of *calamus*. The teeth and facial muscles were affected, but not the eyes. The application was then made immediately to the membrane of the eye, and continued until tears were copiously excited. The sensation of light was perceived during the first application. Sensations of cold and heat, and also of prickling, were present in subsequent sittings, which usually lasted ten or twelve minutes. Eight days from the commencement, some objects could be distinguished, and the application was suspended for a week, for the trial of strychnine ointment; but no improvement took place.

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* Nouv. Encyclog. des Sc. Med. Oct. 1847.

On renewing the application, colors were soon distinguished, and the iris was observed to contract. The retina only seemed to be restored in particular positions with reference to the current, and the conductors were so placed as to act as far as possible on all parts. Some spasmodic affections and irritation of the conjunctiva occurred from time to time, and modified the application, but the patient gained steadily; and, when removed by his parents, after forty-two applications, during a period of two months, could move about freely, recognize the features of friends, and distinguish the hands of a watch. Different effects were produced on the eye, in this case, by the different strength of the current, and during different degrees of sensibility in the organ. The sensation produced by a moderate current was that of cold; of a stronger one, heat; of a still stronger, pain, and flashes like lightning. Where the paralysis is extensive, the light appears white and sparkling; when less, of a ruddy, flaming aspect; and when slight, of a blue color — indications which may have their value in determining the progress of cure.

127. In the *Gazette Medicale de Paris*,* twelve cases of amaurosis, treated by electro-puncture, are given by Dr. Person, of Bourdeaux, which are of especial value, as showing the conditions of failure, as well as of success. The outlines of these are given below.

I. A dentist, aged 34, of a bilious temperament,

* Nouv. Encyclog. des Sc. Med. July, 1843.

had suffered, for several years, with loss of vision, to the extent of confusion of objects, and want of distinction between colors, except black and white. He was especially annoyed by the constant presence of *muscæ volitantes*. The pupils were permanently dilated. For the first fifteen days, under electro-puncture, there was no improvement; but it soon afterwards manifested itself, and three weeks later the sight was restored, so as to be used even by artificial light. This cure had continued two years.

II. A man, aged 40, almost entirely amaurotic for ten years. Pupils immovable, and exceedingly dilated. Submitted to acu-puncture, one of the needles being inserted in the orbit, and the other in the back of the neck. No improvement was manifested till the eighteenth sitting, when restoration commenced. After five months, and one hundred and fifty applications, of half an hour each, the sight was entirely recovered.

III. An officer, of 36 years, with amaurosis of six months' standing, underwent thirty applications without benefit. A needle was then passed into the vitreous humor of the eye, and a slight current sent through to the neck. Perception of light was immediately restored, but only during the operation. A similar result ensued on the following day; but pain in the globe of the eye and in the head prevented a recurrence to the operation, and the amaurosis remained.

IV. A mantua-maker, aged 27, with complete amaurosis for five years. Pupils immovable and dilated, and a grayish spot at the bottom of the eye. One

needle was passed, as in the last case, into the vitreous humor. Vision was at once restored for the time of the operation. The day following, it was repeated, with the same result, vision being restored permanently, though not perfectly. This cure had remained for eighteen months.

V. A man, aged 34. The right eye completely amaurotic, the left partially so. In two months' treatment with electro-puncture, confined to the orbit, the left eye was entirely restored, and the right eye partially.

VI. A woman, aged 24, with complete amaurosis for four years. No benefit from six applications.

VII. A woman, aged 30. Amaurosis for six years. No relief from twelve applications.

VIII. Amaurosis of infancy (congenital?). No relief from seven applications.

IX. A man, with amaurosis of two years' standing. No relief from fifteen applications.

X. Amaurosis for two years. No relief from fifteen applications.

XI. A man, recently amaurotic. No relief from twelve applications.

XII. A woman, amaurotic for several years. No relief from fifteen applications.

128. Dr. Person remarks, that the seven latter cases were of individuals too indifferent as to the treatment to follow it to any successful result, and that to cure amaurosis it requires a greater number of applications than have usually been given to it. The suggestion may be made, that the use of acu-

puncture to the back of the neck seems to have been unnecessary in these cases, unless some local action was intended on the upper part of the spinal cord. As a mere terminus of the voltaic current, a sponge handle, applied to the neck, would be preferable.

129. The eye-glass for electrical application (§ 39) presents a means of very powerful action upon the eye, which at the same time is diffused and tends to allay inflammation. It is here recommended, as a resort, at any rate, in the less severe cases of amaurosis. A very mild form of application is, to place a handle containing a soft sponge, moistened with water or a saline solution, in contact with the closed eyelid.

130. Night-Blindness. — A case of this affection, in connection with deafness, will be found under the following head.

131. *Paralysis of the Auditory Nerve.* — A case has already been presented (§ 116) of the cure of this affection by galvano-puncture. In Guy's Hospital, the treatment by machine electricity proved generally unsatisfactory. The most common mode of treatment has been, to introduce into the auditory canal a slender conductor, insulated by caoutchouc or other substance, except at the extremity, which may be either a sponge, or metallic ball covered with moistened leather. One conductor may be placed in each ear, and the current made to pass between; or the second conductor may be placed upon the tongue, or in the Eustachian tube. The conductors may also be applied externally, immediately behind the ear.

Both electro-magnetism and galvanism have been successfully employed. The application should be made with gentleness and caution, as distressing and confusing sensations may be readily transmitted by the auditory nerve to the brain.

132. In the *Annali Universi di Medicina* of December, 1846,* notes are given of cases of deafness treated by Dr. Finella, and reported by him to the Scientific Congress at Genoa. The first was of a sexagenarian, who had been confined eleven months in the fortress of Saluces. In his youth he had suffered from otorrhœa. Two years before, he had become night-blind, and six months later, nearly deaf. The positive pole of the battery was applied, by a proper conductor, to the tympanum, and the negative to the tongue. After the first application, a slight discharge took place from the ear. This continued after the second, on the following day; but a slight improvement in hearing was perceived. On the third, the improvement continued, and the sight gained also. On the fourth, the hearing was much improved, and in the right ear, which had not been galvanized, as well as the left. After twelve applications, the hearing was perfectly reëstablished, and the cure remained permanent. In the second case, a man, aged 30, had become deaf from inflammation of the ear, following rheumatism two years previous. The same application of galvanism was used, and hearing was restored in both ears, after the eleventh

* Nouv. Encyclog. des Sc. Med. April, 1847.

operation, although the right ear was never galvanized. Two other precisely analogous cases are mentioned, of gradual deafness, in a man aged 65, and a woman aged 63, cured in a similar manner. Dr. Finella remarks, that the introduction of the conductor into the ear as far as the tympanun, is at first very painful, and should be performed by the patient himself. A sense of titillation remains in the ear for several days after the application. Some swelling of the membrane of the meatus takes place, which renders it advisable to make the application only every other day.

133. It is stated, in the *Bulletin general de Therapeutique*,* that M. Jobert de Lamballe cured several cases of deafness, following inflammation from cold, and of recent paralysis of the acoustic nerve, by the following process: A needle was introduced, in a sheath, into the Eustachian tube, and made to transfix the walls. Another needle was introduced into the external ear, and made to transfix the tympanum. A galvanic current was then passed, for a moment, through these, and the application repeated in eight days.

134. In a notice of a work of Dr. Niney, on this subject, in the *Revue des Specialités*,† it is stated that the author regards the mode of application as of principal importance, considering the influence upon the organ of sensation to be due to reflected action from the nervous centre of that organ. He modifies the

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* Revue Med. Sept. 1842. † Revue Med. Nov. 1842.

application of M. Jobert by introducing two needles, through a sound containing two channels, into the Eustachian tube, transfixing its walls with the one, and carrying the other into the inner ear. In five cases treated in this way, two were moderately benefited, two were cured, and one was progressing towards a cure.

135. A case is reported by M. Hoering,* in which a man, aged 60, with deafness of a year's standing, was cured by twenty applications, by means of an insulated conductor passed into the external ear.

136. *Tinnitus Aurium.* — A patient of Dr. Hoering had been affected with typhus fever, and had been treated for three months, without success, for ringing in the ears. A conductor was passed into the ear, and with the first application the noise had diminished. The cure was complete in about twenty-two sittings.

137. Deafness from other Causes. — Dr. W. Wright, of London, states that he has found benefit from the use of electricity in producing gradual absorption of pus and coagulable lymph in the cavity of the tympanum; also in exciting the ceruminous glands to a secretion of wax; also in deafness from the abuse of mercury, and from exposure to cold. For this purpose, it requires a high degree of power, and the use of the battery.

138. Suspended Animation. — Matteucci states, as a characteristic of electricity, that it arouses the

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* Encyclog. des Sc. Med. June, 1847.

nervous system after all other stimulants have ceased to act (§ 10). It stands alone, therefore, in its power of restoring suspended animation. Dr. Wilson Philip* points out the necessity of supplying nervous power, after removing any cause of asphyxia, to enable the lungs and circulation to resume their functions, and also to arouse the general vitality of the system. This should be done, in the first instance, by a current directed to the lungs and diaphragm; and in the second, to the brain, and spinal marrow. Wilson Philip urges that not more than fifteen or twenty pairs of the battery should be employed.

139. *Drowning.* — Leroy d'Etoiles made experiments,† witnessed by Magendie, for the resuscitation of animals, nearly drowned, by introducing long needles between the eighth and ninth ribs, into the fibres of the diaphragm, and making them the poles of an electric current. Respiration was reëstablished, and the animals so treated recovered, while those left to themselves never revived.

140. Dr. Ferguson, surgeon to the Westmeath Dispensary,‡ relates the case of a man who fell into the water in a state of intoxication, and who was immersed six or seven minutes. He was then carried half a mile, the stomach-pump used, and ordinary means of restoration exhausted. Dr. F. then cut down to the diaphragm, below the seventh rib, and applied a battery of fifty pairs. Spasmodic

* Vital Functions.

† Ed. Med. and Surg. Jour. Jan. 1842. — Braithewaite, Part V.

‡ Dub. Med. Press. July and Sept. 1840. — Braithewaite, Part II.

action of the diaphragm commenced at once, and, shortly after, regular respiration and the circulation were renewed. The *Gazette des Hopitaux Civils et Militaires*, of Paris, in commenting on this case, recommends the use of acu-puncture needles, instead of the incision, and applying the poles a greater distance apart.

141. *Narcotism.* — In narcotism, the excitability of the nerves is impaired, and the most powerful and stimulating application is often required, as the electro-magnetic shocks, the interrupted current of the battery, or the Leyden jar. A case is given by Dr. C. H. B. Williams, physician to University College Hospital,* of a young woman who had swallowed an ounce and a half of laudanum. An emetic of sulphate of zinc had been administered with effect, and the stomach-pump had been used. A state of coma, however, existing, electro-magnetic shocks were passed across the shoulders, with the effect of instantly restoring the patient to consciousness, the object being, at the same time, to influence respiration. The usual means of reaction being also employed, the patient subsequently recovered.

142. The following case is reported by Dr. James Russell, house physician to King's College Hospital.† An infant of two months had taken twelve drops of laudanum. After five and a half hours, during which time life had been once considered entirely extinct, and all remedies exhausted, electro-magnetic

* Lond. Lancet. July, 1841. — Braithewaite, Part IV.

† Lond. Med. Gaz. March, 1843. — Am. Jour. of Lond. Med. Sc. — Apr. 1843.

shocks were passed from the back of the neck to the sternum, reëstablishing respiration, and gradually extending its influence to other functions. The surface becoming warm, after three hours, the application was considered no longer necessary; but half an hour later, dilatation of the pupils and exhaustion, without coma, ensued, from which it was found impossible to rouse the patient, who lingered for several hours, and then died.

143. Dr. Th. S. Page, of Valparaiso, aided by Dr. Houstoun, of the English navy, and Dr. Barrabino, of the United States navy,* treated the case of a young man, aged 22, who had taken half an ounce of pulverized cubebs, mixed with opium. A state of narcotism was induced, which, after about fifteen hours, threatened to terminate fatally; respiration being short and hurried, jaw fallen, pulse hardly perceptible. Every mode of producing reaction had been exhausted. Vomiting, cupping, applications of ammonia, cantharides, and turpentine, to the spine and feet; injections of turpentine and ammonia; sinapisms to chest, stomach, and thighs; castigation; forced exercise, and internal stimulants, had been resorted to. Electro-magnetism was then tried as an experiment. The first application, from the left to the right side, through the heart, produced convulsive motions; and, at the fourth contact, the patient cried, "No more." Reaction was established, the pulse revived, and the surface became warm. He

* Lond. Lancet. Feb. 4, 1843.

recovered without further application. He had lost consciousness, until the shock had aroused him with the sensation, as he expressed it, of a "gun fired off within him."

144. Mr. Corfe, of Middlesex Hospital,* reports the case of a man who had taken an ounce and a half of laudanum, six hours previously, and was in an almost lifeless condition. "After the stomach had been relieved of its contents, green tea, with ammonia, was injected therein; flagellation, with thin splints, and wet towels, the cold douche, turpentine stupes, and sinapisms, to the calves and abdomen, were applied, in succession, without the least improvement in his condition. Electro-magnetism, conjointly with shocks from the jar, were then employed. The pulse rallied, and respiration improved at once. The result was, that the man soon began to abuse the operators for "trying specimens" upon him, and recovered.

145. Dr. M. Barry relates the case of an infant of nine months,† who swallowed thirty drops of laudanum, and was not seen till seven hours afterward, when in a state of profound coma. It was aroused by electro-magnetism, but fell off when the current ceased for a moment. The application was continued for four hours and three quarters, before it was thought proper to discontinue it. The child then recovered.

146. A case of poisoning, by Godfrey's Cordial, is

* Lond. Lancet. Jan. 1844. — Braithewaite, Part IX.

† Med. Gaz. May, 1847. — Braithewaite, Part XVI.

reported by Mr. Tubbs, in the Medical Gazette.* He found the child, who was three weeks' old, in a state of complete narcotism, from swallowing half a teaspoonful of Godfrey's Cordial, five hours previously. After a resort to the usual means, the child was sinking, pupils contracted, the temperature of the body falling. Electro-magnetism was then employed. Feeble shocks, sent through the spine and cardiac region, brought on muscular contraction, voluntary motions, and a cry. The application was continued for ten minutes, the heart's action being accelerated, and the eyes kept open. Stimulants were then administered internally and externally, and the little patient recovered.

147. A female, aged 29, was brought into the Middlesex Hospital † an hour after having swallowed an ounce of laudanum. Unconsciousness and contracted pupil were present, and the glottis embarrassed with ropy mucus. The battery at first produced no excitement, but soon quivering of muscles of the neck, and in half an hour vomiting and general reaction ensued. In an hour longer, the patient was quite lively; but the application was necessarily renewed, occasionally, for five hours, to prevent relapse.

148. An excessive dose of laudanum, administered in the summer of 1848, to a workman in the navy-yard at Charlestown, occasioned death. The most powerful electro-magnetic shocks, applied four or five hours later, failed to produce the slightest mus-

* Med. Gaz. Sept. 1847. — Braithewaite, Part XVI.

† Lancet. June, 1847. — Br. Med. and Surg. Jour. 1847.

cular contraction. This loss of excitability in narcotism, shared both by the nervous system and tissues, is one of the most striking symptoms, and requires for its treatment the most energetic forms of administration.

149. *Etherization.* — M. Ducros stated, before the French Academy,* that chickens and pigeons, subjected to etherization, and placed upon the insulating stool of the machine, and positively electrified, recovered from insensibility in about thirty seconds; whereas they ordinarily remained insensible for seven or eight minutes. If subjected to shocks, either from the machine or the magneto-electric apparatus, the recovery was instantaneous. Electrification with negative electricity upon the insulating stool rather retarded than accelerated restoration.

150. Congestive States. — Dr. Th. S. Page, of Valparaiso,† after narrating the case which will be found under the head of *Narcotism*, uses the following language: "I would beg leave to add my impression that electro-magnetism will not only be found a most useful agent, in cases like the above, but in some forms of disease, particularly those of a highly congestive character, where oppression of the organs and the nervous system prevents reaction and speedily destroys life. . . . . In practice, I think we frequently see cases where death seems to be caused by an *obstruction* of the functions or organic movements which support life, more than by

* Lond. Med. Gaz. May, 1847. — Comptes Rendus, Feb. 1847.
† Lancet. Feb. 1843. — Am. Jour. Med. Sc. April, 1843.

an *exhaustion* of the organic functions, or of life itself."

151. These remarks may be extended to *collapse*, or sinking conditions of the system, either from disease or violent injury. *Syncope*, or fainting, and exhaustion, would be included in the same treatment. Dr. Dewees, in the New York Journal of Medicine,* remarks, "In cases of exceeding prostration, where the pulse was extinct, I have witnessed a return of impulse take place in a few minutes, and the sense of weakness fully as well overcome as by the administration of brandy or wine."

152. *Typhus.* — Dr. Wilson Philip states that Mr. Knight suggested to him "the use of galvanism in the worst cases of typhus, in which there is a universal failure of the secreting power, and the debility of the nervous system forms so prominent a feature. It may certainly be used with safety, and probably with advantage, in this disease. The circumstance which appears to me to render it doubtful how far it may prove useful in typhus, is that here the due supply of fluids, as well as of nervous influence, fails."† The battery current, as a stimulant of secretion, might, in this case, be employed, as well as the arousing application of the electro-magnetic shocks. The battery current, however, should not be sent through congested organs, where an increase of action would be injurious. The application would, with propriety, be directed to the spinal column.

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* N. Y. Jour. of Med. Sc. May, 1847.

† Vital Functions, 2d ed. p. 309.

153. It may also be observed here, that the battery current may exert a favorable influence, in typhoid conditions, over the blood and tissues, where there is a tendency to disorganization and loss of vital character. For this purpose, the sponge handles, moistened with spirit or ammonia, might be moved freely over the surface of the body, stimulating the skin, at the same time that an organizing influence would be exerted over the tissues and blood in the capillaries.

154. Asiatic Cholera. — Galvanism was recommended, in cholera, as early as 1825, by Dr. Ainslie, in India,* who states, that where the morbific influence was overpowering, in the commencement, he "should have recourse to galvanism to supply the deficiency of nervous influence in the sinking frame." The use of electricity was subsequently urged, in England, in 1832, by Dr. Wilson Philip and others, and some results of interest, though imperfect, were obtained. With the improved appliances which we now possess, this most powerful reactive agent should be fully tested in this disease. Two cases are reported, by Dr. Knight, of Edinburgh,† in which galvanism was used without effect; the first patient being in a moribund state, and the second far advanced in the disease. A want of information seems also to have existed, as to the modes of application.

155. Dr. C. F. Favell, senior physician of the

* Lond. Med. Gaz. Jan. 1832.
† Lond. Med. Gaz. March, 1832.

Sheffield Cholera Hospital,* reports the two following cases of cholera, treated in part by electricity.

I. A man, aged 30, was admitted, at 10 A. M., in a favorable state for treatment. He was ordered two grains of mercury every five minutes, and to have mercurial frictions. At noon, he was sinking rapidly; stools involuntary; cramps in the calves; pulse quick and small. Port wine was given, and an injection of warm water, with opium. At 5 P. M. stools less copious, pulse indistinct, surface cold, voice much affected, eyes sunken, urine deficient. Galvanism was then applied, from the neck to the pit of the stomach, and from the wrists to the ankles. The pulse became more perceptible, and voice strong, with a disposition to sleep. During the night, the patient slept; countenance improved, pulse one hundred and twenty and stronger, tongue cleaner, voice more natural, urine still deficient, no purging, and little sickness. Mercurial treatment continued. No ptyalism ensued, but some dysenteric symptoms. The man recovered in less than a month. The reaction, in this case, was ascribed exclusively to galvanism.

II. A man, aged 36, admitted at 9½ A. M., with purging, vomiting, and cramps; countenance sunk, tongue sodden and cold, pulse small and quick. Sinapisms and hot sand were ordered to legs and feet, enemata of opium and alum, and, internally, neutral salts. At 3 P. M. pulse irregular, sometimes insensible, surface cold, hands blue, stools less frequent. Galvanism

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* Lond. Lancet. March 2, 1833.

was then passed from the neck to the epigastrium, for twenty minutes. It was then passed to the hand. The pulse became stronger and fuller, and the blueness disappeared from that hand. Wine and water were given. He became again subsequently worse. Stimulating injections and frictions were ordered, and the galvanism was repeated. He then gradually recovered.

156. Dr. Favell states that in every case, in addition to these, in which galvanism was tried, the most decided and immediate benefit resulted, though he by no means cured all his patients. In cholera, where there is already an excess of secretion, it would seem that stimulation should be addressed chiefly to the nervous system; and it may be a question whether the uninterrupted battery current should be employed, except, perhaps, through the limbs, to allay the spasms of the muscular system.

157. Neuralgia. — This disease has been treated with great success by many applications of electricity. M. Magendie strongly recommends acupuncture in obstinate neuralgia of the face.* One of the needles constituting the positive pole should be inserted by a sudden thrust near the origin of the nerve, and the other needle, connected with the negative pole, should be inserted near the termination or expansion of the nerve. Magendie uses the magneto-electric machine, the application being seldom more than a few seconds. Sometimes it is necessary to

* Medico-Chirurg. Rev. (July, 1841), from Gaz. Med.

pursue the pain to another branch of the same nerve. The following case deserves attention.

158. "M. Thelin had been subject to frequent attacks of most severe neuralgia, affecting the superior maxillary nerve of the left side, when he first consulted M. Magendie. The pain in the gums, lips, cheek, and ala nasi, was insupportable. The patient could scarcely utter a word, and as for mastication, it was impossible. All methods of treatment had been tried, and all tried in vain. What with having many of his teeth extracted, and being leeched, and blistered, and physicked for months and months at a time, his constitution had suffered severely. He consulted M. Magendie on the 5th of March, 1838. At one sitting of a few minutes, the pain was *chassé*. Since that period, whenever the neuralgia returned, he repaired to M. Magendie, and always left him cured of his suffering. It is now several months since he has had an attack."

159. In two cases of neuralgia of the tongue, reported by M. Magendie, one of the needles was inserted into the affected side of the tongue, the other into the trunk of the facial nerve, where it enters the parotid gland. In one case, the pain in the tongue immediately ceased, and fixed itself in the mental branch of the inferior maxillary nerve. The needle was transferred from the tongue to the skin over the *foramen mentale*. The pain was then driven to the infra-orbital nerve, and the needle transferred to the aperture whence the nerve escapes. The pain was thus pursued, and expelled at a single sitting. In the

other case, the pain, driven from the tongue, went to the sub-orbital nerve, and again back to the tongue, but was ultimately expelled. M. Magendie has found electricity particularly useful in neuralgia of the branches of the fifth pair.*

160. M. James, after referring to the treatment of M. Magendie,† states that he himself uses sometimes electro-magnetism, sometimes the battery. The needles, of gold or platinum, are inserted in contact with the affected nerve. Their insertion rarely gives pain. Blood-vessels should be avoided. A temporary cure is effected at once; but a permanent cure requires several sittings.

161. A tailor, aged 47, under the care of Dr. John Grantham,‡ was attacked, in 1829, with severe paroxysmal neuralgia of the right facial nerve, attended with contraction of the facial muscles. In 1835, after the removal of decayed teeth, and salivation, he was relieved from pain for three months. On its return, arsenic was tried, ineffectually; but carbonate of iron gave a second respite of three months. An attack, of terrible severity, then took place, which gradually declined, after the extraction of another tooth. Carbonate of iron, and galvanism from twenty-four pairs applied to the head, were next employed, which was followed by a respite of two months, when a return of still greater violence took place. Exercise was next tried, without much effect. A battery of

* Med. Chirurg. Rev. April, 1846.

† Ed. Med. and Surg. Jour. July, 1841. — Braithewaite, Part IV.

‡ Lond. Med. Gaz. April, 1837.

forty pairs was then employed, the contact with the skin being made with a shilling attached to the wires. The power was sufficient to excoriate the skin, and the current was passed through the principal nerves of the head and face. Carbonate of soda was given daily during this treatment. In two months, the patient was better than at any previous time, and remained well in March, 1837, six months afterwards.

162. *Sciatica.* — Dr. E. Hermel, in the *Annales Medico-Psychologiques*, of March, 1844,* states that electro-puncture is efficient in idiopathic or essential neuralgia. The intensity of pain is no contraindication, and it is not increased by the application. Palsy, supervening on essential neuralgia, is removed by electro-puncture. These conclusions are illustrated by the following cases, mostly of sciatica.

I. A man, in the Hotel Dieu, aged 44, afflicted with traumatic neuralgia of the sacro-lumbar and lesser sciatic nerves, of five months' duration. Vapor baths had been very useful. Subsequently, moxas had been employed without benefit. The needle, connected with the positive pole of a battery of twenty pairs, was inserted into the sacro-lumbar region, and the negative needle, a little below the external malleolus. The applications, which were of ten minutes, excited copious perspiration in the limb, which could immediately afterwards be bent with less pain. After the fourth or fifth application,

* Lond. and Ed. Month. Jour. of Med. Sc. June, 1844.

the pain did not return, but electro-puncture was still repeated on the three subsequent days.

II. A man in the Hotel Dieu, aged 26, with neuralgia of the right peroneal nerve, of fifteen days' duration, accompanied with convulsive movements. Exacerbations at night. The first application removed the night pains, and lessened the movements. After the third, the punctures became painful, and a suppurating pustule appeared later, which was speedily healed. No further application was made, and he left the hospital cured. There was no perspiration of the limb in this case.

III. A man with sciatica, of four months' standing, was the subject of a single application. It is referred to as having produced a copious sweat.

IV. A woman, at the Hotel Dieu, aged 70, laboring under sciatica, of a very aggravated character, of six months' standing. One application caused copious sweating, and effected a cure.

V. A harness-maker, aged 33, at the Hotel Dieu, with neuralgia of the lumbar plexus, of a month's standing. It had been relieved by leeching and cupping, but had returned. One needle was inserted in the right lumbar region, the other just within the anterior superior spine of the ileum. Twenty pairs of plates were used for twelve minutes, which gave relief. Some slight shooting pains remaining, the application was repeated, three days later, with thirty pairs of plates. From this time he remained well, and was dismissed eight days after.

VI. A butcher's boy, at the Hotel Dieu, with

double sciatica and paralysis, of five weeks' standing. The first application brought the pain to an end, and was followed by involuntary discharge of urine during the night. Several applications were made afterwards, and in thirteen days he was cured, and in twenty-one days dismissed.

VII. A laborer, aged 45, in the Hotel Dieu, with double sciatica and partial paralysis, of a month's standing. He complained of almost total want of sleep. After the first application of electro-puncture, a copious sweat occurred in both limbs, with immediate relief to the pain, and increased power of motion. He also slept well. On the next day, it was repeated with equal advantage. Application was suspended for sixteen days, the vapor bath being substituted. He was then able to walk with only a stick; but, on account of a four hours' return of pain in the right thigh, electro-puncture was used for the third time, with the effect of permanent relief, until his dismissal, nine days later, a slight numbness only remaining.

VIII. A man, aged 27, with severe sciatica, of fifteen days' standing, following meningitis. Electro-puncture, beef tea, and an anodyne, were prescribed. The first application was with difficulty borne for four minutes. The next day, the patient better, and electro-puncture applied for ten minutes. The pain ceased, but he was still unable to stand. The next day, electro-puncture for the third time. He stood and walked. Two days later, he was dismissed, cured.

163. The following cases are related by MM. Bally and Meyraux.

I. A man, aged 63 years, in the Hospital de la Pitié,* in 1825, having femoral neuralgia of eight years' standing, was subjected to electro-puncture. One needle was inserted in the lumbar region, the other in the middle of the inner part of the thigh. The patient's constitution was irritable, and strong contractions were produced by a current from four to six pairs. After the second application, the intervals of paroxysm became longer, and the paroxysms themselves shorter. After five applications, he was completely cured.

II. A man, aged 26 years, with sciatica, which had prevented an upright position for six months, and on which the usual treatment, including simple acu-puncture, had been exhausted, was subjected by the same physicians to electro-puncture. In ten applications, the cure was complete.

III. A man entered the Hospital de la Pitié with femoral and perineo-tibial neuralgia. The paroxysms and spasms were very frequent and severe. One needle was inserted above the great trochanter, the other in the ham. The first application occasioned relief, and a cure followed the eighth.

IV. A man, aged 34, with neuralgia in the inferior and inner part of the foot, of a very severe and paroxysmal character. Cured by eight applications.

164. A case of sciatica which resisted all medical

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* Revue Med. October, 1825.

treatment for several months, but yielded to electro-puncture in fifteen days, is reported in the *Revue Medico-Chirurgicale* of December, 1847. The patient had been twice confined for some weeks to his bed by the disease, frequently passing sleepless nights. The limb finally had wasted considerably, and was kept in absolute rest, as the only condition of exemption from the most severe suffering. The patient was much reduced, by sleeplessness and pain. Galvano-puncture was then employed, with twenty-five pairs, gradually increased in number. The first application was exceedingly painful, but some hours of relief followed its use, so that the operation was subsequently performed late in the day, that the respite might be available to the patient for sleep. In eight days, the patient could stand upon the limb, and in fifteen days the application was abandoned; and shortly after, the patient returned to his home. At a later period, his health was fully reëstablished, without any return of the affection.

165. In the Lancet of July, 1827, Dr. Marchant, of Hemsworth, relates his own case, in which the pain extended from the sacrum to the hip. Leeches, blisters, opium, and other remedies were employed, with some amelioration of the symptoms, but not beyond the point at which a crutch could be dispensed with. Sparks were then drawn, night and morning, for fifteen minutes, from the affected parts, which treatment was followed, in a week, by material improvement, and in three weeks an entire cure. It is stated in the Reports of Guy's Hospital, that relief

was often obtained, in sciatica, by drawing sparks from the seat of pain.

166. *Neuralgic Affection of the Bladder.* — A man, above 40 years of age, under the care of Dr. Hoering,* suffered from severe pain of the bladder, occasioned by cold, and aggravated by the frequent passage of water. One conductor, enclosed in a caoutchouc catheter, was inserted in the bladder, and the other applied to the epigastrium. A cure was effected by sixteen applications.

167. *Neuralgic Rheumatism.* — A correspondent of the Boston Medical and Surgical Journal† furnishes a case, of two years' standing, in which the arm was affected with this complaint, occurring periodically in the night. After a few applications of galvanism and the use of a stimulating liniment, the patient reported himself well, save a slight numbness of the fingers, which was successfully treated by strychnine.

168. Condition of Pain. — The simple condition of pain or uneasiness has been spoken of by writers as allied to neuralgia, and one which may often be removed by electricity, and which, in connection with special diseases, may properly become a subject of treatment.

169. Nervous Headache. — This affection has been represented as easily and rapidly curable, by passing the electro-magnetic or galvanic currents through the brain, from the back of the neck to the

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* Encyclog. des Sc. Med. June, 1847.

† Boston Med. and Surg. Jour. Oct. 1846.

forehead. The sponge handles may be conveniently used, and the application, if properly modulated, will not be found painful or disagreeable. There are some places upon the forehead, in the course of nerves, which are peculiarly sensitive, and which will be readily discovered. This application of the current to the brain deserves to be carefully studied, as regards its influence over the intellectual as well as organic functions.

170. *Sick Headache.* — This complaint may be treated in the same way as the above, but with less certainty or permanence of relief. The treatment should be also directed to the stomach and liver.

171. Nervous Irritability. — In approaching diseases of a spasmodic or convulsive character, electrical shocks, for the most part, cease to be indicated, and a resort becomes necessary to the uninterrupted current of the battery, which promotes, in a very high degree, the regularity of nervous action, or to the electrical spark. In nervous irritability, the stimulus of the electro-magnetic shock may overcome a slight form of disorder; but in graver cases, this application is no longer beneficial, and may even become injurious. The treatment hereafter indicated in chorea would then be appropriate.

172. Hysteria. — No authentic cases have been found on record of the treatment of simple hysteria; but this condition is allied to others which have been treated by electricity with so much benefit, that the battery current may rationally be employed in the paroxysms of this disorder. The uninterrupted cur-

rent should be passed down the spine, or across the chest, by means of the conductors held in each hand. The remarks in the preceding paragraph, and under the head of Chorea, will apply to this disease.

173. Palpitation of the Heart. — Palpitation, where the result of irregular or deficient nervous action, is a proper subject for electrical application. A feeble current from the battery may be passed from the spine to the chest, so as to traverse the heart. The regular action of the heart is then generally increased. An interrupted current would produce, on the other hand, still greater irregularity. A powerful current should be avoided, as it may occasion, at least, distressing sensations. The handle applied to the spine may be moved, during the operation, over the upper half of the vertebral column. The current may also be made to traverse the chest by allowing the patient to hold the cylinder handles.

174. Asthma. — That form of this disease which may be called *habitual* asthma, or difficult respiration, is simulated by division of the eighth pair of nerves in animals. This induced Wilson Philip* to resort to galvanism, in such cases, in the human subject, and almost uniformly with relief. From eight to sixteen pairs were usually employed. Two thin plates of metal, dipped in water, were applied, one to the nape of the neck, the other to the pit of the stomach, or rather lower. The wires from the battery were constantly moved over these, to avoid injuring the

* Vital Functions, 2d ed. p. 331.

cuticle beneath. The breathing became easy, sometimes immediately, generally in from five to fifteen minutes. He found it equally efficacious in cases of from ten to twenty years' standing. In all of the cases to which it was applied, the patients had been able to return to their occupations, and the relief had continued, in many cases, for several months, without relapse, and in others, had been again obtained from the same source. In inflammatory cases of asthma, Wilson Philip found the application of galvanism injurious, until the tendency was subdued by blood-letting. The presence of a severe cough was not found to contra-indicate the use of galvanism; but, on the other hand, the cough was relieved by the removal of phlegm, which took place in consequence of the application.

175. The following are furnished by Wilson Philip, as illustrations of the most and least successful cases of asthma, in which galvanism was employed by him.

I. A lady, aged 35, for many years subject to habitual asthma;—breathing very much oppressed. The immediate effect of the application was to give greater ease than she had experienced for years. Part of this relief remained permanent, and when galvanized for ten minutes daily, she suffered little dyspnœa. On one occasion, to try the effect of imagination, he deceived the patient by scratching the wire upon the neck, without allowing the passage of the galvanic current. No relief was felt. He then passed it from the neck to the upper part of the chest, when slight

relief was obtained. Finally, the current was passed to the pit of the stomach, when the usual effect of former applications was experienced.

II. A young woman, who had been several times galvanized in the usual way, was treated by a current passing down the spine. The breathing was easier, but less so than on former occasions; and after exertion, she was obliged to have recourse to galvanism, as previously administered. This patient remained free from the disease for half a year, when she returned with a slighter attack, which yielded immediately to galvanism, in connection with remedies, which alone had proved inactive.

III. A blacksmith, aged 50, with severe habitual asthma of seven months' standing. Cough troublesome, with thick, yellowish expectoration. After three applications of galvanism, for about ten minutes each time, he declared himself well, and resumed work. Several weeks later, the disease was renewed by intoxication, and he was again relieved with equal facility. During ten months, several slighter attacks occurred, following exposure, which were immediately relieved in the same manner.

IV. A gloveress, aged 28, with asthma of four years' standing. The breathing was rendered easy, in a few minutes, by galvanism, and after the second application, continued so. Three weeks later, she experienced some return of dyspnœa, which was relieved by a blister, which had been previously tried with slight effect. During several months after, she remained well.

V A female domestic, aged 30, with asthma of two months' standing. She was relieved in a few minutes, and after three applications, remained well for several weeks. Reference is made by Wilson Philip to several other similar cases.

VI. A laborer, formerly a soldier, aged 68. He was unable to walk, save at a slow pace, and sometimes had been obliged wholly to abandon work. During his most severe attack, he was relieved in a few minutes by galvanism; and after three weeks of daily applications of ten minutes each, the relief became permanent. A sense of sinking in the stomach was perceived in this as in the previous case, after the application of electricity (probably from the stimulation of that organ), which was removed by carbonate of iron. After two years, this patient had experienced no return.

VII. A female domestic, aged 40, with asthma of five years' standing. The first application of galvanism gave great relief; but this proved unequal in subsequent administrations. Her attendance was irregular, and her consumption of malt liquor excessive. Her breathing and digestion were both improved, though the former continued oppressed.

VIII. A female domestic, aged 24, with asthma of a year's standing. She was quickly relieved by galvanism, but the effect was not permanent. She was cured, subsequently, by an alterative course of medicines, — in part, as Wilson Philip suggests, a result of the previous electrical treatment.

IX. A domestic, aged 29, with severe asthma of a

year's standing, and an inflammatory tendency. She was much relieved by a few minutes' application, and her case improved for ten days, when galvanism failed of its effect. The epigastrium was now tender on pressure. This was removed by blood-letting, blistering, and small doses of calomel. Galvanism became then more efficient even than in the commencement, and she finally left much, though not entirely, relieved.

X. A woman, who had for many years labored under habitual asthma, was galvanized incautiously with such power as to occasion severe pain, and a refusal to submit herself again to the application. She had obtained, however, immediate relief to her breathing, a part of which remained permanent many months afterwards.

176. In a paper, read by M. Pascalis before the Royal Academy of Medicine,* some general remarks are made upon the treatment of asthma, and the following cases are given.

I. A woman, aged 32, an enamel worker, had been asthmatic for ten years. Of late, the disease had increased, and for periods of fifteen or twenty days, there would be a diurnal access of alarming severity. This would be followed by an interval of comparative rest for two or three weeks. The current from a galvanic pile was passed from the back of the neck to the stomach. With the first application, the inspiration, cough, and expectoration, became easier;

* Revue Med. Feb. 1824.

the râle, previously loud, was hardly to be heard. After eight sittings, in the course of fifteen days, she was presented in the following condition. — The specific attacks had ceased. The patient, for the first time, could assume a horizontal position. She could walk without suffocation. A goitre sufficient to embarrass respiration, had diminished, within these few days, an inch and a half in circumference. The patient was able to laugh, without distress, from which she had been long prevented. As a last effect, the application had determined frequent daily discharges from the bowels.

II. Le Général d'Aigremont, aged 55, had been asthmatic for a long time, and to a very high degree. Hearing of the preceding case, he submitted to galvanization. After the first sitting, he was able to ascend three flights of steps without stopping; although previously he was obliged to stop several times in ascending one. After several applications, the amelioration was sufficient to permit singing, dancing, and ascending several flights of stairs without trouble; but it did not remain constant, owing to the full habit of the patient, to imprudences, and intractability, and to the date of the disease. It resulted, however, in great and permanent relief over the previous state.

III. The wife of a *chef de bureau*, at the treasury, had been asthmatic for three years. The asthma was continual, but with frequent exacerbations of three to five hours, or longer, during which she did

not expect to live — cough convulsive, râle excessive, appetite null. There was a painful condition of the larynx, engorgement of the epigastrium, and frequent palpitations of the heart. She had been attended by the best physicians in the capital. MM. Fouquier, Orfila, Leroux, and Bertin, had been called in consultation, and medical treatment exhausted. Improvement commenced with the first exhibition of galvanism. After five applications, the patient assumed a horizontal position the first time for three years. The pain at the heart was less severe; appetite good. After eight days, she ascended and descended the stairs, and walked in the court. Gradually the patient, who was in an advanced state of marasmus, recovered a portion of her embonpoint, and her other symptoms were much improved. This was her condition at the date of publication. An examination of the lungs, by several physicians, at this time, showed the existence of emphysema highly developed.

177. M. Pascalis speaks of a metallic taste, of flashing before the eyes, of rubefaction, and the formation of pustules on the skin under the metallic conductor, and some movement of the stomach as attendants on the galvanic application; also a strong titillation of the throat, by which the secretion of mucus is favored. Respiration becomes deeper, and expectoration free. The patients are left in a state of vigor, contrasting in a sensible manner with previous depression.

178. *Spasmodic Asthma.* — Two cases of this

form of asthma, treated by Wilson Philip,* during the paroxysms showed no improvement. It is probable, however, that the action was too overpowering, and that the cautions, by means of which spasmodic affections have of late been treated with so much success by electricity, were not adopted.

179. Emphysema. — This disease, affecting the structure of the lungs, may be said to constitute a form of asthma, which is equally under the control of galvanism with that complaint, when uncomplicated with structural change. The structural disease also appears to be removed with the dyspnœa. It may be suggested that the dilatation of the air-cells is perpetuated by the difficulty of respiration, and that by relieving the morbid excitement of the nerves, which control the motions of respiration, an opportunity is afforded to the air-cells to return to their original state. A case has already been quoted (§176, III.) of relief in asthma complicated with emphysema.

180. Dyspnœa. — Difficult respiration, from every source, excepting organic lesion, may be treated by galvanism with the prospect of success. The same rules of application would be observed as in asthma.

181. Angina Pectoris. — This disease, so distressing, and so generally fatal, would seem to be included in the class of those ordinarily relieved by electricity. No reliable case of its treatment by

* Vital Functions, 2d ed. p. 336.

this means appears on record. Still, in the confessed inutility of other treatment, the powerful influence of galvanism should be fully tested. The treatment can be inferred from the remarks under the head of asthma and palpitation of the heart. The handles employed would preferably be the surface handles covered with leather. The current should not be excessive. Subjection of the system to the general influence of galvanism by the daily use of the cylinder conductors — one held in each hand — might also be advantageous.

182. Chorea. — Chorea, or St. Vitus's dance, has been treated successfully by the uninterrupted current of the battery, and by the electric spark drawn from the spine of the patient while seated on the insulating stool. The following record of cases at Guy's Hospital, in which the latter method was employed, will be found to possess great interest. The first five cases are by Dr. Addison.*

I. A girl, aged 14, subject to epilepsy, and for four years to periodical chorea; progression and articulation embarrassed. After five applications of electricity, articulation distinct, and walk almost steady. In three weeks a cure.

II. A boy, aged 14, with violent chorea, of which he had had two previous attacks. Little benefit from treatment with zinc for six weeks. Cured by twenty-two daily applications of electricity to the spine.

III. A young woman, aged 21. Had been in St.

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* Guy's Hospital Reports. Oct. 1837.

Thomas's Hospital ten months, with little benefit, afflicted with chorea, and disordered menstruation, and subject to epileptic attacks. The right side most affected. Unable to stand, or lie quiet. After electrical treatment for three or four months, can walk steadily. Much improved.

IV. A girl, aged 16. Chorea with deranged catamenia. Aspect "fatuous, occasionally wild, and almost maniacal." Disease of twelve months' standing. Sparks from the spine, and shocks through the pelvis, for a month. Perfect cure.

V. A girl, aged 12, with chorea and pain in occiput. Electricity, every other day, from spine, for six weeks. Cure. Slight return after two months, which yielded to sulphate of zinc.

183. In Guy's Hospital reports for 1846, Dr. Hughes gives a digest of one hundred cases of chorea, fourteen of which were treated by electricity. Several of these were of long duration, and of the most severe form. A cure was effected in nine cases, and failed in five. Dr. Hughes remarks, "The effects of electricity in chorea are sometimes very remarkable. On some occasions, I have known it to effect a cure after a great variety of other remedies had for weeks and months been tried in vain. . . . . The change has not been more beneficial than it has been rapid. In the course of a week or ten days, the entire aspect of the patient has been changed. . . . . When electricity acts beneficially in chorea, it produces its effects more rapidly than any other remedy with which I am

acquainted; but it is a remedy which is not of universal application in chorea. In some patients it has obviously done harm. In weak, nervous, timid children, electricity increases the disease." This statement should be compared with the following testimony.

184. Dr. Golding Bird furnishes a table of thirty cases treated by electricity in Guy's Hospital,* in addition to those given by Dr. Addison, in one of which, where organic disease of the spinal cord was indicated, there was no relief; one left from alarm, five were much relieved, and twenty-three cured. A few of these were under contemporaneous medical treatment — mostly mild purgatives. In many of them, every variety of treatment had been exhausted before having recourse to electricity. The treatment was confined to machine electricity drawn by sparks from the spinal column. The application was made every other day, for five minutes, or until the papular eruption appeared (§ 13). The disease was sometimes increased on the first application, from the alarm of the patient; but this rapidly subsided. Details are given of nine cases, which may be thus briefly stated.

I. A girl, of 8 years, with universal chorea, following rheumatism. Treated by the ordinary remedies for a month, without success. After three days' electrical treatment, speaks and swallows easily. In sixteen days, not a trace of chorea left.

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* Guy's Hospital Reports. April, 1841.

II. A boy, aged 12, with chorea, apparently caused by tapeworm; muscles almost universally affected. Two months' ordinary treatment ineffectual. Electricity for three days. Much improved; — in thirty-four days cured.

III. A girl, aged 16. Chorea resulting from amenorrhœa. After five applications, the catamenia, absent for three months subsequent to its first appearance, recurred, and the chorea vanished. Two months later, the catamenia not appearing, she applied again, and a few shocks restored the function.

IV. A girl, aged 15. Chorea from fright, affecting right side. In three weeks, she left, nearly cured. Disease returned again in twenty days. In thirty-nine days, discharged well.

V. A girl, aged 12, with chorea confined to right arm. After three applications, she left, relieved. The disease again rallied. In twenty-four days, discharged cured.

VI. A man, aged 40, with chorea from exposure to cold, confined to sterno-mastoid muscles. The spasms, on any excitement, produced torsion of the neck, threatening strangulation, and were resisted by the hand of the patient applied to the head. Sparks taken from the spine and sterno-mastoid muscles. In about a month, he left, tolerably well. Irregular habits brought on a return. He was again subjected to electricity, and in a short time was convalescent.

VII. A lad, of 18. Chorea of right side. In sixteen days, only slight affection remaining. *Shocks* were now passed along the leg and arm. In three

days, the disease had returned, with almost full strength. *Sparks* were again ordered, with sulphate of zinc, and in six weeks he was discharged cured.

VIII. A man, aged 45, with congenital (?) chorea, causing constant motion of the fingers, increased by excitement. Had continued from his infancy. After a fortnight's application, while under treatment for another disease, the motion remarkably diminished.

IX. A man, aged 40, subject to spasms of the jaw, producing dislocation. Sparks drawn from affected muscles with remarkable benefit. Subsequently, under use of sulphate of zinc, he was discharged cured.

185. Dr. Bird has found that *shocks* applied to the affected parts, in chorea, are always injurious. This agrees with the universal experience in spasmodic diseases, in which the uniform and harmonizing current of the battery, and sometimes the spark, are exclusively indicated. Dr. Bird considers the "eruption," produced by his peculiar use of the spark, as contributing much to the effect. A similar local irritation might be found useful in applying the battery, as in Wilson Philips' treatment of asthma.

186. Catalepsy. — A prisoner, at Beccles,* was seized with catalepsy, of which he had had an attack nine years previously. The upper extremities retained any position in which they were placed, the power of swallowing was suspended, and the pulse varied from eighty to one hundred and twenty beats

* Prov. Med. and Surg. Jour. Nov. 1846.

in the minute. After four days' use of other treatment, with occasional remissions, electro-magnetic shocks were passed through the right arm. Powerful contraction ensued, with convulsion of the lower jaw, and rapid protrusion and retraction of the tongue. A more powerful application caused violent and irregular respiratory efforts, raising the pulse from sixty to one hundred and forty beats per minute, and finally the lower extremities became also convulsed. Violent sobbing succeeded, and sensibility gradually returned. On the following day, another attack was treated in the same manner, with a similar result. A slighter one subsequently occurred, within a few days, when he left the neighborhood. This case was under the care of Dr. W. H. Crowfoot. The effects produced by electro-magnetism, in this case, show, in a striking manner, the impropriety of using the induced series of shocks in any convulsive disease. The primary current of the battery should be alone used in catalepsy, with the object of restoring the nervous equilibrium and increasing the nervous power. Galvanism is stated to have been rapidly successful, in similar cases.

187. Convulsions. — In all convulsive diseases in which there is not organic lesion, benefit may be anticipated from the use of the uninterrupted current of the battery flowing in the direction of the ramifications of the most important nerves, and especially in the course of the spinal column.

188. Epilepsy. — In the treatment of epilepsy, referred to the brain, no advantage was obtained, in

Guy's Hospital, by Dr. Bird, from the use of the spark. In hysteric epilepsy, connected with derangement of the uterine functions, electricity was of material service. The following case is given in illustration.* A girl, aged 15, who had never menstruated, became subject to epileptic attacks, six months before admission; intervals irregular, duration fifteen to twenty minutes. Oct. 10, 1839, shocks to be passed through the pelvis thrice a week. After the second application, pains were felt in the back and loins, and the catamenia soon afterwards appeared. From this time, the fits ceased.

189. Dr. Addison relates a similar case,† complicated with chorea, much relieved by electro-magnetism. This was a girl, aged 17, who, after a violent fright, was attacked with chorea, accompanied by peculiar automatic movements of the hand, and thenceforward was subject to menstrual disorder. She was at length seized with epileptic fits, which had begun to show their worst effects upon the mind and active powers. The ordinary treatment was exhausted, and the paroxysms now returned two or three times daily. Electricity was ordered, as a last resource. On the 20th of April, the electro-magnetic current was passed down the spine for the first time. On the 10th of May, she could use her needle with tolerable precision, and the fits were slighter, though as frequent. Sparks were then drawn from the spine, every other day, with most marked benefit. June 1, twelve shocks

* Guy's Hospital Reports. April, 1841.
† Guy's Hospital Reports. Oct. 1837.

through the pelvis were ordered. The first application was followed by pelvic and abdominal pains, the immediate precursors of the catamenia. July 3, continued improvement, but no return of the catamenia. A second exhibition of the shocks again developed the function. July 15, she left the hospital free from chorea, though still subject to fits of diminished force and frequency.

190. Other cases will be found under the head of Chorea, in which epilepsy, as a complication, was benefited by the same treatment.

191. A French practitioner * details a case under the name of epilepsy, in which the patient, a girl, aged 12, had been subject to attacks since her sixth year, in consequence of a fright. Galvano-puncture was used. One needle was inserted immediately beneath the occiput, the other in the integument of the epigastric region. The first application was during a seizure, and was followed by an immediate return of sensibility. It was repeated on the following day, and no fit took place for a week. Two attacks then occurred, at intervals of eight days. Subsequently the application was made at the commencement of the seizure, and a respite of a month ensued, after which, during six months, the disease had not returned.

192. In true epilepsy, electro-magnetism should not be employed; the use of the spark is at best doubtful; while the uniform current of the battery

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* Lancet. July, 1843.

deserves always a trial, and in epilepsy, without organic change in the nerve centres, it may be expected to produce a favorable effect.

193. Tetanus. — Matteucci states that the passage of the continued current of the battery in the direction of the ramification of the nerves, exhausts their excitability, and prevents spasm in the case of frogs tetanized by narcotics.* To reduce the nervous irritability in tetanus and convulsive diseases, he urges therefore this use of the current of the battery. A case of tetanus, which came under the observation of Matteucci at an earlier date, is given below.

194. D. Branzanti, aged 51 years,† received a charge of shot above the internal malleolus of the left ankle. After the cicatrization, symptoms of tetanus appeared. The current of thirty to thirty-five galvanic pairs was then passed from the back of the neck to the sacrum, to the abdomen, and to the wounded limb. The time of application was twenty to thirty minutes, and it was repeated six times during seventy hours. Each time the patient seemed more calm, and the spasms of the jaw and muscles diminished. The warmth of the surface was also increased, perspiration reëstablished, secretion of the kidneys excited, and the capillary circulation quick ened. Unfortunately, this amelioration ceased about half an hour after each application, the condition of the patient grew worse, and he finally yielded to the violence of the disease. A post-mortem examination

* Lancet. Aug. 1847.

† Revue Med. Oct. 1839.

showed softening of the spinal cord, and entire disorganization in the branches which form the cauda equina. No other result could, therefore, have been anticipated, at least in the latter part of the disease. The use of the battery current is here shown in calming spasmodic excitement. M. Matteucci, in communicating the above case to the French Academy,* remarks, that the impression of the beneficial effect of this application was such upon those physicians who were present, that they would at once resort to it in similar cases. The experiment was not thoroughly satisfactory, in that the battery was out of order, and could only be used in the intermittent way described above, instead of continuously.

195. Dr. Taylor reports a case of tetanus, occasioned by a blister, in a lady aged 30. The jaw was firmly closed, and other tetanic symptoms present. The most powerful antispasmodic treatment was employed, including ether to the shaved head, belladonna to the face, and opium, by draught and injection. The spasm increased so that the body was bent like a bow, and supported only by the heels and occiput. Weak shocks from a Leyden jar were then administered to the face, which soon produced relaxation of the jaws and muscles of the abdomen, accompanied with exhaustion. Wine and a suppository of opium were ordered. The patient slept, but in the morning suffered another paroxysm. Electricity now applied was without effect, until

* Revue Med. June, 1838.

opium had been administered for two hours, when relaxation of the muscles was again produced by the same means. The patient gradually recovered. Dr. Taylor ascribes the success to the conjoint use of the opium and electricity. The form of application in this case was so unfavorable, that the full effect of electrical treatment could not be observed.

196. Dr. J. Adams relates two cases of traumatic tetanus, in the London Hospital, in which he attributes the cure to electricity.*

I. A boy, of 7 years, seized with tetanic symptoms, in consequence of laceration of the skin and muscles of the calf of the leg. Spastic curvature of the spine appeared. Opium gave no relief. Sparks of machine electricity were then drawn from the spine, while on the insulating stool, with at first an aggravation of the spasms; but afterward with decided improvement, the curvature of the spine relaxing under its influence. It was frequently repeated with the best effect, until it seemed to have lost its power; and on the third day a relapse occurred. Opium and strychnine were then resorted to, and gradually proved effectual, the child entirely recovering. In this case, the primary current of the battery was strongly indicated, and would, it may be presumed, have proved more powerful, as well as more safe, than the use of machine electricity.

II. A man, aged 45, with tetanus supervening on a punctured wound of the great toe. The symp-

* Lond. Med. Gaz. Jan. 1842.

toms were severe, and opium, in large doses, gave no relief. Strychnine was administered with decided benefit, but increased the spasms in the legs, so that the patient refused to continue it. Electricity was then employed, as in the last case; after which he was immediately able to walk back to his bed. It was subsequently applied whenever there was severe spasm, and always with success; the man gradually recovering. A blister was applied to the spine during the treatment.

197. Hydrophobia. — The spasms of this disease, like those of tetanus, may be well supposed to be under the control of galvanism. Dr. Donovan, of Dublin, relates a case in which it was successfully employed.* In both of these violent spasmodic diseases, the inhalation of ether would now be prescribed. Another powerful antispasmodic agent should not, on that account, be overlooked, especially as the action of galvanism and etherization are complementary to each other. Etherization acts by overcoming nervous excitement, and occasionally produces an unfavorable prostration. Galvanism acts by bringing the nervous system into full and harmonious action, thus controlling irregular manifestations. Both agents may, therefore, have an important place.

198. Spasm. — Dr. Dewees† says, in the New York Journal of Medicine, "In the most frightful case of tonic spasm from utero-spinal causes, the

* Dub. Jour. May, 1847.

† N. Y. Jour. of Med. May, 1847.

continued current has, in my hands, proved a perfect charm, as witnessed by our distinguished townsmen, Drs. Mott and F. U. Johnston. In this extraordinary case, the *interrupted* current proved highly injurious, causing convulsive actions, while by the simple galvanic current the spasms would be immediately broken."

199. Stammering. — It is stated that this affection has been cured by diligently passing the electro-magnetic shocks from the tongue to the surface of the throat, to which a sponge handle should be applied in various positions. Considering stammering, however, as a convulsive affection of the glottis, the current should be directed particularly to that organ, and galvanism should be preferred to electro-magnetism.

200. Hiccup. — Two cases are reported in the London Lancet,* from a French practitioner, in which hiccup was treated by passing the galvanic current by acu-puncture needles from the back of the neck to the epigastrium. The first was a case of two years' standing, in a young woman subject to chronic gastritis, who was cured by a few applications, but required a continuance for six weeks to prevent a relapse. A case of hiccup after typhus fever was cured in the same way.

201. Colic. — The spasms of this disease, and the irregular or inverted peristaltic motions of the intestines, are subjects for experimental treatment

* Lond. Lancet. July, 1843, from Jour. des Conn. Med. Chir.

with galvanism. The current would be passed from the back of the neck and spine to the perineum, and different parts of the abdomen.

202. Fevers. — The nervous system is very largely involved in the phenomena of fever. In this condition, circumstances often arise in which the use of electricity may be of great value. These have been partially indicated under preceding heads. The alterative action of electricity, generally applied, may prove useful in breaking up a sluggish fever, especially of a nervous origin. In congestive and typhoid fevers, its use in arousing the system has already been spoken of. (§§ 150, 152.) In fevers connected with the bilious system, an important application would consist in arousing the liver to a state of functional activity. (§ 216.) In fevers resulting from local inflammation, the revulsive action of electricity (§ 64) may have a place. In eruptive fevers, it has been proposed to use the stimulating power of electricity over the skin, to bring out suppressed eruptions. Statements have appeared, though not authoritative, of the successful use of this form of application. When it is considered that a large surface may be rapidly excited by sweeping the sponge conductors over it, moistened with a stimulating solution, the proposition will not appear irrational. In the cases also of suppressed eruption, in exanthematous fevers, there is usually great nervous depression, which galvanism may, at the same time, be employed efficiently to combat.*

* N. Y. Jour. of Med. May, 1847.

These suggestions are made principally with a view to draw attention to a class of applications which may well repay investigation.

203. *Intermittent Fever.* — Mr. Luke Howard, F. R. S., reported, in 1833,* several cases of intermittent fever in the care of Mr. P. Smith, as having been cured by placing the patient on the insulating stool, and drawing sparks from the spine at the same time that they were received at the epigastric region. When this was done in the hot stage, the pulse was speedily reduced, and a few applications produced a permanent cure, even in obstinate cases. The statement is of interest, as indicating a probable application of electricity in effecting reaction, and changing the nervous condition in this disease.

204. M. Fabré Palaprat stated before the French Academy, in the same year,† that he had cured a case of quartan fever by the electrical transfer of quinine through the body of the patient. This is based on the well-known principle of the transfer of substances in solution by the electrical current. Where a membrane like the skin, however, is interposed, it requires a very powerful current to effect the passage of a substance through it. If the surface was blistered, where in contact with the conductors from the battery, a current of less power would probably be sufficient. The rapid dissemination of medical agents, in this way, through the system, is a subject which deserves additional investigation.

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* Lond. Med. Jour. March, 1833.

† Revue Med. May, 1833.

RHEUMATISM AND GOUT.

205. These inflammatory affections may be classed together, in reference to their electrical treatment. In rheumatism, at least, electricity has proved extensively useful. Dr. Prosch, of Hamburg,* in reporting fifty-three cases of different diseases, chiefly of the muscular and nervous systems, treated by electro-magnetism, of which only twenty-four were cured or much improved, yet includes among the latter ten cases out of eleven in all, of rheumatism of the muscles and fascia. With the exception of this comparison, the table, as republished, and referred to above, is valueless, as the mode of treatment does not appear.

206. Rheumatism. — *Acute.* — According to Dr. Dunglison, of Philadelphia,† "Sarlandiere restricts the use of electricity to rheumatic or neuralgic pains, uncomplicated with organic mischief or inflammation." This refers especially to machine electricity, but is not sustained by later authorities. Rheumatism, from its neuralgic relations, appears to have been treated beneficially by electricity in almost all its forms, in all periods of inflammation excepting that of greatest excitement. Galvanism, which generally increases the action of a part, should be used with caution. The electric sparks and electro-magnetic shocks have been found of great service; the latter, it is stated, sometimes at once relieving the pain.

207. *Lumbago.* — Muscular rheumatism is stated,

* Boston Med. and Surg. Jour. 1845.

† Braithewaite, Part V.

by M. Raciborski, of Paris, in the *Gazette Medico-Chirurgicale*, to yield readily to galvanism [electro-magnetism]. Lumbago was sometimes so far relieved by a few shocks, as to permit muscular motion without pain. He says, "We do not doubt that the forced contraction which the galvanic shock produces in the fibres of the muscles rendered motionless by the rheumatism, must contribute considerably to the good effects derivable from this means."

208. Relief was frequently obtained, in lumbago, at Guy's Hospital, by drawing sparks from the seat of pain.

209. *Chronic Rheumatism.* — A case of rheumatism, disabling the left knee and foot, in a countryman, aged 60, is reported by MM. Bally and Meyraux, of the Hospital de la Pitié,* which was cured by galvano-puncture, being one of the earliest instances of that treatment. In the case of the knee, the needles were plunged half an inch beneath the surface, and at a distance of three inches apart. Six applications effected a cure, and four additional ones to the foot produced a similar result. The usual resources had been previously exhausted.

210. A case of chronic rheumatism of the shoulder, in a mason, aged 23, is also reported by the same physicians. A needle was implanted in each shoulder, and the current of six pairs passed through them by frequent contacts. After the seventh application, the pain had ceased, and only slight stiffness remained.

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* Revue Med. Oct. 1825.

A superficial application, in this case, proved ineffectual.

211. The action of electricity, in chronic rheumatism, is probably alterative and stimulant in the first instance. Any neuralgic tendency is removed, and the absorbents are excited to action. The sponge handles may be applied on opposite sides of the affected part, and moved so as to pass the electro-magnetic shocks in all directions through it. The spark was used with success at Guy's Hospital. Galvanism is reported to have acted with efficiency in many cases, by superficial application as well as acu-puncture. It is to be regretted that the details of treatment have not been more generally preserved in the almost universal testimony to the value of electricity in this form of the disease.

212. *Rheumatic Swellings.*—Dr. Hoering, of Heilbronn,* gives the case of a patient who was affected with rheumatic swellings of the cellular tissue, especially of the upper extremities. One conductor was placed in the hand or in a foot bath, and the other was passed over the diseased surface. The improvement was marked from the first application, and in fifteen days all the movements were more free. In the sixth week, all the pain and swelling had disappeared. The case of an ecclesiastic is also given, with very painful rheumatic swellings of almost all the articulations. After the first application, the pain was so much diminished as to allow

* Encyclog. des Sc. Med. June, 1847.

him to sleep for two hours, which had not occurred for months previously. In three weeks, the pain had completely disappeared, and the movements had become more free, when the patient discontinued its further use.

213. In all rheumatic enlargements, where absorption is to be promoted, the current of the battery should be used.

214. *Periodic Rheumatism.* — A case was related by M. Chailly to the Society of Medicine of Bourdeaux,* and by them ordered to be printed, in which a courier, aged 38, subject for five years to periodic attacks of rheumatism and gout, and also to pleuritic affections, had been apparently cured, and his general health restored, by a powerful shock from a flash of lightning, which prostrated the four horses of the carriage in which he was travelling. His flesh had returned, and the month of March, in which he was always subject to ingress of disease, had passed without any attack of gout or rheumatism.

215. Gout. — This disease is said to have been treated successfully, at its height, by the galvanic moxa, the platinum needle being plunged into the inflamed part, and instantly becoming incandescent. The inflammation is stated to centre on the ulcer thus produced, which discharges freely. Dr. Koenig † states that he has treated gout successfully by galvano-puncture, inserting the needles as deep as possible.

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* Revue Med. Oct. 1835. † Revue Med. April, 1830.

SECRETING ORGANS.

216. Torpid Liver. — Where an inactive state of the liver exists, as a cause or effect of other diseases, the power of speedily developing the bilious secretion is possessed by galvanism to a very striking extent. Wilson Philip, in a remark already quoted, says, "I have repeatedly seen the same effect upon the biliary system which arises from calomel; a copious bilious discharge from the bowels coming on within a few hours after its employment." This application is an important one. The current of the battery should be transmitted from the back of the neck and spine to the region of the liver, by means of surface handles.

217. Mucous Surface. — The effect of electricity upon the mucous secretion in the respiratory organs cannot be better illustrated than by the following remarks upon a disease embarrassing respiration, in part, by its effects on secretion.

218. *Mucous Secretion in Apoplexy.* — Wilson Philip* states that the respiration in sanguineous apoplexy is interrupted more by accumulation of phlegm than by the lessened action of the muscles of inspiration, the secretion assuming its character and remaining adherent on account of the withdrawal of the nervous energy from the lungs — a conclusion amply established by his experiments on the division of the eighth pair of nerves. This accumulation is

* Vital Functions, 2d ed. p. 272.

often the cause of death. On passing the battery current through the lungs in this condition, Wilson Philip says, "After the rattling breathing had come on, and the patient seemed about to be suffocated, he was, at least a dozen times, made to breathe with ease, the accumulation of phlegm gradually disappearing on the application of galvanism, by which his life was evidently prolonged." Galvanism is not here employed as a means of cure in the original disease, but for the purpose of removing an obstruction by which time can be gained for the use of other remedies. It should be employed with caution, and not more than ten minutes at once. Other functions may be stimulated in a similar manner. The battery alone should be used, and any injurious effect upon the circulation may be neutralized by blood-letting.

219. *Secretion of Throat and Lungs.* — The electro-magnetic current passed through the throat from side to side, and from the back of the neck to the sternum, is stated to relieve irritation of the throat, probably by its alterative action on the mucous membrane. In deficient secretion or dryness of the throat, and also of the lungs, the battery current would be preferable, in a gentle and diffused form.

220. Salivary Glands. — These glands are very readily excited to increased action by electricity passed through them, or through almost any part of the face. Whether, in excessive salivation, any benefit would be derived from the alterative influence of electro-magnetism, has not been ascertained.

221. Tear Glands. — In the treatment of amaurosis by Magendie, the stimulation of the tear glands has been alluded to. (§ 123.) In deficient secretion, this might prove a valuable resource.

222. Urinary Secretion. — In both the deficient and diseased secretion, electricity would deserve, by analogy, to be applied — the current being passed through the kidneys from side to side, and also in the course of the spine. Galvanism and electro-magnetism would be employed respectively when increased or alterative action was required.

223. Suppressed Perspiration. — The function of the skin is very readily influenced by galvanism, either when applied by handles placed near each other on the surface, or when it is passed through a whole limb. This will have been observed under preceding heads. In suppressed perspiration, and all diseases in which the skin is inactive, use may be made of this application. Electrification on the insulating stool is stated, by Wilson Philip, to increase the action of the skin.

DIGESTIVE FUNCTION.

224. Dyspepsia. —Wilson Philip treated a number of cases of dyspepsia in connection with asthma,* in all of which the improvement in the digestive function was marked. The action of galvanism on the bilious secretion, where deficient, has already been stated. (§ 216.) Experiments made on animals, by

* Vital Functions, 2d ed. p. 339.

Wilson Philip, show that the process of digestion is continued after the division of the eighth pair of nerves, by means of a supply of galvanism. This may be attributed to the influence of electricity on the secretions and vital warmth of the stomach. The conclusion, from all observations on that class of diseases commonly known as dyspepsia, is, that where functional, and not organic, they are peculiarly under the control of electricity, especially of galvanism. Where active inflammation exists, galvanism should not, however, be employed. The chronic diseases of digestion, which are so obstinate under medical treatment, should become peculiar subjects of investigation, with those who wish to develop the applications of electricity. All the organs contributing to digestion may be roused into action, and another advantage may be gained by the exercise or movement of those organs by means of the electro-magnetic shocks. If these are passed through the abdomen, contractions take place in every direction, effecting a thorough agitation of the organs, without any serious discomfort.

225. *Constipation.* — It has been shown that the peristaltic action is readily promoted by electricity in a majority of cases. (§ 111.) Dr. Dewees states,* "There is, in most all cases of chronic constipation (from enteric inactivity), excessive dryness, not only of the fæces, but of the mucous surface of the intestines. This state is speedily remedied by the cur-

* N. Y. Jour. of Med. May, 1847.

rent, the secretion of the bowels being announced in a few days. Where the nervous prostration is very great, and the person should be of a relaxed leucophlegmatic habit, the gut is frequently found in an opposite condition, being relaxed and coated with a gluey mucus, the presence of fæcal matter not being noticed by the bowel. After a few days' use of the battery, this becomes remedied, in both states; the intestine is stimulated, and a secretion of fresh mucus takes place, with increased propulsory powers." By passing galvanism through the liver at the same time, the stimulus of the bile is also brought to bear upon the intestine. The form of application, in these cases, is to pass the current, by means of surface handles, from the back of the neck or spinal column, to the perineum, or to the abdomen over the organ to be excited.

226. *Sick Headache*, as a result of indigestion, has already been spoken of. (§ 170.) *Heartburn*, where produced by a similar cause, would be treated primarily by action on the stomach and spinal cord, and by the passage, perhaps, of a weak current through the heart.

DISEASES OF INFLAMMATION.

227. Laryngitis. Bronchitis. — Where these inflammations are chronic, or passive, electricity has been found beneficial, by its alterative influence on the mucous membrane, and also by increasing secretion, or rather by adding to the fluidity of secretion. In ulceration of the throat, of a specific character,

this alterative action may also deserve a trial. The same may be said in regard to *croup*. In a congested state of the mucous membrane, the stimulating influence of electro-magnetism might, in some cases, be employed. When the disease is in the throat, the current may be passed through the larynx in various directions, or from the tongue to the chest; when in the lungs, from the back of the neck or tongue to the base of the chest. It may be useful to make the application to the throat in such a way as to increase the action of the skin.

228. Pleurisy. — This inflammation, accompanied with effusion, has been treated with success by electricity, according to various accounts. It may be said that the inflammations of the serous membranes generally seem to be benefited rather than injured by the influence of feeble electrical currents. The subject of serous effusion will be treated of hereafter.

229. Pneumonia. — The testimony is universal as to the bad consequences attending the use of electricity in this disease, at any rate, in the active stages of inflammation. In the latter periods of oppression from a viscid secretion, or from a passive congestion of the lungs, electricity might, with the utmost caution, be resorted to, in default of other means, to relieve respiration. The revulsive use of electricity applied to other organs might be serviceable in earlier stages of the disease.

PHTHISIS.

230. Phthisis. Consumption. —Dr. Wilson Philip remarks, "In some, laboring under the most chronic forms of phthisis, in whom the symptoms had lasted several years, and habitual asthma had supervened, the relief obtained from galvanism was very great, notwithstanding some admixture of a pus-like substance, in what was expectorated. I need hardly add, after what has been said [concerning inflammation], that, in ordinary cases of phthisis, nothing could be more improper than the use of galvanism." * This last has reference to the battery current exclusively. In cases of insufficient secretion of the lungs connected with phthisis, or of a secretion deprived of its fluid constituents, or of a generally inactive state, the battery current may be applied in Wilson Philip's way. In cases where the inflammatory tendency was distinctly marked, feeble electro-magnetic shocks might be found useful to give nervous tone to the lungs, without increasing inflammation. Where the mucous membrane is extensively diseased, there is a possibility, which should be always kept in view, of increasing its vital action, by subjecting it to galvanic or electro-magnetic influence. Neither should the idea of promoting absorption of tuberculous matter, however improbable, be dismissed without a moment's consideration. Another application to phthisis, of which electricity

* Vital Functions, 2d ed. p. 340.

is always capable, is its influence upon other functions, and the general tone of the system. It may also be used as a counter-irritant to the lungs, by bringing the skin, or other organs, into normal or excessive action. In the last stages of phthisis, when the accumulation of mucus is a cause of distress and danger, the battery current might be used, as in apoplexy (§ 218), to relieve the burdened respiration of the patient, by its effect on secretion.

DISEASES OF TISSUES.

231. Atrophy. — In the wasting of an organ by deficient nutrition, either from the want of nervous supply, or of vitality in the tissue, the daily use of galvanism is indicated. The current should be sent in the opposite direction to the organic nervous current. Where the organ or part is to any extent muscular, electro-magnetism would also be employed to advantage, and would not be excluded in other cases.

232. Hypertrophy. — Where an interstitial deposit takes place in any organ from a want of proportional activity in the absorbent system, electricity, by its vital stimulation, in many cases, effects absorption, and occasions a return to the healthy state. This may not cover a large proportion of cases of enlargement of organs. Still the power of stimulating absorption exists, and deserves a trial in all such cases. In hypertrophy of the heart, with serous effusion, it may be employed with caution. The battery current would here be most efficient.

233. *Enlarged Liver.* — This affection, following so many diseases, deserves especial notice in connection with the power of promoting absorption and vital action in the tissues. A moderate and patient use of galvanism through the organ would be required. Inflammation or over-action would contra-indicate its use.

234. Hemorrhage. — Where this exists of a passive character, from vascular inertia, or diseased condition of the tissues, electricity may be with confidence employed, though with discretion, in case of inflammation. A moderate, uninterrupted galvanic current may be sent through the organ; or, in the case of the mucous surface connected with the digestive and respiratory apparatus, it may be sent from the mouth to the rectum, or base of the chest. The power of electricity in producing organic contractility would here be of use.

CUTANEOUS DISEASES.

235. It has been stated that electricity exerts a powerful influence over the skin, stimulating all its functions. This action is, of course, alterative, and inconsistent with many diseased states. Under surgical applications, its use in ulcers and tumors will be spoken of. It is sufficient to say here that, wherever an application to the skin is proper in a cutaneous disease, the free use of electricity with a soft sponge handle, moistened with an appropriate solution, and swept over the surface, deserves a confident trial. In inactive states of the skin, this is

especially the case. In active inflammations, only electro-magnetism would be proper. Otherwise, the battery would be indicated.

236. The bath is a very favorable mode of application in cutaneous diseases. With a powerful battery, the electrical decomposition of the liquid employed would probably exert a decided influence upon the diseased surface. According to the direction of the current, the electro-positive or electro-negative element of the chemical compound in solution would be given off in a nascent state in contact with the skin. The electrical air-bath (§ 13) has been suggested by Dr. Golding Bird as an alterative agent in cutaneous diseases.

237. In cutaneous diseases, such as *Herpes*, in which there is a neuralgic complication, electricity deserves especial attention. It should then be administered generally, as well as locally, to give tone to the system. The proposed use of electricity in suppressed eruptions has been spoken of under eruptive fevers.

238. *Baldness.* — In connection with cutaneous diseases, I venture to suggest the application of electricity to the scalp, when the loss of hair ensues upon deficient vitality of the skin. The diseased state of the surface, including the roots of the hair, producing ultimate baldness, may probably be removed by an occasional stimulating application of galvanism.

UTERINE SYSTEM.

239. *Amenorrhœa.* — No function has been more readily excited by electricity than that of menstruation. Dr. Golding Bird, in his lectures delivered in 1847,* says, "In electricity we possess the only really direct emmenagogue which the experience of our profession has furnished us with. I do not think I have ever known it fail to excite menstruation where the uterus was capable of performing this function." He says again,† "The rule for insuring success, in the great mass of cases of amenorrhœa, is sufficiently simple: Improve the general health by exercise and tonics; remove the accumulations often present in the bowels by appropriate purgatives; and then a few electrical shocks, often a single one, will be sufficient to produce menstruation, and at once to restore the previous deficient function." With but one or two exceptions, every case in Guy's Hospital, in which the general health was not too much involved, as by chlorosis, proved successful with this treatment. In cases of chlorosis, the treatment was directed first to the removal of that disease. A dozen shocks of the Leyden jar were usually passed through the pelvis from the sacrum to the pubes. After the establishment of the discharge, Dr. Bird generally discontinued the application till about a week before the next period. If the catamenia were not established in four or five weeks, he discontinued electri-

* Lond. Med. Gaz. June, 1847.

† Guy's Hospital Reports. April, 1841.

cal treatment, and renewed it, after searching for and removing the cause of general derangement. A table of twenty-four cases is given by Dr. Bird, in which there was no relief in four, who were subjects of well-marked chlorosis, but cure in the remaining twenty. The following is an abstract of the detailed cases.

I. A girl, aged 16. No return of menstruation from the first period, nine months previous, owing to a cold. Twelve shocks were passed through the pelvis. The next morning, the catamenia appeared, and lasted four days.

II. A woman, aged 21, with amenorrhœa for three years. Health improved, and a slight appearance of the discharge three days previous. Twelve shocks passed through the uterus. Catamenia shortly appeared, and continued two days.

III. A girl, aged 17. Appearance chlorotic. Amenorrhœa for one year, except a slight appearance three months since. Shocks daily through the pelvis, and tonic treatment. On the third day, menstruation commenced, and continued four days.

IV. A girl, aged 18. Suffering from amenorrhœa for a year, and irregularity for four years. A slight appearance five weeks since, attended with pleurodynia. Jan. 3, 1840, shocks thrice a week, and aloetic prescription. Jan. 13, catamenia appeared, and lasted two days. Electricity intermitted for a fortnight, and recommenced Feb. 4. Feb. 14, menstruation occurred freely.

V. A young woman, aged 19, with suppression

for two months. Aloetic purgatives. Jan. 31, shocks through pelvis thrice a week. Feb. 10, free menstruation. Electricity suspended for a fortnight, and renewed. Menstruation returned copiously at the proper period.

240. Other and still more striking cases will be found under the head of Chorea, from the Reports of Guy's Hospital. Machine electricity was here almost exclusively used. Electro-magnetism and the battery have been found elsewhere equally efficient.

241. Dr. Collins, in the London Lancet, relates the case* of a woman, aged 35, in whom suppression had taken place, from cold, six months previously. After trying the usual remedies without success, he applied one pole of the electric apparatus to the lumbar region, and the other to the pubes, changing the direction of the current from time to time. After continuing it for five to ten minutes each day for five days, the menses were reëstablished.

242. In amenorrhœa, an admirable mode of application is the hip bath, in which one of the poles of the electro-magnetic or galvanic apparatus is immersed near the organs to be specially operated upon. The other handle may be applied in the course of the spine, or in the bath on the opposite side of the body. In all diseases of menstruation, it is stated that the passage of a current from the spine to the mammæ aids the development of the function.

243. Dysmenorrhœa. — Dr. R. McDonnel, in the

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* Lancet. Jan. 25, 1845.

Dublin Medical Press,* speaks of the efficiency of electricity in this form of menstrual derangement. The mode of application of electro-magnetism recommended by him, is to pass the current from the sacrum to the pubes by surface handles, or in some cases to substitute a vaginal conductor for the anterior one of these. The effect of electricity is, in this case, to restore the function to its normal condition and activity.

244. Menorrhagia. — This disease, where requiring tonic treatment, may be properly subjected to galvanism. The alterative action of electricity may also be employed.

245. Leucorrhœa. — This morbid secretion has been reported frequently to have been relieved by galvanism. The change of action produced by electricity in the uterine system, and its influence on the mucous membrane, may readily prove useful in leucorrhœa.

246. Chlorosis. — The remarks made by Dr. Bird (§ 239) are the most authoritative which have been published on this disease. Cases, however, are reported, in which galvanism or electro-magnetism has been of essential service in restoring the general tone of the system, and of the uterine organs. The current may be directed to the organs of digestion, and also to the breasts.

247. Displacement of Uterus. — The use of electricity has been suggested in uterine displace-

* Dub. Med. Press. Aug. 1846.

ments, on the principle of giving tone to the muscular fibres connected, directly or indirectly, with the support of the uterus, and especially of increasing the organic contractility of the ligaments.

248. Uterine Contraction. — One of the most obvious effects of electricity is muscular contraction. The idea of stimulating the contraction of the uterus by this means, was therefore an obvious one, and was suggested by Dr. Ramsbotham in 1834,* and was, at a later period, introduced into practice by Dr. Thomas Radford. It may be observed, that in those cases of labor to which electricity is applicable, there is generally an abundance of time to procure the simple and manageable apparatus which is required.

249. Dr. Radford,† speaking of the first case in which he applied electricity, (a case of hemorrhage, with extreme exhaustion before delivery, the os uteri remaining rigid,) says, "By this case, I ascertained that galvanism produces an effective and powerful contraction of the uterus, and not only so as regards its tonic contraction, but it has also the power of energetically exciting alternate contraction when applied at intervals." "The alternate contraction excited by this agent is analogous to, and as powerful as, that which is observed in normal labor, and the tonic contraction is greater." He therefore urges this application in all those cases where artificial delivery would be prescribed by the common practice on account of hemorrhage. He also says, "I think

* Braithewaite, Part XI.

† Prov. Med. and Surg. Jour. Dec. 1844. — Braithewaite, Part XI

it probable that it may produce one of the other natural means of suppressing hemorrhage which I have already referred to; viz., coagulation of the blood." In treating of placental presentation, after describing a mode of detaching the placenta, he advises the use of galvanism to complete delivery. He says, "I am convinced that the influence of galvanism has no evil influence on the life of the child in utero, and after its birth that it is an important means of its resuscitation in cases of asphyxia." In another connection, he observes, "In hour-glass contraction, and other forms of irregular uterine action after labor, I anticipate great benefit from its use." He remarks upon its use in tedious labor, and suggests also its application to the production of premature labor.

250. The electro-magnetic apparatus was employed by Dr. Radford, and the current or shocks were sent from the parietes of the abdomen to the os uteri in different directions. The handle, applied internally, was a curved metallic rod, covered with some insulating substance, and having at its end a silver ball for contact with the uterus. One of the wires of the apparatus was connected with the other extremity. The sponge might be substituted for the silver ball Otherwise the ball should be covered with moistened leather. The following cases have been published by Dr. Radford.*

I. A woman, in the eighth month of pregnancy, who, as a consequence of fright, was seized with

* Lond. Med. Gaz. 1846.

chills and hemorrhage. Labor pains were absent, but movements of the fœtus continued. The os uteri was rigid. Four hours later, the hemorrhage increasing, Dr. R. ruptured the membranes. The uterus remained inactive, and galvanism was then applied. Expulsatory efforts and tonic contraction immediately commenced. The application was continued, at intervals, for half an hour, by the vagina, and then the current was passed through the uterus in various directions, from the surface. The hemorrhage diminished, and soon ceased. The child was born alive, in about six hours; the placenta was expelled, and the uterus contracted firmly.

II. A woman, in labor with her fourth child, after the dilatation of the os uteri and rupture of the membranes, lay without pains, and with constant hemorrhage, for more than six hours.* Dr. R. then employed galvanism, with the surface conductors, applying them to opposite points of the abdomen, in different directions. The atonic state of the uterus was gradually exchanged for one of firm contraction, succeeded by powerful expulsatory efforts. The child was born alive in one hour from the first application. The placenta was expelled five minutes later; the uterus contracted firmly, and no post-partum flooding or after-pains occurred, although they had taken place in all former labors.

251. The following cases were communicated by Dr. Dorrington to the Manchester Medical Society.†

* Prov. Med. and Surg. Jour. 1847. — Braithewaite, Part XVI.

† Lond. Med. Gaz. June, 1846.

I. A woman, several hours in labor, the membranes having ruptured, and much hemorrhage having occurred. The os uteri was hardly dilatable, and the uterus passive. Ergot was given, and in twenty minutes contractions commenced, and external hemorrhage ceased. Dr. Radford arrived, at this time, and, indications of internal hemorrhage still existing, he applied electro-magnetism, for twenty minutes, with intermissions, with the effect of increasing the pains and establishing tonic contraction. The uterus ceased to act before delivery, which was accomplished instrumentally. The woman sunk, and died of exhaustion three days afterward. This case was reported chiefly on account of the distinction between the pains produced by ergot and those by electro-magnetism. The latter are represented to have been more immediate, stronger, and connected by periods of tonic contraction of the uterus.

II. A case, in which slight hemorrhage had taken place before the time of labor, and a long walk at the full time had brought on a sudden flow, accompanied with syncope and vomiting. These symptoms continuing, and internal hemorrhage being apprehended, the membranes were ruptured. The uterus remained inactive, and the os uteri was undilatable. Galvanism was then applied. The effect upon the uterine fibres was most decided. A very energetic tonic contraction, which was persistent, immediately took place. The uterus was felt, as a hard tumor, through the walls of the abdomen, and the head of the child was immediately in contact with the os uteri. The gen-

eral effect was no less advantageous. The woman rallied, and the pulse rose to ninety-eight, and was stronger. Labor commenced nineteen hours after the application of electricity, lasting two hours and a half. The child was born alive. No hemorrhage occurred, in the interval or subsequently, and the woman recovered well.

III. A woman, aged 31, in the eighth month of her fifth pregnancy, had been subject, for a fortnight, to slight flooding. It was ascertained that the placenta presented, and, slight pains occurring, the membranes were ruptured, and electricity applied for twenty-five minutes. Strong contraction set in at once, and the hemorrhage became very slight. Two hours and forty minutes later, the contractions having diminished, electricity was reapplied, action became stronger, and in two hours the labor was completed, the placenta having been partially detached at an early period, and the child being stillborn.

IV. A case of uterine inertia with the second child in the delivery of twins. The pains were feeble, and twenty minutes to half an hour apart. On applying electricity, strong labor pains came on. On suspending it, tonic contraction took place. In an hour and a half, after occasional applications of electricity, intervallic contraction was excited, and a small female child was subsequently born alive, with foot presentation. The placenta came away well, and the mother recovered rapidly. The child, which was puny, died in three or four days.

V. A case of premature delivery, by means of elec-

tricity. From narrowness of the pelvis, a first delivery had necessarily been performed by the crotchet, and it was therefore resolved to bring about a second delivery at the eighth month. Electro-magnetism was employed, at intervals, for twenty minutes, the uterus becoming tense, and true pains occurring; but these ceased with the application. Eight and a half hours afterwards, the membranes ruptured, and about fifty hours later, labor commenced, and in nine hours the child was born, by uterine effort alone. A hemorrhage occurred twelve days later, from which the woman recovered. In this case, the rupture of the membranes was ascribed to the tonic state induced in the uterus. Dr. Dorrington remarks, in connection with the above cases, "I believe there is no other means by which we excite uterine contraction, which is not liable to fail, when severe hemorrhage has weakened the vital powers."

252. W. F. Cleveland, Esq.* gives the case of a woman, in her sixteenth confinement, who had suffered, in previous labors, from inertia of the uterus. Health delicate. Pains commenced on Sunday, and continued till Wednesday, when the liquor amnii was discharged. On Friday, the pains returned twice, and ergot had been given, with very slight effect. The alternative was instrumental delivery with an exhausted patient, or the use of electricity. With the employment of the latter, regular strong pains came on, and in a *quarter of an hour* a living

* Lond. Med. Gaz. June, 1845.

male child was born. The uterus contracted at once firmly and permanently, with an unusually slight amount of hemorrhage.

253. Dr. Frank, of Wolfenbüttel,* reports the following case, at the full time, of a primipara, aged 40. Contractions were very inefficient, the woman much agitated, pulse small and quick, body covered with sweat, vagina without secretion, os uteri undilated, pain in the region of the stomach, and vomiting. Considering the symptoms nervous, he passed a feeble electro-magnetic current through the pelvis, in different directions, for about five minutes. Energetic and normal contractions of the uterus immediately took place, the vomiting was stayed, and the morbid sensations disappeared. The delivery was afterwards conducted according to the ordinary rules. In a second case of a primipara, aged 20, after nearly two days spent in labor, the head being engaged in the superior strait, the strength of the patient began to fail. There was a small, quick pulse, cold skin, vomiting, and general discouragement. M. Frank applied a feeble current, as before, chiefly through the anterior part of the uterus, from without, for about three minutes. A strong and sustained contraction ensued, which was repeated in six or seven minutes. The woman rallied, and in an hour and three quarters the child was born. In another case, reported by M. Frank, after two days' labor, the use of electro-magnetism, for six minutes, determined strong and repeated contractions. The

* Encyclog. des Sc. Med. Dec. 1847.

forceps were finally employed, to complete labor. The woman died subsequently, of accidental hemorrhage. In a fourth case, of hemorrhage following an abortion, in the fifth month, consequent on a fall, the woman, when seen by M. Frank, was in a very alarming anhæmic condition. After unsuccessful attempts to administer an internal stimulant, he passed the electric current from the lumbar region through to the abdomen, above the fundus uteri. Some minutes after, the uterus contracted, and the hemorrhage ceased. In ten minutes, another contraction took place, and the patient was restored to consciousness.

254. In opposition to the preceding statements, and to a mass of other testimony, Prof. J. Y. Simpson has reported a negative result obtained by him in eight cases.* In one of these, the pains were more frequent and shorter, in five they remained the same, in one they ceased during the application, and in one they ceased during and for twenty-four hours after the application. These experiments were made with a powerful electro-magnetic apparatus, one conductor being applied to the os uteri, and the other to the abdomen over the fundus.

255. Dr. Golding Bird† is not willing, for a moment, to admit the validity of Prof. Simpson's objections, in opposition to the experience of Dr. Radford, Dr. Lever, and others. He accounts for the failure of Prof. Simpson, by his use of a magneto-electric machine,

* Month. Jour. Med. Sc. July, 1846; and Am. Jour. of Med. Sc. 1846.

† Lectures. — Lond. Med. Gaz. June, 1847.

improperly constructed, so as to produce currents alternately in opposite directions. In this case, however, contractions to a certain extent should still have been observed in the uterus.

256. In speaking of the experiments of Dr. Simpson, Dr. West,* in his report on midwifery, says, "These observations seem to have been made with great care, but can hardly, as yet, be allowed to outweigh the results made by Reil and Carus in their experiments upon animals, and the recent evidence in favor of the reality of the influence of galvanism, afforded by some of the cases which Dr. Radford has recorded." Dr. Simpson ascribes all effect to imagination, coincidence, or mechanical irritation of the os uteri and abdomen. That the effect of electricity, which induces such powerful contraction in all muscular tissue, should be null in the case of the uterus, at a time when contraction has become its special function, is hardly conceivable.

257. *Exhaustion in Labor.* — Dr. Henry Wilson, of Runcorn,† details a case of uterine hemorrhage which had proceeded to the last stage of exhaustion, stimulants, and cold applications having been used for many hours. The pulse was hardly perceptible, the eyes open and fixed, the patient's condition that of insensibility bordering on syncope. Electro-magnetism, as a last resort, was then tried. No sensibility appeared for ten minutes, when the patient

* Lond. Med. Gaz. April, 1847.

† Prov. Med. and Surg. Jour. April, 1846 — Braithewaite, Part XIII.

rallied to a considerable extent, and the shocks were intermitted. This case is given to illustrate the reactive power of electricity in exhaustion from flooding. The vaginal conductor was an insulated wire bearing at its extremity a moistened sponge.

258. Abortion. — Dr. Dewees, in the New York Journal of Medicine,* states that he has used the continued galvanic current with success in two cases where abortion was threatened, apparently from irregular nervous supply to the uterus. Such cases would require very careful discrimination. In the previous cases, the electro-magnetic shocks were employed for the purpose of producing muscular contraction. In this case, the uninterrupted galvanic current was employed for the purpose of harmonizing irregular nervous action. In cases of over-action of the uterus, the application would be manifestly improper.

SURGICAL APPLICATIONS.

259. Aneurism. — Electro-puncture has been applied successfully to the coagulation of the blood in the vessels. A large number of cases of aneurism, treated by this means, are on record, which, in so grave a disease, deserve especial consideration. It may be also kept in view that an important influence may be exerted by galvanism upon the coats of the diseased vessels, by inducing a more vital and healthy condition, or by aiding organic contractility, which would be of

* N. Y. Jour. of Med. May, 1847.

value in the subsequent processes of the cure. The absorbent power is also stimulated by the battery.

260. The *Annali Universali di Medicina** contains a report of a commission of the Scientific Congress at Genoa, made through M. Asson. The experiments were performed mostly upon animals. The commission arrived at the following results: It is possible, by means of electro-puncture, to produce in the vessels a persistent coagulum of blood, composed of fibrous granulations adherent to the walls of the vessel, and sufficient entirely to stop the circulation. This clot is formed independently of diseased alterations in the arterial walls. The granulations forming the clot commence the moment the battery is applied. The clot is sufficiently developed in ten, twenty, or thirty minutes, to close the vessel. A clot can be formed equally well in the veins as in the arteries, but is less consistent and higher colored. The clot formed in an artery between two ligatures, without electricity, is less consistent and higher colored than that formed by electro-puncture. The character of a clot between two ligatures is not altered by the coöperation of electro-puncture, which shows that the power of electricity to produce coagulation is dependent upon the blood while included in the living circulation. Blood drawn from the vessels, and subjected to electricity, does not coagulate. The formation of the clot depends chiefly upon the position of the needles with regard to the

* Encyclog. des Sc. Med. April, 1847.

vessels and blood contained in them. A persistent clot can be obtained by proper management, with a constant current, without cauterizing the arterial tissue, or producing grave derangements. The hemorrhage, on withdrawing the needles, is generally from the negative pole, and easily arrested by cold water.

261. The vital character of the coagulum, formed by galvanism, has been denied elsewhere,* but apparently without sufficient reason. M. Petrequin, surgeon-in-chief of the Hotel Dieu, of Lyons, — to whom the priority of this application is generally accorded, though a claim has also been made by Mr. B. Phillips, of London, — performed his first experiments upon human blood immediately after its extraction. Blood, therefore, seems to be susceptible of coagulation while its vitality lasts, although withdrawn from the vessels.

262. In the session of the French Academy of Oct. 27, 1845,† M. Petrequin communicated the first case of aneurism treated by this method. This was a traumatic aneurism of the temporal artery of the size of an almond, of a soft consistence, and slightly sensible on pressure. Two fine needles of steel (gold or platinum should always be employed) were plunged about four fifths of an inch into the tumor, so as to cross at right angles. A battery, gradually increased to fifteen pairs, was connected with these for ten or twelve minutes. Considerable pain was experienced, the pulsations gradually diminishing to

* Ranking's Abstract, No. 5.

† Encyclog. des Sc. Med. Nov. 1845. — Comptes Rendus.

the close of the operation, when they had entirely ceased. In ten days, the tumor was in process of absorption. In *La Clinique*, of Montpellier,* Petrequin refers to two other cases — one of aneurism of the ophthalmic artery, in which the operation was unsuccessful, and in which the ligature had also been tried ineffectually, and the other of aneurism of the right brachial artery, in which the tumor became more compact during the first application, but the patient refused further sittings.

263. In the *Journal de Medicine de Lyon*, of April, 1846,† Petrequin refers to the danger and frequent inefficacy of the old operation, and contrasts acu-puncture, as leaving the patient at any rate no worse than before. To avoid the destruction of the flesh immediately around the needle, he suggests that the needle be varnished with shellac, that is, insulated except near the end. This, in the hands of others, has not generally proved successful. It is necessary that the needle should terminate in the fluid blood, and not in the walls of the sac. In large aneurisms, he recommends using several needles, so as to send the current, and form fibres of coagulum in various directions. In these cases, the current should be continued longer, and, if necessary, the application repeated. Petrequin refers especially to deep-seated aneurisms, beyond the reach of the knife, even where no compression of the artery could be made, as subjects for his process. In the

* Revue Medicale. Jan. 1846.

† Encyclog des Sc. Med. 1846.

Revue Medicale, of November, 1846, he affirms, in view of his own experience and that of others, that the curability of aneurism by galvanism is fully demonstrated. The editor of the *Revue Medicale* expresses confident hopes of such a result, and the editor of the *Bulletin de Therapeutique* accepts the practice.*

264. Dr. L. Ciniselli, in the *Gazzetta di Milano*, in the early part of 1846,† reports the following case: A man, aged 70, entered the hospital at Cremona, in January, 1846, with a popliteal aneurism of the right leg. It had commenced in October, and was the size of a large goose's egg, pulsating strongly. Varices were present in both the lower extremities, and the skin dry. The ligature was decided against, and it was resolved to try the process of M. Petrequin. Four very fine needles were passed into the tumor, with care to avoid the trunks and branches of the two saphenas. A ligature was placed over the crural artery, enough only to impede its pulsations. A battery of twenty-one small pairs, subsequently increased to thirty, was made to communicate with the needles, two of them at a time, in different directions. The discharge was moderated by passing it through a conductor of cotton cloth, moistened with a saturated solution of salt. Every contact occasioned some muscular contractions. The patient interfered in the operation, relaxing the ligature, and brought the application to an end in twenty-five minutes. The needles, from the improper use of

* Ranking's Abstract, No. 5.

† Revue Med. March, 1846.

steel instead of platinum, were oxydized, and removed with difficulty. The patient, at the close, insisted on the removal of the ligature. A bladder, with ice, was applied for six hours, at the end of which time the tumor pulsated as before. Twenty-four hours later, however, pulsation had ceased. The work of coagulation, commenced by electricity, had continued. In the following days, the tumor diminished gradually in size, and became more dense; the other symptoms disappeared, and in one week from the operation he walked freely, and would not be retained longer at the hospital, well contented with his unexpected cure. Six weeks later, the tumor remained about the size of a hen's egg, becoming more and more dense, and occasioning comparatively little inconvenience.

265. In the Dublin Quarterly Journal of the same year, a remarkable case is reported, by Dr. J. Hamilton, surgeon of Richmond Hospital, who performed the galvanic operation in presence of Drs. Hutton, MacDonnel, MacDowell, and Stapleton. The patient was a soldier, aged 42, with constitution much impaired by the effects of tropical climate, alcoholic excesses, and the venereal virus. Obstinate vomiting was one of the most severe symptoms. At length, aneurism of the carotid was recognized, which had increased to the size of a hen's egg, when it was determined to try the galvanic process. Compression below the tumor produced pain and vomiting. The pulsations were very strong. Gold needles, protected with shellac, except at the point, were introduced into the tumor. The current of twelve pairs gradu-

ally excited, was allowed to pass for twenty-five minutes, at the end of which coagulation was complete, and pulsation had ceased. In the mean while, however, an alarming increase of size had taken place, the tumor enlarging to three or four times its original bulk, and creating the sensation of suffocation. Also the flesh around the positive needle was destroyed, so that a few drops of blood escaped, on withdrawing it. The patient also showed alarming prostration. Reaction having taken place, pulsation was renewed in the tumor. A repetition of the operation was deemed impossible, and in three weeks the patient died, the vomitings continuing throughout. The tumor, on examination, proved the size of a large orange, and solid, the outer part showing fibres, with the appearance of organization. As far as the coagulation of the tumor is concerned, Dr. Hamilton considers the operation successful; and that, in more favorable cases, it might prove an important resource. It may be remarked, that from the destructive effects upon the skin, the quantity of the battery employed was probably too great, and this may have occasioned an over-action of the parts connected with the aneurism.

266. M. Restelli, in the *Gazzetta Medica di Milano*,* gives the case of a man, aged 41, having an aneurism, the size of a nut, in the bend of the elbow. The needles were inserted, as usual, and connected with a number of small pairs. The current passed

* Encyclog. des Sc. Med. Sept. 1847.

for twenty minutes, when the needles were withdrawn, the positive with difficulty, as it was *steel.* The tumor was without pulsation, as also the radial and cubital arteries. The following day, the tumor had diminished, and was harder; the limb cold, with a prickling sensation. Stimulating frictions were used. On the second day, the eschars produced by the needles fell out, the sores cicatrizing readily. A month after, only a small, hard tumor remained — the circulation being restored in the radial and cubital arteries, and the arm as useful as before. M. Restelli had not found, as yet, a varnish sufficiently adherent to the needle, and polished, to insulate it, except at the point. He is theoretically opposed to changing the direction of the current during the process for coagulation.

267. Varices. — The treatment by electrical coagulation was suggested by Petrequin, for varicose tumors, as well as aneurisms. The following reports from the practice of the Italian physicians, will sufficiently illustrate the progress already made in this application.

268. Dr. M. Gamberini gives two cases, in the *Bulletino delle Scienze Mediche,** of the successful obliteration of varicose veins. A young man, aged 24, with good constitution, was the subject of the first experiment, at the Hospital of St. Ursula, in November, 1846. The principal trunks of the left leg were affected. One of these was slightly compressed,

* Encyclog. des Sc. Med. June, 1847.

and four needles inserted in it, and connected successively with the conductors of a battery of twenty-four small pairs. The pain was at first severe; and on making a particular contact, after fifteen minutes, a spasm ensued, which compelled the suspension of the operation. The negative pole was much oxydized, from the improper use of steel, and with difficulty withdrawn. An areola also surrounded it, and the tissues in contact were destroyed. The vein was hard, evidently filled with coagulum. A few hours after, slight fever ensued, which was readily dissipated. Six days later, another vein was attacked in the same way, without any subsequent reaction. The operation was subsequently resorted to twice again, and each time with entire success. The second case was a man, aged 36, with varices on the left leg. The largest of these was successfully obliterated by the use of two needles and only nine pairs of the battery.

269. M. Bertani, in the *Gazzetta Medica di Milano*,* relates the case of a peasant, aged 36, who had many and extensive varices in the veins of the lower extremities, especially those of the left leg. Bandages were applied above and below the point of operation. A pair of platinum needles were made to pass through the same two varicose veins, and another pair of platinum needles were introduced into two other veins, the points of the needles always left free in the second vein. Another needle was afterwards

* Encyclog. des Sc. Med. Aug. 1847.

inserted between the two latter, in the saphena. The passage of the current between the different needles continued thirty minutes. An erysipelatous ring, about an inch in diameter, formed around the needles. Bandages and ice were applied, and the patient slept well. The next day, the veins proved to be hard in the intervals between the needles, but, the second day after, the clots seemed less compact, and the patient refused to submit to another operation, and on the third day left the hospital with the result incomplete.

270. M. Milani gives the case of a man, aged 50, at the Hospital of Varese, afflicted with most extensive varices, the internal saphena offering a succession of knots. Electro-puncture was applied to one of these. In ten minutes it diminished in size, and did not swell when the vein was compressed above it. Its contents were hard to the fingers. On the day following, the trunk of the saphena was attacked in the same way, with twenty-six pairs. In the third application, clots were obtained, for two or three inches, in the saphena, in quarter of an hour. In the fourth, clots were formed in a tumor above, in four minutes. In ten operations, the whole of the varices had disappeared. The needles, though varnished, cauterized the skin, and formed an areola around them, especially the negative one.

271. M. Milani refers to another case, where a varicose swelling, the size of a goose's egg, was already filled with clots, by two applications of galvano-puncture.

272. Inflammation. — The effect of electricity up-

on inflamed tissues has already been spoken of. (§ 62.) The following distinction in practice may be readily arrived at. In simple inflammation, where there is excess of local excitement, the application of electricity is contra-indicated. In passive inflammations, where there is a deficiency of vital action in the affected part, electricity, on the other hand, is strongly indicated. This includes the advanced stages of most inflammations, when local reaction or exhaustion has taken place. Where there is infiltration or interstitial effusion, resolution may be promoted by the increase of vital power. Congestion, of a passive character, may be relieved by the same means, the reduction of the engorged part being effected. The power of electricity, over diseased tissues at the surface of the body, may already be considered as one of its most important influences, though so imperfectly developed. In all specific inflammations, the vital stimulation of the battery, or the alterative influence of electro-magnetism, constitute an application which deserves a far more general attention than it has yet received.

273. Erysipelas. — A correspondent of the Boston Medical and Surgical Journal* reports a case of œdematous erysipelas, extending from the groin to the foot, accompanied with enormous distention. Other treatment having proved ineffectual, a feeble galvanic current was passed through the limb, gradually increasing in strength. Daily improvement re-

* Boston Med. and Surg. Jour. Oct. 1846.

sulted until the limb was reduced to one half the former size. Galvanism was then suspended, and tincture of iodine used, with every prospect of permanent cure. Erysipelas is one of those diseases in which peculiar benefit would be anticipated from galvanism, as the vital condition of the tissues is to so great an extent involved. The current of the battery is especially indicated, and the direct application to the diseased surface by the sponge will be obviously resorted to.

274. Gangrene. — The remarks just made apply equally to gangrene. The application, in this instance of the battery, may be made by a sponge, or by means of a stimulating bath.

275. Ulcers. — Much discrimination may be used in the application of electricity to ulcers and sores, both as to the form and mode of application. Free electricity may be drawn from the diseased part, while the patient is seated on the insulating stool, by means of a pointed rod connected with the rubber of the machine, and directed from a little distance to all parts of the surface. The battery may be employed with a greater or less number of pairs. The local bath or sponge handle may be used as conductors, or the moist dressing of the ulcer may be made the medium of communication. A gentle application of electro-magnetism will also sometimes be indicated. In indolent or inveterate wounds and ulcers, the effect of the battery is sometimes very rapid and complete. The influence of the different poles upon the surface deserves careful attention.

It has been the general opinion that the negative pole tends to produce cicatrization,* and with that view it would be applied to the diseased surface. Where there is an open sore, especially of a specific character, it is a caution, which, in the present state of knowledge, at least, should be regarded, not to pass the electric current through a greater extent of the sytem than is necessary, while the diseased part makes one of the poles. It is a possibility, in this case, that the virus, or the disease itself, may be transferred to other parts. One of the conductors may be applied to the ulcer, and the other may be conveniently swept round it, or the current may be passed through the ulcer, from side to side, in all directions. The decomposition of a specific virus in an ulcer is one of the agencies which has been suggested in connection with the application of the battery. In fistulous sores, a sponge handle adapted to the opening, or the moist dressing, may be conveniently used for conduction. Dr. Shuster, in a communication to the French Academy on the use of electro-puncture,† claims its application to indurations of the cellular tissue in the neighborhood of certain ulcers, and in the walls of fistulous passages.

276. Cancerous Affections. — Dr. Shuster, in immediate connection with the use of electro-puncture suggested above, observes, "There would be nothing irrational in attacking cancerous affections in

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* Lancet. Nov. 1834. † Revue Med. Jan. 1843.

the same way." In the acknowledged inefficacy of medical treatment, the action of the battery, in the whole class of malignant tumors and ulcers, should be made the subject of thorough investigation. Dr. Crusell is stated to have employed galvanism beneficially in the Naval Hospital of Cronstadt * for ulcerating cancers, using fluid conductors, (a local bath.) He is represented to have obtained permission to establish a hospital at St. Petersburg for the treatment of external diseases by galvanism.

277. Syphilitic Ulcers. — Dr. Crusell is also stated to have applied galvanism with success to syphilitic sores. Fluid conductors were apparently used in contact with the ulcer, the negative pole being connected with the diseased part, so that the current should leave the system by the diseased surface. In forty-three cases, the results are represented as having been favorable.

278. Scrofulous Ulcers. — A case is reported in the Lancet,† from the Calcutta Medical Society, in which Dr. R. Tytler applied the negative wire of a galvanic series to the surface of a scrofulous sore in front of the trachea of a native, which had existed several years, and defied all remedial treatment. Two applications were made, and the man was discharged cured in seventeen days. The dispersion of scrofulous tumors of the neck before, as well as after ulceration, has been frequently reported as a result of galvanic application.

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* Lond. Med. Gaz. 1846. † Lancet. May, 1837.

279. Hip Complaint. — The following cases of scrofulous disease of the hip-joint are reported by M. Hoering, of Heilbronn.*

I. A daughter of the mayor of Boekingen, aged 8 years, was affected with hip complaint, and elongation of the right limb to the extent of two inches. After thirty applications of electricity through the hip, the pain, before very severe, had entirely ceased, and the child was able to stand upon the leg, which did not exceed the other in length more than three lines.

II. A child, of 9 years, from the same city, had been a subject of hip complaint from her third year, accompanied with caries, fistulous openings, and shortening of the left limb to the extent of four inches. After fifty-three applications, the limb had increased in length, the fistulas had closed, and the child was able to walk with freedom.

280. White Swelling. — Dr. Hoering relates the case of a woman, aged 25, who, when four years old, was attacked with this disease in consequence of a fall, and kept her bed for several years. She recovered so as to walk and labor, but the knee remained stiff. In consequence of another fall, three years previous to the consultation of Dr. H., the knee had enlarged; and, in spite of all treatment, the disease had increased to such an extent that amputation had been proposed. The patient was in an alarming state, sleepless for several weeks, great pain in the

* Encyclog. des Sc. Med. June, 1847.

knee, no appetite, pulse frequent and small. The conductors of the magneto-electric machine were applied by means of moist cloths, enveloping the knee, for a quarter of an hour. The nervous excitement was so far relieved that the patient was then able to sleep. By the fifteenth day, the limb could be moved without severe pain, and it was ascertained that there was no anchylosis. The power of the apparatus was increased, and the conductors applied to places where the skin had been cauterized. The tumor yielded gradually, and the patient went out in the fifteenth week. Applications were continued twice a week till the twenty-fourth week, making one hundred and twenty in all. The patient was able to walk without a cane, the knee being flexible, of normal color and temperature, and not larger than before the last fall.

281. Dr. Koenig* states that he has used deep electro-puncture with advantage in white swelling.

282. Tumors. — Petrequin, writing in connection with aneurism, states that vascular and erectile tumors, and also sanguineous tumors, which offer great difficulties to extirpation by the knife, are proper subject for galvano-puncture. In these cases, coagulation may be effected, and absorption stimulated. The absorption of scrofulous tumors has already been referred to. The general remark may be made, that wherever tumors or enlargements of any kind constitute the original disease, or are subjects of direct treat-

* Revue Med. April, 1830

ment, galvanism may be resorted to, with the hope of increasing the vital action of the part, and especially of the absorbent system. The current should be passed through the tumor, from the surface, or by electro-puncture needles.

283. Goitre. — A case of goitre, much relieved by galvanism, has been reported (§ 176, I.) in a patient under treatment for asthma, by M. Pascalis. This is an instance of a class of cases in which much may be expected from electrical treatment.

284. Sarcocele. — M. Fabré Palaprat, at the sitting of the French Academy of the 6th of May, 1833,* communicated a case of sarcocele successfully treated by the mode of galvanic transfer (§ 204) of a chemical agent. The negative pole was placed in contact with a compress moistened with a solution of iodide of potassium, the compress resting upon one side of the tumor. The positive pole was placed upon a compress on the other side of the tumor, moistened with solution of starch. The battery current soon caused the appearance of the purple iodide of starch under the positive pole. The sarcocele had been cured, inferentially, by absorption, occasioned by the joint influence of the electrical current and of the iodine.

285. Dropsical Effusions. — In Hufeland's Journal, the following case is given by Dr. Koenig:† A man, aged 56, as a consequence of lumbago, by which the body was bent forward, was affected with dyspep-

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* Revue Med. May, 1833. † Revue Med. April, 1830.

sia, and finally, after exposure to cold, with hæmoptysis and œdematous swelling of the legs. The spitting of blood was relieved, but the dropsical affection extended to the abdominal cavity. The urine was scanty, throat dry, pulse frequent, bowels costive. Purgatives and diuretics had no good effect. The anasarca finally spread to the face and hands, and the abdomen was enormously distended. Two needles were then inserted from one eighth to one sixth of an inch into the walls of the abdomen, on either side of the linea alba, and their number was subsequently increased. These were touched, three times a day, with the wires from a battery of sixty pairs, twenty or thirty contacts being made. The secretion of urine immediately increased, the skin became moist, and the appetite returned. No internal remedy but infusion of juniper berries was used. In four weeks, the œdema and ascites had greatly diminished, and a few weeks later the patient had perfectly recovered. Another patient was found, by Dr. Koenig, with symptoms of hepatitis and ascites. The inflammatory tendencies being subdued, the swelling of the abdomen seemed still on the increase. Galvanism, employed as above, restored the healthy functions, especially perspiration and the urinary secretion, and in about three weeks effected a cure.

286. *Dropsy of Articulations.* — Dr. Koenig has used galvanism successfully in articular dropsies, in the same way as above. He recommends that the needles be introduced as deep as the bone of the affected articulation.

287. Effusion from serous membranes, according to very general testimony, is peculiarly subject to galvanic influence. Electricity is only contra-indicated by a state of active inflammation. Dr. Shuster* speaks of the successful use of electro-puncture in hydrocele, ascites, (idiopathic or symptomatic of curable lesions,) hydrothorax, articular dropsies, dropsy of the pericardium, and even chronic hydrocephalus.

288. Hydrocele. — The electrical treatment of hydrocele is said to have originated with Dr. Pecchioli,† who was attached to the Hospital of Sienna. His first case was a young man who had had a double hydrocele for three years. Four needles were introduced into the scrotum, and the current from a small battery passed between them. This was continued five minutes, acute pain in the right testicle being felt. In five hours, the sacs were almost empty; but towards evening, there was increased action and reëffusion. After some days, the experiment was repeated, with the same result; but after a third operation, the fluid was permanently absorbed. Dr. Leroy, at the Hotel Dieu, repeated the experiment on a man of 70, with a single hydrocele. He caused a small battery of sixteen pairs to act upon the tumor, by means of two needles, one placed in the subcutaneous cellular tissue of the scrotum, the other penetrating the cavity of the tunica vaginalis. Two days after the operation, the tumor had entirely disappeared. A

* Rev. Med. Jan. 1843. — Braithewaite, Part X.

† N. Y. Jour. of Med. Jan. 1843.

slight return rendered a repetition necessary, twice afterwards, for twenty and for ten minutes. It may be assumed, that the application, in the first of these cases, was so violent as to provoke reaction. Dr. Stewart records another successful case, in the same connection. He recommends the patient to keep a recumbent position for several days. The needles should be fine, and about four inches long.

289. Opaque Cornea.—Dr. C. Usiglio, of Corfu,* reports the case of a female, aged 35, having opaque spots, increasing in size, upon the cornea of the right eye, the result of a long ophthalmia. Ordinary treatment proving ineffectual, electricity was resorted to. Six galvanic pairs, increased to sixty, were employed. The negative pole was placed upon the tongue, the positive upon the closed eyelid. When the plates were numerous, the current was intermitted from time to time. The conjunctiva soon became injected, the vessels filled with red blood, and the secretion of tears increased. The improvement commenced with the first sitting, and in a month the cure was perfect, excepting a slight irregularity in the contour of the pupil, which diminished daily. A similar result was obtained in two other cases. In *Albugo*, or deep-seated opacity of cornea, no effect was produced by similar application for a year, in the case of a woman; but in another case—that of a man—an advantageous result was obtained.

290. The writer has been informed of a case of

* Revue Med. March, 1844.

superficial opacity of the cornea, successfully treated by drawing free electricity from the surface of the eye. This may be conveniently done, by placing the patient on the insulating stool, and approaching a pointed rod very near to the opaque spots.

291. Cataract. — Dr. Crusell, of Finland, and Dr. Lerche, of St. Petersburg,* made early experiments upon the electrical treatment of opacity of the cornea, by bringing the positive wire of a single galvanic pair in contact with the surface of the eye, and the negative pole in contact with the tongue. Encouraged by success in this application, they proceeded, in the case of an elderly patient, to pass a fine cataract needle into a firm capsulo-lenticular cataract, and connect it with the positive pole of the same battery, the negative conductor being introduced into the ear. They represent a sort of dispersion of the cataract to have taken place, and a partial vision to have been obtained. Seven cases are subsequently reported,† in which absorption of the cataract sometimes took place, to some extent, as a consequence of inflammation; but in others, the result was decidedly injurious.

292. Dr. C. Usiglio ‡ performed acu-puncture three times for cataract. A fine needle, of gold, was connected with the positive pole, and passed into the crystalline lens. The negative pole was applied to the tongue, and only two pairs of plates used. In the

* Med. Zeitung. June, 1841. — Am. Jour. of Med. Science. January, 1842.

† Am. Jour. of Med. Science. April, 1842.

‡ Revue Med. March, 1844.

first case, that of a woman aged 78, a capsulo-lenticular cataract existed in both eyes, complicated with slight disease of the conjunctiva, and lachrymal fistula for twenty-five years. The experiment was made on the right eye. This was consequently attacked with inflammation, which was subdued. Three months later, no further application having been made, the eye had shrunk in volume, the sclerotica was wrinkled, the cornea flattened and opaque. Complete blindness remained. In the second case, that of a man, aged 50, similar results were produced. In the third, a man, aged 50, had lenticular cataract of the right eye, and partially obscured crystalline of the left, the pupil nearly immovable, but sight still remaining. The application was made to the right eye, and antiphlogistic treatment employed. On the second day, some absorption of the humor contained in the anterior chamber took place. After ten days, the eye was restored nearly to the normal state, the sight being better than that of the other side.

293. From these experiments, the gravity of the operation will be inferred. The most important result at which Dr. Usiglio seems to have arrived, is the readiness with which absorption may be promoted in various conditions of the eye by the stimulus of electricity.

294. Swelled Articulations. — M. Raciborski, of Paris, states, in the *Gazette Medico-Chirurgicale*, "Certain it is, that in many cases we have applied galvanism, [electro-magnetism,] with some success, even to painful swellings of the knees, rendering

walking, if not impossible, at least very painful. Certainly galvanism did not cause the swelling to disappear, but the pain became dissipated, or so diminished as to allow the patient to walk about."

295. Sprains. — M. Raciborski says, in continuation of the above, "We cannot terminate this paper without signalizing the admirable effects which galvanism produces in the treatment of *sprains*." In simple sprains, he states that it is the pain felt on the slightest motion of the part which retards the cure, the other symptoms being usually promptly dissipated. He adds, "Now, just as we have seen in lumbago, so in sprain, galvanism relieves this pain instantly, and allows the patient to walk without lameness." He suggests that galvanism may also act by restoring the contractility and tension of capsular fibres and tendons.

296. An important part of the treatment of sprains, by this method, is the exercise by means of electro-magnetism. The sponge handles may be passed around the articulation and over the muscles connected with it, causing them separately to undergo contraction. A stimulating solution may be employed. This application may also be made to advantage by the touch of the operator, the hand being used as a conductor.

297. False Articulation and Callus. — M. Heller, of Stuttgard,* reports the case of a man aged 22, of a scrofulous temperament, who entered his

* Encyclog. des Sc. Med. Aug. 1846.

orthopedic establishment in June, 1844, for false articulation, accompanied with callous overgrowth, from an oblique fracture of the thigh of eight months' standing. Contraction had taken place, and the bones met at a sharp angle. Gradual extension was used to bring the bones into a true position, and electro-magnetism was then employed every other day to effect absorption of the callus. One conductor was placed upon the tumor, the other, either held in the hand or applied to the foot. After the twelfth application, absorption was complete, and the parts had commenced to consolidate. In the mean time, the patient had been put on a nourishing diet, and his general health had improved.

298. It may be remarked, that electro-puncture would have a special application in cases of false articulation, where the object is to increase the vital action of the parts, and at the same time produce local irritation.

299. Spontaneous Luxation. — The following case is given by Dr. Hoering.* The patient was a girl of 18, who was subject to spontaneous luxation of the femur. Considering it due to relaxation of the capsular ligament, and the surrounding muscles of the left thigh, Dr. H. applied the conductors to the left sacral and left inguinal regions, continuing the application for fifteen minutes, and increasing its strength progressively during each sitting. The

* Encyclog. des Sc. Med. June, 1847.

patient, in the course of sixty-four applications, gradually recovered the use of the limb.

300. Weakness of the Back. — This, when a muscular affection, is readily relieved by electricity. The electro-magnetic shocks may be passed down the spinal column, and also across the part most affected. Where it is symptomatic of scrofulous disease of the spine, the reports of cases leave it to be inferred that much advantage may be gained by increasing the vitality of the part and absorbent action, by the application of electro-magnetism or galvanism in the early stages of the disease.

301. Curvature of the Spine. — This distortion, where the result of unequal muscular contraction, from habitual causes, may be treated by passing an electro-magnetic or galvanic current through the muscles, on the side of the spine which is relaxed. An increase of vigor in the deficient muscles is stated to be readily obtained. This mode of action may be applied to any similar distortion. It has even been resorted to in strabismus, without, however, any reliable result.

302. Calculus. — Dr. Donovan* states that Orioli, a distinguished Italian, and Dr. Harle, of Norwich, were the first to direct attention to the decomposing power of galvanism, as a means of dissolving urinary calculi. MM. Prevost and Dumas submitted a calculus composed of phosphates, and placed in water, to

* Dub. Quart. Jour. of Med. Sc. May, 1847. — Braithewaite, Part XV.

the action of a battery of one hundred and twenty pairs. In twelve hours, it had lost twelve grains. In sixteen hours longer, the mass became so friable as to be broken up, by the slightest pressure, into small crystalline grains. These experimenters then introduced two insulated conductors through the urethra of a dog, into the bladder. The dog discovered no uneasiness, while the bladder was distended with warm water, and a pile of one hundred and thirty-five pairs was connected with the conductors. A calculus attached to two conductors, was subsequently introduced into the bladder of a bitch, and connected, at various times, with a powerful battery. On being withdrawn, it had lost in weight, and become friable, as before. The animal, killed a few days after, showed the bladder in a perfectly healthy state. Calculi of uric acid are spoken of as probably an exception to this mode of treatment. MM. Prevost and Dumas propose the introduction of two conductors, by means of a sound, into the bladder, so arranged that by a spring the extremities may be made to spread and embrace the calculus.

303. Strangulated Hernia, and Invagination. — MM. Emery, Cloquet, and Dubois, to whom the subject had been referred, reported, in the session of the French Academy of the 25th of May, 1826,* that the passage of galvanism from twenty-five pairs from the mouth to the anus produced contractions and undulations of such a character, in the intestines of animals,

* Revue Med. July, 1826.

upon whom the experiment was made, that it might be usefully employed in the commencement of strangulated hernia and invagination of the intestine, as suggested by M. Leroy. Where a part of the intestine was included between two ligatures, the action was diminished, but increased in the contiguous portions.

304. Prolapsus Ani. — This disease, where it may properly be treated by astringents, or by means calculated to produce organic contraction, comes under the class of those which may be benefited by the power of the battery over relaxed tissues.

305. Obstruction of Œsophagus and Larynx. — The commission of the French Academy, referred to under the head next the preceding, observed that the progressive contractions of the œsophagus were especially increased when it was made the conductor of the galvanic current. This fact may have an application to various cases of obstruction or stricture of this tube. It is stated by Dr. Golding Bird* that the charge of a Leyden jar, transmitted from the pit of the stomach to the back, causes the diaphragm to contract violently, expelling the air from the lungs with a loud shout. This might also have a possible application in accidental obstructions of the larynx.

306. Poisoned Wounds. — M. Pravas relates experiments with several dogs, showing the effects of galvanic cauterization on a poisoned wound. In the

* Lond. Med. Gaz. May, 1847.

first instance, two dogs were inoculated with the saliva of a rabid dog, in the kennel of the Veterinary College at Alfort.* The poles of a battery of forty-eight pairs, terminating in platinum wires or strips, were placed in contact with the wound of one of the animals. Thorough cauterization ensued, and the eschar produced was detached the twelfth day. The dog so treated had shown no symptoms of the disease four months afterwards. The other dog showed symptoms of hydrophobia twenty-seven days after inoculation, and died on the twenty-eighth. Another dog, bitten by a rabid animal, was subjected to galvano-cauterization forty-four hours afterwards, and had manifested no symptoms of the disease after more than four months had passed. In a third case, two dogs were inoculated with the saliva of a rabid dog. The first was cauterized by galvanism after fifty-four hours, and had remained well for more than four months. The second, without any treatment, showed symptoms of hydrophobia ten days after the inoculation, and died two days subsequently.

307. VENESECTION. — It is well known that a fluid, escaping in drops from a capillary orifice, may be made to flow in a stream, by subjecting it to electricity on an insulating stand. Dr. W. Wright, of London, in the Lancet of October, 1831, states that he has placed patients, in whom the blood escaped with difficulty from a vein, on an insulating chair,

* Revue Med. Dec. 1830.

and has then obtained a ready flow by turning the machine. The cup, in this case, receiving the blood, should also be insulated. Circumstances may exist, in which advantage may be taken by the practitioner of this, as well as many other applications of electricity of a mechanical or miscellaneous character.

SUPPLEMENTARY CHAPTER

TO THE FIFTH EDITION.

308. The first edition of this treatise was prepared in 1848, to supply the want, then beginning to be felt, of an impartial and comprehensive statement of the principles and facts of Electro-Medical Application. In pursuance of this object several hundred volumes of Medical Journals and Reviews, in different languages, issued during the last three quarters of a century, were examined, and every published case of the electrical treatment of disease, whether successful or otherwise, was reported in the preceding pages. Laws and methods of application were deduced from these sources as well as from immediate observation and the current experience of electro-medical practice in America. The book was therefore original in its classification and foreshadowing of laws, and has remained until the present time the most thorough treatise on the subject published in this country, if not in the English language.

309. The development of electro-medical science involves, necessarily, the knowledge of two sciences; and this fatality has attended its pursuit almost invariably, that the practitioners best able to use electricity have been ignorant of physiology and the his-

tory of disease, while those most experienced in the medical profession have been incapable of handling with discrimination the protean agent, electricity. Two important works have been recently published in France by distinguished physicians, M. Duchenne, of Boulogne,* and M. A. Becquerel,† of Paris. Both of these works contain much valuable medical and experimental observation; but their methods of using electricity are often inadequate, and founded sometimes on grave misapprehensions of the nature of the agent. The forms of apparatus, especially in the first-named work, are objectionable, and very inferior to the more simple and less costly apparatus used in this country.

310. In this treatise it will be seen that the writer has dwelt especially on the reactions of electricity with the living system in health and disease, and that much attention has also been given to the forms of medical electricity, and to the instruments for its application, as the success of the treatment depends largely on the modes of developing and using this principle.

311. Electricity is now commanding such general attention in Europe, and is passing so rapidly into practice as an essential agent in therapeutics, that the best service which can be done to electro-medical science is to point out prominently, in this chapter, the chief source of misapprehension

* "Traité d'Électrisation localisée." 1855.

† "Traité des Applications de l'Électricité á la Therapeutique Médicale et Chirurgique." Paris, 1857.

which has vitiated its theory and paralyzed its practice.

312. Into all electrical currents two elements, *quantity* and *intensity*, enter, in infinitely variable proportion, each exerting a different physiological influence, as well as conferring different physical properties. Electricity differs from itself, according as one or the other of these qualifying elements predominates, presenting so immense a scale of diversity, that its extremes are almost unrecognizable. At one of these extremes we have the electrical spark, whose quantity is almost inappreciable, while its intensity is absolute. The physiological effect of this is simple stimulation. At the other extreme we have the current from a single galvanic pair, whose quantity is so enormous as hardly to be comparable with that of the electric spark, while its intensity is so feeble as to be unable, under most conditions, to overcome the resistance offered to its passage by the tissues and fluids of the body. By adding to the number of galvanic pairs, however, we obtain a corresponding increase in intensity, until, in a series of, from ten to fifty or a hundred pairs, we possess a current of immense *quantity*, as well as intensity or energy, which we can cause to traverse any nerve, organ, member, or part of the system. The physiological effect of this *quantity current* may be stated to be vital or organic reaction, affecting the life of the tissues, as well as the function of the nerves. The currents in which intensity predominates are stimulant and alterative, chiefly confined in their action

to the nervous system. These waken the system from narcotism, etherization, suspended animation, and some states of nervous torpor and paralysis, while the currents characterized chiefly by *quantity* react with the organs and tissues in a manner imitated or approached by no other agent in nature, increasing the circulation, even perhaps to engorgement, if prolonged, raising each organ to its highest vital state, and developing or quickening its functions.

313. Between the extremes of the electric spark and the galvanic series we have the induced electro-magnetic or magneto-electric shocks. These have more quantity and less intensity than the spark, but still are to be considered as intensity currents, especially in their characteristic interrupted or convulsive action. For the full effect of *quantity* and a continuous current, the galvanic battery must at present be used, although the primary current of a very large magneto-electric machine may be substituted to obtain lesser effects.* A discovery has recently been made of an instrument called the Ruhmkorff coil, combining for the first time the highest intensity with comparatively large quantity. The flashes, six inches or more in length, thus obtained, bear more resemblance to lightning in their energy than any thing which has been hitherto obtained. A modification of this apparatus may perhaps be advantageously applied in electro-medicine.

314. The successful application of electricity to

* See Davis's Manual of Magnetism, § 458.

the human system depends, primarily, upon holding the balance between these powers of *quantity* and *intensity*, in the currents applied, and adapting them precisely to existing vital conditions. The correspondence between electricity and the special organic or vital force has been already discussed (§ 1). It is only necessary now to call attention to the importance of studying electricity in its whole scale of manifestations, in order to apply it in strict accordance with vital states, with every one of which it appears to have, not an accidental, but a specific and corresponding reaction.

315. While electricity is endowed with these special powers in relation to vitality, it has also other properties which render its use in therapeutics eminently safe and easy. Its full power can be developed and withdrawn in an instant. It is capable of application to internal organs and tissues with the same facility as to the surface. It can be sent through the body in any linear direction desired. This is the "localized electricity" on which M. Duchenne insists, the principle of which will be found to have been fully adopted in these pages some years previous to Duchenne's publication. Electricity can be modulated and varied indefinitely in its quality and strength. It can be given in a continuous current or in intermittent shocks. It leaves nothing behind it in the system.

316. It has been customary to "try electricity" in cases of paralysis or other disease without any idea or knowledge of its modulations. This kind of

practice has given no systematic results, though sometimes accidental and remarkable cures have followed. These have constituted the chief claim of electricity to public regard. No more fruitful or attractive field for exploration and domain can offer itself now to a young practitioner than this new and opening continent of electro-medical science. This may be illustrated by a single example. Comparatively little use has yet been made of the great power of the galvanic current continuously applied to any organ. The menstrual function is the only one in which the uses of electricity have been extensively developed, and with unvarying success, according to Dr. Golding Bird in Guy's Hospital Reports. We know (§ 216) that the function of the liver is quickened by the battery current often more readily than by calomel. What might not be hoped from the extended use of galvanism in the class of diseases in this country characterized by a torpid condition of the liver?

317. We have referred to the physiological relations of electricity, to the different character of currents, and to the forms of medical electricity. We have thus passed in review over a part of the ground more systematically treated in the text heretofore. We shall proceed, in the order of the remaining divisions of this book, to speak of recent improvements and developments in application, although it will be impossible to present more than a general view of the state of medical electricity in a period of so great activity and such general

unfolding. We shall endeavor to indicate to the practitioner the latest methods and results.

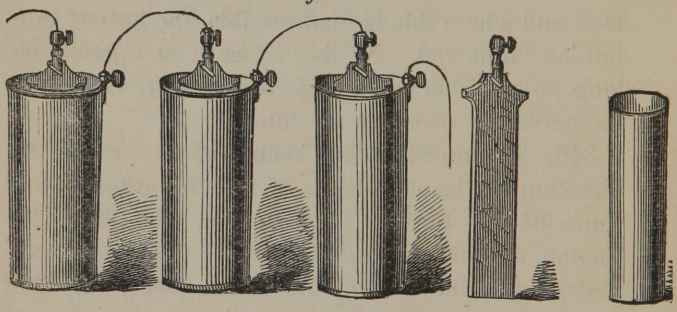
318. The quantity current of the galvanic battery is more effective and powerful than the induced magneto-electric or electro-magnetic currents, or than the electric machine, in many cases, although every form of electricity has its important applications. Paralysis of special sensation, and other forms of paralysis, sometimes yield readily to the battery after resisting entirely the induced currents. Corresponding caution is required in using the galvanic current. It increases organic action, as its first effect, and where this is inadmissible, the battery cannot be employed. Neither must it be applied too long, so as either to engorge organs or to embarrass the nerves by over stimulation.

319. The question has been revived whether the direction of the current is of any importance, and some of the French practitioners, who, like Duchenne, confine themselves mostly to induced currents, doubt the law of Matteucci, (see § 76,) that electricity exhausts when sent in the direction of the ramification of the nerves, but increases vital reaction when sent in the opposite direction. Where galvanism, or a really efficient current, is used, the law of Matteucci, cannot be set aside. Sometimes it is useful, in arousing the system, or to prevent exhaustion by an overpowering monotony of influence, to employ currents rapidly reversed in direction. Where there is a persistent cerebral lesion, especial care must be taken not to send the

galvanic current through the nerves in the direction of the brain. Indeed, electricity is then wholly inapplicable.

320. The use of the constant battery marks an era in electro-medicine. It would be generally impossible to employ a galvanic series which required to be charged every day, and this perhaps explains its unfrequent employment in France. A battery has been recently introduced by Mr. Hall, which fulfils all the conditions of an apparatus for medical use. This is represented in Fig. 9.

Fig. 9.



321. A series of three pairs are shown in connection. The outer cup is of copper, though in an improved form it consists of a glass cylindrical vessel enclosing a copper cylinder. Within the copper cylinder is a porous cell, *a*, which contains the zinc plate *b*. When put into action the space between the copper cylinder and the porous cell is filled with crushed crystals of blue vitriol, and the porous cell within is filled itself with water. After

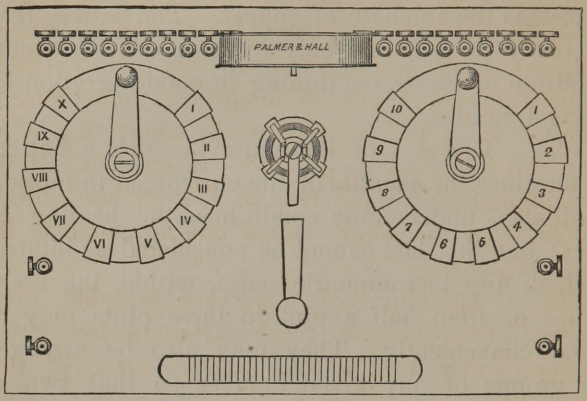
standing some hours the water filters through, and moistens the sulphate of copper. The battery then is ready to act, and only requires the occasional addition of water, continuing in good operation for several months.

322. The size of the pairs in such a battery determines the *quantity* of the current set in motion, and also, under some conditions, the heating effect; but this last cannot be considered as influential, in any thermometric sense, within the body. Cups of from half a pint to three pints may be used conveniently. They may also be arranged in groups of any given number so that two or more groups may be connected collaterally, instead of consecutively, by means of a "switch," so as to increase the *quantity* at will, instead of the *intensity*.

323. For many applications ten or fifteen pairs of this battery are abundant; but in some cases of paralysis it would require fifty pairs, and occasionally, though rarely, a larger number. The battery may be placed in a closet, and its current brought to the office table by means of wires.

324. In order to bring the constant battery within the grasp of the operator with as much facility as the electro-magnetic apparatus, I have had a switch- and key-board constructed by Mr. Hall for the office table, which gives entire control over any number of cups of the battery from one to one hundred. A plan of this is represented in Fig. 10. The galvanic pairs of the battery are connected in groups of ten. Each of the first ten

Fig. 10.

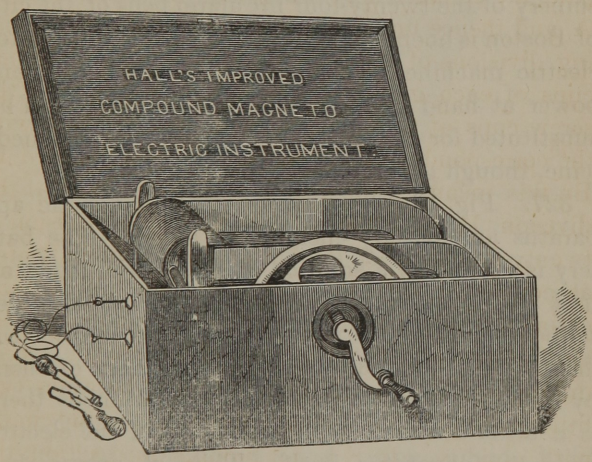


pairs are connected by wires with the screw cups at A, and thence under the board with the corresponding divisions of the switch-board B. The terminal cups of each group of ten are connected with the screw cups at C, and thence under the board with the corresponding divisions of the switch-board D. By this means, if the switch D should be set at the division II, and the switch B at the division 4, twenty-four cups of the battery would be indicated as connected with the screw cups *a*, *b*, communicating with the handles. E represents a clock-work electrotome, which, when wound up, causes a pendulum, armed with platina, to vibrate between two little metallic pillars, making and breaking the circuit with rapidity. If E is not brought into action, the current may be broken or closed at such intervals and for such times as the operator pleases by manipulating the telegraph key F. If it is desired to

reverse the current while operating, this is readily done by the pole changer G. All these different methods may be employed, varying the number of cups at pleasure without disturbing the handles in contact with the patient or the connecting wires screwed into the cups *a* and *b*. H is a rasp. If the peculiar shock of the rasp is desired, the wire is taken from the screw cup *b* and drawn over the rasp at pleasure.

325. An improved and very portable magneto-electric machine, furnished at a low price, is represented in Fig. 11. It is so arranged that

Fig. 11.



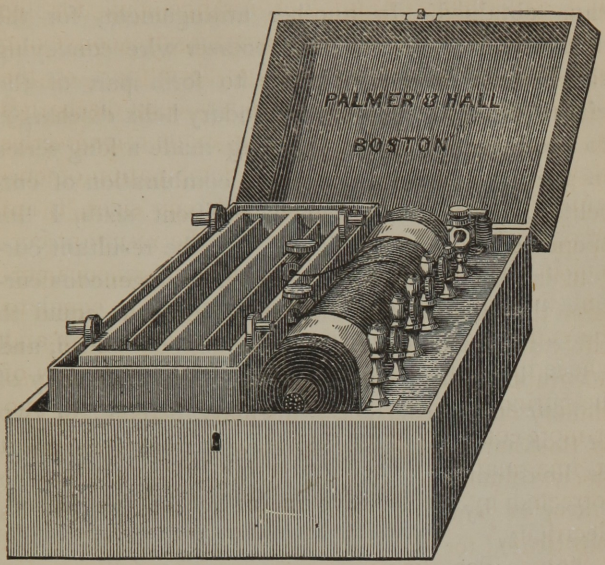
the induced shocks are all in one direction when the handle is turned one way, and in the opposite when it is turned in the other. The direction is easily

ascertained by the sensation, according to the rule in § 46. The breakpiece is also adjustable, so that a feeble and continuous primary current can be obtained instead of the shocks. The strength of the shocks is adjustable to a certain extent by the movable armatures. The wires and handles are seen connected with the box. It is made without belt or gearing, and makes little or no noise in operating.

326. The continuous quantity current from large magneto-electric machines has been employed lately as an equivalent for the battery current in telegraphing and electrotyping. The striking machinery of the twenty-four fire alarm bells of the city of Boston is liberated by the current from a magneto-electric machine. Where there is any convenient power at hand to move such a machine, it can be substituted for the galvanic battery in electro-medicine, though generally at greater expense.

327. Fig. 12 represents an electro-magnetic apparatus and battery enclosed in a box. The battery is excited by a solution of blue vitriol made as in § 20. It is remarkable that the batteries described in connection with the recent French instruments are all excited by acid, and, in most of them by nitric acid. In M. Duchenne's instrument there is a nitric acid battery in the drawer of the electro-magnetic apparatus itself. This, of course, has proved in practice destructive by its corrosive fumes to the apparatus. The blue vitriol solution is not corrosive, and does not discharge colors, and the

Fig. 12.



battery is easily taken care of. It may be remarked here that there is, practically, no advantage in galvanometers, rheometers, and other scientific toys, in connection with these instruments. The simple American form, as in Fig. 12, with the movable bundle of wires in the centre of the helix, and a vibrating interruptor, seen very distinctly in Fig. 13, is much preferable. (See § 22.)

328. M. Duchenne and some others have recommended, for the production of the shock, the association of two inducing helices composed of wires of different diameters and length, with the

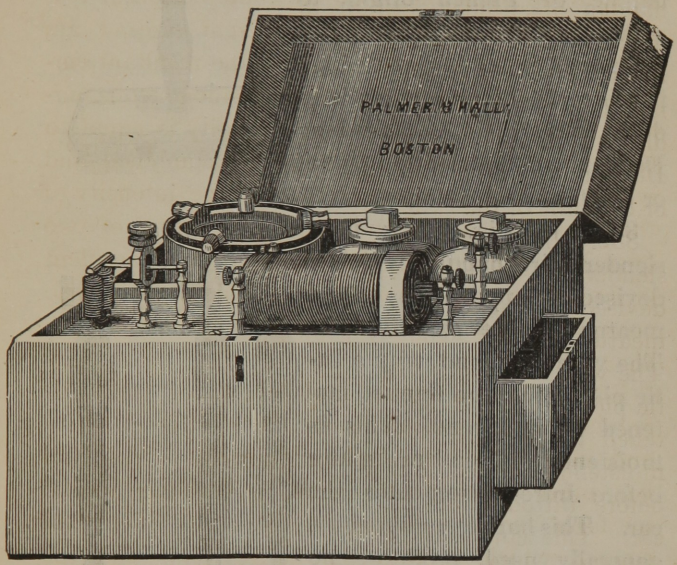
idea that distinct currents of different orders are thus obtained. In another arrangement, for the same purpose, the helix of coarser wire conveying the battery current is made to form part of the circuit through which the secondary helix discharges to produce the shock. Having made a long series of metrical experiments on the combination of currents, induced by helices of different sizes, I am prepared to say unqualifiedly that the resultant current in all such cases is a single, homogeneous current through the body, whose quantity is equal to the sum of the two or more currents combined, and whose intensity is equal to the average intensity of the currents. Any peculiar effect, therefore, of two or more combined coils must be ascribed to accident or imagination. The notion of Duchenne is also corrected by De la Rive in his recent treatise on electricity.*

329. The diameter and length of the coils regulate within certain limits the relative quantity and intensity of the induced current. Mr. Hall has made some instruments, resembling Fig. 3 in form, with a single coarse wire helix of copper, which is both the battery coil and the shock-inducing coil. In these the relative proportion of the quantity to the intensity of the resultant shock is very much greater than in the common form. As a general remark, the electro-magnetic machines, as commonly made, may be improved in efficiency by increasing the diameter of the wire of

* Treatise on Electricity, vol. iii. p. 602.

the secondary coil, and making it of copper. An electro-magnetic apparatus in a box, containing also stoppered bottles for the exciting fluid, and a drawer for handles, is represented in Fig. 13. In other respects it resembles the preceding figure.

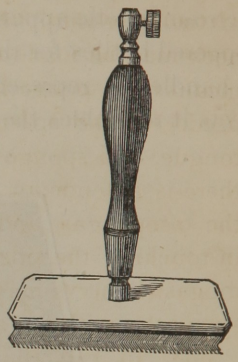
Fig. 13.



330. The handles used to make contact with the surfaces or cavities of the body are an essential part of the means of medical electricity. In addition to those before described, (§ 35,) the following forms deserve to be noticed. They all have a screw cup at one extremity, and a shank of some non-conducting material.

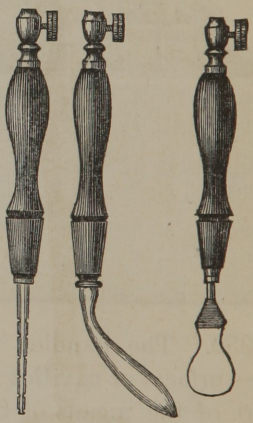
331. Fig. 14 represents a wire card, backed with metal, and attached to a wooden shank, which encloses the rod making connection with the screw cup. This is a new and very good handle, of French origin, to make contact with the scalp of the head through the hair, which is difficult with any other handle. It is also employed by Duchenne as an electric irritant or excitant of the skin.

Fig. 14.



332. In Fig. 15, *a* is a slender wire handle, which I devised for applications to the meatus of the external ear. The wire is wound with a little piece of cotton flannel, fastened by a thread. This is moistened with salt and water before introduction into the ear. This handle, unlike those generally used, produces no excoriation. *b* is a spatula of silver, protected with sheet india rubber, except at the extremity, which is laid on the back of the tongue, and which I also contrived for use in connection with the ear handle, *a*. *c* is a handle for introduction within the rectum for the

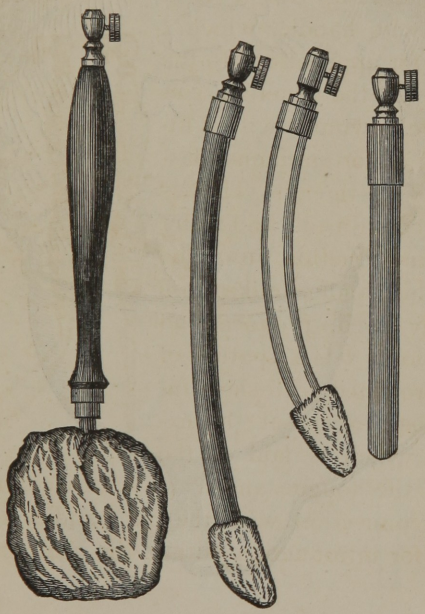
Fig. 15.



purpose of exciting summarily the peristaltic action of the intestines. For this purpose the back of the neck may be made the other pole of the circuit, by means of a sponge handle, or the spatula *b* may be used. If the spatula is carried far back on the tongue, or a sponge handle applied to the pharynx, there is a tendency at once to inverted action of the œsophagus and emesis. Care must be taken in touching the sides of the pharynx, as the pneumogastric nerve may be unpleasantly influenced by sympathy with the glosso-pharyngeal.

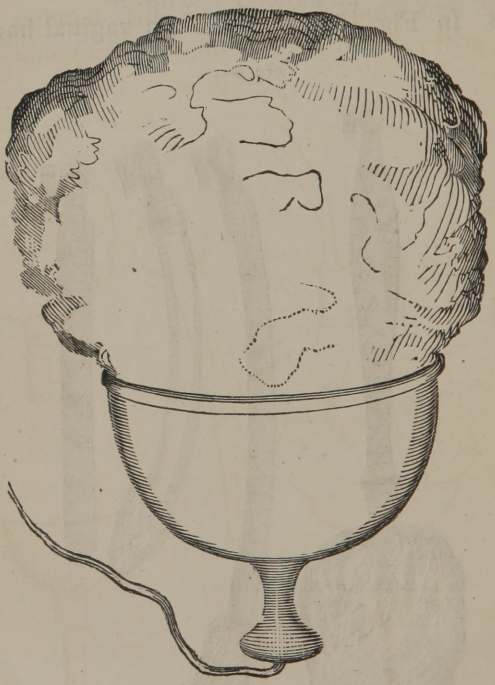
333. In Fig. 16, *a*, *b*, and *c* are vaginal handles.

Fig. 61.



a is metallic and plated, forming a conducting surface to the vagina through its whole extent. *b* is insulated by a glass shank, and *c* by bone rubber, except at the extremity, which is a sponge. These two last are particularly applicable to ulceration of the os uteri. For exciting the menstrual function one of these may be used, or a sponge handle may be applied to the pubes, with the opposite handle in either case, applied to the spine. *d* is a flat sponge

Fig. 17.

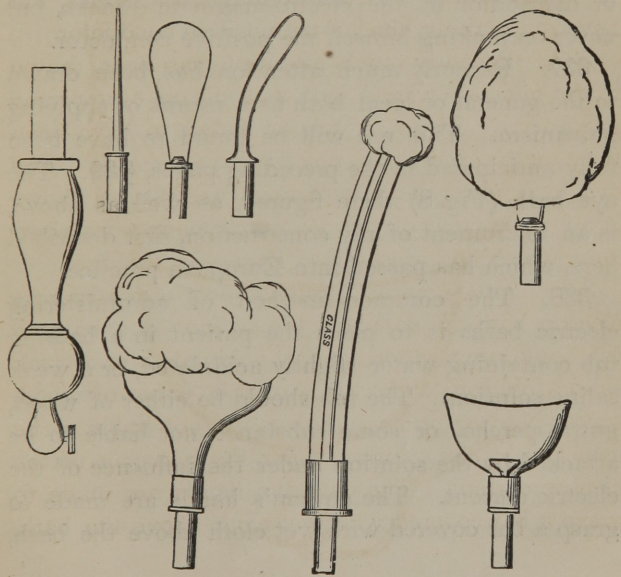


handle, which may be conveniently applied to the surface of the body beneath the clothes.

334. Fig. 17 represents a sponge handle devised by Mr. Hall, in which the insulating portion is a hemisphere, *a*, of bone rubber, lined with foil, so as to make good conduction between the battery wire, *b*, and the sponge, *c*, which is crowded into the hemisphere when the handle is in use. The advantage of this handle is, that the sponge can be taken out, washed, and replaced with perfect ease.

335. In Fig. 18, *a* is the shank of a universal handle, into which a full set of other handles slide. The upper extremity constitutes also a cylinder han-

Fig. 18.



dle, which may be grasped by the hand. *b* is the ear handle; *c*, the spatula for the tongue; *d*, handle for the rectum; *e*, for the vagina; *f*, a flat sponge; *g*, a full sponge; *h*, the electrical eye bath.

336. A very valuable method of application, now much in use, is the conduction of the current to the diseased part by the hand of the operator. (See § 38.) It is not in our province to inquire here how far any vital influence accompanies the electrical influence in this case; but the most successful electro-medical practitioners have been those, perhaps, using this method. A friend who acts in this way informs me that he habitually experienced exhaustion when making his hand the negative pole or distributor of the electro-magnetic shocks, but never on making himself the positive conductor.

337. Recently much attention has been drawn to the general or local bath as a means of applying galvanism. This use will be found to have been fully anticipated in the preceding pages, § 39. The eye bath (Fig. 8) there figured, as well as above, is an instrument of my construction, first described here, which has passed into European practice.

338. The common method of administering electric baths is to place the patient in a bathing tub containing water slightly acidulated, or a weak saline solution. The tub should be either of wood, gutta percha, or some substance not liable to be attacked by the solution under the influence of the electric current. The patient's hands are made to grasp a bar covered with wet cloth above the bath,

which bar communicates with one pole of the galvanic battery. The other pole is introduced into the bath in the form of a plate of metal or handle, which exercises an influence over different parts of the body in proportion to its nearness to them. The galvanic current can thus be easily concentrated on any part of the body, or may be more or less diffused in its ingress or egress.

339. Unless the metallic conductors or handles which convey the battery current to the fluids of the bath are made of platina, or some unoxidizable material, they are liable to be attacked, and a portion of metal dissolved and carried into the bath, under the influence of the electric current. A metallic bath-tub has been sometimes used, and made itself to serve as one pole of the battery. This is obviously improper, unless the whole tub should be made of an unoxidizable metal.

340. The battery current used in these baths has been obtained frequently from ten, twenty, or even thirty Grove's cups. Under such heroic treatment very powerful effects have sometimes been obtained, and rheumatic and paralytic affections of long standing have been broken up. But I have also seen cases in which severe and prolonged neuralgia and nervous prostration have followed the indiscreet use of the electric bath. In the hands of a judicious practitioner it is one of the most efficient means of applying electricity generally or locally. (See § 39.) An extended series of the constant sulphate of copper battery (Fig. 9) may be substitut-

ed for the Grove's battery, requiring, however, two or three times the number of cups.

341. It has been sometimes claimed for these baths that they will dissolve and remove from the animal system metallic poisons therein contained. The transfer of substances under the influence of galvanism through membranes or tissues offering much less resistance than those of the body, is a process of great difficulty, and requiring much time and power. It is sufficient to say that, at the most, no notable quantity of a metallic salt could be removed from the system without subjecting the organism to currents whose energy and duration would exercise a controlling and probably destructive influence over the vital functions, and, perhaps, the tissues themselves. Where lead or other mineral substances are precipitated under the cuticle or detained in the pores of the skin, the electric bath may readily dissolve them, and thus give rise to the idea that they are removed from the interior of the system.

342. Galvanic belts have been introduced into practice, consisting of two metals, in electric connection, worn next to the skin, and discharging through the intervening or neighboring tissues and organs of the body. Unlike those referred to in § 44, these give an appreciable, though feeble constant current, and some testimony has been adduced to show their efficacy in chronic affections, as rheumatism, neuralgia, dyspepsia. The chain of Pulvermacher consists of numerous pairs of zinc

and copper, which, when dipped for a moment in dilute acid, then grasped by the extremities in both hands and shaken, produces sensible galvanic shocks of minute quantity. This may also be worn as a belt; but it is to be regarded rather as a toy than a medical instrument. Where the metals of a galvanic pair touch the body, silver should be used instead of copper, which is liable to poison the skin, and the place of contact should be changed from time to time, to avoid too great irritation under the zinc surface.

343. *Nervous deafness*, or auditory paralysis, is treated by M. Duchenne by placing the patient on his side and filling the meatus auditorius half full of water. Into this, but not touching the membranes of the ear, a wire is introduced, conveying electro-magnetic shocks to the *ear bath*. The other wire of the electro-magnetic apparatus is connected with a moistened sponge handle applied to the nape of the neck. Entire success is stated sometimes to have been achieved by this treatment. Becquerel states that electro-magnetism has no real effect in nervous deafness which is essential, not merely symptomatic. After prolonged experiment I have never seen any benefit in this form of paralysis from the electro-magnetic shocks.

344. This conclusion led me, in 1848, to use the direct galvanic current of from one to twelve pairs in auditory paralysis. The positive wire of the battery was connected with the ear handle, Fig. 15, *a*, and the negative wire successively with a

cylinder handle held in the hand, with a sponge handle applied to the nape of the neck, and with the spatula, Fig. 15, *b*, placed far back on the tongue. I found at once that the *continuous* current of the battery entering at the ear produced a condition which tended towards syncope or unconsciousness, but which was recovered from easily without general apparent injury. I therefore withdrew the negative wire from permanent connection with the battery, and made the application always afterwards by touching the wire momentarily to the cups, including first only two or three in the circuit, and gradually increasing the number up to twelve, according to the endurance of the patient. The application consisted thus, for fifteen or twenty minutes, of rapid intermittent shocks, with occasional entire cessations, never using the continuous current. Patients who showed no improvement under electro-magnetism gained rapidly and at once under this treatment. My friend, Dr. Edward H. Clarke, of Boston, who has tried this method, allows me to say that while he has never seen any advantage from electro-magnetism in nervous deafness, he has occasionally seen a notable improvement follow this use of the battery.

345. I believe that in all paralysis of special sensation the galvanic current will be found much the most efficacious. Even M. Duchenne speaks of the special power of the galvanic current to excite the retina, — a power which requires caution in its development, but which conducts sometimes to a

favorable issue in *amaurosis*. I have seen a decided gain in a partially amaurotic eye connected with nervous deafness on the same side. In this case the positive sponge handle, moistened with salt and water, (as is necessary where galvanic currents of low intensity are used,) was placed over the closed lids of the eye, and the negative sponge handle was placed on the back of the neck. My electric eye bath, (Fig. 8,) may be used with advantage in the same application. Where any organic lesion exists in connection with amaurosis, of course electricity is inapplicable. In *ophthalmic inflammation*, electricity acts with remarkable efficiency and mildness, always benefiting, except, perhaps, in the early stages. Both galvanism and electro-magnetism, applied as above, are useful here, but especially the former.

346. *Aphonia* is often relieved by galvanism either applied directly by a small sponge handle or olive-shaped metallic handle, to the pharynx, (avoiding the sides,) or by passing the current through and through the throat from without. M. Duchenne has succeeded with electro-magnetism. Golding Bird states that he has known the voice almost immediately to return by insulating the patient, and drawing sparks from the region of the larynx. In this connection I will mention the remarkable efficiency of galvanism in chronic inflammation of the throat. The battery current may be sent through the throat from the outside in different directions by means of two sponge handles.

Where there is an inactive state of the mucous membrane, and an accumulation of adherent mucus, it is sometimes instantly started by the galvanic current. Twelve pairs is usually sufficient to effect this. There is every reason to expect decided benefit from the same application in membranous or other *croup*.

347. *Tonic* and *clonic convulsions*, not proceeding from any existing lesion, have been subdued, for the time, at least, according to Becquerel, both by continuous and induced currents. Many cures of *epilepsy* have been lately reported, though without sufficient detail. In this disease, it is certainly desirable to give to electricity the fullest trial. M. Person is stated to have passed the current from the epigastrium to the first cervical vertebra by means of electro-puncture needles. The patient, a girl of twelve, epileptic for six years, recovered.* The continuous current of the battery cautiously applied is most to be relied on in these cases, as well as in *catalepsy* and *hysteria*.

348. *Neuralgia* yields readily in many cases to galvanism, and also to electro-magnetism passed through the seat of pain. In using the galvanic battery for nervous deafness, Dr. E. H. Clarke informs me that he has seen neuralgic affections of the head, which were favorably influenced, and which sometimes disappeared altogether. M. Duchenne reports a cure of *angina pectoris* by the powerful application of electro-magnetic shocks

* Becquerel Traité, p. 248.

applied, during the attack, to the mammary region and upper part of the sternum in such manner as to excite the skin powerfully. (See § 358.)

349. *Nervous headache* yields often readily to the sponge handles connected with a few cups of the galvanic battery, the positive sponge placed on the forehead, and the negative at the nape of the neck. Dr. Daniel Parker, of Billerica, informs me that he applies electro-magnetism successfully by one sponge on the forehead, temples, or top of the head, and the other at the gastric region. The pit of the stomach may often thus be substituted for the back of the neck, especially in applications where we may suppose that the stomach, liver, or uterine system is involved as a cause of disturbance in the special affection we are treating.

350. Dr. E. H. Clarke informs me of the case of a middle-aged man of sedentary habits and occupation, who is liable to severe *sick* headaches, especially after public speaking, or when his digestion is not good, who has obtained repeated and speedy relief from electro-magnetism, one handle being grasped in his hand, the other handle being applied to the epigastrium. The headache was alleviated in ten minutes, and in twenty the relief was complete.

351. Cases are continually occurring of the successful use of eleetro-magnetism in *narcotism* or *suspended animation.* No other vital stimulant is comparable to it in these cases. M. Duchenne states that *artificial respiration* may be produced by

the alternate application and withdrawal of the poles of any powerful electro-magnetic apparatus to the spot where the phrenic nerve passes the anterior scalenus muscle on each side. " The instant that the current is passed, the lower ribs expand, the abdominal walls rise, and air rushes with sound into the lungs. After a second or two the current is broken, the walls of the chest subside, and expiration takes place," * which may be assisted by external pressure.

352. No use of galvanic electricity, perhaps, gives greater or more immediate relief than that in *asthma*, which is described § 174.

353. Dr. Geo. B. Wood, quoting largely from M. Duchenne, says, " In the neuralgic form *rheumatism* will often yield with great facility to the electric influence; and it is probable that many of the cases treated successfully under the names of neuralgia, sciatica, angina pectoris, &c., have been either of this character or gouty. But ordinary muscular subacute rheumatism, such as lumbago, pleurodynia, torticollis, [wry-neck,] &c., will also frequently yield to the remedy as a charm. Sometimes a single *faridization of the skin* [irritating application of electro-magnetism] is sufficient to effect a cure; but more frequently the pain returns, and five or six applications may be necessary for the purpose. It should not be abandoned till the last vestige of pain has been removed. *Rheumatic*

* Wood's Therapeutics and Pharmacology, vol. i. p. 547.

arthralgia will also often yield happily to the remedy. To acute inflammatory rheumatism it is wholly inapplicable. * * * *Rheumatic contraction of the muscles*, which not unfrequently affects the face, neck, shoulder, and parts of the chest, and which has a very disagreeable distorting effect, will generally yield to this remedy applied to the skin." *

354. Dr. Golding Bird states that he has reduced *rheumatic effusion* in the joints by insulating the patient, and "drawing strong sparks from the joint, till the skin becomes red and papulated." †

355. Dr. Edward H. Clarke informs me that he has known a rheumatic joint, which had been so stiff as to admit of scarcely any motion, become moderately flexible under the influence of a strong local electric bath; but he does not know how permanent the relief continued.

356. Becquerel gives a detailed statement of a case ‡ in which he recalled the secretion of milk to the left breast of a young woman, from which it had disappeared almost entirely eleven days previously. The electro-magnetic shocks were passed by means of sponge handles through the breast from side to side, in different directions, for fifteen minutes at each of three sessions. The milk began to return after the first application, and it continued abundant after the third.

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* Wood's Therapeutics and Pharmacology, vol. i. p. 550.

† Lectures by Golding Bird, Philadelphia, 1854, p. 187.

‡ A. Becquerel, Traité des Applications, &c., p. 292.

357. Dr. Daniel Parker, of Billerica, who has used electro-magnetism extensively, informs me that he relies upon it in congested states of the lungs and bowels, applying it both generally and locally at the same time by means of four wires, two positive and two negative, proceeding from the electro-magnetic apparatus. This method of dividing currents, or sending them in different directions at the same time, deserves consideration. Dr. Parker states that in cases of *cholera* and *dysentery* he has seen the pain subside speedily under this treatment. He also states that he has never seen any thing act so kindly on sore, inflamed, and ulcerated lungs. This is supported by the peculiarly favorable action of galvanism on chronic inflammation of the throat, already referred to, and on mucous surfaces generally. Galvanism, however, cannot be used in most cases of acute inflammation, while the electro-magnetic current may still be available. Dr. Parker states that he has used electro-magnetism with invariable benefit in typhoid fever, in measles and *scarlet fever*. In the latter disease he places one positive handle in the hand of the patient, applies another positive sponge to the back of the neck, one negative handle to the feet, and the other negative sponge he passes over the gastric region and about the throat, continuing the operation for about fifteen minutes. Three or four applications are sometimes required, and the recovery is complete, no bad effects remaining in ear, eyes, or lungs, or any ascitical difficulties.

358. The action of electricity upon the skin opens one of the most important chapters of its application. As a revulsive agent it may be employed to stimulate the skin to its highest vascular condition, even to inflammation. A galvanic current of large quantity acts very powerfully on the surface, especially under the handle at which the electricity leaves the system. M. Duchenne's method of exciting the surface by the use of electro-magnetism consists in drying the skin artificially by lycopodium or other absorbent powder, which concentrates the electric current at its point of entrance or departure, and produces great excitement of the skin. In so far as the influence is peculiar in this case, it is simply due to the revulsive action. Duchenne seems to think that the electricity so applied is directed to the surface exclusively and does not obey its invariable law of transmission through the deep-seated tissues or organs which lie most nearly in a straight line between the poles or handles through which the current enters or leaves the system. By using moist conductors, or by moistening the skin, the current is diffused at the point of entrance or departure, and exerts a less intense effect on particular points of the skin. The effects of the electric bath or of the moist sponge are very decided upon diseased surfaces. The influence of electricity in *ophthalmia* has already been referred to. In *erysipelas* it is very effective.

359. Dr. Daniel Parker reports electro-magnetism as highly efficient in *ulceration of the os uteri*,

and in promoting absorption or resolution of uterine tumors. Its influence upon a tumor like the common boil is very marked, promoting suppuration or discussion at an early day.

360. In his "Localized Electricity" M. Duchenne has dwelt upon the importance of being able to exercise or call into action each separate muscle. The handles used for this purpose may be sponges; or, for small muscles, like those of the face, or intercostals, or for deep-seated muscles, conical metallic conductors, covered with moistened leather. They should be placed from one to four inches apart over the course of the muscle which it is proposed to excite. The following observations on this subject are credited by Dr. Wood in general terms to the work of M. Duchenne:* "The influence is never to be directed to the tendons. To act on a muscle duly, its whole surface must be covered; and consequently, if this is large, the excitors [surface conductors] must be moved from point to point successively, until the purpose has been accomplished. The muscle is known to be contracting by its firmness or hardness under the fingers, and it often happens that one part of a single muscle will be relaxed, while another contracts. The thicker the muscle, the more intense must be the current applied. In the face it is difficult to avoid affecting the nerves so abundantly distributed over it. One of these is known to be touched when the

* Wood's Therapeutics and Pharmacology, vol. i. p. 527.

contraction extends to several muscles simultaneously. Should this happen, the excitors should be moved a very short distance from the point until the effect is no longer produced." "When a muscle, on account of its depth, cannot be reached directly by the electric influence, it may be excited by means of its supplying nerve. The excitement of a nerve or of a muscle always produces, in the healthy state, both a sensation and a contraction. But the susceptibility of different nerves and muscles is very different in degree; and a force which will affect one but slightly, will, on another, act with great energy. Again: while one part is unusually excitable in relation to contractility, another is more so in relation to sensibility. It is against the latter that the operator must be particularly on his guard, prepared to diminish the force of the instrument when the influence becomes excessive. Sometimes the sensibility to pain is so great as to preclude this method of electrization. It is apt to be particularly strong in the muscles of the face, supplied by the fifth pair. The excitor should never be placed over the points corresponding with the suborbitar or mental nerve; and the excitation of the frontal nerve produces severe pain, which radiates through the head. The muscles of the eyelid, of the alæ nasi, and of the upper and lower lips are peculiarly susceptible. Of the muscles of the neck, the platysma myoides, the upper half of the sterno mastoid, and the external edge of the upper half of the trapezius, are much more excitable than the remainder. The

great pectoral and the muscles of the subspinal fossa are rather sensitive, the deltoid and muscles of the arms somewhat less, the anterior being much more so than the posterior. The long dorsal and the sacro-lumbar are but slightly sensitive. The gluteal and fascia lata muscles are very much so, compared with those on the outer and posterior parts of the thigh; those of the internal crural region more so than those of the external. The posterior muscles of the leg are but slightly sensitive, compared with the anterior and external."

361. Electro-magnetism has been applied successfully for the production of *uterine contraction* in an increasing number of cases. In *amenorrhœa*, the shock of the Leyden jar, the electro-magnetic shocks, and the galvanic current, have all been employed with the greatest success.

362. Dr. Edward H. Clarke informs me of the case of a woman who suffered several years from profuse *leucorrhœa*. She had partial prolapsus uteri, with a congested os uteri, liable to attacks of ulceration. Occasionally there was profuse purulent discharge from the cavity of the uterus. She was subjected to treatment for a long time. Various applications, local and general, were made, and, on the whole, she improved. Still the leucorrhœa continued as profuse as ever. Electricity was tried by means of a bath. The water serving to conduct the electric current was brought in contact with the os uteri through a speculum in the vagina. While the parts were subjected to the influence of the battery, a

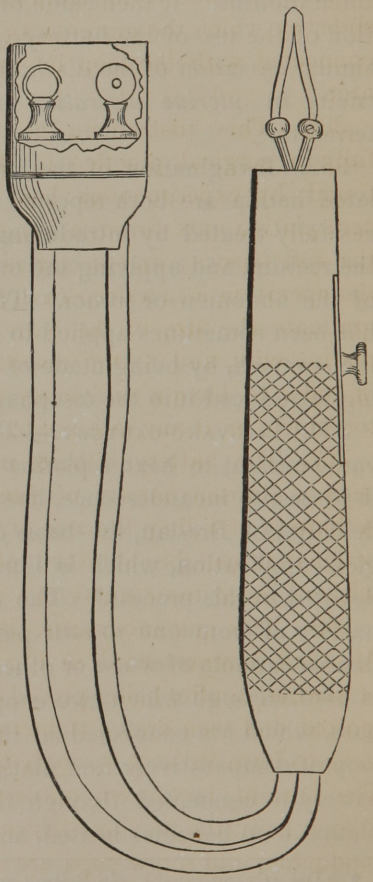
most copious discharge poured out of the vagina. After five or six applications the leucorrhœa subsided altogether, and did not reappear for nearly three months. It then came on again, and a repetition of the use of the battery was *not* followed by a similar cessation of the discharge. The use of electricity in *uterine ulceration* has already been referred to.

363. Invagination of the intestine and strangulated hernia are both reported as having been successfully treated by introducing one conductor into the rectum, and applying the other over the muscles of the abdomen or tumor. The second conductor has been sometimes applied to the cardiac orifice of the stomach, by being made of proper form, and being introduced into the œsophagus.

364. Galvano-cautery.—The power of a galvanic current to heat a platina wire, through which it passes, to incandescence, has been made by Middeldorpf, of Breslau, the basis of an important surgical application, which is illustrated in a volume devoted to this process.* The current of a Grove's battery of from one to four pairs is employed. A double cannula of wood or other insulating material is used, through which two copper conducting wires pass, which are connected at their extremities by a loop of comparatively fine platina wire. When the battery is connected through the copper wires, the platina loop becomes heated, according to the *quan-*

* "Die galvano-caustik, ein Beitrag zur operativen medicin, von Dr. Albrecht Theodor Middeldorpf." Breslau. 1854.

tity of the current, passing gradually through the whole thermometric scale, even up to the melting point of platina. The loop can be made of any shape desired, and when incandescent can be used as a knife to burn a path through tissues which it is desirable to remove. The patient, being subjected to ether, experiences no suffering. Amputations and extirpations, where actual cautery is desired, on account of the danger of hemorrhage, or other causes, can readily be accomplished by this method.



365. Fig. 19, represents the galvano-caustic knife, as adapted by Mr. Hall. The loop of platina is seen at *a*. The handle, *b*, is of ivory, containing two channels for the separate conducting wires. *d*

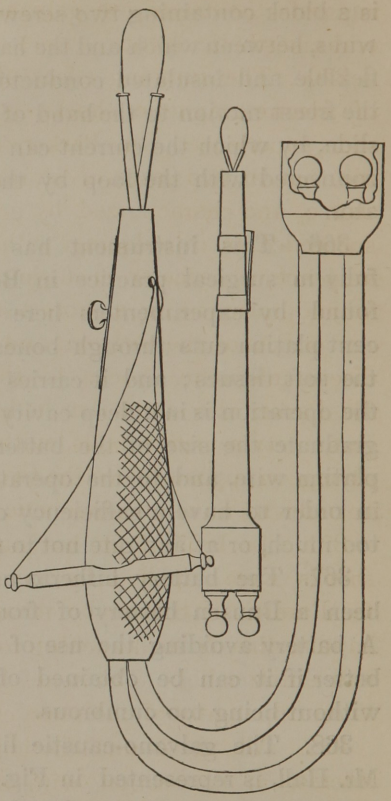
is a block containing two screw cups for the battery wires, between which and the handle, *b*, are two very flexible and insulated conductors, to give scope for the freest motion to the hand of the operator; *e* is a slide, by which the current can be connected or dis connected with the loop by the finger of the operator.

366. This instrument has been used successfully in surgical practice in Boston. It has been found by experimenters here that the incandescent platina cuts through bones as well as through the soft tissues; and it carries its own light where the operation is in a deep cavity. It is important to graduate the size of the battery to the size of the platina wire, and to the operation to be performed, in order to have a sufficiency of heat, and yet not too much, or at any rate not to fuse the platina wire.

367. The battery hitherto usually employed has been a Bunsen battery of from one to four pairs. A battery avoiding the use of nitric acid would be better if it can be obtained of sufficient quantity without being too cumbrous.

368. The galvano-caustic ligature, as made by Mr. Hall, is represented in Fig. 20. Here the loop of platina, *a*, after being placed over a tumor, can be ignited, and then drawn tight by the cross handle, *b*, so as to burn its way through the enclosed tissues. The current is thrown on or off by means of the slide, *c*, as in the previous instrument. The flexible conductors and screw cups are also seen in the same relative position as in Fig. 19. A small cauterizing

instrument for dentists' use is represented at *e*, in Fig. 20. The loop should be more pointed or compressed than in the cut, so that it can be introduced into the cavity of a tooth. The battery current is connected with the coil by means of a little spring, *f*, which can be operated by one finger.



369. In passing the direct current, of from four to twelve galvanic pairs, through the head, in an application for auditory paralysis, in 1849, I found that a peculiar faintness and loss of consciousness, more or less complete, was induced; and I have since repeatedly made the same observation. Dr. Edward H. Clarke, in making the same application, obtained the result, more recently, in a single case, of complete unconsciousness and insensibility, which was speedily recovered from when the application was suspended, without any ill result. This

suggests the use of the galvanic current as a general anæsthetic agent.

370. The numbing effect of a rapid succession of electro-magnetic shocks is a matter of common experience. Dr. Parker, of Billerica, informs me that in two cases of strangury of long continuance, and characterized by great sensitiveness, he succeeded in introducing, with little pain or inconvenience, a catheter enclosing a conducting wire, which protruded for a short distance beyond the inner orifice of the catheter, and which conveyed the electro-magnetic shocks to the sensitive urethra. Dr. Parker also states that he has been able to compress very sensitive boils, with slight pain, by applying, on opposite sides, the two sponge handles connected with an electro-magnetic instrument in action.

371. In 1857, slight but rapid electro-magnetic shocks were applied by my friend, Mr. Moses G. Farmer, of Salem, by means of a little clamp handle, directly to an aching tooth, with immediate and entire relief. The relief in neuralgia is sometimes apparently of the same character.

372. All these anæsthetic phenomena are of interest in connection with a still more recent discovery. On May 25, 1858, a patent was issued to Jerome B. Francis of Philadelphia,* for the combination of a dental forceps with an electro-magnetic or other apparatus for generating electricity for the extraction of teeth without pain.

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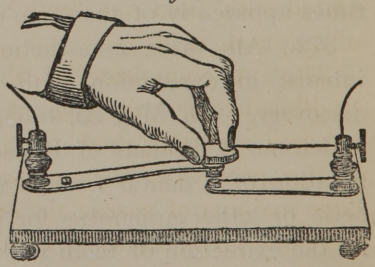
* Assigned to James J. Clark.

373. In this important application of electricity to the production of local anæsthesia, the patient grasps one handle, preferably the positive, (§ 70,) of the electro-magnetic apparatus shown in Fig. 3. The other wire is connected directly with the forceps of the dentist, which grasps the tooth. The electro-magnetic apparatus is adjusted and graduated so as to give very rapid and rather slight shocks, (§ 24, 25.) The extraction, under these circumstances, is effected without pain in most cases, the external and internal nerves of the tooth being paralyzed by the current. An occasional cause of failure is the contact of the forceps with the lips, cheek, or gums of the patient. It is desirable, for the sake of entire security, to insulate all parts of the forceps except the inside of its jaws, where they grasp the tooth.

374. As it is not desirable that the electro-magnetic shocks should pass until the forceps is adjusted on the tooth, a key (Fig. 21) is interposed between the electro-magnetic apparatus and the handle held by the patient. This interrupts the circuit, unless the knob is pressed down, which may be done by the hand or foot of the operator, or by the pressure of his person against the chair or table. Where it is to be depressed by

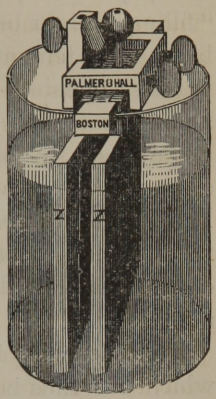
Fig. 21.



the foot, it may be made like a pedal. The key may also be made with a spring and catch, which last is disengaged by a slight motion of the operator, and which then closes the circuit permanently until the tooth is extracted.

375. As the sulphate of copper battery, shown also in Fig. 3, requires frequent cleaning, the Smee's battery, of large size (Fig. 22) is preferable for dentists' use. This will keep in operation several weeks or months without attention, except to add water to compensate evaporation. Z Z represent two amalgamated zinc plates, between which a platinized silver plate is suspended. The wires to the electro-magnetic machine proceed from the two screw cups seen in the figure. The containing vessel is glass, and the fluid used is water acidulated with from one tenth to one twentieth part of sulphuric acid.

Fig. 22.



376. A committee of the Franklin Institute of Philadelphia * reported, April 8, 1858, that one hundred and sixty-four teeth had been extracted by this process in their presence, with no pain in a large majority of cases; the exceptions being where there was much disease, (the forceps probably touching the gums.) A member of the committee, Dr.

* American Journal of Dental Science, July, 1858.

W. S. Wilkinson, reported having extracted between four and five hundred teeth with entire success in ninety-five per cent. of the cases.

377. Many anæsthetic uses will suggest themselves in connection with this application. A clamp placed upon a tooth during the process of "filling" might be effective in deadening the sensibility. Statements have been made already of the painless opening of tumors in which the knife was made one of the conductors of the electro-magnetic apparatus. Another method of producing anæsthesia for surgical operations is that employed by Dr. Parker, (§ 370,) in which the torrent of electro-magnetic shocks is passed, by means of sponge or other handles, directly through the part to be operated upon.

378. It will be observed, from the review which has thus been made of the progress of electro-medicine during the last ten years, that some new applications have been discovered, and some former ones, which were in doubt, have been confirmed. Dr. George B. Wood, of Philadelphia, gives electricity a place among diffusible stimulants, in an elaborate article from which we have quoted, in his work on therapeutics and pharmacology. Even this, however, will not cover the whole ground. Electricity is entering, year by year, more extensively into medical practice, and is to become one of the most universal and important of therapeutic agents.

BOSTON, October, 1858.

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