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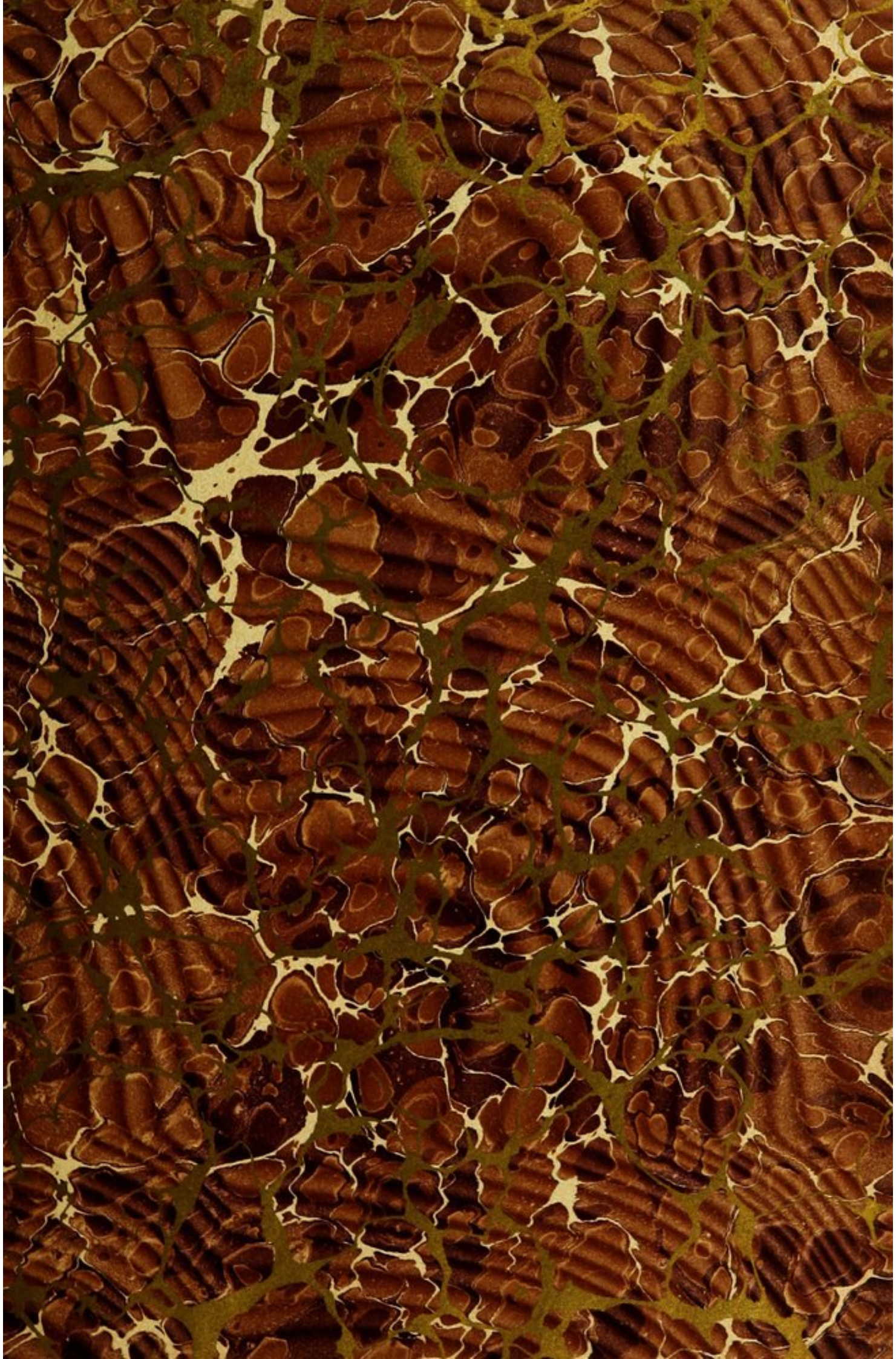
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A SYSTEM

OF

ELECTROTHERAPEUTICS

AS TAUGHT BY THE

INTERNATIONAL

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SCRANTON, PA.

VOLUME IV

ELECTROTHERAPY

ELECTRICITY IN DISEASES OF THE NERVOUS SYSTEM

ELECTRICITY IN SURGERY

FIRST EDITION

SCRANTON

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CONTENTS.

CONTENTS.

Electricity in Diseases of the Nervous System.

	Section.	*Page.*
General Introduction	11	1
General Pathology	11	4
Defects of Development	11	5
Nutritive Disorders	11	5
Disorders of Circulation	11	7
Inflammations	11	9
Atrophy and Degeneration	11	9
Tuberculosis and Syphilis	11	10
Tumors	11	11
Trauma	11	12
Functional Disorders	11	13
General Therapeutics	11	13
Hygiene	11	13
Diet	11	14
Clothing	11	15
Climate	11	16
Hydrotherapeutics	11	16
Muscular Exercise	11	17
Enforced Rest	11	18
Psychotherapeutics	11	18
Surgical Measures	11	19
Medication	11	19
Nutrients	11	20
Tonics	11	22
Eliminants	11	26
Sedatives	11	28
Hypnotics	11	32

	Section.	*Page.*
General Electrotherapeutics	11	33
Action of Electricity	11	33
The Direct Current	11	34
The Induced Current	11	35
High-Tension, High-Frequency Currents	11	37
Static Charge and Currents	11	39
Magnetic Fields and Alternating Magnetic Stress	11	39
Other Therapeutic Uses of Electricity	11	40
Diseases of the Spinal Cord	11	41
Introduction	11	41
Defects of Development	11	42
Malformations	11	42
Spina Bifida	11	43
Syringomyelia	11	43
Morvan's Disease	11	44
Hereditary Ataxia	11	45
Nutritive Disorders	11	46
Spinal Irritation	11	46
Landry's Paralysis	11	48
Disorders of Circulation	11	49
Spinal Anemia	11	49
Spinal Hyperemia	11	50
Spinal Hemorrhage	11	51
Embolism and Thrombosis	11	52
Caisson Disease	11	52
Inflammations	11	53
Pachymeningitis	11	53
Leptomeningitis	11	54
Myelitis	11	56
Abscess	11	58
Anterior Poliomyelitis	11	60
Atrophy and Degeneration	11	63
Progressive Muscular Atrophy	11	63
Muscular Dystrophies	11	65
Primary Lateral Sclerosis	11	69
Posterior Spinal Sclerosis	11	71

Atrophy and Degeneration.—*Continued.*	*Section.*	*Page.*
Ataxic Paraplegia	11	73
Tuberculosis and Syphilis	11	74
Tumors	11	75
Trauma	11	78
Functional Disorders	11	80
Diseases of Peripheral Nerves	11	80
Introduction	11	80
Deformities and Malformations	11	80
Nutritive and Functional Disorders	11	81
Neuralgia	11	81
Facial Spasm	11	84
Torticollis	11	85
Writers' Cramp	11	87
Disorders of Circulation	11	90
Raynaud's Disease	11	90
Angioneurotic Edema	11	92
Hyperemia of Nerves	11	93
Erythromelalgia	11	94
Neuritis	11	95
Simple Neuritis	11	95
Disseminated Neuritis	11	96
Leprous Neuritis	11	97
Rheumatic Neuritis	11	98
Multiple Neuritis	11	98
Alcoholic Neuritis	11	100
Diphtheritic Neuritis	11	101
Malarial Neuritis	11	102
Typhoid Neuritis	11	102
Diabetic Neuritis	11	103
Neuritis From Carbonic Oxid	11	103
Neuritis From Lead	11	103
Arsenic Neuritis	11	104
Beriberi Neuritis	11	104
Atrophy and Degeneration	11	107
Tuberculosis and Syphilis	11	108
Tumors	11	108
Trauma	11	109

	Section.	*Page.*
Diseases of the Brain	11	112
Introduction	11	112
Deformities and Malformations	11	113
Disorders of Nutrition	11	117
Neurasthenia	11	118
Megrim	11	122
Chorea	11	125
Tetanus	11	129
Tetany	11	130
Hydrophobia	11	131
Plumbism	11	133
Alcoholism	11	135
Morphinism	11	137
Cocainism	11	138
Circulatory Disorders	11	139
Hyperemia	11	139
Cerebral Anemia	11	140
Aneurism	11	142
Embolism	11	143
Trombosis	11	145
Meningeal Hemorrhage	11	146
Cerebral Hemorrhage	11	147
Inflammations	11	151
Pachymeningitis Externa	11	152
Chronic Pachymeningitis Externa	11	152
Pachymeningitis Interna	11	153
Leptomeningitis	11	155
Chronic Leptomeningitis	11	157
Tubercular Leptomeningitis	11	157
Syphilitic Meningitis	11	158
Epidemic Cerebrospinal Meningitis	11	159
Encephalitis	11	162
Atrophy and Degeneration	11	167
Chronic Progressive Softening	11	168
Disseminated Sclerosis	11	168
Chronic Bulbar Paralysis	11	170
Paralysis Agitans	11	171

	Section.	Page.
Tuberculosis and Syphilis	11	174
Tumor of the Brain	11	175
Injuries to the Brain	11	178
Traumatic Neurasthenia	11	179
The Neuroses	11	184
Hysteria	11	185
Epilepsy	11	188
Catalepsy	11	192
General Electrotherapeutic Technique	11	193
Introduction	11	193
Technique of the Direct Current	11	193
Conducting-Cords and Connections	11	194
Polarity of the Current	11	195
Electrodes	11	195
Gradual Variation of Current	11	200
Reaction of Degeneration	11	201
Universal Method for Using Direct Currents	11	202
Break-Circuit Handle	11	204
Graduated Dimensions for Electrodes	11	204
Technique of the Induction-Coil	11	205
Modification of Current-Strength	11	206
Variation of Interruptions	11	207
Sensory Stimulation	11	208
Muscle Stimulation	11	208
Diagnosis by Induction-Coil Currents	11	209
Duration of Treatments	11	210
Treatment of Patients by Laymen	11	211

Electricity in Surgery.

Surgical Uses of Electricity	12	1
Electricity as an Aid in Diagnosis	12	1
Electricity as a Source of Roentgen Rays	12	2
Induction-Coil	12	3
Tesla Coil	12	4
Static Machine	12	5

	Section.	*Page.*
Electricity as a Source of Heat	12	8
Heat as a Therapeutic Agent	12	8
Electrotherms	12	9
Electrocautery	12	10
Electrohemostasis	12	12
Directions for Using the Electrical Forceps	12	16
Bottini's Method	12	18
Electricity as a Source of Light	12	22
Transillumination of the Stomach	12	26
Urethroscope and Cystoscope	12	28
Electric Light in Therapeutics	12	30
Electric-Light Bath	12	31
Finsen Method of Treating Lupus	12	32
Electrolysis in Surgery	12	34
Removal of Abnormal Growths	12	34
Advantages of Electrolytic Method	12	38
Myeloma of the Superior Maxillary Bone	12	38
Squamous Epithelioma	12	40
Electrolysis of Rectal Neoplasms	12	41
Epithelioma of the Rectum	12	43
Epithelioma of the Penis	12	44
Moles	12	46
Electrolysis of Aneurism	12	49
Stricture of the Urethra	12	51
Fibroid Growths	12	57
Fibroid Tumors of the Uterus, Fibroid Goiter, Fibroid Growths in the Mammary Gland, Fibroid Hypertrophy of the Prostate Gland	12	57
Cathodal Electrolysis	12	58
Cathodal Electrolysis of Exostoses, Warts, Moles, and Superfluous Hairs	12	61
Electricity as a Stimulant to Nutrition	12	63
Electricity as a Motive Power	12	68
Questions.		

ELECTRICITY IN DISEASES
OF THE
NERVOUS SYSTEM.

ELECTRICITY IN DISEASES OF THE NERVOUS SYSTEM.

GENERAL INTRODUCTION.

1. In attempting a systematic arrangement and brief discussion of the more common derangements of the nervous system, with the main intent of suggesting the use of certain of the electric modalities in the treatment of them, it is not our purpose to write a comprehensive treatise on nervous diseases.

It is presumed that the modern accepted views as to the architecture and physiology of the nervous system are sufficiently familiar to the professional reader that assumes to treat its diseases, and that he is also well trained in the fundamental facts and principles of morphology, pathology, and general therapeutics.

For our purpose it will suffice, therefore, to call attention to that limited class of pathological processes that are associated with the nervous system, to name and describe the diseases in which they appear and the symptoms that attend them, and to mention the therapeutic measures that are ordinarily suggested and employed for their treatment. And then, when it is believed that electricity in any form is a suitable remedy with which to counteract the morbid action or to aid in the removal of any of its detrimental effects, the attempt will be made to show the manner in which electricity can best be made to accomplish this result.

It is well for us, occasionally, when considering the diseases that have become classified with one or another special branch of medical or surgical practice, to remind ourselves that no

organ or tissue of the body maintains an existence independent of another or of any one of the others. All are correlated and interdependent, the welfare of one demanding the welfare of all the others.

This dependence for integrity on the normal action of all other processes in the body is eminently true of the nervous system, because of its high organization and the variety and delicacy of its functions.

The source of many of its disorders is found oftentimes outside the boundaries of its own structure, and the therapeutic measures, to be successful, must be directed so as to control and correct the beginnings of the morbid process.

2. Elements of Nervous System.—The nervous system is made up of individual elements, termed *neurons*, together with *neuroglia*, *connective tissue*, *blood-vessels*, and *lymphatics*. The diseases that pertain to it must affect one or more of these structures.

These tissues are not many in number, nor are the pathological processes that arise in them very numerous. Owing to the fact, however, that the symptoms, course, and effects of any one pathological process differ greatly, according to the location or function of the tissue involved in it, there arises from these few tissues and the operation of this limited number of morbid activities in them, a very great variety of clinical pictures.

This is likely to occasion much perplexity, especially in the mind of one that approaches the field of nervous diseases from the clinical side rather than from the anatomical and physiological side, and this perplexity is in no measure lessened by the long array of remedies and therapeutic suggestions offered with which to combat these conditions that one finds filling his special text-books and monographs.

3. In many affections of the nervous system wherein the clinical symptoms indicate nothing in common, the same morbid action is present, whereas, in other cases, with clinical pictures apparently almost identical, the underlying cause and the result that will follow it are found to differ as light does from darkness.

This shows the necessity there is for that intimate knowledge of anatomy, physiology, and pathology in dealing with nervous diseases, which will enable one to rightly interpret these apparent anomalies.

By reason of such knowledge, also, therapeutic measures are much more wisely selected and simplified. It has become an axiom in therapeutics that "ignorance of the nature of a disease is shown by the great number and variety of the remedies employed to treat it." The deeper insight one acquires of the nature of physiological action in living tissues and of the causes and influences that tend to divert that action beyond the limits of health, the more simple and rational will be the therapeutic means that he will employ to remove those causes and check those morbid tendencies.

4. Uses of Electricity.—Electrification is one of the known forms of energy. It is correlated to all other energies known to us operating in the physical universe. Both in inanimate matter and in living things, plants and animals, its presence is at all times detected. It shares with radiant energy, as light and heat, with chemism and with mechanical force, the burden of work accomplished. In association with the other forces known to the physicist or the biologist, it determines molecular movements and shares in all physiological and pathological action.

In one or another manner of action, it has been found to have definite effects in modifying nutritive processes in living organism. It therefore has a legitimate place among those agents that we employ to lead back the wayward functions to the boundaries of normal life. By reason of its capacities to do effective work in this field, it deserves universal recognition and employment intelligently directed. But it is not a cure-all, and must not be expected or called upon to do duty where other means are better fitted for the service.

Finally, we would discourage any one from attempting to treat, with any prospect of success, the disorders that involve the nervous tissue of the body by depending wholly on the information that he may obtain from this Section, for this is

intended only as a guide to the already well-furnished mind and skilled hand.

5. Wisdom, judgment, and patience, as well as abundant knowledge, must enter in to solve the problems that arise in dealing with the disorders of that substance which serves as the machinery for the highest activities, both of the body and mind of man.

GENERAL PATHOLOGY.

6. There is no pathology peculiar to the nervous system. The same conditions that cause disturbance of normal function elsewhere in the body, affect the nervous system in proportion as its tissues and functions are implicated.

7. Classification of Nervous Derangements.—We may, for convenience, classify the derangements of the nervous system as follows:

1. *Defects of Development.*—(*a*) Malformations. (*b*) Retarded evolution.
2. *Nutritive Disorders.*—(*a*) Due to misuse, occupation neuroses. (*b*) Due to faulty metabolism, glandular defects, diatheses, autointoxications. (*c*) Due to unsuitable climate, improper diet, and hygiene. (*d*) Due to infectious, metallic, and other poisons, parasites, parasitic products, etc.
3. *Disorders of Circulation.*—(*a*) Vasomotor disorders, anemia, hyperemia. (*b*) Thrombosis and embolism. (*c*) Structural disease of arteries and veins. (*d*) Edema, hemorrhage.
4. *Inflammations.*
5. *Atrophy and Degeneration.*—(*a*) Softening. (*b*) Sclerosis. (*c*) Gliosis.
6. *Tuberculosis and Syphilis.*
7. *Tumors.*
8. *Trauma.*
9. *Functional Disorders.*

8. No attempt at systematic classification of diseases is free from defects. The reasons for this are that many morbid states

are as yet but poorly understood, and many others have several elements entering into the process, and of these we are often in doubt as to which should take precedence; whether, for instance, a nutritive change is the origin of a derangement of circulation, or vice versa.

DEFECTS OF DEVELOPMENT.

9. There are many instances of *defects of development* in the nervous system, and they differ greatly in importance, according to the part affected. An injury in embryonic life may cause arrest in development of some most essential part of the brain or cord. Infants born with such gross defects are seldom long-lived. But injuries at birth or structural or functional defects due to one and another cause in early life may disturb the normal evolution of the various parts and so derange the harmony of adjustment that great or less deformity is the result. Yet this may not be of a nature to seriously affect vitality, provided the body is sufficiently well nourished, though it may prove a marked impediment to function. Congenital defects of this nature furnish the idiots, the feeble-minded, and the cases of syringomyelia and hereditary ataxia, together with many lesser deficiencies in which only a special sense-organ, as the ear, or the eye, or some less important group of peripheral neurons, is wanting.

NUTRITIVE DISORDERS.

10. Viewed in one way, all disorders of whatever sort are defects of nutrition. We might with reason say that this is the first step in every abnormal process, or, indeed, that it constitutes the whole of it. Both the evolution of the nerve-element to that stage where its function begins and the maintenance of it in a state of integrity for the continuous performance of that function depend on a suitable supply both in quality and quantity of nutriment. If it were possible for us at all times to know what is at fault, and to be at hand when nutritive processes first begin to depart from physiological paths, and have at our command and apply those means to set the

process right, both our pathology and our therapeutics would have reached their ideal stage. But ignorance and inefficiency yet attend us at every one of these stages, and so the abnormal action goes on and oftentimes we recognize it only at some later stage. This we name, and here it is we begin our process of repair, if repair is possible.

11. Faulty Nutrition.—Faulty nutrition gives rise to the vast majority of morbid states that we have enumerated under the headings that follow that one on the scheme of classification. These represent the later stages of the processes that disorders of nutrition set going. It is well, then, when we can do so, to come upon the morbid stream well up toward its fountainhead. But, as is well known, this is oftentimes impossible, since the later stages are the only ones in many instances that are brought to the notice of the physician, and frequently the patient himself is unaware of the beginnings of disease. Still, there are many nervous disorders that can be directly traced to defects in nutrition. All function depending on material structure is intermittent. Action brings waste, and time and rest are needed for the reconstruction of the wasted substance. The action may, by disregard of this physiological law, be carried beyond the limits of normal structural waste. When this is done, repair takes place slowly and laboriously. Even a cessation of effort at repair may be occasioned, or a degeneration begun in the structure on which that function depended. Thus, an occupation calling into use a part or whole of the nervous mechanism may have inordinate demand thrown upon it, and such demand persisted in gives rise to exhaustion, local or general, of nerve-force. Metabolism involves anabolism and catabolism.

12. Nutrition of Nervous System.—The nutrition of the nervous system may be deranged by defects either in the substances that are furnished it for growth and maintenance, or in the removal of that which has done its work and is no longer useful. Any one of the organs engaged in the work of fitting the crude foodstuff for nerve-nutriment may fail to do its whole

duty, and thus permit material to pass by it on which its work of preparation is but half completed. The organs of elimination may fail, in whole or in part, to remove from the nutrient fluids the waste products resulting from work done, many of which are poisonous to the neurons. Thus, both at stages of the processes of anabolism and of catabolism, the nervous system may be caused to suffer. These are the sources of the autointoxications, and they account for a large share of the primary morbid states of the nervous system and are the beginnings of many of the organic disorders that are known under one or another name, that name being chosen to designate some special pathological feature in them.

13. Faulty Metabolism.—Faulty metabolism misuses suitable food and brings about a defective nutrition from causes originating within the body, but there is another class of nutritive derangements that are due to the food-products themselves. These may be unsuited in quality or quantity to the needs of the nerve-mechanism. The air, the food, and the drink that are furnished the patient may either directly or indirectly prove hurtful, and a return to health demands a removal of one or other of these extraneous causes of disorder.

So, likewise, from without the organism, there may be admitted, through some gateway, an infectious germ or parasite, a metal, a metallic salt, or a vegetable extract, by means of which some change is wrought in the nutrient fluids or in the metabolism of the cells comprising the nervous system, and their action thus prevented and in time their structure changed.

DISORDERS OF CIRCULATION.

14. Causes of Disorders of Circulation.—The nervous structure is very sensitive to any morbid action in the blood-supply. The nervous tissue everywhere is well supplied with arterial blood. The large size of these vessels and their free anastomoses give evidence of the need that this tissue has for an abundant stream of nutrient fluid in order that its activities may not flag. Irregularities in the supply of blood, which in some

less important organ might not occasion serious disturbance, soon cause grave symptoms of disorder in the brain or spinal cord.

This is oftentimes one of the stages preceding the nutritional disorders, for a lack, an excess, or a fitful supply of blood soon impairs the function of the neurons. The nerve-mechanism, which regulates the musculature of the blood-vessels may be affected by mental or by physical causes. A sudden fright or profound emotion may cause the blood to leave the brain with a deficient supply, and a loss of consciousness may result. A slowly acting but more prolonged emotional cause frequently affects nutrition in a similar manner but with more lasting result.

15. Effects of Toxic Substances on Nerves.—Toxic substances circulating in the blood have, for their first effects, an action on the nerves of the blood-vessels, causing anemia or hyperemia, with their attendant disturbances of nutrition.

Occasionally, through injury to the walls of the vessels or by reason of changes in the blood itself, some channel becomes obstructed by a foreign mass or by a coagulum, either formed at the point of obstruction (thrombus) or brought there by the blood-stream from some distant focus of disease or injury (embolus). When an important nerve-center is depending on a blood-vessel so obstructed, its structure is seriously damaged and usually destroyed, owing to the defective nutrition.

16. In advancing years and in earlier life, owing to defect in the nutrient fluids, the walls of the blood-vessels themselves become impaired and are thus unable to propel the blood-stream with the needed force and regularity. Changes in the structure of the walls of the vessels narrow the lumen and obstruct the flow of blood, and deficiencies in the wall permit the serum of the blood to escape, causing edema, or the walls give way at some point, by reason of the pressure, and hemorrhage is the result. The brain is very sure to be the seat of these vascular diseases, both of the functional and structural varieties, and a large proportion of the nervous diseases of the brain are vascular in origin.

INFLAMMATIONS.

17. It is but a step from vascular changes to inflammations. A local irritation through reflex nervous action occasions hyperemia, and this, if severe and more than temporary in duration, is followed by inflammation. The character of the inflammation depends on the nature of the irritant, the violence of the reaction, and the particular tissues of the nervous system that take chief part in it. The inflammations that directly affect the nervous system may be confined to the membranous coverings of the brain and spinal cord, the connective tissue or neuroglia that serves as a supporting structure to the nerve-elements proper, or may involve the latter primarily. We may have, therefore, meningeal, interstitial, and parenchymatous inflammations.

18. Those inflammations that attack the parenchyma directly are the gravest in their nature, but, fortunately, they are also the rarest. Yet an inflammation involving any one of the tissues that forms a part of the nervous system, if at all severe or prolonged in its nature, is always a serious disease, and likely to do permanent damage to the function of the part of the nervous system involved in it. Even if the inflammation is confined to the supporting tissues, the stasis, the compression, and the exudates at once interfere with the nutrition of the neurons and a degeneration or organization of these exudates will leave obstructions that prolong the nutritive disturbance of the neurons and may start a degenerative process in them.

Suppurative inflammation of the parenchyma is prone to produce necrosis and abscess in the nerve-centers.

ATROPHY AND DEGENERATION.

19. When, from any cause, the nutrition of the tissues of the nervous system is deficient or defective, atrophy and, later, degeneration of those tissues take place. Acute or sudden arrest of nutrition, continued beyond the vital capacities of the nerve-cells to recover, results, in some instances—especially

in the brain and spinal cord—in a disintegration and softening of the nervous structure. At other times, while the conditions present may not be such as to fitly nourish the more highly organized neurons, they may be sufficient to maintain the growth of the connective tissue or neuroglia tissues, and then, associated with degeneration of the neurons, we have an increased growth of connective tissue (sclerosis) or of neuroglia (gliosis). This is a pathological result that is found frequently in diseases of the spinal cord in their later stages, as in chronic myelitis, spastic paralysis, tabes, etc. When this result is reached, little can be done to restore the integrity of the parts involved, since the nerve-tissue proper has perished, and a neuron once destroyed is never renewed.

TUBERCULOSIS AND SYPHILIS.

20. There is no excuse for a separate mention of these special forms of abnormal change in the nervous system, except that they occur frequently and are a little better known to us in their beginnings and progress. The tubercle bacillus and the syphilitic irritant, whether it be a bacterium or its product, each excite a special form of inflammatory action in the tissues of the nervous system. The process is usually chronic in nature and by preference selects for its starting-point the connective tissue surrounding the blood-vessels of the pia mater, and may penetrate deeply with these vessels into the parenchyma of the central nervous system. The resulting abnormal growth due to these processes may be either diffuse or localized in nodules varying in size from the diameter of a millet-seed to that of an English walnut. Diffuse tubercular growths are found most commonly along the course of the main cerebral arteries, especially at the base of the brain. The larger tubercular masses, though they are rare, occur by preference within the substance of the brain, in any or all the lobes of the cerebrum or cerebellum. They are often multiple. The diffuse form of syphilitic growth is a chronic arteritis starting in the perivascular tissue at the base of the brain, along the main arterial trunks leading to the cerebral cortex, or those of

the pia mater of the cord. The plastic exudate partially organizes and obstructs the flow of lymph in the perivascular spaces, impairing the nutrition of both the walls of the vessels and the nervous tissue that the vessels supply. Later, the inflammation and exudate extend to the intima of the blood-vessels, diminishing their caliber and causing degeneration and atheroma of their coats. A more localized syphilitic inflammation with a greater amount of exudate results in the growth of gummatous masses that, in the brain, occur most frequently at the base or on the parietal cortex, having their starting-point in the blood-vessels of the membranes and in the spinal cord originating in the same structures, and being located at any point.

21. The diffuse forms of tubercular and syphilitic inflammation are often accompanied by meningitis, with symptoms varying by reason of locality and the extent and severity of the morbid process and growth. The localized masses of tubercle or gumma give rise to the symptoms of tumor, and cause obstruction of vessels and compression of nerves and nerve-centers, producing interference with nutrition and function, the gravity of which depends on the locality of the growth or growths.

TUMORS.

22. Aside from the tumors due to tubercular or syphilitic growths, glioma and sarcoma are the more common forms that occur in the nervous system. But neoplasms such as are found in similar tissues elsewhere, as lipoma, fibroma, and carcinoma, are occasionally found in the brain. Vascular tumors, as aneurisms and venous varicosities, and parasitic growths, such as echinococcus and cysticercus, are occasionally found in the brain. Psammoma and neuroma are rare, but are peculiar to the brain-tissue.

23. Abnormal growths having their origin external to the nervous tissue may affect it secondarily by pressure, and thus prove quite as harmful as if their origin were in the nervous

tissue itself. Osteoma or osteosarcoma or chondroma in the bony or cartilaginous envelopes of the brain or cord do damage to the nutrition or structure of these parts, and the nerves are frequently obstructed in their course by abnormal growths occurring in the lymphatic glands or other adjoining tissues.

It is interesting to note the period of life at which certain forms of neoplasm are more likely to develop. Tubercle and glioma are much more frequent in childhood. In early adult life, sarcoma and glioma are the more common forms, while in later adult life, sarcoma, carcinoma, and gumma are the varieties that are most likely to occur. Brain-tumors are more common in males than in females, two to one, with the exception of sarcoma, which occurs with equal frequency in both sexes. Tumors of the brain, of any kind, are extremely rare after the age of sixty (*Dana*).

TRAUMA.

24. Causes of Trauma.—Any part of the nervous system is liable to injury from blows, cuts, bruises, punctured wounds, lacerations, and the like, though its tissues are marvelously well protected from exposure to harm from such causes. Permanent damage may result from either direct injury to nervous structure or some secondary effect of it, as hemorrhage, pressure, inflammation, or enfeeblement of function due to the shock or concussion. If the injury has not destroyed the vitality of the affected neurons entirely, there is a possibility of their structure and function recovering at least in part, and appropriate treatment can contribute much to this end. Injuries that may not produce much apparent damage to nervous structure as their immediate result, are followed in some instances after an interval of some weeks or months by functional derangements or even degenerations of certain nerves or nerve-tracts. The mental shock or the instability caused by the severe concussion is held responsible for these sequelæ to traumatism, though in many such cases the nervous system is the more liable to such effects of injury by reason of hereditary debility or some specific diathesis.

FUNCTIONAL DISORDERS.

25. A large share of derangements of the nervous system in their incipient stages are regarded as *functional disorders*, and such they are. A morbid action in many instances is not immediately followed by structural change, at least not by such change as is demonstrable to the naked eye or by means of the microscope. Such diseases as insanity, epilepsy, chorea, neuralgia, and neurasthenia are classed as functional solely because we have not as yet discovered any constant source of irritation or disturbance to account for the perverted action, and, further, because that morbid action has not resulted in any uniform series of structural changes.

Such disorders must needs be treated symptomatically, or in accordance with some rational hypothesis as to their causation. The progress of modern medical science is toward the discovery of those factors in neural pathology that operate to pervert function, and on the success of such discoveries must depend all substantial advances in therapeutics.

GENERAL THERAPEUTICS.

26. To meet and counteract the foregoing pathological tendencies, there are many considerations, broad and comprehensive in scope, which will apply equally well to most of them, and which it would be well to mention briefly under the head of general therapeutics. Among these we may mention *hygiene, diet, clothing, climate, hydrotherapeutics, passive and active muscular exercise, enforced rest, psychotherapeutics, surgical measures, and medication.*

HYGIENE.

27. *Hygiene*, in its most general meaning, embraces all conditions that are conducive to the complete and perfect development of the individual into his highest capacities. The nervous system of man requires appropriate nutriment for both body and mind, in order that it may reach its highest

development. Not only, then, must all conditions favorable to the perfect evolution of the body be observed, but attention must be given as well, and, mainly, to the needs of the mind, which resides in the body, and which both rules it and depends on it. A nervous system is often blighted in its development by hereditary defects, and enters on its independent existence handicapped by parental endowments. It is clearly the physician's duty to make plain the consequences of a disregard of the laws of heredity, such as the dangers of consanguinity and of the reproduction of infected blood or wasted vitality. The evil effects of early training and of faulty methods of education, customs, and modes of life are daily thrust upon the notice of the neurologist, and it becomes his duty to his patients to point these out and strive to correct them. In this effort, if it is to be successful, his voice and influence must extend into a wider circle than that which includes his own generation and those that enjoy his personal ministrations.

He must do what he can for the present patient, often a hopeless task; but knowing the cause of its hopelessness, his further duty consists in warning others lest they likewise become wrecks of humanity or help to produce them.

28. Simple and unstimulating foods in moderate quantity, and at regular intervals; bodily exercise without strain or extreme fatigue; pure air and sunlight; clothing that is clean, decent, and comfortable; mental occupations that are attractive, inspiring, and beneficial; amusements that delight and yet fail to excite the evil passions, are the hygienic conditions that the physician should recommend and strive to bring about for his patients, for these are the essentials for health of body and mind.

DIET.

29. Effects of Diet.—Those experienced in the treatment of nervous diseases are very generally agreed that a diet of readily digested meats, such as fowl, fish, beef, and mutton—in other words, a nitrogenous diet—is best suited to the needs of

the irritable and readily exhausted nervous system. At the same time, it is true that such invalids are usually devoid of fat, and that a fair amount of readily digestible fats in the diet, as butter, milk, and olive oil, is beneficial. Faults in diet are readily acquired by nervous invalids, and the main thing to be accomplished is to secure regular hours of taking both nitrogenous and hydrocarbonaceous food in such quantity and variety as will meet the demands of healthful nutrition and growth, and also aid, when necessary, their digestion and assimilation by the addition of active artificial digestive powders or liquids.

CLOTHING.

30. Effects of Improper Clothing.—Too little attention is given to the healthful clothing of the body, especially in young children and in girls during the growing period. The clothing is too often fashioned to meet the requirements of some style or fad rather than adapted to comfort and the normal requirements of the movement of the body. In our changeable and widely varying conditions of climate, where extremes of heat and cold, moisture and dryness, follow each other in quick succession, garments composed of all-wool or of a texture composed largely of wool and of a weight suited to the season of the year, are most conducive to health. In all other respects, the first essential of clothing should be to protect the body without impeding the function of any of its organs, and, in our girls and women, especially, the prevailing methods of dress are still far from meeting this requirement.

Faulty and hurtful clothing contribute much to the maintaining of many forms of nervous disorder, if they do not actually produce them. Congestions of the pelvic and abdominal viscera, laxity of the abdominal and spinal muscles, with consequent torpidity of the movements depending on them, and obstructions to the free and easy movements of the heart and lungs, are potent factors in the production of nervous disorders that can, in many instances, be traced immediately or remotely to faults in clothing.

CLIMATE.

31. A low elevation and moist atmosphere is, as a rule, sedative and allays nervous irritability. Residence at the seashore at points free from strong or cold winds, or sea voyages in temperate latitudes, are usually beneficial to the irritable and hypersensitive nervous system. Where the cause of that irritability is some autotoxic state or torpid action of the blood-making or eliminating organs, a higher altitude with a dryer air, such as is found on the mountain slopes inland, is more suitable. A person with feeble nervous energy or weak heart-action should avoid very high altitudes, as their symptoms of nervousness and especially insomnia are usually increased by the dryness and the diminished pressure of the atmosphere.

HYDROTHERAPEUTICS.

32. Baths as a Curative Agent.—Water used either internally or externally is mainly an aid to the elimination of effete matters. If pure and taken internally at such times as not to dilute the digestive fluids unduly, it can seldom be used to excess. It is carried off from the system by the kidneys, skin, bowels, and lungs without overworking these organs, while its passage through them is the chief means for removing the waste that has accumulated in them from tissue action. Nervous people as well as others do not drink enough water.

The external use of water for cleanliness of the skin is one of the first essentials to health. A morning or evening sponge bath, and at least two thorough cleansing baths each week are ordinarily required to keep the skin in a healthful state.

The external application of hot or cold water by means of dipping, spraying, douching, or pouring exerts a decided sedative or stimulating effect on the nerve-centers and circulation, either generally or locally, according to the manner in which it is applied. The use of water for therapeutic purposes should always have the intelligent direction of the physician. Its indiscriminate use as a curative measure is very often hurtful rather than beneficial.

MUSCULAR EXERCISE.

33. Necessity of Muscular Exercise.—The circulation of the fluids of the body depend largely on the motion given to them by muscular contraction. It is, therefore, in a large measure, this action that conveys the nutrient fluids to the tissues and the waste products away from them. Muscular exercise that is volitional and purposive is the most effective and healthful, provided it is called into play daily and is not excessive. At times, to aid the action of particular organs, special forms of muscular exercise are advisable, as horseback-riding, bicycling, rowing, or walking. Where there is lack of symmetry in development or need of improved nutrition in a part of the body, as in a limb, or one side of the spine, specially devised muscular exercises with appropriate apparatus may be employed with profit to the patient. General gymnastics, either with or without special appliances, are also helpful to the nutritive activities of the body and so to the nervous system, provided they are wisely selected and pursued with moderation. But outdoor games and occupations that call into play the musculature so as to cultivate its skill in accomplishing work are more serviceable than any of the artificial and mechanical devices designed for exercise alone.

34. Forms of Muscular Exercise.—The mechanical movements of the nutrient fluid ordinarily performed by muscular action are so essential to health that when the muscular tissue fails in whole or in part to do its share of this work, the nervous system as well as other tissues and organs suffer in consequence, and the work that the muscles fail to do must be done in some other way. Passive exercise, Swedish movements, massage, muscular contraction caused by electric stimulus, by mechanical vibrators or percussors, are some of the means employed for accomplishing this, and they are all more or less effective according as they are used skilfully and intelligently. Massage and electricity in some form are the most suitable and serviceable of the methods adapted for giving to the human body passive or involuntary muscular exercise, and by the use of these means the nervous system may be

kept in a good state of nutrition and at the same time be expending but little of its own energy to accomplish this. They are valuable aids, therefore, in conserving nerve-energy and restoring a weakened or exhausted nervous system or a part of it to normal nutrition and action.

ENFORCED REST.

35. Weir Mitchell Method.—What is known as the Weir Mitchell method of rest-treatment is an attempt to reduce to a minimum the expenditure of nerve-energy, and at the same time to maintain at the highest possible efficiency the processes through which nerve-force is generated. One needing such treatment is a neural bankrupt, and is in need of such measures as will restore him to a state of neural solvency. By this mode of treatment, while the business of nutrition is kept up with its usual profit in nerve-force, the greatest economy is exercised in the expending of that force. This method requires the greatest attention to details in matters of diet, aids to digestion, assimilation, and excretion. The nutrient fluids must be conveyed about the system by the help of massage and electric stimulus, to excite muscular contraction and maintain the tonicity of the tissues. A passive and acquiescent state of mind on the part of the patient is indispensable to the success of the rest-treatment, for, otherwise, as much or more neural energy may be wasted through fretting and emotion than could be gained by the rest in bed and the arrest of volitional effort.

PSYCHOTHERAPEUTICS.

36. Psychical Influence.—The influence of the mind on the body is a fact recognized and made use of by every intelligent physician. A hopeful and expectant state of mind has oftentimes more curative power than medicine. If the normal-acting mind can, with all its power and volitional energy, be brought to cooperate in the efforts made by the physician to remove the diseased condition, the circumstances are as

favorable as is possible. Reasonable and rational suggestion as to the helpful effects of time and the measures employed to effect a cure can and do, through their reception and belief on the part of the patient, act as a potent element in bringing about the desired result. It is questionable, however, whether the production of an abnormal mental state, created for the purpose of pitting it against another abnormal condition of the body, as is the case in the therapeutic use of *hypnotism*, is of any real or permanent utility as a curative measure. More is often lost through undermining the mental stability and weakening the self-control than is gained in relief from bodily disease.

SURGICAL MEASURES.

37. The help of surgery must often be called upon to assist in the treatment of nervous disorders. Where a fracture or dislocation of bone is causing pressure directly or from hemorrhage, where a tumor or an abscess is the source of disturbance, where an irreparable degeneration or irritation is threatening progressive disease or causing persistent and unendurable pain, surgical methods, when they can be utilized, are the best. If the surgical plan proposed is one that is permanently destructive to the function of the part of the nervous system involved, it should be utilized only as a measure of last resort. Nerve-resection for spasm or pain and nerve-stretching have proved of doubtful utility. Operations for microcephalus and hydrocephalus have also been disappointing. But that branch of surgery that has to do with deformities is closely allied to neural therapeutics, since distorted spines and paretic and paralyzed limbs need for their proper treatment the skill of both the neurologist and the orthopedic surgeon.

MEDICATION.

38. Excessive Use of Drugs.—It is too much the custom at the present day, as it has always been, for both physician and patient to place chief reliance on the therapeutic action of drugs. The belief is beginning to dawn upon us, however, that

the only successful road to rational therapeutics is a regard for those conditions that nature has ordained as the essential ones for the growth, development, and healthy maintenance of both body and mind. Let these conditions, known as the *laws of health*, be persistently disobeyed or disregarded, and the penalty is inevitable, despite the help of drugs. It is indeed a fortunate thing for humanity that there are no drugs that restore to perfect health the misused functions of the body. Yet drugs have their place in a rational system of therapeutics, only it is to be remembered that it is a very subordinate one and accessory only to the more fundamental requirements embraced in sanitation, hygiene, dress, diet, and correct habits of thought and occupation. In these latter are to be found the main springs of nerve-energy, and the supply will be copious or meager according as they are heeded or ignored.

39. Drugs and medicines should be considered as instruments more or less helpful, according as they are wisely chosen and skilfully used, in aiding nature's efforts to regain the normal range of physiological action. In attempting a brief discussion of their therapeutic relations in a general way to the pathological states of the nervous system already enumerated, we will classify them as *nutrients*, *tonics*, *eliminants*, *sedatives*, and *hypnotics*.

NUTRIENTS.

40. Nutrient Remedies.—A *nutrient remedy* is one that supplies some needed element to nutrition in a convenient and readily assimilable form. The artificially prepared digestive ferments are of this nature, and their service consists in that they supply to the weakened and debilitated digestive system that substance, such as *ptyalin*, *pepsin*, *pancreatin*, etc., which is needed to properly prepare suitable food for absorption in the alimentary tract. The preparations of *malt* and *maltin*, which contain a large proportion of diastase, are not only themselves nutrients, but are beneficial in that they materially assist the digestion of the starches. They thus not only conserve nervous energy in the digestive process, and furnish the nervous tissue

with needed foodstuff, but prevent nervous irritation that would result from the imperfectly digested food in the stomach and intestines. The nervous tissue consumes much fat in its structure. Many of the functional disorders that arise in it appear to be due, in part at least, to a lack of this element. *Cod-liver oil*, plain or in the form of an emulsion, is a prompt means for supplying this need on account of its easy assimilation. By the addition of suitable adjuvants, it can be taken by the majority of nervous invalids.

41. Nerve-Foods.—Phosphorus, which is present in nerve-tissue in considerable quantity, is looked upon as a special nerve-food, and when the nervous tissue is wasted and its energy exhausted, the *acid phosphates* and the *hypophosphites* of *lime*, *soda*, and *iron* are found to be very helpful in restoring its lost vigor. In recent years, frequent attempts have been made to reach a step higher in the stage of anabolism by introducing into the organism the products of animal life already built up into their most potent combinations.

42. Animal-Extract Therapy.—Animal-extract therapy is based on the conception that the vital processes of the nervous system or other tissues of the body will, when they are waning, be most quickly and effectively restored by having presented to them the refined elements they are needing, without extraneous matter to be disposed of, and in combinations so near their own as to require but little additional energy to transform them. By this means, the natural energy of the neurons is quickly revived and their former resistance to disintegrating influences restored. These views have given birth to *nuclein*, *cerebrin*, *testicular fluid*, and many other substances derived from one or another animal tissue, and have introduced them into neural and general therapy. Whether these attempts to short-cut the ordinary processes of nutrition will prove of permanent value, time and further experience alone will disclose. The results so far obtained in neural therapeutics are sufficiently encouraging to justify a more prolonged trial of this class of remedies.

43. There is another class of animal extracts, such as those obtained from the thyroid and thymus glands, which seems to act not so much as direct nutrients to the vital structure of the cells, but rather to aid in neutralizing or eliminating some substance in the blood, which, if allowed to remain unchanged or unremoved, produces peculiar morbid states. Myxedema, tetanus, exophthalmic goiter, melancholia, epilepsy, and other forms of disorder involving mainly or in part the functions of the nervous system, have seemed to be benefited by these extracts when they have been carefully prepared and given with caution.

TONICS.

44. Distinction Between Tonics and Nutrients. The dividing line between tonics and nutrients is not very sharply defined. Some substances, as *iron*, may be properly classified in either group, for it is a permanent and essential constituent of the blood-corpuscles. There are other mineral and vegetable substances that aid in giving strength and vigor to the nervous tissues and system, generally, that are not built up into tissue structure, but in some manner exert a favorable influence on metabolism so as to check morbid action or stimulate the normal nutritive processes. Among the mineral products that, after iron, have proved most helpful in renewing or conserving nerve-energy are *arsenic*, *zinc*, *silver*, and *gold*.

45. Arsenic Preparations. — Arsenic in the form of *Fowler's* or *Donovan's solution* has long been used with benefit in increasing the tone and vigor of the nervous system and in checking the tendency to overgrowth of connective tissue. The primary action of these arsenic preparations is in all probability on the digestive tract, the nervous system profiting by the improved activity and vigor of digestion and assimilation. More recently, combinations of arsensic with iron and with gold have met with much favor among neurologists, because of their direct tonic action on the nutrition of the neurons. The arsenate-of-iron and arsenauro preparations are those more commonly used.

46. Sodium and Gold Chlorid.—Sodium and gold chlorid has achieved some reputation as a remedy in checking the degenerative processes that terminate in sclerosis. In the functional neuroses, as hysteria and neurasthenia, the preparations of zinc and copper are of service as tonics, the oxid and the valerianate of zinc, especially, being much used.

47. Silver.—Silver in the form of the nitrate has won a well-deserved reputation in retarding the progress of the degenerative nervous disorders, such as lateral and posterior spinal sclerosis.

48. Vegetable Tonics.—Among the vegetable tonics we may properly enumerate those that give tone and vigor to the heart and blood-vessels, for on their condition to a great extent the normal nutrition of the nervous system depends. Most of the vegetable extracts that are tonic to the nervous system act through the medium of the circulation. Digitalis and strophanthus act most directly on the heart itself in increasing the strength of its contractions, and so provide a fuller and more constant stream of blood to the nerve-centers. Caffein, in addition to its effect of increasing the force of the cardiac contraction, has a direct stimulating effect on the cerebrum, and when used moderately, increases the capacity for brain-work.

49. Use of Cactus.—The cactus acts on the intracardiac ganglia, and it quickens the heart-action and raises the blood-pressure with very little disturbance of the vasomotor or inhibitory nerves. It is especially serviceable in functional cardiac weakness due to the overuse of *tea*, *coffee*, *tobacco*, *alcohol*, or to *sexual excesses*.

50. Action of Nitroglycerin.—Nitroglycerin has a pronounced action in dilating the coats of the blood-vessels and lowering arterial tension. It is of much service in relieving the pains of angina pectoris and in arresting the onset of motor spasmodic attacks such as in epilepsy. In *petit mal*, the immediate cause of which in some instances appears to be a vasomotor spasm, it has proved quite serviceable.

51. Use of Strychnin.—Strychnin, either in the form of the nitrate or sulfate, is our main reliance as a prompt and efficient tonic to the nerve-centers of the spinal cord and medulla. It has no specific action on the cerebral convolutions, but it stimulates the heart directly as well as through excitation of the cardiac-accelerator centers, and the blood-pressure is raised. The increased flow of blood to the brain brought about in this manner quickens its activities. The direct injection of strychnin nitrate into the substance of muscles that are undergoing atrophy, as in cases of progressive muscular atrophy or amyotrophic lateral sclerosis, appears to have a stimulating effect on the muscle nutrition and checks or retards the degenerative process.

52. Antiseptics, Disinfectants, and Antitoxins. Many diseases are known to be due to the presence of pathogenic germs or their products in the tissues. Drugs and other substances that have been found to check the development of these bacteria or to neutralize the toxins that they produce have properly secured a very prominent place in modern therapeutics. Some of these are employed to act on processes going on outside of the body, so as to prevent the growth or destroy the vitality of pathogenic micro-organisms before they gain access to the body. These are the *disinfectants* and are represented by such germicides as heat (boiling water at 212° F. or dry air at 200° to 300° F.), corrosive mercuric chlorid (1 in 1,000 to 1 in 5,000), formaldehyde, chlorinated lime, carbolic acid, potassium permanganate, menthol, boracic acid, and iodoform. It is not necessary here to dwell upon the individual merits or comparative value of these substances.

53. The distinction between *disinfectants* and *antiseptics* is not very clearly drawn in medical literature. All the substances above mentioned are antiseptics in the sense that they arrest putrefaction either by preventing the growth of or by completely destroying the micro-organisms on which decomposition depends. But when the micro-organisms have found access to the body, but few of these substances can be employed within the body to counteract them. "It would appear proper

to confine the word antiseptic to such drugs and remedies as are employed for this purpose within the body, but we do not know of any drugs that, when taken internally or inhaled, will certainly destroy micro-organisms, either in the gastro-intestinal tract or respiratory passages, unless they are sufficiently concentrated to be fatal to the patient" (*White*). Yet there are quite a number of drugs recommended for internal use and employed with the expectation of some therapeutic benefit based on their supposed antiseptic action. From among these may be mentioned salol, naphthol, bismuth naphtholate, menthol, creosote, turpentine, benzoin, and eucalyptol.

54. It is possible that the presence of one or other of these, distributed along the intestinal tract or suspended in the inhaled air in the form of a spray or vapor, and so conveyed to the mucous membrane of the respiratory passages, may retard somewhat the growth of pathogenic germs that have found lodgment in these localities. But not much reliance should be placed on such defences.

55. Antitoxins.—The antitoxins are a comparatively recent addition to our therapeutic resources, and, as yet, the number of products justly entitled to the name is few. An antitoxin is a substance that is generated by the vital activities of the tissues of man or the higher animals in consequence of the presence of pathogenic bacteria or their poisonous products in the blood. As its name indicates, the antitoxin is antagonistic in its action to these toxins, and tends to neutralize their harmful effect on the tissues. When the system invaded by these toxins does not of itself produce a sufficient amount of antitoxin, it has been found that this deficiency can be made good by injecting into the blood, by means of a hypodermic syringe, the needed additional amount from a supply of special antitoxin that has been artificially created in the circulating blood of some suitable animal, as the horse, which is extracted from the animal and properly preserved for such purpose.

56. Use of Antitoxins in Diphtheria and Tetanus. The diseases diphtheria and tetanus, whose toxins are peculiarly prone to attack the motor cells of the nervous system, are

those in which treatment by means of their antitoxins has met with most signal success. There are other toxic diseases, however, that have been combated in like manner, notably those forms of septemia caused by the streptococcus, with results so encouraging as to confirm the belief that a most important advance has been made in therapeutics by the discovery. The fact must not be overlooked in this connection, for it is very significant, that the production of antitoxins is one of the natural capacities belonging to the vital activity of tissue cells, and we can safely assume that if vital energy were at all times maintained at its highest stage of efficiency, there would be oftentimes less need by the system of an outside source of antitoxic material.

ELIMINANTS.

57. Names of Eliminants. — We have considered samples of those drugs or special preparations that directly as nutrients or indirectly as tonics assist in building up and maintaining the strength and energy of the nervous system. It is quite as essential to the welfare of that system that it should be rid of obstructing and effete matters. Both in the nervous tissues themselves and in the blood and other fluids circulating about them, substances may accumulate that by their presence impede, irritate, or depress the action of the nerve-elements. Drugs and other agencies that assist in the removal of such obstructions, and the elimination of such deleterious substances from the vicinity of the nervous system, and from the body as a whole, form an important class of remedies. We include under the head of eliminants all drugs or agencies that assist in freeing the system from useless or harmful material, which in one or another manner have accumulated in it. As samples of these, it will suffice to mention here mercury, potassium iodid, pilocarpin, ammonium acetate, potassium citrate, sodium salicylate, sodium sulfate, potassium sulfate, cascara sagrada, aloes, and castor-oil.

58. Use of Mercury and Iodin.—The preparations of mercury and iodin are the main remedies that are relied on to

assist in the disintegration, absorption, and thus the removal of abnormal growths and exudates occurring in the nervous tissues as well as elsewhere in the body. In the final excretion and removal of effete matters from the body, the action is effected through the skin, the lungs, the kidneys, or the intestines.

59. Ammonium Acetate and Pilocarpin.—Ammonium acetate and pilocarpin act as diaphoretics. The first is stimulating to the heart and circulation, and is aided in this effect by the addition of heat and alcohol; the second is powerful in its action on the sweat-glands, but is depressing in its effect on the heart. By means of suitable remedies of this nature, assisted by hydropathic measures, elimination through the skin may be promoted. Potassium citrate is an efficient excitant to renal secretion. By means of it, both the fluid and solid substances that are thrown off by this channel are increased in quantity. In a gouty or rheumatic diathesis, excretion of the deleterious products, causing irritation, is hastened by the use of sodium salicylate and the other salicylates. The disturbed condition of nutrition that attends gout and rheumatism, supposed to be due to incomplete catabolism, is responsible for many of the neuroses. It is not improbable that some of the acute and subacute inflammations, involving both the central and peripheral neurons, and not a few of the degenerative processes that have been described, have their origin in the irritation that arises from the imperfect disintegration or excretion that accompanies rheumatism and gout. Attention to those measures that secure complete catabolism and the perfect excretion of the effete substances may be the means of warding off many of the disorders that otherwise might find foothold in the nervous system.

60. Elimination Through Intestinal Tract. — We have a long list of medicines from which to select for the purpose of effecting elimination through the intestinal tract. If the object is to remove irritating or effete matters from the blood, the saline laxatives or purgatives, as sodium or potassium sulfate, are very serviceable. Given in a concentrated solution with hot water before breakfast, they serve, in most

instances, to clear the system of refuse and give freedom and ease to the nervous activities. The use of saline purgatives requires a somewhat vigorous state of the constitution, and in those that are suffering from feeble nutrition and a frail and sensitive state of the nervous system, the form of laxative required is more often one that will stimulate gently the peristaltic action of the intestines and overcome the habitual constipation that is due to feeble muscular contractions. For this purpose, cascara sagrada, or a dinner-pill of aloes and mastic, is more suitable. The latter is to be preferred or added when the intestinal torpidity is chiefly confined to the colon and rectum, for its action on these parts is most pronounced. When the intestinal tract needs to be promptly relieved of indigestible substances or of that which is the cause of much reflex irritability of the nervous system, as is often the case in children or those suffering from nervous dyspepsia, *castor-oil* is a most suitable remedy. It is both prompt and efficient, acting both on the ganglionic nerves of the intestinal tract and on the muscular coats of the intestines, and brings about a gentle and uniform peristaltic stimulation without much griping or subsequent exhaustion.

61. The habitual use of eliminants of whatever sort has the effect of creating a habit whereby the action of the organism depends on them. The object should be to choose such remedial measures and to select such diet as will enable the system to perform these acts of elimination without the need of special aids. Massage, appropriate exercises, and electric stimulus are the most efficient means for bringing this about.

SEDATIVES.

62. Classification of Sedatives.—We have occasion quite frequently, in the treatment of disordered action of the nervous system, to bring about a quieting, soothing, a pain-dispelling, or antispasmodic effect. All remedies that are used for this purpose we will classify as *sedatives*. The irritable, excited, or spasmodic action requiring such remedies for its

control may manifest itself either in the sensory or motor sphere of the nervous system separately, or in both at the same time.

63. Sedatives may be divided into two classes, local or general. Among the local sedative drugs commonly employed for allaying pain or oversensibility, the chief are *cocain*, *aconitin*, *veratrin*, *carbolic acid*, *menthol*, *ethyl chlorid*, *ether*, and *chloroform*.

64. Cocain.—Cocain is the safest and most efficient of these, since, in a dose that ordinarily is not harmful, it allays pain, provided it can be brought in contact with the terminations of the affected nerves. This is readily accomplished when it is applied in a watery solution to mucous membranes, but such solutions do not easily penetrate the unbroken skin when applied to it, and unless used hypodermatically or caused to traverse the skin by means of the direct electric current, its use is not of much service when applied to surfaces covered by cuticle with the view of obtaining a local sedative effect.

65. Aconitin and Veratrin.—Aconitin and veratrin are both powerful alkaloids whose constitutional effect is soon felt, even when they are applied locally, so that they must be used with caution. Applied in the form of an ointment, a grain of either, or of both, to a dram of lanolin or of lanolin and olive-oil, they are very serviceable in allaying the oversensitiveness of surface nerves. A similar sedative action is obtained, though not so promptly or to the same degree, by ointments or solutions containing *carbolic acid* (2 to 5 per cent.) or *menthol* (5 to 25 per cent.).

66. Ethyl Chlorid.—Ethyl chlorid, applied in the form of a spray, quickly blunts, for a few moments, the local sensibility, and is extensively used in minor surgical practice and for the temporary relief of neuralgia.

67. Ether and Chloroform.—Ether and chloroform are soothing to some degree when applied to the surface of the body as constituents of liniments, but their effect is evanescent, and if they are not permitted to evaporate readily, they cause vesication of the surface to which they are applied.

68. The majority of remedies chosen to allay motor-nerve or muscle irritability or spasm, effect this through their constitutional action and not by local application. *Curare*, *opium*, *with its alkaloids*, *morphin and codein*, *atropin*, *hyoscin*, *conium*, and *gelsemium* are representatives of this class.

69. Curare.—We have in curare a drug that appears to act directly by allaying the irritability of the motor endings of nerves in muscles. It has been employed with some success in the treatment of tetanus, but must be used with extreme caution, since it is a very active poison.

70. Opium.—Of the preparations of opium, *codein* has proved most serviceable as a sedative to spinal motor irritability, while it is at the same time less disturbing to the nutritive and eliminating functions than the crude drug, or its associate—*morphin*.

71. Atropin and Hyoscin.—The action of atropin and hyoscin are so varied in their effects that the result sought in one direction is often attended by some very objectionable result in another. But these remedies have a sedative effect on unstriped muscular tissue, and are indicated, in small doses, in spasm of the intestines, uterus, and bladder. The dominant action of atropin is to "depress the activity of the terminations of nearly all varieties of nerves." But it dilates the pupil, dries the throat, and checks the secretion from the skin, any one of which effects makes it an objectionable remedy for prolonged use. Hyoscin is a powerful cerebral and spinal sedative, and has found favor in the treatment of the motor excitement of delirium, acute mania, and agitated melancholia. It has also been of service in allaying the tremors of paralysis agitans and chorea, but on these it does not appear to exercise any curative influence. Because of its untoward effects on the cerebral function and on the circulation, its use cannot be long continued.

72. Conium and Gelsemium.—One of the active principles of conium, *conin*, "powerfully depresses the functional activity of all the motor-nerves in the body. This depression

begins at their periphery, and gradually ascends until the whole nerve from the periphery to the spinal cord is incapable of responding to stimuli" (*White*). And yet the preparations of conium are so unreliable and variable in strength that it has been used but little by the neurologist. Gelsemium likewise, by exercising a depressive influence on the anterior cornua of the spinal cord, allays excitability of all the muscles depending on these centers. Some sensory depression with anesthesia likewise results. It has been extensively used in the treatment of motor spasm, such as spasmodic torticollis and motor tic, and by some neurologists is used for functional trigeminal neuralgia and megrim.

73. For the relief of pain, when this is the most urgent symptom demanding attention, opium, and especially morphin, which is the most efficient alkaloid in the crude drug, are the remedial agents most commonly employed. But for continued or recurring pain, as headache, neuralgia, and the like, or for the relief of the condition commonly termed *nervousness*, *hysteria*, or *neurasthenia*, the frequent use of opium or of morphin is neither beneficial nor wise. The derangement of nutrition and the mental deterioration that the drug produces are in no measure compensated by the temporary relief from pain or discomfort.

74. The pain that so frequently accompanies the nutritional disorders and takes the form of neuralgia, megrim, or of the steady aching, burning, smarting, or stinging of rheumatism and gout, or the fleeting, darting pains of locomotor ataxia, are very generally relieved by the use of *phenacetin*, *exalgin*, *antipyrin*, or *acetanilid*. All these remedies are somewhat depressing in their effect on the circulation. Phenacetin is the least, and antipyrin the most, harmful in this respect; but, by the addition of strophanthus or caffein, this danger is greatly lessened. As all these remedies have an antipyretic, in addition to their analgesic, action, they are especially serviceable in diseases where the pain or nervous irritability is accompanied by fever.

75. A state of fidgetiness or nervousness with a preponderance of emotional symptoms is a very common result of defective nutrition, or congenital or acquired instability of the nervous system. Hygienic, mental, and moral management are here more helpful than drugs, but for temporary soothing and quieting effect, the bromids and the combinations of sumbul, valerian, and asafetida, all of which diminish the excitability of both sensory and motor neurons, are to be employed. Potassium bromid has a reputation for greater efficacy than other bromid preparations, but it is also disturbing to the digestion and depressing to the heart; bromid of soda and ammonia can often be substituted for it with advantage. Valerian and sumbul are very frequently combined with iron, zinc, or arsenic, since the conditions of the body that create a demand for the nerve-sedation are accompanied, in most cases, with evidences of anemia or malnutrition, and the combination is made with a view of meeting both needs.

HYPNOTICS.

76. Use of Drugs for Insomnia.—Sleep is dependent not on one only but on the combination of several physiological conditions. These are a decrease in the amount of blood in the brain, an abolition of sensory stimuli, and a presence in the blood of the products of muscular fatigue or of fatigue brought about by brain activities. When the important restorative effect of sleep is wanting, the nervous system suffers greatly.

In seeking to replace the conditions favorable to sleep, simple means most closely allied to nature's methods should be employed before resorting to drugs. It is doubtful if any single drug or combination of drugs can be made to meet all the requirements of normal sleep, and secure to the system the benefit that it confers. There are many remedies, however, that are helpful in this way and assist in one or another manner in producing a sleep more or less refreshing. When pain is the chief cause of sleeplessness, opium or morphin, or phenacetin, antipyrin, or exalgin will so far allay the pain as to permit of sleep.

But insomnia is often due to a less apparent cause, and is of more persistent character than the sleeplessness caused by pain. For this condition, when it is necessary to resort to drugs, relief will usually be obtained from paraldehyde, trional, or sulfonal. Paraldehyde is disagreeable to the taste but is prompt in action, as a rule, and leaves but little unpleasant after-effect. Trional is not so certain in its action, but, when efficient, it acts promptly and without much depression. Sulfonal is less prompt in action, requiring to be given several hours before the time at which it is desired to produce sleep, and its depressing effect on the circulation is such as to prohibit its being used in some cases. The sleep produced by it is, however, usually both prolonged and deep. A combination of trional and sulfonal often acts more happily than either given separately.

GENERAL ELECTROTHERAPEUTICS.

ACTION OF ELECTRICITY.

77. The action of electricity as a remedial agent for counteracting the pathological states and tendencies to abnormal function mentioned is of very general application.

When employed intelligently and skilfully, it is found to act in one or another form as a tonic or constructive, as an eliminant, as an antitoxic, as a sedative, or as a hypnotic.

If this is true, then electricity deserves a place in every group of remedies mentioned under the head of general therapeutics of the nervous system, except the first—the nutrients. The experienced electrotherapeutist knows this claim for efficiency in the action of electricity in neural therapeutics to be true and that it is based on sound and demonstrable physical and physiological facts and principles, which is more than can be said for many of the drugs used and recommended by high authority.

78. Modalities of Electricity.—The modalities of electricity that are employed at present, to a greater or less extent

in therapeutics, both in the treatment of nervous disorders and diseases of other parts, are the following:

1. The direct or galvanic current.
2. The induced current derived from (*a*) physician's induction-coil; (*b*) magneto-electric machine; (*c*) alternating-current dynamo; (*d*) sinusoidal machine.
3. Currents obtained from the high-tension, high-frequency apparatus.
4. The static charge or the currents of the influence-machine.
5. Magnetic fields or alternating-magnetic stress.

Each of these modalities possesses a physical and physiological action peculiar to it, and, by reason of this, has its special adaptation to certain pathological states.

THE DIRECT CURRENT.

79. By means of the direct current, the neurologist obtains knowledge concerning the action, nutrition, and capacities of muscles and nerves that can be obtained in no other way (Diagnosis).

The direct current causes contraction of muscular tissue both of the striped and unstriped varieties, and invigorates the processes that depend on this muscular activity (Tonic, Eliminative).

By the action of the direct current, nutritive material may be conveyed in greater abundance to the tissues needing it, and the metabolism of the neurons may be quickened (Constructive).

Through the influence of the direct current on the muscular walls of the intestines, excreting organs, and blood-vessels, elimination is promoted and the irregular distribution of blood, as in hypostasis and passive congestion, is overcome (Eliminative, Sedative).

By means of the direct current, exudates and neoplasms are broken up and prepared for removal (Eliminant, Through Electrolysis).

By the aid of the direct current, morbid fluids and substances in solution in them are removed from the tissues, and remedies

in solution may be brought into them (Elimination and Medication by Phoresis).

The direct current is both directly and indirectly germicidal, because of its electrolytic action, and gives promise, in the results of recent experiments, of a capacity to transform toxins into antitoxins (Antitoxic, Antiseptic, Disinfectant).

The local effects of the anode of a direct current on nerve-tissue are such as to diminish its excitability (Sedative, Analgesic, Antispasmodic).

It is thus seen that the direct or galvanic current, which possesses chemical, physical, and mechanical properties, can be turned to therapeutic account to meet and counteract a great variety of morbid conditions that arise in the nervous system and elsewhere in the body.

This electric modality has, as we have already noted, its function as a direct stimulant of nerve and muscle, or is sedative in its action upon these tissues according to the polarity employed and the manner of application; but a more appropriate modality for these purposes, within the range of physiological action, will be found in some one of the various forms of the induced current.

THE INDUCED CURRENT.

80. Nature of the Induced Current.—The induced current is that which is obtained from a closed circuit including a coil of wire, which coil is in some manner subjected to a varying magnetic field during longer or shorter intervals of time.

The characteristics of the current induced depend on the construction of the machine that produces it. The physiological and, in turn, the therapeutic effects following the use of these currents, as of all electric currents, are the results of these characteristics of the current. In other words, every electric current has its "characteristics of excitation," and when used for therapeutic purposes, these determine its physiological and therapeutic effects.

81. In the several kinds of apparatus recorded above, from which induced currents are derived, the principle of induction

is the same, just as in the various forms of steam-engine in use, the physical and mechanical principles are the same. But the nature of the work done by these several kinds of apparatus, just as it is with the different kinds of steam-engine, may vary greatly.

All the induced currents employed in electrotherapeutics, with the exception of the primary-coil current of the physician's induction-coil or faradic battery, are to-and-fro, or alternating, currents. They are also currents of comparatively high electromotive force as compared with the direct currents, but with very little quantity.

82. Reaction of Living Tissue.—Living and normal nerve and muscle of a kind that is found in man and other warm-blooded animals, when made a part of the path of an induced current of moderate frequency, tension, and quantity, react in a manner corresponding to their physiological action at every sudden change of electromotive force or potential, no matter in which direction the current travels. Such induced currents are therefore exciters of nerve and muscle, and the force and frequency of such excitation depend on the degree of electromotive force and the frequency of its variations.

83. The protoplasm of living tissue cells, other than those of nerve and muscle, also reacts in some measure to the sudden change of electric potential to which it is subjected by an induced to-and-fro current, for the metabolism of the cells is quickened, and improved growth and tone is the result in those whose nutrition was before feeble. But the momentary duration of each impulse and the reversal of polarity that characterize the alternating-induced currents deprive them of the electrolytic, phoretic, and mechanical action that the direct or galvanic current possesses.

Sensory and motor-nerve or muscular fiber can respond in a manner peculiar to each of them when subjected to electric excitations to the number of from 6,000 to 10,000 per second. But, in proportion as the frequency of the alternations and the range of potential increases, the physiological response of nerve and muscle, as such, diminishes.

84. Effect of Frequency and Potential.—The lower frequencies and lower potentials have, generally speaking, an exciting and irritating effect, while the higher potentials and frequencies have a quieting and sedative effect on nerve and muscle. The manner in which the potential increases and decreases likewise has its influence on sensation and motion, irrespective of the degree of the potential or the rapidity of the alternations.

85. A current in which there is abrupt or irregular increase or decrease of electromotive force is irritating and exciting, while one that is smoothly graduated in its rise and fall of potential is soothing and agreeable. The induced current derived from the primary of the physician's induction-coil or faradic battery and that from the magneto-electric machine partake of the exciting and irritating properties, while the current from the secondary of a physician's induction-coil, provided it is composed of many turns of very fine wire, and the current from a well-constructed sinusoidal machine are less disagreeable to the patient and often quite soothing and sedative in their effect.

The current from the alternating-current dynamo employed for industrial purposes, when adapted to therapeutic uses, possesses qualities somewhere between these two extremes.

From these statements concerning the induced-current modalities, it will be seen that they are adapted, by suitable selection, for producing an exciting or stimulating effect (Tonic, Constructive, Eliminant), or a soothing and quieting effect (Sedative, Antispasmodic, Analgesic, Hypnotic), on both nerve and muscle tissue, as the exigencies of the case may require. And also let it be noted that they exert a certain amount of stimulating influence on the nutritive activities of the protoplasm of all living cells (Tonic, Constructive).

HIGH-TENSION, HIGH-FREQUENCY CURRENTS.

86. Nature of High-Tension, High-Frequency Currents.—The high-tension, high-frequency currents of Tesla, Elihu Thomson, and D'Arsonval are found from numerous tests

made by these experimenters and by ourselves, to have effects on the living animal organism of much therapeutic value. These currents are alternating in polarity like the induced currents already described. The frequency of alternations that have been reached by one or another form of apparatus, and employed in physiological experiments and therapeutics, have ranged from 10,000 to 1,500,000 per second. The electromotive force has varied from 60,000 to 300,000 volts. The current has been estimated to range from $\frac{1}{3}$ ampere to 5 amperes. When we consider these characteristics, the physiological effects, which have been observed more or less by all that have experimented with currents of this character, are truly remarkable. They are daily demonstrated to students in the laboratory of electrotherapeutics of the University of Michigan upon their own persons.

87. Physical Effects of High-Tension, High-Frequency Currents.—The results are that currents of this nature: (*a*) Have no effect on motor nerves. (*b*) Have no effect on sensory nerves except, perhaps, a gentle feeling of warmth at the place where contact is made with the surface of the cuticle. (*c*) Have no contractile effect on muscular tissue. In some instances, a very slight degree of tension or heaviness is noticeable in the muscles in the immediate vicinity of the electrode. (*d*) Cause, at first, vasomotor dilatation, with lowering of blood-pressure, but this is soon followed by energetic contraction of the vessels, which then remain contracted and the blood-pressure rises. (*e*) Increase tissue metabolism, as is shown by the larger consumption of oxygen and the greater elimination of carbon dioxid and urea by the person experimented on. (*f*) Increase the production of heat. (*g*) Retard the growth of pathogenic bacteria and decrease the virulence of the toxins that they produce (*D'Arsonval* and *Charrin*).

From these results, it will be seen that the high-tension, high-frequency currents impart an extraordinary activity to the nutritive processes of animal tissues, without disturbing to any extent the phenomena of conscious life.

88. In the majority of cases where these currents have been employed for therapeutic purposes, they have exercised a

powerful and generally reparative action on diseases caused by, or attended with, feeble nutrition, by accelerating the organic changes and by increasing the activity of enfeebled or perverted catabolism and elimination. Excretion is hastened and diuresis becomes generally more satisfactory. Neurasthenia and many other functional and nutritional nervous disorders are benefited by this method of treatment. Especially when the nervous condition is the result of mental overwork, accompanied with the defective elimination characteristic of rheumatism or gout, the use of the high-tension, high-frequency currents results in return of sleep, return of good feeling, capacity to work, increase of appetite, and a renewal of force and vital energy.

STATIC CHARGE AND CURRENTS.

89. Static, or Franklinic, electricity, as obtained from the static or influence-machine, has, under certain of the conditions of generation, the qualities of high-tension, high-frequency currents, and the same effects that are mentioned under that head can be obtained from it. The static machine is, however, adapted for a much wider range of therapeutic applications. Its capacities have received full consideration elsewhere.

MAGNETIC FIELDS AND ALTERNATING MAGNETIC STRESS.

90. For a long time it was thought that magnetism was in no way correlated to animal physiology, since a variety of carefully devised experiments by competent observers gave no tangible results. But this was owing to the fact that these experiments were conducted with unvarying magnetic stresses and were not continued over a sufficiently long period. In a series of experiments with alternating magnetic stresses, which have been carried on in the electrotherapeutic laboratory of the University of Michigan, under our direction, for more than three years, it has been proved conclusively that magnetism in this form has a marked influence in quickening metabolism, in promoting growth, and in increasing the excretion of urea. These results have been obtained from a prolonged series of

tests on both young animals and man, by keeping them in a space pervaded by rapidly alternating magnetic stresses for several hours each day.

These tests on physiological action have been supplemented by a few attempts to determine the effect of a rapidly alternating magnetic field on the treatment of chronic muscular and articular rheumatism and sciatica. The benefit that these patients seem to have obtained from the treatment is, to say the least, quite marked, and the method gives promise of much therapeutic usefulness. One strong recommendation in its favor is that it can be readily applied to bedridden patients and to children without its exciting the least opposition or discomfort. The patient need not be aware, from any sensations experienced, that he is undergoing treatment.

OTHER THERAPEUTIC USES OF ELECTRICITY.

91. Electricity may be employed to advantage in the treatment of nervous disorders in many ways that cannot properly be regarded as electrotherapeutics. It is very serviceable in the following respects:

1. *As a source of heat.*
   - (*a*) For producing an electrocautery to be used as a counter-irritant or as a surgical tool.
   - (*b*) For heating warming-pads, poultices, etc., with a constant temperature of any desired degree.
2. *As a source of light.*
   - (*a*) For the treatment of many nervous diseases by means of electric lamps.
   - (*b*) For diagnosis in the exploration of the passages and cavities of the body.
   - (*c*) For mechanical vibration. Many forms of vibrating apparatus have been constructed by Mortimer Granville, Charcot, Gilles De la Tourette, and others, for treating headaches, neuralgia, and many functional and nervous diseases in which the motive power employed is electricity. Mechanical vibration as a therapeutic measure has been followed by benefit in many instances.

DISEASES OF THE SPINAL CORD.

INTRODUCTION.

92. Construction of the Nervous System.—According to the latest physiological researches, the nervous system is made up of a myriad of individual nerve-elements, termed *neurons*. These, while interdependent and necessarily associated in the performance of the functions assigned to them, possess each an independent nutritive activity and vitality that must be maintained throughout the entire structure of the neuron in order that it may at all times be prepared to do its part in the community of neurons with which it is associated in function.

No part of the individual neuron, no matter what its special work may be, whether that of receiving or conveying a motion or impulse, is exempt from the influences that affect for good or ill any other part of its structure. In other words, an individual neuron, though made up of nucleus, and, probably, nucleolus, cell-body, neuraxon, and numerous dendrites or protoplasmic prolongations, the latter often of great length and complexity of arrangement, is responsive throughout all its parts to influences that act on it deleteriously or beneficially. We cannot, therefore, have diseases that affect only a part of the neuron, as the neuraxon, or dendrites, or cell-body, to the exclusion of the other parts. We may, however, have diseases in which the pathological processes are more accentuated in one, rather than in another, portion of the neuron. For instance, the earliest signs of functional disorder or of degeneration in the neuron or group of neurons may be seen in the dendrites, the end organs, or the neuraxon, rather than in the cell-body or nucleus. Yet all parts of the individual nerve-element must be understood to take part in these abnormal changes.

93. Classification of Diseases.—While we arbitrarily, therefore, for the sake of convenience in considering the special

diseases of the nervous system, divide them into diseases of the central and peripheral nervous system, or into diseases of the brain, spinal cord, and nerves, this classification must not be taken as indicating a sharp line of separation of the normal from the abnormal. For the nerves are but the prolonged dendrites and neuraxons belonging to cell-bodies located within the spinal cord and brain, and the spinal cord and brain are made up in a great part of these dendrites and neuraxons which come both from the periphery of the body and from cell-bodies located at distant points in the central nervous system.

94. Since the peripheral nerves do not then represent complete neurons, and because the neurons comprising the brain are very complex in their groupings and functions, it seems best to adopt an order for considering the special diseases of the nervous system that will begin with a part representing entire neurons, but still those that are simple in structure, groupings, and function. This we find to be the case in the spinal cord. We will then, for these reasons, consider first the *diseases of the spinal cord;* next, *diseases of peripheral nerves;* and, finally, *diseases of the brain*, taking up the disorders under each in accordance with the arrangement adopted under the heading General Pathology.

DEFECTS OF DEVELOPMENT.

95. Enumeration of Defects.—Under the heading of Defects of Development among the disorders arising in the spinal cord, we find *malformations*, *spina bifida*, *syringomyelia*, and *hereditary ataxia*. The order in which these are named indicates, from greatest to least, the gravity of the result following the defect.

MALFORMATIONS.

96. Causes of Malformations.—The spinal-cord neurons, sensory and motor, control the growth and nutrition of the parts to which they are distributed. If these neurons fail to evolve in the embryo, or are blasted from some cause in the

early stages of their evolution, the parts that they were destined to supply with nerve-stimulus are wanting or incomplete. Thus, bodies with various kinds of defects arise. A limb or a part of it may be wanting; an organ, as the uterus, bladder, or rectum, may be lacking or incompletely fashioned. A muscle or group of muscles may not develop, giving rise to some such distortion as clubfeet or knock-knees. Many of these defects may arise from causes operating outside the spinal cord or its neurons. But we are here considering only the results of spinal-cord deficiencies.

SPINA BIFIDA.

97. An incomplete closure of the spinal canal leaves the parts surrounding it incomplete. This occurs usually in the lumbar region, but may be found at other places in the spine. The vertebral laminæ and spinous processes are rudimentary over that portion of the cord, and the soft parts bulge, forming a cyst filled with cerebrospinal or subarachnoid fluid. The nutrition and growth of the entire central nervous system is disturbed and enfeebled.

SYRINGOMYELIA.

98. Nature and Pathology.—This is an embryonic defect of less degree than the preceding, but here, likewise, there are sacculations and distortions of the central canal of the spinal cord due to incomplete closure or defective evolution of the neural elements surrounding it. The gliomatous tissue is in excess in places and the neurons are wanting or incomplete in development. This defect is most common in the cervical and upper dorsal segments of the cord. Trophic changes are seen in the parts of the body innervated from these segments. The skin is thin and glossy, or thick and horny, or edematous. Whitlows are common, and eruptions such as eczema, bullæ, and herpes appear on the skin. The nails are grooved and fissured. The bones are brittle, the joints imperfect. The symptoms as a rule are bilateral. There is loss of pain and temperature sense in certain areas. Hyperesthesia may precede

this loss. Various paresthesia, pain in the spine, and spontaneous pain in the trunk and arms are common.

99. Symptoms.—The symptoms of syringomyelia are as follows: Muscular atrophy of the progressive type, with paresis in the ulnar region of the hands and in the muscles supplied by the musculospiral and circumflex nerves; fibrillar tremors in the affected muscles; the muscles of the legs may show spastic paralysis; the knee-jerk may be normal or exaggerated, together with ankle-clonus; the affected muscles may give quantitative changes to electric tests, or, if much atrophied, the reaction of degeneration; a distortion of the spine (scoliosis) occurs; the cranial nerves may be involved, causing disordered respiration and cardiac action, difficulty in swallowing, irregularity of the pupils, and nystagmus; and mental dullness may result.

MORVAN'S DISEASE.

(*Analgic Panaritium.*)

100. Nature and Pathology.—This disorder appears to be a combination of syringomyelia with neuritis, and by some is thought to be a variety of the former. It occurs between the ages of twelve and sixty, and is slow in progress. In some cases the spinal, and in others the neural, changes are more pronounced. Painless felons or whitlows are a frequent and characteristic morbid condition.

101. Symptoms.—The symptoms of Morvan's disease are as follows: Neuralgic pains in the arms and hands; loss of pain and temperature sensation and at times loss of all forms of sensation over the arms, the trunk, and even the face; paresis of the muscles of the hands and forearms; atrophy of muscles of the hands and forearms, and in the late stage, loss of electric excitability; swelling and disorganization of the joints in the hands at times, painless whitlows, ulceration of the fingers, the skin on the hands becoming pale or livid, dry, cracked, and the nails brittle; the legs and feet may be similarly affected in some cases, while in others the disease may extend to the medulla and its nerves.



PLATE I.

Treatment by Alternating Magnetic Field.

HEREDITARY ATAXIA.

(*Friedreich's Ataxia.*)

102. Nature and Pathology.—This, likewise, is a disorder commonly believed to be due to defective development. It results in sclerosis of the posterior and pyramidal tracts of the cord. The direct cerebellar tracts may be involved, and, at times, the medulla also. The sclerosis is caused by a proliferation of neuroglia. The peripheral nerves may be affected. The posterior roots are sclerosed in some cases. The defect occurs in several members of the same family, and, as a rule, before puberty.

103. Symptoms.—Symptoms, when typical, exhibit few or no sensory disturbances. Occasionally, there is headache and patches of anesthesia. The motor symptoms are an ataxic gait, jerky incoordination, and at times difficulty in micturition. Frequent pulse rate has been sometimes noted. As a rule, there are few and slight cerebral disturbances. These may be slow, jerky articulation, nystagmus, or loss of pupillary reflex. Mental disorders are usually not marked, except, in some cases, by feeble mentality.

104. Treatment.—These disorders having in common, at their foundation, a fault in evolution, require for their correction, as far as that is possible, measures that will strengthen the growth of nerve-tissue. Hygienic management, warm baths, and massage are necessary, and suitable surgical treatment is advised. Among the drugs advised are arsenic, phosphate of soda, strychnia, and silver nitrate. Other treatment must be adapted to meet the indications as they arise.

105. Electrotherapeutics.—The direct current is applied to the defective neurons. Where the indications are chiefly those of degeneration, the negative electrode is applied alternately over the nerve-center and the periphery, with a current-strength of 10 to 20 milliamperes. Where pain, redness, and swelling are prominent, the positive electrode should be used. The induction-coil current, slowly interrupted, should be applied through the defective motor neurons and atrophied

muscles for 5 or 10 minutes, daily. The high-tension, secondary-coil current should be applied for the same length of time to painful and sore nerves, and general faradism should be given. The static insulation or breeze should be applied for the purpose of stimulating general nutrition, or the static-induced current, to stimulate locally the defective muscles or the enfeebled circulation and nutrition of a limb. The tonic and nutritive influences of the high-tension, high-frequency currents, or of the alternating magnetic fields (Plates I and I *a*), employed for a half hour daily, might be used to advantage in many of these cases.

NUTRITIVE DISORDERS.

106. Faulty Nutrition.—(The reader is referred to the remarks made under General Pathology in regard to the disorders of nutrition.) Deranged nutrition usually gives rise to defective function, and among the disorders of the spinal cord, the functional disorders and those arising from malnutrition are scarcely distinguishable, and will be classified together here.

The main characteristics that determine this arrangement for diseases differing so greatly in symptoms and prognosis are: (1) marked interference with normal function; and (2) lack of demonstrable pathological changes accounting for this or resulting from it. We recognize that these characteristics may pertain to diseases that have little or nothing in common in their real pathology, and when we obtain a more intimate knowledge of their etiology, they will no doubt be widely separated in classification. But, for the present, since a serious fault in nutrition is the only prominent factor of which we can speak positively, we will discuss under this head, *spinal irritation*, or *neurasthenia*, and *Landry's paralysis*.

SPINAL IRRITATION.

107. Nature and Pathology.—This is usually but the local manifestation of a general disorder. Spinal neurasthenia is but a part of general neurasthenia, with the spinal symptoms accentuated. A defective state of nutrition is recognized as

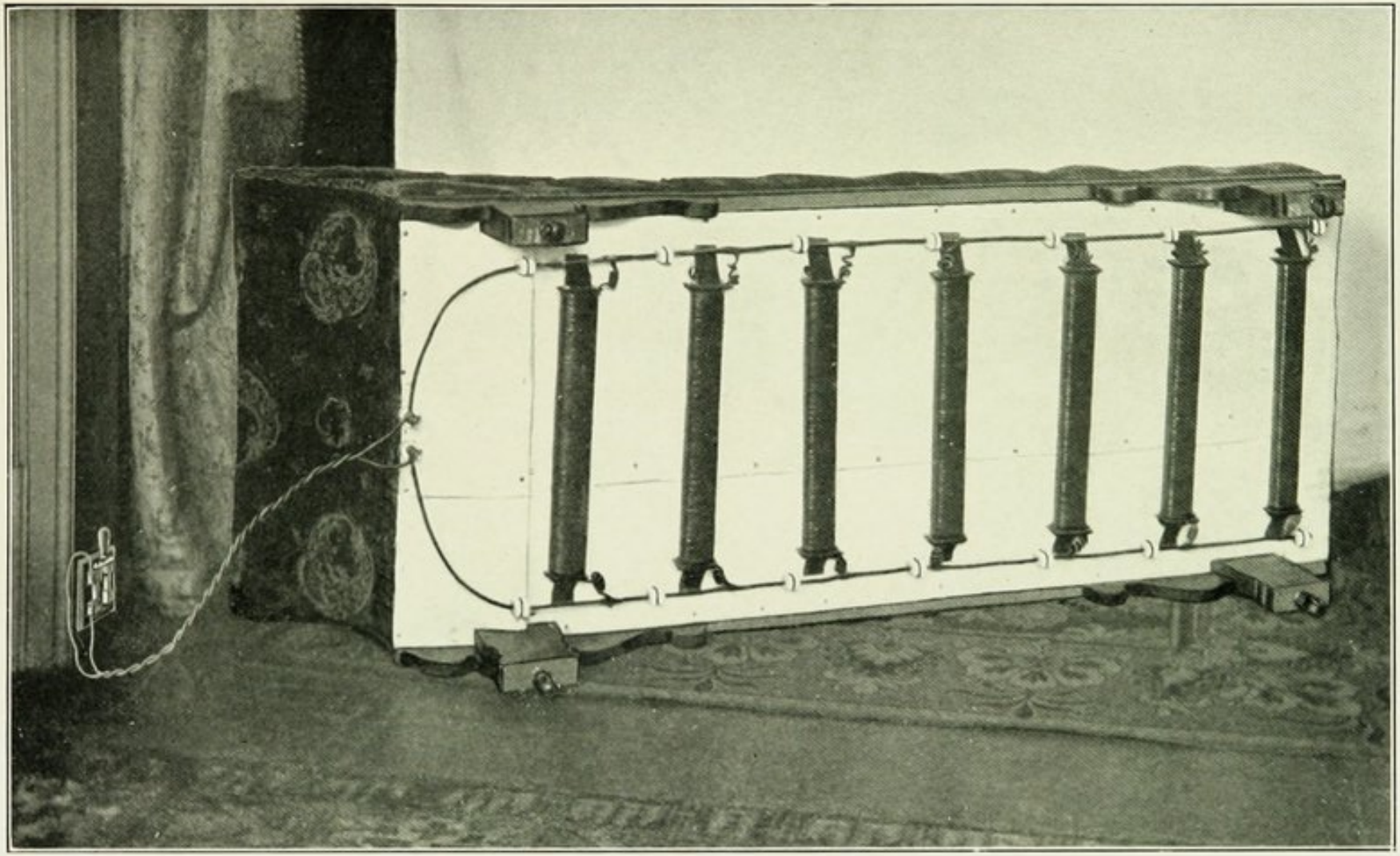


PLATE I *a*.

Arrangement of Electromagnets for Producing Alternating Magnetic Flux.

always present, but there is an infinite variety of causes, some mental, others physical, that may operate to impair the nutrition of the spinal centers. A defective state of the blood is of course an immediate precedent, and this may be a disorder of quantity, a lack in it of the needed constituents, or the presence in it of irritating and toxic substances obtained from without the body or arising from imperfect elimination of those that are found within it. There may be anemia or hyperemia, but with no tendency to inflammation. A fickle vasomotor control is a prominent factor.

108. Symptoms.—The symptoms are numerous and varied and the onset is gradual. Among the sensory disturbances are paresthesia, numbness, formication, cold and hot feelings, extreme sensitiveness of the tips of the spinous processes, especially in the cervical and lumbar regions, pain in the back, loins, and extremities. The chief motor symptoms are weakness and fatigue when standing and walking, tendon reflexes weak or exaggerated, and muscular tremor. The digestion is weak and disordered, heart-action is disturbed, vasomotor irregularities present, bladder sometimes irritable, and sexual disturbance common. As a rule, there is great restlessness and defective sleep. Mentally, the patient is self-centered and apprehensive, readily disturbed by trifling causes, timid, and emotional.

109. Treatment.—The treatment should be such as will improve the general nutrition, prevent a prodigal waste of nerve-force, and establish a stability of nerve-action. Enforced rest, simple but nutritious and unstimulating food, massage, tonic baths, and mental quiet are necessary. Tonics, digestives, and eliminants, to aid assimilation of food and remove toxic substances should be given. Simple sedatives, as bromids, sumbul, and valerian, to quiet excessive nervous irritability, should be administered.

110. Electrotherapeutics.—This should be begun cautiously, starting with gentle general faradism, with perhaps the use of the operator's hand as an electrode. The treatments should be gradually increased in severity as the patient gains

confidence and will tolerate them. The static insulation may be substituted for, or alternated with, general faradism; and, finally, the faradic brush or the static spark is applied along the spine (Plate II), by means of which vasomotor stability is gradually established.

LANDRY'S PARALYSIS.

(*Acute Ascending Paralysis.*)

111. Nature and Pathology.—This is believed to be an acute toxemia affecting primarily the peripheral motor neurons. It is presumed to be the result of a microbic poison such as is generated in typhoid fever, splenic fever, pernicious anemia, and, at times, in whooping-cough. Whatever the toxic agent is, it acts quickly and powerfully on the protoplasm of the neurons and gives no time for gross pathological changes to take place.

112. Symptoms.—The symptoms include, as a rule, prodromata, such as general malaise, some fever, and general dragging or tearing pains in the head, back, and extremities. Then, in a few hours or days, the legs show a flaccid paralysis that rapidly ascends to the trunk, arms, neck, and head. The tendon reflexes are soon lost. Facial and ocular paralysis does not always occur, but may in some cases. There is usually profuse sweating, a continuous elevation of temperature, and the spleen is, as a rule, enlarged. A large proportion of the cases end fatally, though the disease may at times pursue a milder course and the patient recover.

113. Treatment.—The treatment consists in hot-water baths, counter-irritation to the spine, with rest in bed and nutrients to sustain the strength. Ergotin and belladonna should be used with a view of diminishing spinal congestion. Benzoate of soda, salicylate of soda, or quinin should be used as antitoxics, and alcohol and strychnin as stimulants. Many of these remedies are of doubtful utility.

114. Electrotherapeutics.—If the case progresses rapidly toward a fatal termination, there is little to be hoped for from electric treatment. Applications of the positive electrode

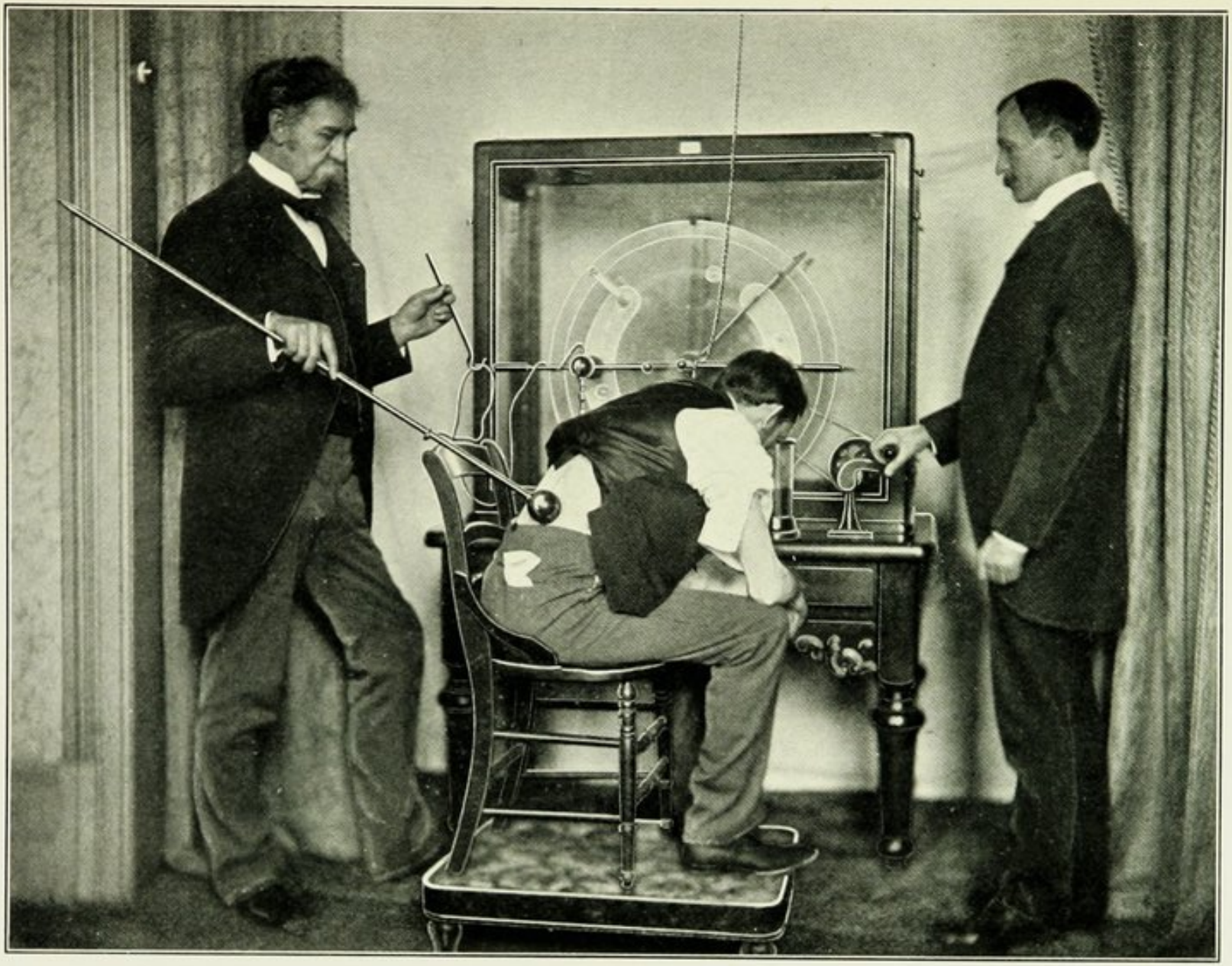


PLATE II.

Static Friction Spark to Spine.

of the constant current over the spinal centers (Plate III) may diminish, somewhat, the congestion in the early stages, and when the acute action subsides, and is followed by debility, the nutrition of the neurons may be aided by the use of the negative electrode of the direct current applied along the spine. In the cases that are less severe, the toning effect of general faradism would be helpful, as would also the stimulating action of static insulation and a gentle spark-treatment along the spine. These electric treatments may be given twice a day with benefit if the case tends toward improvement.

DISORDERS OF CIRCULATION.

115. The Spinal Cord.—Although disturbances of the circulation seldom have their origin solely in the blood-vessels, nor can they continue long without bringing about consequent pathological changes in other tissues, yet there are certain disorders of the spinal cord that, for the time being, manifest themselves by symptoms that are chiefly due to vascular changes. These are *spinal anemia*, *spinal hyperemia*, *spinal hemorrhage*, *spinal embolism and thrombosis*, and *caisson disease*.

SPINAL ANEMIA.

116. Nature and Pathology.—Spinal irritation has for its immediate cause, not infrequently, a deficient supply of blood, so that the symptoms of anemia of the spinal cord are, at times, almost identical with those we have recorded in describing spinal irritation. Severe hemorrhages, disease of the arteries, vasomotor spasm, general anemia, and chlorosis are some of the conditions that give rise to anemia of the spinal cord.

117. Symptoms.—The symptoms are pain in the back, tingling, a pricking sensation like that caused by pins or needles, leg-ache, weakness of the legs, cramps, intermitting or "paroxysmal" lameness. These symptoms are usually relieved by the supine position.

118. Treatment.—The treatment consists in attempts to improve the blood-state, to strengthen the cardiac impulse with digitalis and nux vomica, and quicken the nutritive activity of the spinal-cord neurons with strychnin.

119. Electrotherapeutics.—Electrotherapeutics in the form of general faradism and the application of the negative electrode of the direct current in a labile manner along the spine may be helpful. General nutrition may be stimulated by means of static insulation or the magnetic field.

SPINAL HYPEREMIA.

120. Nature and Pathology.—A defective nutrition of the spinal-cord structures may result from a passive hyperemia as readily as from an anemia, so that spinal irritation quite often has this condition as a cause of its symptoms. A disturbed vasomotor control having its origin in nervous weakness may give rise to persistent dilatation of the spinal blood-vessels —a vasomotor paresis. This may result from a toxic cause, from excessive or prolonged muscular effort, exposure to wet and cold, or be due to weakness following an exhausting fever, or meningitis.

121. Symptoms.—Among the more pronounced symptoms are a tingling and aching in the back and legs, increased by lying on the back, or even neuralgic pains. The patient is easily fatigued. There is some twitching of the muscles of the lower extremities and there may be some impaired action of the bladder and rectal sphincters.

122. Treatment.—The treatment advised is rest in the horizontal position of the body upon the side or face. Cold applications, dry-cupping, counter-irritants, and, in severe cases, the cautery should be applied to the spine. Bromids, belladonna, and ergot should be used to reduce congestion, and laxatives and warm baths should be used as derivatives.

123. Electrotherapeutics.—Electrotherapeutics is applicable in the form of the galvanocautery when it is indicated. The sedative action of the direct current should be used with



PLATE III.

the positive electrode along the spine. In the more chronic cases, where the vasomotor control is lessened, the faradic brush or the static spark along the spine is very salutary in restoring the tone of the blood-vessels. This in many cases proves to be the most efficient treatment.

SPINAL HEMORRHAGE.

124. Nature and Pathology.—Spinal hemorrhage may be due to direct injury or concussion resulting in either a localized or diffuse hemorrhage. Disease of the blood or walls of the vessels may give rise to capillary hemorrhages or hemorrhagic infiltrations. A weakened state of the vessels, as in syringomyelia, often results in hemorrhage. New growths, by their developing imperfect vessels and by their pressure obstructing the circulation, favor the escape of blood. It may attend softening, degeneration, and myelitis.

125. Symptoms.—The symptoms depend on the place and extent of the hemorrhage. The symptoms are usually sudden in onset, though some prodromata due to congestion or obstructed circulation may precede. Some pain at first in the back, near the seat of the lesion, then numbness and rapid loss of sensation, and clonic muscular twitchings preceding paralysis are some of the symptoms. Reflexes are variable. If the lesion is transverse and complete, there is a loss of the reflexes below it—even the bladder and rectal reflexes are impaired. If the lesion is but partial, there may be exaggeration of the tendon reflexes. The hemorrhage may be so severe or so located as to disturb the general circulation directly or in a reflex manner, and loss of consciousness may ensue.

126. Treatment.—The treatment has in view the limitation of the hemorrhage by ice to the spine and the use of ergot or aconite internally. The patient should rest in the prone position. The bowels should be opened freely, so as to direct the blood-current to the abdomen.

127. Electrotherapeutics.—Electrotherapeutics is of no service except in the treatment of the after-effects. If the

damage to the cord structures has not been too great, repair may be promoted by the action of the direct current with the negative electrode over the seat of lesion. The paretic neurons and the weakened muscles may be improved in nutrition by the use of the induction-coil current.

EMBOLISM AND THROMBOSIS.

128. Nature and Pathology.—Although these conditions do no doubt, at times, occur in the vessels of the spinal cord, the immediate complications to which they give rise—necrosis and myelomalacia—soon modify the primary pathological features. Injuries to the cord-structure or some disease of the blood or walls of the vessels usually precede the formation of an embolus or thrombosis.

129. Symptoms and Treatment.—The symptoms of embolism and thrombosis would be much the same as those of hemorrhage, and the treatment would also be similar.

CAISSON DISEASE.

130. Nature and Pathology.—Caisson disease is a form of nervous affection, disturbing mainly the functions of the spinal cord, which is caused in divers and those that are at work in caissons, mines, etc., where they are subject at times to great variations in air-pressure. Congestion of the cord is a result, minute or capillary hemorrhages resulting in some cases. It is thought by some that gas is generated in the blood, giving rise to lacerations in the cord-structure, but this is doubtful.

131. Symptoms.—The symptoms are faintness, prostration, headache, giddiness, nausea, vomiting, incoherent speech, double vision, hemorrhage from ears, slowing of pulse, at times coma, pains in the joints and legs, sensations in the legs diminished or lost, and the patient may have complete paraplegia or hemiplegia, retention of urine, and constipation.

132. Treatment.—The treatment consists in the return of the patient promptly to a greater degree of air-pressure, the

use of a pneumatic cabinet or forced artificial inspirations, the lateral or prone recumbent position of the body, cold to the spine, ergot, and bromids. The subsequent debility and paralysis should be treated in the same manner as has been advised for spinal hyperemia.

INFLAMMATIONS.

133. Classification of Inflammations.—Under this head are included all diseases of the structures within the spinal canal that are attended by inflammation: *Pachymeningitis*, external, internal, or hypertrophic; *leptomeningitis*, acute, chronic; *myelitis*, acute, chronic, diffuse, disseminated; *anterior poliomyelitis*, infantile, adult; *abscess*.

PACHYMENINGITIS.

134. This is an inflammation of the dura mater of the spinal cord, usually limited in extent, and, according to the cause, may be chiefly *external* or *internal*.

135. External Pachymeningitis.—This is commonly due to injury involving at the same time the vertebræ, or to extension from caries of the spine as a result of tuberculosis or struma. Blood-disease, as pyemia, may also occasion it. The inflammation is of a purulent, semipurulent, or fibropurulent type, or it may be tubercular. Thickening and cellular infiltration of the dura results, causing it to encroach upon the nerves at the intervertebral foramina. This increase of connective tissue is at times so abundant as to give a special character to the inflammation.

136. Symptoms.—The symptoms are localized pains in the back, radiating pains along certain nerves, tenderness of the vertebral column at the point inflamed, hyperesthesia, and, later, anesthesia, twitching of muscles, exaggeration of reflexes, paresis, paraplegia, and involvement of bladder and rectal sphincters. If the disease is prolonged, bed-sores occur.

137. Treatment.—The treatment in the acute or primary stage is largely surgical, so as to fix the spine to secure absolute

rest for the part, and counter-irritation, to limit the extent of inflammation. Sedatives should be given to allay pain, and tonics, to improve the general health.

138. Internal, or Hypertrophic, Pachymeningitis. This is an inflammation of the dura mater, especially in the cervical region, where the membrane is more closely adherent to the internal surface of the vertebræ. It is characterized by capillary hemorrhages upon the arachnoid surface of the dura, together with plastic exudates, which organize and cause thickening of the dura. Its course is somewhat chronic, and the cause is a blood and vascular disorder the nature of which is still obscure.

139. Symptoms.—The symptoms consist in neuralgic pains in the neck, head, shoulders, and arms, with paresthesias then anesthesia of the upper extremities. There may be thermoanesthesia and analgesia without tactile anesthesia. The sensory changes may be unilateral. Loss of power and wasting of the muscles of the hands, forearms, and shoulders result. The muscles supplied by the ulnar and median nerves, especially, are liable to be so affected. Paraplegia, with exaggeration of the patella-tendon reflexes and rigidity of the muscles of the lower extremities, may occur. Occasionally, there are changes in the pupil due to involvement of the sympathetic.

140. Treatment.—The treatment indicated is fixation and rest for the inflamed part, antiphlogistics, counter-irritants, sedatives, and measures to maintain the general and local nutrition.

LEPTOMENINGITIS.

141. Nature and Pathology.—The pia mater of the spinal cord may be inflamed separately from the dura mater, though both the latter membrane and the cord-substance itself are soon involved secondarily. The disease may manifest itself either in an acute or chronic form. These two forms do not differ essentially in their pathology, the distinction being due mainly to the suddenness and violence of the onset and progress

in the stage of the inflammatory process. A toxemic cause of some sort is presumed to start the inflammatory process, where it is not the immediate result of injury. A hyperemia of the pia arachnoid is soon followed by exudates of lymph, leucocytes, and blood-serum into the cellular meshes of the membranes. This exudate is often purulent. The membrane becomes thickened and opaque, then partial absorption of the exudate with some organization of new connective tissue follows, causing adhesions of the pia, dura, and cord. The nerve-roots are compressed by the exudate and the circulation of blood impeded.

142. Symptoms of Acute Form.—The symptoms of the acute form of leptomeningitis may be conveniently referred to three stages. The *first stage* is that of irritation. It begins with a chill, a feeling of general malaise, loss of appetite, disturbed sleep, restlessness, elevation of temperature, and pain along the spine that is constant and increased on movement. The pain radiates to the extremities and about the trunk, and the skin is hyperesthetic. There is rigidity of the muscles of the back, and there may be retraction of the head. Both the sensory and motor reflexes are exaggerated. The *second stage* is that of paresis or paralysis. Anesthesia and analgesia replace the irritation symptoms, bed-sores form, the reflexes are dimished or lost, muscular atrophy occurs with reaction of degeneration, and the bladder and rectal sphincters are affected. The *third stage* is that which results from the disease after it has subsided. Seldom, even under the most favorable circumstances, are normal functions fully restored. Defective action in the circulation of the cord or in the nutrition or activity of the centers remains. The patient is subject to pains, and is less enduring and more easily fatigued. Soreness and stiffness in the whole or some portion of the spine are common, but often permanent anesthesia and local or general paralysis follows the attack.

143. Symptoms of Chronic Form.—The symptoms of chronic leptomeningitis are essentially the same as those of the acute form, except that they are less marked and the stages are

more protracted. In the chronic form, the stiffness of the back is less and retraction of the head is rare.

144. Treatment.—The treatment usually advised consists of rest in bed, leeches, cupping, and cold applications to the spine, hot general baths, counter-irritation to limit the severity and extent of the inflammation, eliminants as derivatives, sedatives, bromids, opium, morphin, or codein to allay the pain. Salicylates are used as antitoxics. Nitroglycerin, digitalis, and readily assimilable nutrients are given to sustain the heart and general strength; and, in the later stages, to promote absorption and restore function, tepid baths, mercurial inunctions, potassium iodid, and massage and passive movements are administered.

145. Electrotherapeutics.—Electrotherapeutics in this, as in all forms of nervous disease attended by much inflammation, has been employed in the terminal stages to assist the enfeebled nutrition, aid the removal of exudates, and restore the function of the damaged neurons. The sedative action of the direct current, the anode over the seat of the inflammation, would seem to be a suitable form of application to relieve both the oversensitiveness and diminish the hyperemia in the first stage of the disease; but its action in this respect would in all probability be less effectual than other antiphlogistic measures.

The direct current is invaluable in the later stages in promoting the removal of exudates and assisting nature in restoring normal nutrition to the damaged cord. The negative electrode of the direct current over the seat of inflammation is the method to be used for this purpose. The induction-coil current to the peripheral nerves and the atrophied muscles (Plate IV) is indispensable as a means for supplementing massage in the restoration of function.

MYELITIS.

146. It is doubtful if inflammation of the spinal cord ever occurs spontaneously. It may follow traumatism, obstruction or disease of the blood-vessels, toxic or toxemic conditions, and may present a great variety of forms and symptoms dependent

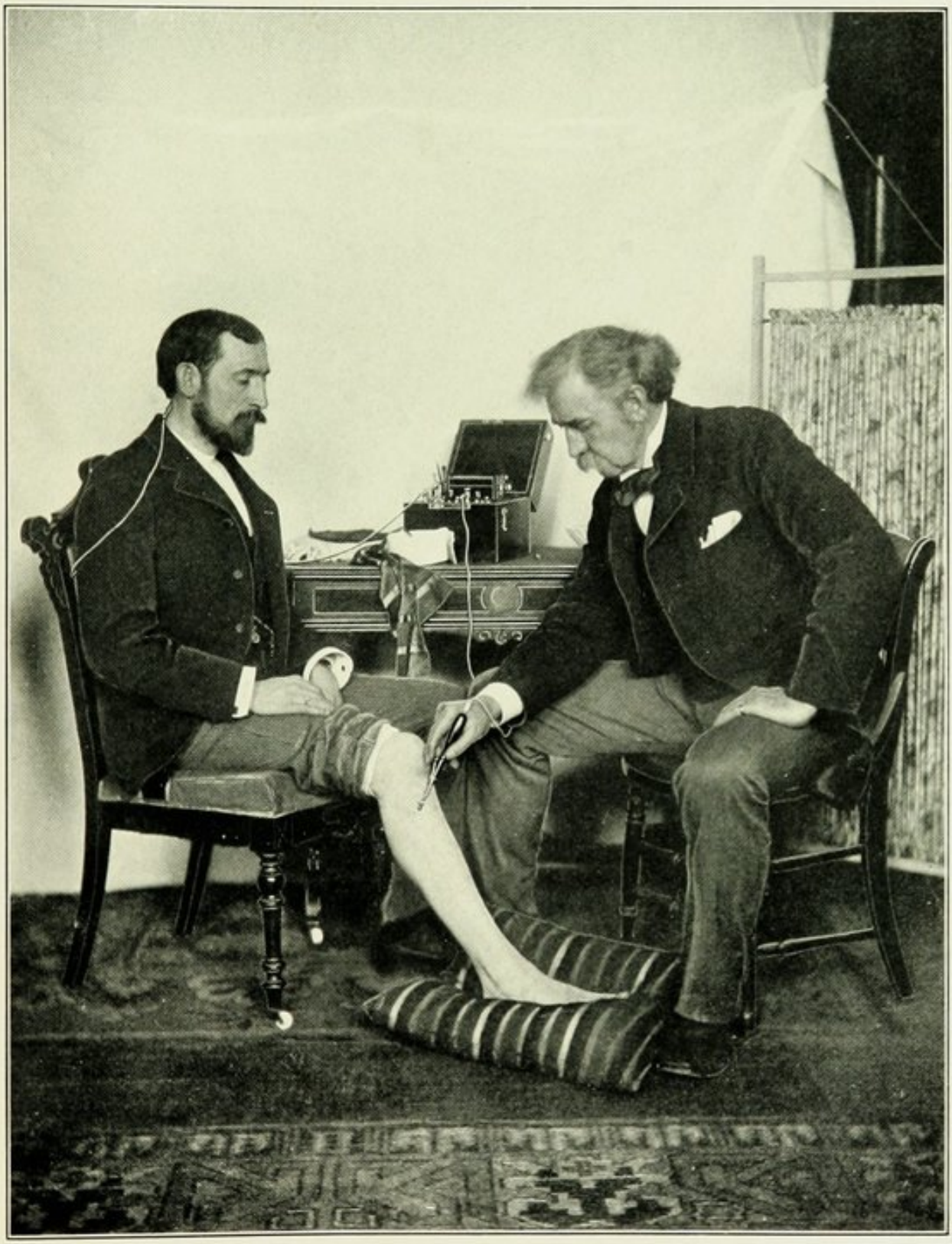


PLATE IV.

Induced-Current Treatment of Anterior Tibial Nerve.

on the location, extent, nature, and severity of the inflammatory process and its sequelæ. Thus we may have transverse, disseminated, central, and anterior poliomyelitis, any one of which may be acute or chronic in its manifestations.

147. Transverse myelitis is representative of those inflammations of the cord that primarily involve some portions of its entire thickness, while anterior poliomyelitis is typical of systemic inflammations, and is confined, at least in its first stages, to the cells of the anterior cornua. The more common form of inflammation of the spinal cord is *acute transverse myelitis.*

148. Acute Transverse Myelitis.—Secondary to wounds, bruises, or concussion of the cord, or as a result of infectious disease or extreme exposure, the substance of the cord at some point takes on inflammatory changes. The blood-vessels are distended, leucocytes increase, and the neurons and their prolongations swell and disintegrate. There may be hemorrhagic extravasation. Softening of the cord follows, having a red, yellow, or white appearance, according to the preponderance of blood-elements extravasated. If time is allowed and the vital conditions are favorable, some organization of connective tissue may follow; this is more common in the subacute or chronic forms.

149. Sensory Symptoms.—Occasionally, there are prodromes such as paresthesia, pain in the back or legs, sometimes a chill, and, in a few cases, convulsions. Soon complete anesthesia occurs below the seat of the lesion. There is girdle-pain and an area of hyperesthesia above the girdle-pain, the skin reflexes being exaggerated. The temperature of the skin is at first raised, then lowered, over the affected area; the skin is dry and harsh, or moist, and there may be urticaria and edema at times and changes in the secretion of sweat, and bed-sores soon form.

150. Motor Symptoms.—Weakness of the legs, or, if the lesion is high up in the cord, weakness of the arms also, occurs, and, later, paraplegia. Below the level of the lesion, the tendon

reflexes are exaggerated, and opposite the lesion they are diminished or lost. Twitching of the muscles and clonic spasms often occur. Below the level of the lesion, the muscles atrophy from disuse, while those innervated from the inflamed area show degenerative atrophy. The bowels are at first much constipated, and later there may be loss of control. There is retention and incontinence of urine, often resulting in cystitis. The electric changes are both quantitative and qualitative.

151. Chronic Transverse Myelitis.—In chronic transverse myelitis, practically the same range of symptoms is observed as in acute forms, except that the progress of development is less rapid. Contractions are likely to affect muscles innervated from centers in the cord not directly involved in the inflammation.

ABSCESS.

152. Abscess of the spinal cord is of very rare occurrence. A focal suppurative inflammation here would be of the nature of a transverse myelitis, resulting in a breaking down of structure and accumulation of pus. Gower reports one case in which the symptoms were severe abdominal pains, sense of constriction at the level of the lesion, quickly followed by loss of sensation, paralysis of the legs and bladder, and a disappearance of the reflexes.

153. Disseminated and Central Myelitis.—Disseminated myelitis and central myelitis are characterized by the wide range and variety of the lesions and the rapidity with which grave symptoms of disorder in the regulative functions of the cord are developed. The pathological findings are similar to those of acute transverse myelitis, except that they are more general. There is rapid loss of sensation and of reflex action, elevation of temperature, and speedy onset of trophic changes. The arms and legs may be affected simultaneously, or, if the center for the control of one pair of limbs is first involved, the disease soon extends to the other. For a short time, there may be evidence of dissociation of the various sensory paths, or there

may be sensory loss without muscular atrophy, or the reverse, but soon all functions are destroyed and death occurs almost invariably within a few days or weeks. Should the attack prove to be a very mild one and the destructive process fail to destroy the vital centers of the cord, the treatment to be employed would not differ essentially from that which would be suitable in other forms of myelitis.

154. Treatment.—The treatment advised in the early stages is rest, counter-irritation, cupping, leeches, actual cautery, hot douches to the back, general lukewarm baths, and ergot. With a view of limiting the sclerosis and degeneration, iron, silver nitrate, arsenic, strychnin, and gold and sodium chlorid are recommended. Potassium iodid, iodid of iron, and mercury are given to assist the removal of exudates and débris. Careful attention is required to secure elimination by the bowels, kidneys, and bladder, and cleanliness with freedom from pressure must be maintained, to prevent the formation of bed-sores.

155. Electrotherapeutics.—The electrotherapeutic treatment of acute and chronic myelitis should be adapted to the stage of the disease and the pathological features that need be counteracted. The pains may be relieved by the positive electrode of the direct current, or the induced current from the secondary coil applied at the painful area. The sedative action of these electric modalities will also assist in allaying the irritation of motor nerves and the spasmodic action of the muscles. After the early and more acute stage has given place to the symptoms of compression, paralysis, and defective nutrition, both in the cord and the periphery, the negative electrode of the direct current applied in a labile manner over the seat of the damaged neurons and to the parts supplied by them in the periphery, will promote the absorption of inflammatory exudates and assist in bringing about a better state of nutrition.

It is mainly through the helpful action of electricity and massage that such recovery as is possible in these cases is brought about. Such treatment will oftentimes arrest the

tendency toward further degeneration of neurons and prevent serious contractions and deformities, even though it should not succeed in restoring to complete integrity the damaged nerve-centers. In these cases, the localized application of electric action is usually the most beneficial, but it is also helpful to employ those forms of electric modality that are general in their effects and act beneficially on the nutrition of the body as a whole.

The static-insulation and magnetic-field treatments may be employed for these purposes, or, in the later stages of the disease, the nutrition of the spinal cord may be stimulated by the direct application to it of the static spark.

ANTERIOR POLIOMYELITIS.

156. Nature and Pathology.—Anterior poliomyelitis is an inflammation of the spinal cord in which the cells in the anterior horns of the gray matter of the cord chiefly suffer. It is supposed to be due to a toxic state of the blood, wherein the poisonous agent has a special affinity for the large motor-cells of the anterior cornua. The conditions giving rise to this form of inflammation occur most frequently in young children at any time from early infancy to the age of ten or twelve, but especially during the periods of the first or second dentition. When the disease attacks the child, it usually comes on suddenly, acutely, and with slight or no premonitory symptoms.

This form of the disease has been variously named *infantile spinal paralysis*, *acute atrophic paralysis*, *essential paralysis of children*, these names being some of its synonyms. Rarely it may occur in a more chronic form even in children, but, ordinarily, adults are the victims where the disease is characterized by a more gradual onset, and it is then generally known as the *chronic*, or *adult*, form of anterior poliomyelitis. The pathological changes that take place have not been found so far to differ much in the two forms. The inflammation is parenchymatous or interstitial, there is congestion of the capillaries with capillary ectasiae in the anterior gray matter, swelling of the ganglion cells, and neurogliar elements with infiltration of

leucocytes. These changes result in degeneration and atrophy of the cells of the anterior cornua with consequent sclerosis. There is no suppuration.

157. Symptoms of Acute Form.—The symptoms of the acute attack, when premonitory, are pyrexia, headache, pain in the loins and limbs, prostration, and, at times, a stupid somnolent condition, possibly convulsions, occasionally vomiting, and diarrhea. There is a rapid onset of widespread motor paralysis, which within a few days or weeks becomes more limited, leaving one or two limbs or only single groups of muscles affected. The affected muscles are flaccid, and within a few days lose faradic excitability. They soon atrophy, their reflexes are lost, reaction of degeneration is observed, and, later, all response to direct electric currents fails. There is a tendency to permanent shortening of the still active muscles, causing deformities in the affected limbs and at times subluxation of joints. There is but little if any change in sensory action. The skin in the affected area is usually cool and cyanotic.

158. Symptoms of Chronic Form.—The symptoms of the chronic form of the disease are quite similar to those here mentioned, except that they are slower in onset. The prodromal symptoms, while more constantly present, are seldom severe, and the tendency to improvement in the primary paralysis is not so constant a feature in the adult form. The paralysis may even gradually increase rather than diminish, by a progress upward in the cord involving the upper cervical and medullary motor cells of the cord.

159. Treatment.—The treatment for the early and acute stage of the disease consists in rest, sweating, warmth to the extremities, cold applications to the spine and also to the head if the cerebral symptoms are prominent, calomel, tincture of aconite, tartrate of potash, sweet spirits of niter, salicylates, salol, belladonna or ergot, and chloral hydrate or bromids, if there is much restlessness or pain. Later, potassium iodid, massage, Swedish movements, gymnastics, and

hot and cold douching of the paralyzed parts are given to restore activity. Surgical and orthopedic treatment is needed to correct deformities.

160. Electrotherapeutics.—Electrotherapeutics is absolutely essential to aid in regaining to the fullest extent possible the activity of the damaged motor neurons and restore the functions of the atrophied muscles. Experience would seem to show that complete destruction of the motor cells in the anterior cornua seldom takes place in the beginning in this disease. Neglect and disuse due to weakness and paresis of the limb or muscles may eventually result in such permanent destruction. An early and intelligent course of treatment persisted in for months and even years will result in the partial or complete restoration of the action of muscles and limbs that have suffered in this disease, which, without such treatment, would remain permanently disabled.

As soon as the acute symptoms have subsided, that is, at the end of 2 or 3 weeks, the paralyzed parts should be treated with the induced current in connection with hot and cold bathing, massage, and the inunction of sweet-oil and lanolin. With the negative electrode of the primary-induced current over the seat of lesion in the spinal cord, a pointed anode should be placed over the "motor point" of each muscle that is paralyzed or paretic, and a current of moderate intensity allowed to pass for a few seconds. Since the skin retains its sensitiveness, a very strong current will not be tolerated by the patient, nor is it needed. Oftentimes it will be necessary at first for the operator to make use of his own hand as the active electrode, and to stimulate the muscles by applying the tip of one of his fingers over the motor points. Only the damaged nerves and muscles should be given the electric stimulation, since the purpose is to restore them to a condition that will enable them to do their share of the work.

Should all the muscles in the limb receive the treatment indiscriminately, the general nutrition of the part would be improved but the disturbed balance in muscular action would not be corrected, but on the contrary might be worse. The



PLATE V.

Direct Current, Cathode to Musculospiral Nerve.

treatment should be given by one that understands the anatomy and physiology of the part to be treated. Such electric treatments should be given for 15 or 20 minutes daily, and should be continued for a long period of time. The muscles stimulated should always be in a relaxed state at the time the current is applied to them.

In the beginning of the electric applications it would be well to substitute the direct current for the induced current occasionally, using about 10 or 15 milliamperes of current-strength with the cathode over the point of lesion in the spinal cord and the anode on the atrophied muscles (Plate V).

ATROPHY AND DEGENERATION.

161. Classification of Diseases.—There are many diseases affecting the spinal-cord neurons that are unattended by marked vascular or inflammatory changes in the beginning or at any time during their course, but which, from a slow and insidious onset, progress to grave structural changes in the cord-substance proper or in some parts of it. Some defect in nutrition of the neurons is no doubt a primary fault in these cases, but, as the exact nature of this nutritive defect is not in any one instance fully known, and yet the degenerative changes that result are in each case constant and characteristic, it has seemed best, for the present, to classify these diseases under the above heading.

The more common of these disorders are *progressive muscular atrophy*, *amyotrophic lateral sclerosis*, *muscular dystrophies*, pseudo-hypertrophic paralysis, Erbs juvenile paralysis, the peroneal or Charcot-Marie type, the facio-scapulo-humeral or Landouzy-Déjérine type; *primary lateral sclerosis; posterior spinal sclerosis; ataxic paraplegia.*

PROGRESSIVE MUSCULAR ATROPHY.

162. Nature and Pathology.—Progressive muscular atrophy is a disease of male adult life, and ordinarily the patient gives a history of much exposure to wet and cold and of severe muscular exertion. Not infrequently he has been a

sufferer from rheumatism. The pathological changes found are degenerative atrophy of the cells of the anterior horns and of the central gray matter of the cord, degeneration of the lateral columns, atrophy of the motor nerve-roots and of the muscles supplied by the affected areas in the cord.

163. Symptoms.—The onset of the disease is very slow and gradual, and the sensory symptoms are at no time prominent. There may be some pain in the spine and slight rheumatoid pain in the shoulders and arms, with some numbness and general weariness. There is often a feeling of coldness in the parts most affected. The skin is cyanotic and shows *trophic changes*, such as thickenings and fissures, while the nails become brittle, grooved, and curved. Muscular wasting is seen usually first in the interossei, thenar, and hypothenar muscles of the right hand. The muscular atrophy then extends upwards to the muscles of the shoulders and neck, and later involves those of the back, trunk, hips, and thighs. Soon after one upper extremity is attacked, signs of wasting begin in the other extremity in like manner. The motor symptoms are those of paresis and fibrillary twitchings, which attend the muscular atrophy. The tendon reflexes are diminished or lost. The central degeneration may extend to the medulla and involve the motor nerves of the face, lips, and tongue. There are quantitative changes in the electric reactions at first, and, later, qualitative changes. The muscular weakness and atrophy give rise to manual deformities termed *ape hands* and *griffin's claw*, and to lordosis of the spine. The bowels become constipated and the sexual power is weakened or abolished. Excessive sweating, irregularity of the pupils, or nystagmus may be present in some cases.

164. Spastic Form of Progressive Muscular Atrophy.—The spastic form of progressive muscular atrophy has been described under several other names, such as *amyotrophic lateral sclerosis* (*Charcot*) and the tonic form of *progressive muscular atrophy* (*Gowers*). In nature and pathology, it is essentially the same disease as the one just described, except that the degeneration of the lateral tracts precedes the wasting

of the motor cells in the anterior horns of the cord. The latter remain intact, for a sufficient length of time to permit the development of a spastic condition in the muscles of the lower extremities. In the ordinary form of progressive muscular atrophy, the initial wasting not infrequently takes place in the shoulder or trunk muscles rather than in those of the hand. This appears to be the rule rather than the exception in the spastic form of the disease. The tendency for the disease to progress upwards in the cord, and to cause symptoms of bulbar paralysis, is also somewhat characteristic of amyotrophic lateral sclerosis, so that speech defects and difficulty in deglutition and swallowing are common in it as a result of paresis of the muscles of the lips and tongue.

MUSCULAR DYSTROPHIES.

165. Nature and Pathology.—There are many varieties of muscular dystrophies. Although the most obvious changes in all of them—both microscopic and macroscopic—are seen in the muscular tissue, and although few characteristic or constant lesions have thus far been found in the lower motor neurons, yet it is now the prevailing opinion among neurologists that the disease affects primarily the nerve-elements and that further research will demonstrate this. The pathological process is essentially the same in nature whether the muscles first affected are those of the shoulder, back, hips, arms, legs, or face.

Several types have been described, according as one or more of these groups of muscles have been associated in the atrophic change. Thus we have *pseudohypertrophic paralysis*, which commonly occurs in young males, affecting the muscles of the shoulders, hips, thighs, back, and calves of the legs, with an atrophy of the muscular tissue accompanied by hyperplasia of the connective tissue, causing a deceptive appearance of increased muscular development. The *juvenile type of Erb*, also called the *brachial form*, affects mainly the muscles of the arms and shoulders, and appears in early youth and usually in several members of the same family. The *facio-scapulo-humeral form* affects the muscles of the face, shoulder, and arm. In

the *peroneal*, or *leg*, *type*, the peroneal muscles are first attacked, then those of the calf and, later, those of the thigh.

The degenerative process in the first of these forms differs from the others only in the fact that, during that early period of life when the degenerative process sets in, the nutritive activity favors an overgrowth of connective tissue as the muscular tissue atrophies. This tendency to overproduction of connective tissue diminishes with the age of the tissues, and is not often an accompaniment of the muscular atrophy in those cases that develop later in life. Even in the cases of pseudohypertrophic paralysis, the overgrowth of connective tissue breaks down and is removed if the patient lives to adult life, and the muscles have then the atrophied appearance that is seen in the other forms. This hyperplasia of connective tissue gives to the muscles in which it occurs a full and rounded contour, and its resistance may be firm or hard or soft and yielding, according to the amount of connective tissue formed or the proportion of fat contained in it. The new formed connective tissue not infrequently forms a cicatricial-like tissue that causes contractures interfering with joint movements and locomotion. The muscular action in all these forms of dystrophy is much weakened and deformities are the rule, such as lordosis, scoliosis, drooping of the shoulders, etc., due to the weight of the body and limbs and to the unopposed action of normal muscles.

166. In pseudohypertrophic paralysis there may be, in the beginning, some hypertrophy of individual muscle-fibers and increase of muscle nuclei, swelling and rounding of some of the fibers, and splitting of them, but as the hyperplasia of connective tissue takes place, these muscle-fibers atrophy with the rest. When there is a tendency to overgrowth of connective tissue, fat may be deposited in it and result in a lipomatosis. As a rule, it is only in the young that this takes place. In most of the adult cases, whatever the location of the muscular atrophy, the muscle-fibers diminish in size and number, and there is but little increase of the connective tissue-elements. The muscle-nerve plates have been found in some instances

degenerated or undeveloped, and changes indicating degeneration are apparent in the anterior pyramidal cells of the spinal cord.

167. Symptoms.—The symptoms present will accord with the degree and location of the degeneration. The sensory symptoms are seldom a prominent feature in the disease. Some rheumatoid pains may be present. A general feeling of weakness and lassitude and a sense of heaviness, numbness, and weariness in the affected parts are not unusual. But the motor symptoms chiefly characterize the disorder. The affected parts soon exhibit such feebleness in movement as to impair the use of them. When the muscles of the face are involved, an immobile and stolid expression of the countenance ensues. Involvement of the shoulder and arm muscles prevents the arm from being raised to the horizontal position or separated from the side of the body. The contour of the shoulder is flattened or angular and the scapulæ droop. A more general involvement of the muscles of the limbs and trunk, as in the pseudo-hypertrophic form, causes a waddling gait, extreme bending forward of the lumbar spine in standing, due to weakness of the flexors of the thighs, difficulty in rising from the recumbent position because of the feeble calf, thigh, and trunk muscles. The peroneal type early causes such weakness in the legs as to prevent walking or standing. Fibrillary twitchings of the muscles is seen at times, and the electric reactions correspond with the degree of degeneration.

168. Treatment.—The treatment of these various forms of disease, in which degeneration of the motor neurons and muscular atrophy are the chief pathological features, needs to be such as will arouse to a better state of nutrition these weakened elements. Disuse of degenerating tissue is as fatal as overuse. Gentle muscular exercise and suitable gymnastics are essential. Attention to general hygiene, warm baths followed by sponging with cold water at least every other day, and massage are helpful. The diet should be composed of simple but most nutritious articles of food, as milk, eggs,

soups, broths, beefsteak, mutton, all-wheat bread, etc., to be supplemented, when necessary, by the malt-preparations and cod-liver oil. Such medicines as arsenic, phosphorus, iron, quinin, and especially strychnin are advised in order to stimulate the debilitated neurons. The direct hypodermic injection of nitrate of strychnin into the degenerating muscles seems to act beneficially. The nitrate of silver and the chlorid and arsenate of gold are employed with the view of checking the degenerating process in the nerve elements. All authors advise electricity in some form.

169. Electrotherapeutics.—The use of the negative electrode of the direct current applied in a labile manner over the entire range of the neuromuscular structure involved is most helpful. The anode may be placed at any suitable point on the body, as the sternum, and the cathode, first applied to the spinal-cord center of the affected neurons and allowed to rest there for a few moments, should then be slowly carried out along the course of the nerves to their termination in the affected muscles. The degenerating muscular structure should be made feel the influence of the current throughout its entire extent; slowly and with firm pressure, the well-moistened cathode should be moved over the muscles with a current-strength of from 20 to 30 milliamperes. Each muscle-group in process of degeneration should, if possible, receive such treatment for 15 minutes daily, and the electric treatment should be preceded or followed by massage. Where the parts affected are too extensive to permit of a thorough daily treatment of all of them, different regions should be treated in this manner on successive days. The weakened muscles do not respond so well to the induced-current impulses, nor does the induction-current furnish all the requirements for electric treatment in these cases. The chemical and phoretic action of the direct current is serviceable in aiding nature in the removal of the degenerated débris, and thus clears the ground for better nutritive action. Nevertheless, the circulation is quickened, absorption promoted, and the muscle and nerve protoplasm stimulated by the use of both faradism and the static spark in these cases. Care should be taken in the

application of electric stimulus to confine its action for the most part to the affected parts and not cause it to excite indiscriminately the sound and the diseased tissues.

PRIMARY LATERAL SCLEROSIS.

(*Primary Spastic Paraplegia.*)

170. Nature and Pathology.—In primary lateral sclerosis there is destruction of the neuraxon of the central motor neuron and simultaneous increase of the neuroglia tissue of the lateral columns (the lateral pyramidal tracts) of the spinal cord.

In typical cases, the pathological changes are confined to the pyramidal tracts, but there are forms in which, while these tracts exhibit the greater degree of sclerotic change, the degeneration involves to some extent the posterior columns. Toward the later stages of some of these cases, the anterior polar cells become affected, and then the symptoms of amyotrophic lateral sclerosis develop.

171. The disease appears to be hereditary in some families, and is apparently due to teratological defects, even though the degenerative changes may not begin until late in life. At other times, the disease is idiopathic, caused by autointoxication or due to certain vegetable poisons. Exposure to wet and cold, excessive muscular fatigue, and rheumatic diathesis appear to act as a causative factor in some cases. The eating of ergoted grain (ergotism), diseased or fermented maize (pellagra), or of various vetches, as *Lathyrus Satious*, *Lathyrus Cicera*, or *Lathyrus Chymenum* (lathyrism), gives rise to a spastic paraplegia that has at certain times affected many persons who, in a state of poverty or in a famine-stricken district, have been compelled to subsist for some time on such foods. While the vegetable poison seems to have a special selective affinity for the neuraxons of the central motor cells, it causes disorder in not a few instances in other parts of the brain and cord, so that mental derangements and sensory disorders may complicate the symptoms. The disease more commonly attacks persons of middle age, and the idiopathic form is rather more frequent in males than females.

172. Symptoms.—The symptoms of motor derangement preponderate, although a feeling of malaise, rheumatoid pains, numbness, and prickling and tingling sensations in the trunk and limbs may precede or accompany the onset of the paraplegia. The characteristic symptoms are motor paralysis with rigidity of the limbs, exaggeration of the knee-jerk, and, if the upper extremities are affected, of the elbow-jerk, also. Generally, the motor derangement is confined for a long period to the lower extremities. The feet feel glued to the ground and the stiffened limbs are moved by the hip muscles until locomotion becomes impossible and the patient is confined to a wheel-chair or is bedridden. The bowels and bladder are seldom involved, except that difficulty in expelling their contents may arise from a lack of voluntary control over the abdominal muscles, which are not infrequently involved with those of the legs. Muscular cramping may cause the patient much discomfort, and is readily brought on by excitation of the uncontrolled spinal centers.

173. Treatment.—The treatment advised consists of warm bathing, and bromids if the sensory symptoms are at all pronounced. Potassium iodid and mercuric iodid are employed to remove the débris of degeneration, and as antispecifics, if syphilis has been found to be a causative factor. Silver nitrate is suggested with the view of checking degeneration. Arsenic, strychnin, and the phosphates are given to aid neuron nutrition. Massage is serviceable and electricity is helpful if employed in a rational manner.

174. Electrotherapeutics.—As the central neurons of the pyramidal tracts are the primary seat of degeneration, the electric stimulus should be directed to them. The negative electrode of the direct current should be applied in a slowly labile manner to the cervical and thoracic spine for 15 or 20 minutes daily, with a current-strength of 20 to 40 milliamperes. Usually, in the first and intermediate stages of the disease, the lumbar motor neurons are hyperexcitable, owing to the lack of inhibitory control, and during this time any electric application

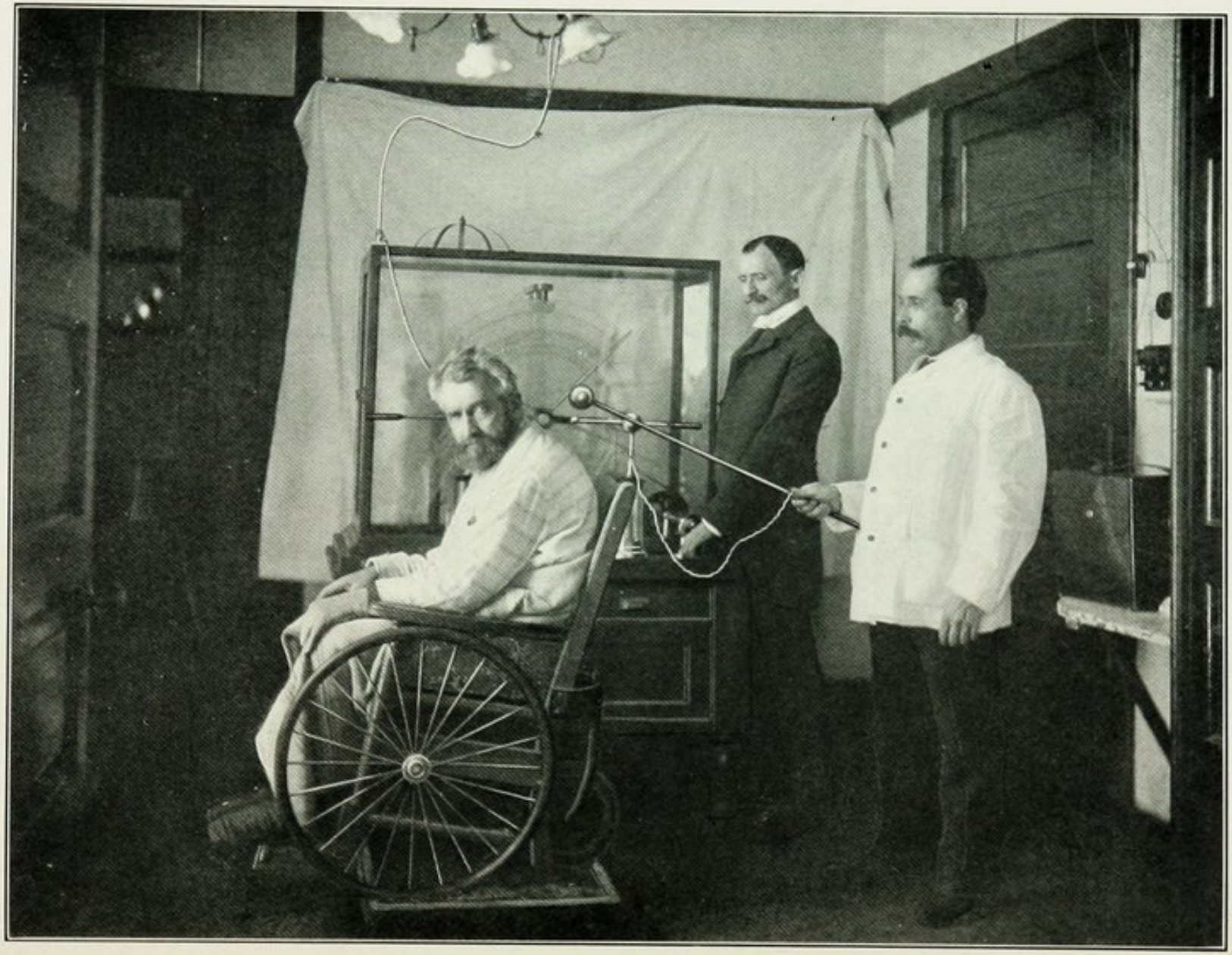


PLATE VI.

Static Spark to Upper Segment of Spinal Cord.

to them should be of a sedative nature rather than stimulating. The general nutrition may be aided by static insulation or general faradism, and the static spark applied to the upper spinal-cord segments would be advisable (Plate VI).

POSTERIOR SPINAL SCLEROSIS.

(*Locomotor Ataxia, Tabes Dorsalis.*)

175. Nature and Pathology.—This is a primary degenerative disease in which a large share of both the central and peripheral nervous structure takes part. The degeneration appears first to attack the posterior spinal ganglia or their homologues in the special-sense organs, causing changes in the peripheral and central ramifications of these neurons. Evidences of this degeneration are not demonstrable at first in the cell-body of the neuron. A sclerosis of the peripheral sensory neuron follows, involving the posterior columns of the spinal cord, the posterior gray horns, and the sensory nuclei of the cranial nerves in the medulla and brain. Cortical lesions are found in some cases. In from 50 to 70 per cent. of these cases, syphilis is found to be a remote causative factor. The presumption is that the syphilitic virus has acted in producing a vulnerable state of the peripheral sensory neurons, and is not itself the immediate factor in producing the degeneration. A meningitis or endarteritis has been found in some cases, and this may be an intermediate step in the process of defective nutrition.

176. Symptoms.—The symptoms are usually slow in onset and in the beginning are for the most part in the sensory sphere. Anesthesias and paresthesias, prickling, tingling, and crawling sensations frequently occur in the feet and legs. Darting, lancinating pains in the legs are characteristic and are seldom lacking. Visceral crises are common. Accumulation of weak sensory stimuli cause "delayed sensations." In touch, pain, and temperature sensations, the areas of changes may not correspond. Girdle sensations are usual. An ataxic gait, inability to stand with the eyes closed, a loss

of the knee-jerk, and impairment of the pupil reflex to light (Argyll-Robertson pupil) are the characteristic motor symptoms. Trophic changes in the skin, joints, and bones occur in a certain percentage of the cases; the carpal and tarsal, the ankle, knee, wrist, and elbow joints are at times affected by the degenerative changes. Perforating ulcer of the plantar surface of the foot occasionally takes place. Optic atrophy occurs not infrequently. Some muscular atrophy is occasionally observed, but this is more often a general atrophy in the muscles of the paretic limbs as the result of disuse. Bladder and rectal disturbances are not uncommon, and after a brief period of sexual excitation at the commencement of the disease, impotence as a rule supervenes. Cerebral symptoms may manifest themselves in the form of insomnia, vertigo, despondency, or in one or more of the various psychoses.

177. Treatment.—The treatment in the early stages of the disease is directed toward the pains and sensory disturbances. For this purpose, antipyrin, acetanilid, phenacetin, potassium bromid, lithium bromid, salicylic acid, quinin, Indian hemp, amyl nitrite, nitroglycerin, Calabar bean, belladonna, cocain, codein, and morphin are recommended by various authors. With a view of checking the degenerative process, iron, strychnin, arsenic, aluminum, nux vomica, silver nitrate, phosphorus, gold and silver chlorid, counter-irritation, dry cups, and the actual cautery are suggested. Mercury and potassium iodid are used on the assumption that the specific virus may still be at work and also for the purpose of aiding in the removal of the degenerated substance. Ichthyol is employed in the treatment of the trophic changes in the skin and joints, both internally and for local application. To allay insomnia, the psychical and cerebral disturbances, Hoffman's anodyne, paraldehyde, chloral, and remedies of this nature are found serviceable. Both for their soothing and nutritive effect, hydropathic measures, massage, bandaging, and other local supports to the limbs and spine have proved beneficial. Physical and mental rest, with careful attention to diet and hygiene, are often helpful.

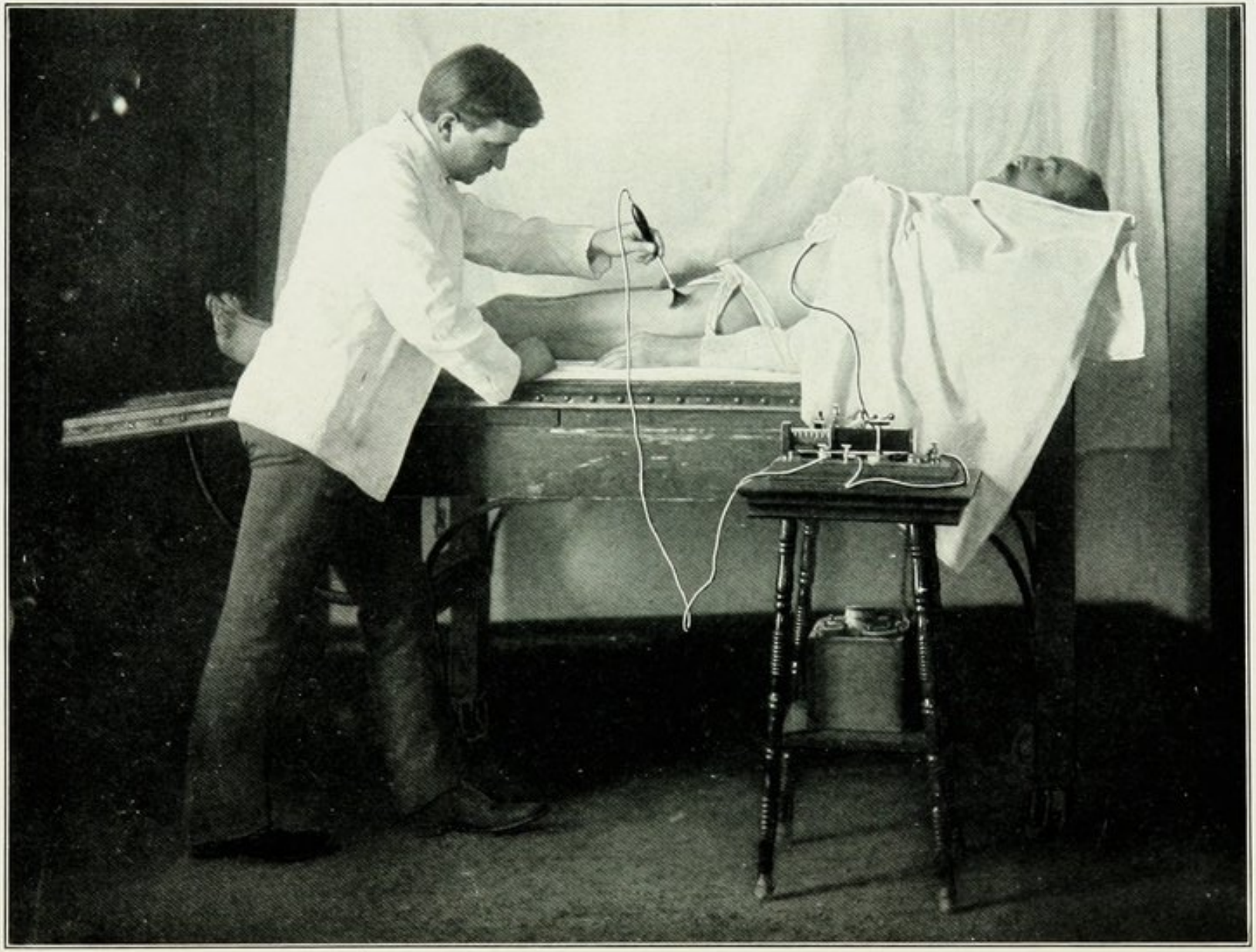


PLATE VII.

Brush-Electrode, Induced Current for Cutaneous Anesthesia.

178. Electrotherapeutics.—If the present view that the beginning of the degeneration is in the peripheral sensory neurons is correct, it would seem best to direct the electric treatment so as to improve their nutrition. Strumpel advises the application of the direct current in a stabile manner to the painful points on the spine. A labile use of the anode to the peripheral branches of the neurons would also be advisable, either with or without the addition of aconite or cocain on the electrode for their cataphoric effect, as suggested by Dercum. The use of the brush-electrode with a strong faradic current applied to the anesthetic, paresthetic, or painful areas, is stimulating, and relieves these sensory disorders in many instances (Plate VII). The static friction spark is also useful in relieving the pains and improving the nutritive activities in the spinal ganglia.

These various degenerative disorders of the spinal-cord structures are all of a nature to be benefited by the nutritive stimulating effect brought about by magnetic fields, and it would seem, on theoretical grounds, that a daily treatment of these patients while in a reclining posture, by means of alternating-magnetic fields for 20 or 30 minutes once or twice daily, could not but prove beneficial.

ATAXIC PARAPLEGIA.

(*Combined Lateral and Posterior Scleroses. Progressive Spastic Ataxia.*)

179. Nature and Pathology.—This is a disease in which occurs a combined sclerosis of the lateral and posterior columns of the cord, but especially of the pyramidal tracts. The direct anterior columns, the mixed zone of the lateral columns, and the direct cerebellar tract have also been found affected. It is a disease of adult life, and has been traced in its etiology to heredity, syphilis, excessive physical labor, venereal excesses, and excessive use of alcohol.

180. Symptoms.—Its onset is slow, with some soreness and aching of the legs, back, and sacrum, accompanied by weakness and trembling. Occasionally there is paresthesia, with numbness in the legs. Lightning-like pains may occur, though

this is rare. The sexual vigor is lost early. Ataxia, paresis, swaying gait, and, later, paraplegia takes place. The patellar-tendon reflexes are exaggerated, ankle-clonus occurs, with spasm and rigidity of the muscles of the legs. Weakness of the sphincter muscles is the rule. The arms are often involved. The pupillary reflex is impaired in some cases. Nystagmus and optic-nerve atrophy may be present. Facial ataxia and slight impairment of articulation have also been observed.

181. Treatment.—The treatment of ataxic paraplegia is similar to that advised for primary lateral and posterior spinal sclerosis.

TUBERCULOSIS AND SYPHILIS.

182. Tuberculosis of the Spinal Cord.—Tuberculosis of the spinal cord seldom occurs as a primary disease, but not infrequently it may be one of the manifestations of a general tubercular infection. A local tubercular inflammation of lymphatic glands or of the vertebræ may extend into the spinal canal and involve the spinal meninges or the cord itself.

183. Tuberculosis in Spinal Canal.—Tuberculosis involving the structures in the spinal canal generally produces a meningitis, by preference a leptomeningitis, but it may give rise to a new growth or a series of new growths less disseminated than a meningitis, and resulting in a mass of solitary tubercular material that, by obstruction and pressure, gives rise to symptoms of tumor and must be treated as such.

184. Treatment.—The treatment of tuberculosis of the spinal cord, whether the disease manifests itself in the form of a meningitis or tumor, would not differ in any essential particular from the treatment that is advised elsewhere for disorders of this nature. If there is strong probability based upon other indications than those arising from the spinal-cord symptoms that the disease of the cord is tubercular in nature, the systemic remedies should be such as are best suited to control or check the progress of this peculiar inflammation.

Creosote, guaiacol carbonate, nuclein, the malt-preparations, and cod-liver oil should be among the remedies used.

185. Electrotherapeutics.—Electrotherapeutics would be of service in the form of general faradism, static insulation or breeze, high-tension, autoinduction or magnetic fields, with a view of arousing the nutritive activity and vigor of the system to combat the disease. Should the tubercular process be arrested or checked, the direct current and the currents of the induction-coil would be helpful in the restoration of function to the damaged but still vital nervous and muscular tissue.

186. Syphilis of the Spinal Cord.—Syphilis of the spinal cord manifests itself as an obliterative endarteritis or meningomyelitis and is followed by localized softening or by irregular disseminated patches of sclerosis. The spinal-cord structures seldom suffer from these effects of syphilis to the exclusion of the brain. It will be best, therefore, to leave the disorders of the central nervous system due to syphilis for consideration under diseases of the brain.

TUMORS.

187. Nature and Pathology.—Localized neoplasms are not of very common occurrence in the spinal-cord tissues, and yet they do occasionally arise here and may present any variety of structure that can develop from similar tissues elsewhere. Thus we may have in this locality osseous, cartilaginous, fibrous, vascular, epithelial, or embryonic tissue growths in the form of tumors. The connective-tissue neoplasms (some form of *sarcoma*) are much the most frequent in the spinal cord, and of this variety, the neuroglia, the kind of connective tissue that is peculiar to the central nervous system, gives rise to the greatest number. A tumor composed largely of neurogliar tissue is known as a *glioma*, and arises in the cord tissue proper, and is often the result of defective evolutionary processes. Tubercular and syphilitic nodules are somewhat common in the spinal cord, as the result of a constitutional

infection. They often find their starting-point in a previously damaged area resulting from injury. The fibroid and carcinomatous growths, when found here, arise most frequently in connection with the membranes of the cord. Osteoma and chondroma take their origin from the spine, and affect the cord-structure by pressure. Angioma and angiosarcoma may occur at any place in the cord-substance proper or in its envelopes.

188. Aside from the immediate and intimate changes produced in the structure of the spinal cord by overgrowth or perverted growth of tissue, all such tumor enlargements give rise to secondary changes, such as inflammation, softening, cystic formations, hemorrhage, or sclerosis. Spinal caries, resulting in degeneration of the osseous walls of the spinal canal, may result in compression of the cord and give rise to like symptoms and results, such as compression, myelitis, and softening not unlike those caused by extra medullary neoplasms.

189. Symptoms.—The symptoms vary greatly according to the seat and extent of the neoplasm, its nature, and the rapidity of its development. Among the *sensory* disorders that may arise are persistent pains, paresthesia, circumscribed areas of anesthesia, hyperesthesia at the level of the upper margin of the lesion, a sense of constriction in that part of the body supplied from the segment or segments affected. The *motor* manifestations are muscular spasm, contractions, stiffness in the back, slowly progressing paralysis of one or more extremities, and loss of sphincter control. Reflexes depending on nerves arising from the segment involved are soon diminished or lost; those due to nerves arising below the lesion are at first exaggerated. *Trophic* changes, such as bed-sores and atrophy of muscles at the level of the lesion are frequent, and vasomotor disorders usually arise. When the tumor is in the cervical or upper-dorsal cord, vomiting, headache, dyspnœa, or dysphagia may occur, and changes in the pupil or optic neuritis may be present. The electric excitability varies to both the

direct and the induced currents. The symptoms are slow and gradual in onset; at times they are steadily progressive, but temporary remissions may occur. Sometimes the symptoms are such as indicate a unilateral lesion and exhibit the characteristics of Brown-Sequard paralysis; at other times the sensory, and, at still others, the motor, symptoms preponderate, indicating a posterior or anterior location of the growth in the cord. Well-marked paraplegia dolorosa, with severe contractions of the muscles of the legs, is somewhat pathognomonic of tumor of the cauda equina.

190. Treatment.—The treatment of tumors of the spinal cord is either symptomatic or surgical. Certain of the neoplasma having their origin in the cord-membranes or the spine are amenable to surgical treatment. While the symptoms are still irritative, the location of the growth can often be made out with accuracy, and its nature may permit of its removal before the structures of the cord have suffered much damage. Mercury by the stomach or through inunctions, and potassium iodid appear to retard or check the progress of certain of the connective tissue growths, and if the tumor is due to syphilitic cause, these remedies will often bring about considerable improvement. The pain is at times very severe and will be controlled only by morphin given hypodermatically, though other anodynes and local sedative applications of ointments and liniments should be tried before the patient is subjected to the frequent or prolonged use of morphin.

191. Electrotherapeutics.—There is not much indication for the use of electrotherapeutics in these cases. The anode of the direct current may be used for its sedative and anticongestive effect during the beginning, or irritative stage. The current should be quite condensed by the use of an electrode of small surface area with a proportionately strong current as near to the seat of the growth as possible. The sedative action of the secondary-coil current may also quiet the irritative symptoms. After paralysis has set in, or degenerative changes have taken place, if the neoplasm is removed or checked in development so that a chance is given for some repair in the

damage done, electricity will be of use in the treatment, and should be employed in the same manner as has been advised in the treatment of chronic myelitis.

TRAUMA.

192. Nature and Pathology.—The effects of injury to the spinal cord vary much. The result depends on the cause and severity of the injury, the condition of the patient at the time the injury was sustained, and the promptness and appropriateness of the treatment given. For convenience of description, and as a guide to treatment, injuries to the spinal cord have been divided into three classes.

193. Class I.—Class I includes those cases in which there has been laceration of the cord, resulting in local softening and structural degeneration due to disturbed molecular nutrition.

194. Symptoms.—The symptoms arising in such cases are immediate, and consist of pains, paresthesia, pyrexia, or subnormal temperature, vasomotor disturbances, irregularity of the pupils, tachycardia, and various trophic changes. There may be paresis or complete paraplegia, both motor and sensory, and loss of sphincter control. Reflex action below the level of the lesion at first is abolished by the shock, but later it may be exaggerated.

195. Class II.—Class II includes certain cases less clearly understood in their pathology. The nature of the immediate effect is obscure, but a subacute myelitis gradually develops, with its characteristic symptoms of irritation and, later, of compression from inflammatory exudates.

196. Symptoms.—The symptoms are a tingling and weakness in the limbs, spinal pain and tenderness, and at times girdle pains. There may be headache, vertigo, faintness, tinnitus, specks before the eyes, anesthesia of special senses, and impotence; there is some pyrexia. Stiffness in the back, tremor

in the limbs, and, later, paralysis and, perhaps, spastic paraplegia with scattered muscular atrophy are among the motor symptoms. Other trophic disorders may also occur, and the action of the sphincter muscles may be impaired.

197. Class III.—In Class III it is presumed that the shock to the nervous system due to the injury has come upon one possessing a neurotic inheritance or a predisposition to disease arising from a tubercular, syphilitic, or other diathesis. The disturbed cellular or secondary vascular changes in such cases are prone to result in some form of degeneration. Traumatism may thus be an immediate or localizing cause in the production of primary spastic paraplegia, ataxic paraplegia, locomotor ataxia, or progressive muscular atrophy, all of which have had their pathology and treatment already considered.

198. Treatment.—The treatment of traumatism of the spinal cord is in many cases largely surgical, at least in the beginning. Rest of the body and limbs, fixation of the spine by supports, splints or plaster-jacket, the removal of pressure caused by fracture or dislocation of one or more spinal segments or as the result of hemorrhage, will require the services of the surgeon. Some additional steps should be taken to prevent, if possible, the onset of inflammation. The continuous application of cold to the spine, laxatives, and sedatives will aid in this. The shock may be great and cardiac stimulants are often needed for a time, but these should not be pushed to an unnecessary extent, lest they augment the tendency to myelitis. A paretic condition of the bowels or bladder may require for a time the use of artificial means to empty them. The subsequent treatment, both medicinal and electrotherapeutic, will depend on the pathological type that follows the injury to the cord-structures. This may be of the nature of spinal irritation, of neurasthenia, of myelitis, or of some form of degeneration, and the management of these conditions has, it is believed, already been sufficiently considered.

FUNCTIONAL DISORDERS.

199. There are no disorders of the spinal cord that have hitherto been termed functional that could not, with propriety, be classified under the head of nutritional or vascular disorders. We have therefore taken the liberty of placing spinal irritation, which is the chief disorder of the cord-structures that deserves the name of functional, under the Disorders of Nutrition, believing that by so doing we have taken one step nearer to its real pathology.

DISEASES OF PERIPHERAL NERVES.

INTRODUCTION.

200. Nerves are but the prolonged dendrites and axons belonging to cell-bodies, which are themselves located within the spinal cord, brain, or ganglionic chain of the sympathetic system. The nerves cannot, therefore, be regarded as independent structures when considered either from a pathological or therapeutic point of view. However, by reason of their location and similar structure, these axons and dendrites constitute portions of the neurons that are subject to special forms of disease or injury, and this of itself furnishes a sufficient reason for giving separate consideration to them in a work whose main object is to serve the practical requirements of therapeutics.

DEFORMITIES AND MALFORMATIONS.

201. There are no embryonic or congenital defects occurring in any part of the organism that have been shown to be due to deficiencies in the prolongations of the neurons to the exclusion of their cell-bodies. Such defects of evolution or development may have their starting-point in injured, diseased, or repressed axons or dendrites; but the neuron bodies lying in the brain or spinal cord must, of necessity, soon suffer with them. Any abnormalities of nerves, therefore, that result in deformities or malformations due to evolutionary defects, are more properly to be considered as disorders of the nerve-centers.

NUTRITIVE AND FUNCTIONAL DISORDERS.

202. As the majority of the so-called functional disorders of nerves are dependent on some defect or disorder of nutrition, it has seemed best to consider under one heading all affections that can be properly so classified, whether they involve sensory or motor nerves separately, or both, such as *neuralgia; facial spasm:* mimic spasm, tic-convulsive; *torticollis:* wryneck, caput obstipum, tic-rotatoire; *writers' cramp:* graphospasmus, chirospasmus, mogigraphia.

NEURALGIA.

203. Nature and Pathology.—Neuralgia (neuron pain), as the name indicates, is but a sensory symptom of an abnormal state varying greatly as to cause. In many cases of neuralgia, the patient possesses a neurotic temperament, with unstable neurons. In such persons, neuralgic pains arise on slight cause. The diathetic poison of gout, rheumatism, or diabetes or other form of autointoxication may act as an exciting cause. Extrinsic poisons, such as lead, arsenic, and the malaria plasmodium, are direct irritants to the nerve-tissue. Anemia or hyperemia, due to a great variety of causes, impair the nerve-nutrition and occasion neuralgic pains. Some of the most severe forms of neuralgia are due to an obliterating arteritis obstructing the supply of nutritive fluids. Pressure from abnormal growths, clothing, and tools constantly used or burdens carried is a common cause of neuralgia. Such pains in not a few instances accompany the primary stage of a neuritis, and are but symptomatic of the hyperemia and edema of the neurilemma that attend the first stage of the inflammation.

204. Symptoms.—An attack of neuralgia is ushered in at times by cold feelings, and by pricklings or slight painful sensations in the affected nerve. The characteristic neuralgic pain is paroxysmal, darting, stabbing, boring, or burning in nature. It intermits, with almost complete cessation of pain in the intervals between attacks, although there may continue to be some soreness or hyperesthesia over the nerve-distribution. At

other times the area supplied by the nerve is anesthetic. The pain is usually unilateral. The paroxysms of pain are induced by cold, by touching, by movement of the part, or by variations in the blood-supply as by that due to emotion. Frequent attacks of neuralgia in certain nerves result in tender points at places along their course, such as the bony foramina at which they emerge or where they pass through layers of fascia (Valleix's points). Vasomotor, secretory, and trophic changes accompany severe neuralgias, especially when the neuralgia is symptomatic of a neuritis. Neuralgic attacks in certain nerves are quite persistent, and are often refractory to treatment.

205. Treatment.—The causes that induce neuralgic pains being so various, it is not surprising that the remedies that have been employed to relieve such pains are so many and that each has been beneficial at times. The first object in treatment should be to discover the cause of the pain, and, if possible, to remove it. Next, temporary relief should be given the patient until the normal function of the irritated nerves is restored.

When the cause is found to be malarial, the appropriate remedies are hygienic measures, quinin, arsenic, or Warburg's tincture. If a gouty or rheumatic diathesis is present, better elimination and oxidation should be promoted, and such remedies employed as colchicum, salol, salacin, salicylate of soda, salicylic acid, or cimicifuga racemosa. When diabetes is the cause, careful attention should be given to the diet, with a view of decreasing the carbohydrates. Methylene blue, permanganate of potash, codein, or sumbul should be tried, together with tonics and local sedatives.

206. Often by relieving one prominent symptom, relief is obtained, even though the cause may not be fully made out. Should this symptom be congestion or hyperemia, it may be allayed by ergot or atropin, by blisters or other counter-irritation, by hot or cold applications, by acupuncture or aquapuncture. The sedative influence of many drugs, as phenacetin, exalgin, or aconitin, will also act as anticongestives.

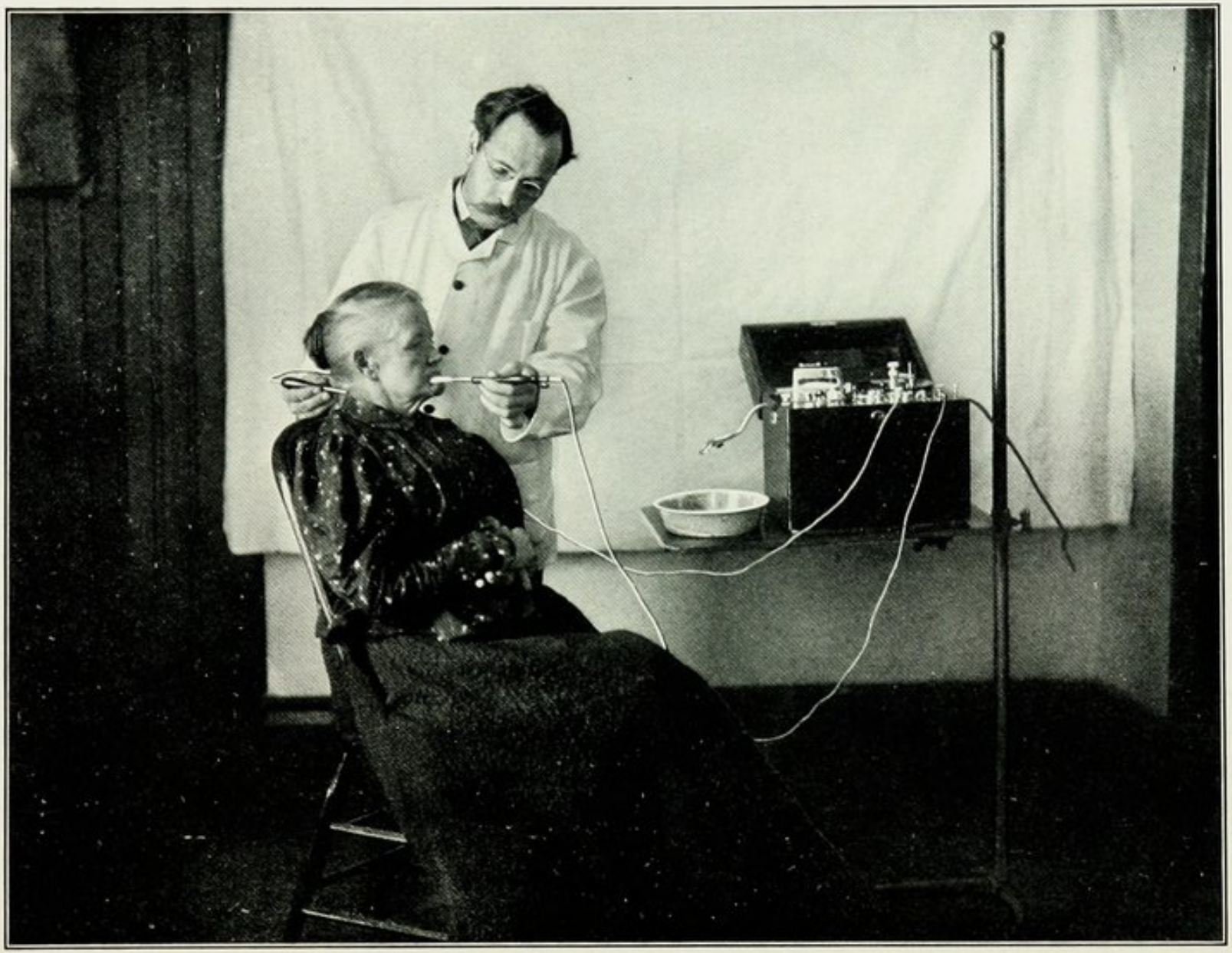


PLATE VIII.

Direct Current for Sedative Effect of Anode (Facial Neuralgia).

Should anemia, either general or local, be present, aside from general dietary and hygienic means, the use of alcohol, nitroglycerin, nux vomica, strychnin, and the aid given by local or general sedatives will, in all probability, bring relief.

207. Use of Sedatives.—The remedies used to allay the pain of neuralgia form a long list. The coal-tar preparations deserve a prominent place among these, and, from among them, those that depress the heart-action least should be given preference. Phenacetin and exalgin are less likely to do this than antipyrin or acetanilid. Valerian and sumbul are especially indicated in the hysterical forms of the disease. Gelsemium and guarana are more helpful when the neuralgia involves the trigeminal branches. Croton chloral, chlorotone, or cocain may be used both as general or local sedatives. Opium, codein, and morphin should be held in reserve and only brought into use occasionally, when other less powerful sedatives fail.

208. Electrotherapeutics.—Both as a means for counteracting the causative factors and as a sedative, electricity deserves a prominent place in the treatment of neuralgia. The sedative action of the anodal application of a direct electric current (anelectrotonus) brings relief, at least temporarily, to a local neuralgia, and this soothing effect can be both intensified and prolonged by combining with it cataphoresis by using the solution of some suitable drug, as cocain hydrochlorate or aconitin upon the anode (Plate VIII).

209. The application of the induced current from a long secondary coil, with rapid interruptions in the impulses, is also sedative, and allays neuralgic pains. These applications are mainly temporary in their effects, the relief obtained seldom being permanent. General galvanism or faradism may, however, by influencing for good the nutritive action of the system, tend to correct defects in metabolism or excretion that have been the cause of the nerve-irritation, and thus bring about an improved action that results in a disappearance of the neuralgia. But the general tonic effect of static insulation or the static breeze, or the general nutritive influence of the high-tension,

high-frequency currents or alternating magnetic stresses are more effectual in correcting defects of nutrition.

The greater convenience of application of these latter modalities and their agreeableness to the patient are considerations likely to make them the more popular electric methods for obtaining relief from neuralgic pains.

FACIAL SPASM.

(*Mimic Spasm, Tic-Convulsive.*)

210. Nature and Pathology.—There are certain of the motor nerves of the body that are especially liable to spasmodic or convulsive action, giving rise to an intermittent contortion of the muscles supplied by them. This affection is usually chronic in nature, and but imperfectly understood as to its cause. The seventh, or facial, nerve is often affected in this way in one or several of its branches, and usually upon one side only. The spasms are either tonic or clonic, and the attacks somewhat paroxysmal as a rule. They are excited by anything that arouses nerve-activity, as emotion, conversation, sudden exposure to light, cold, etc. This affection is probably the expression of some nutritional disorder of the cortical cells or to reflex disturbance. In many instances, disorder of some sense-organ, as the eye, the ear, or the sense of smell, may be the causative factor. In other cases, defects in the peripheral portion of the nerve, as anemia, a pressure, or a neuritis, may be the exciting cause.

211. Symptoms.—The symptoms are a sudden involuntary contraction of one or several groups of muscles supplied by the facial nerve or nerves. These contractions recur with more or less frequency, and continue over a period of months or years, constituting a habit if they are not promptly arrested.

212. Treatment.—The matter of first importance is the removal of any reflex sources of disturbance, such as errors of refraction, defects in coordination of the eye-muscles, nasal polypi, carious teeth, and obstruction of the auditory canal. Improvement of the general health by tonic measures is also

essential. Should there be congestion or inflammation along the course of the nerve, counter-irritation with blisters, the actual cautery, and stimulating liniments are indicated. Sedatives and antispasmodics, such as the bromids, cannabis Indica, hyoscyamus, belladonna, conium, cocain, or codein may be employed to allay the undue excitability of the motor centers. Curare is recommended because of its paralyzing effects on the motor-nerve terminals. Nerve-stretching has been suggested, but it is of doubtful utility.

213. Electrotherapeutics.—The sedative action of the anode of the direct current on the nerve-terminations in the muscles, with the cathode applied in the vicinity of the cortex or medullary center, is of service in quieting the spasm. The application should be made daily, with a current-strength of 10 to 20 milliamperes. The induced current from a secondary coil is also helpful in many instances, as is also general nutritive stimulus from general faradism or galvanism. In improving the general tone of the system, the static breeze or insulation would be indicated, while local nutritive effects, combined with counter-irritation, could be readily obtained by drawing fine sparks from the upper cervical spine.

TORTICOLLIS.

(Wryneck, Caput Obstipum, Tic-Rotatoire.)

214. Nature and Pathology.—This refers to the spasmodic form of muscular contraction in which the disorder has its origin in the nerves supplying the sternoclidomastoid and trapezius muscles and their associates in action. The nerves chiefly involved, therefore, are the muscular branches from the four upper cervical segments of the spinal cord or the spinal accessory. The causes that operate to produce spasmodic action in these motor nerves are similar to those already referred to in considering facial spasm. There is irregular functionating of the nerve-cells, and this may be in the central or peripheral motor neuron, or both. There is an instability either due to direct or reflex cause. The instability is thought

in some instances to be due to degenerative changes in the nerve-center. At times, a congestion or neuritis at some point in the course of the peripheral portion of the nerve appears to be the causative factor, and this in turn may be due to a disordered constitutional state such as rheumatism or gout. Defects in action of special-sense organs have also been found to act in a reflex manner as the exciting cause.

215. Symptoms.—The spasmodic action of the muscles resulting from this nerve-disorder causes the head to be drawn and twisted intermittently. The direction of the pull is determined by the nerves affected. Usually the sternoclidomastoid and trapezius of one side are involved, and this may be either through disturbance of their muscular branches from the cervical plexus or through the spinal accessory. If through the latter, the head is drawn over toward the shoulder of the affected side, and the chin is elevated and turned toward the opposite side. If the disturbance comes through the cervical nerves, certain of the muscles on the back of the neck are likely to be involved also, as the splenius, trachelomastoid, and complexus, and through the action of these the head is drawn backwards and to one or the other side. Some soreness and dull aching pain attend the constant spasmodic action of these muscles, and interfere more or less with deglutition, respiration, and articulation. Some vertigo may be present during the paroxysms. The attacks vary in intensity, duration, and frequency, and are liable to be increased by emotional excitement.

216. Treatment.—The cause being so obscure, the treatment is of necessity somewhat empirical. With a view of producing sedation, the bromids, atropin, hyoscin, gelsemium, conium, cannabis Indica, chloral, valerian, asafetida, and opium and its derivatives have been recommended and used. Nerve-tonics such as arsenic, strychnin, and phosphorus are of service in some instances. Rest in bed or mechanical support to restrain the spasm and prevent overaction have good effects. Massage of the neck and the affected muscles, and systematic

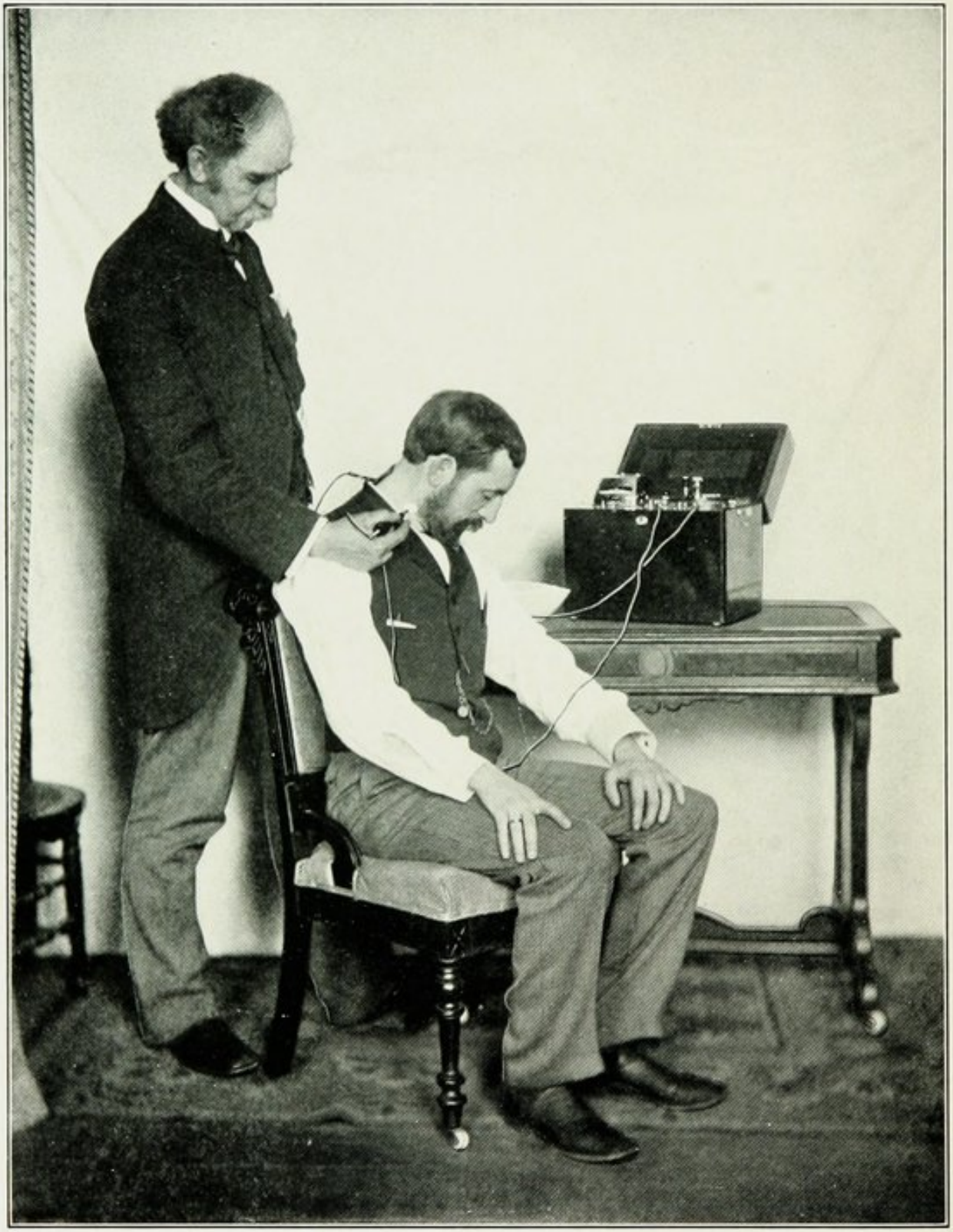


PLATE IX.

Direct Current, Sedative Effect of Anode (Spasmodic Torticollis).

exercise of the opposing muscles give some relief. Counter-irritation over tender spots along the course of the nerves or on the cervical spine, by means of blisters or the cautery, has proved helpful in some cases. Every possible reflex cause of irritation—as, for example, disorders of the eye, ear, nose, throat, or stomach—should be sought out, and, if possible, removed, and the general health should receive attention, if necessary.

Section of the nerves or muscles has some claim to rational treatment, provided it is left as a last resort and the right nerves or muscles are selected for operation, since it puts the over-acting parts into a state of comparative physiological rest for a time and this may be followed by their restoration to normal function when action is resumed. But as yet, surgery has little to boast of in the treatment of torticollis.

217. Electrotherapeutics.—This can be employed both for its general and local corrective influences, according to the indications in each case. The local sedative influence of either the direct or induced currents can be employed with benefit on the abnormally functionating neurons when it is determined which ones are at fault. The indifferent electrode should be placed on the cervical spine and the active electrode on the terminal distribution of the nerves at the muscles (Plate IX). The strength of the direct current need not exceed 20 milli-amperes, and as its application is usually followed by some hours of comfort to the patient, it can be used three or four times daily, if it is convenient to do so. The electric treatments, like all other means employed, are, however, not curative unless they are effectual in allaying the exciting cause of the trouble.

WRITERS' CRAMP.

(*Scriveners' Palsy, Graphospasmus, Chirospasmus, Mogigraphia.*)

218. Nature and Pathology.—This name stands as a representative of a variety of motor disorders that, taken together, might be properly designated *occupation neuroses.* Telegraphers' cramp, stenographers' cramp, and a number of other rebellions on the part of overworked groups of muscles

belong to this class. While attention is directed especially to a certain neuromuscular mechanism in these cases, yet the disorder is, as a rule, the expression of a state of general nervous exhaustion. This is indicated by the general nervousness, insomnia, vertigo, headache, mental depression, general weakness, and the evidences of spinal irritation that these patients so frequently exhibit. An excessive pouring out of energy through some one neuromuscular channel has resulted in exhaustion of the nerve-centers in general and this one in particular.

219. Symptoms.—Aside from the general symptoms above enumerated, there are local symptoms that vary much in different cases. The preponderance of certain of these symptoms over others, in some cases, has permitted a division of the disorder into several forms. The *spastic* form is generally marked by a gradual onset of tonic contractions in the muscles of the hand and forearm when any attempt is made to use them in the accustomed occupation, such as writing. The spasm makes it impossible to hold the pen firmly, and the finger-movements are stiff and irregular. In the *neuralgic* form, aside from the stiffness and fatigue occasioned by the effort to use the muscles, pain and tenderness is brought on by any such attempt. In the *tremulous* form, a tremor is excited in the muscles that are engaged in the voluntary effort. This is termed an "intention tremor," since it is absent until the muscles are called on to act. It may be so troublesome as to wholly interfere with the attempted action. In the *paralytic* form, a tired and exhausted feeling accompanied by pain is present in the affected limb. Paresthesias, such as numbness, prickling, a sense of pressure, constriction, or tension, may be felt in the part. Hyperesthesia or anesthesia of the skin may be present. At times, congestion of the arm or hand, disturbances of perspiration, cracking of the nails, and other trophic changes resembling chilblains have been observed.

220. Treatment.—Rest for the overworked part is a positive necessity. Very often entire rest of the body or a radical change in occupation for a prolonged period is imperative. It

may, in some of the less severe cases, be sufficient to so modify the muscular action as to bring into play neuromuscular combinations that have been less employed, and so relieve those that have been too severely taxed. But as a rule this only delays the period of absolute rest and prolongs the time during which it must be observed.

221. Use of Drugs.—Tonics for the improvement of the general tone of the system are indicated. Strychnin, iron, quinin, arsenic, or the phosphate combinations used in connection with local and general massage, cold baths, or douches will be serviceable as restoratives. Sedatives are required when there is much neuralgic pain or muscular ache accompanying the trouble. Soothing liniments such as camphor, belladonna, or chloroform liniment may be used on the affected area. When there is evidence of spinal congestion at the spinal centers, persistent counter-irritation over that portion of the spine may be required for the brachial plexus. This can be done by blisters, by croton-oil, or by the application of the cautery.

222. Electrotherapeutics.—It is a question of some nicety to decide what electric modality is most suitable for the case in hand, for the pathological features vary in different cases. The general tonic effect of the static breeze or insulation is always of benefit where there is much general loss of tone or exhaustion. Such treatment for 15 or 20 minutes daily would never be misplaced. The application of the induced current from the high-tension secondary to the local area of weakness is usually comforting and beneficial. The nutrition of the exhausted nerve-centers in the spine can be brought under the influence of the cathode of a direct current of 15 or 20 milliamperes strength with the effect of improving the local nutrition and hastening restoration of function. The operator that possesses a good working knowledge of the physical and physiological effects of the various electrical modalities, and has made out the pathological state of the patient, will choose that form of electric action which is best adapted to meet and counteract the abnormal states.

DISORDERS OF CIRCULATION.

(Vasomotor and Trophic.)

223. Classification of Disorders.—We have classified under this head disorders involving the peripheral nervous system, in which symptoms of defective circulation and resultant disorders of nutrition are so prominent as to attract attention to them chiefly. The pathology in these affections is still quite obscure, and it may be found eventually that in this respect the members of this group have very little in common; but for the present, the more salient symptoms must serve as indications for treatment until more exact knowledge of the cause and nature of each disorder points to something more explicit and rational as a guide to therapeutics. The following are the principal disorders: Raynaud's disease, angioneurotic edema, and hyperemia.

RAYNAUD'S DISEASE.

(Symmetrical Gangrene, Local Asphyxia, Neuropathic Gangrenous Trophoneurosis, Sclerodactyli.)

224. Nature and Pathology.—This appears to be a vasomotor neurosis in which there is primary abnormal constriction of the terminal blood-vessels, followed by a dilatation, likewise abnormal, which not infrequently results in gangrene. The seat of the trouble may be in the sympathetic ganglia or in the vasomotor centers of the brain and cord. It is a disease of adult life, occurring, as a rule, between the ages of twenty and forty. Impaired state of the blood predisposes to it, as do other diseases of the nervous system, such as neurasthenia, tabes, myelitis, and hysteria. Exposure to cold, injuries, fatigue, infectious diseases, or grief or fright may act as exciting causes.

225. Symptoms.—There are usually some constitutional symptoms, as nausea, chill, anorexia, constipation, malaise, and pains in different parts of the body. Then, either accompanying or preceding these symptoms, the fingers, toes, more rarely the nose, ears, and prominences of the cheeks, look pale and glossy. There is a feeling of tingling and itching, numbness and loss of dexterity, and tactile sensibility in the extremities.

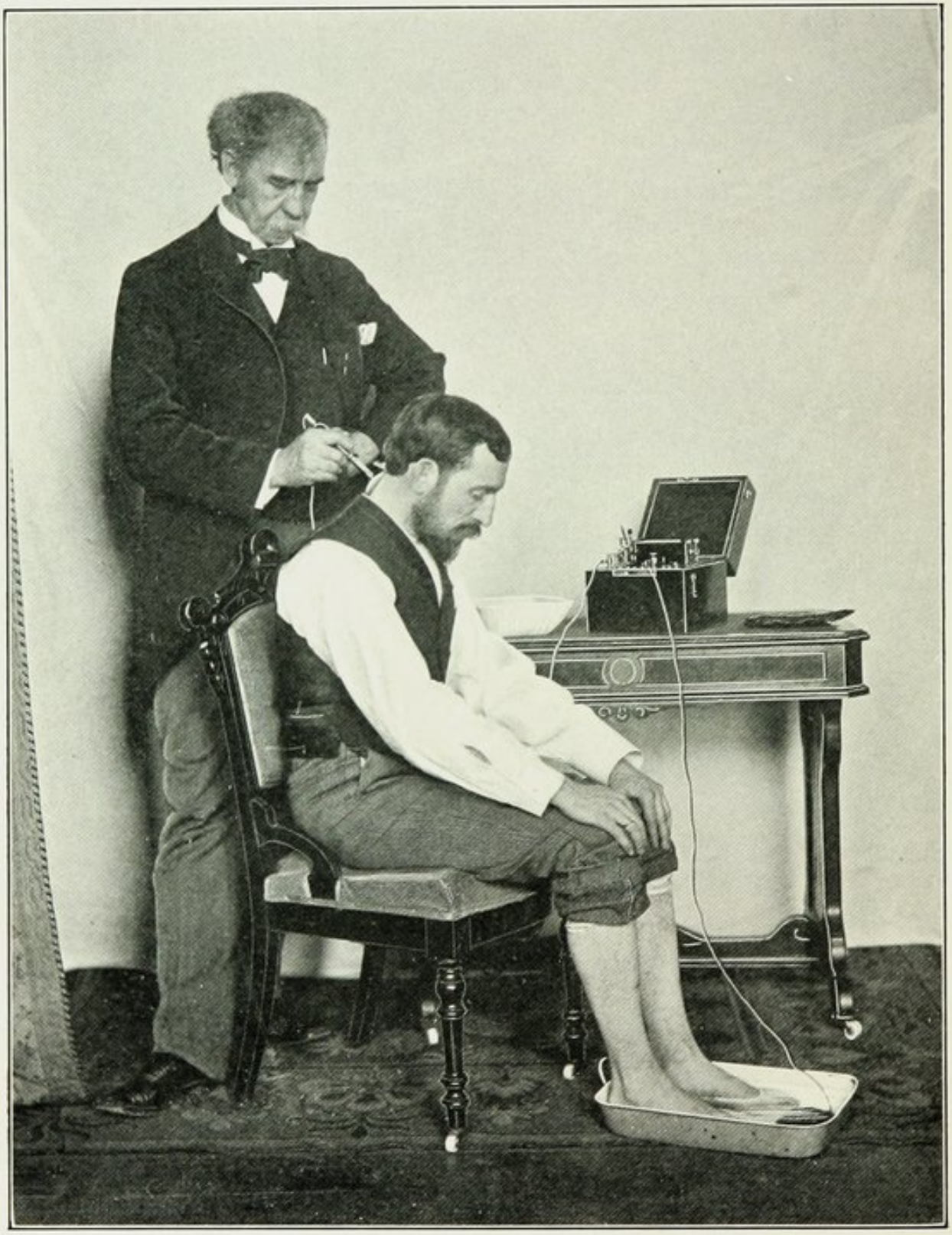


PLATE X.

Induced Current, General Application. (Direct Current May be Applied in the Same Manner.)

These disturbances may pass off after a brief period, leaving the skin with a shriveled appearance. Or such an attack may be followed by a congestion of the tips of the fingers and toes, when they become vivid-red or bluish-black, and may be hot or covered with a cold perspiration. Severe pain often attends this stage. Blisters containing blackish blood may form under the skin. Later, the skin of the affected extremities separates from the adjacent parts, ulcerates, and becomes shrunken and mummified. Spontaneous amputations of the terminal phalanges may occur in this manner. The disease may be so extensive as to involve the heels, malleoli, calves, nates, penis, vulva, the deltoids, and even the abdomen. Intracerebral changes causing transient aphasia, loss of motor power, disturbance of vision, convulsions, or unconsciousness may complicate the disorder. Hemoglobinuria and hematuria are present in some cases.

226. Treatment.—Tonic measures to improve nutrition are usually indicated. Warm local baths, or enveloping the parts in cotton sheeting, tend to equalize the circulation. Nitrite of amyl and nitroglycerin given internally assist in this. Alcoholic-menthol solution applied to the extremities relieves the pain and annoying paresthesias to some extent. Chloral or morphin given internally may be required for this. Surgical treatment of the ulcerations and gangrene will be necessary.

227. Electrotherapeutics.—The direct current is likely to prove most serviceable with the cathode at the extremities and the anode over the cervical enlargement of the spinal cord (Plate X). The affected extremities may be immersed in a warm salt solution contained in a porcelain dish, and the cathode placed in the liquid. In case it is desired to apply treatment to the hands and the feet at the same time, two basins and a divided cord for the cathode can be used. The current should be applied at least once daily, with a current-strength of 20 milliamperes, provided the patient can endure it. Should the pain be severe, a condition that usually accompanies the congested or asphyxiated state of the tissues, the anodal application to the extremities would be indicated.

ANGIONEUROTIC EDEMA.

(Acute Circumscribed Edema, Acute Idiopathic Edema, Acute Non-Inflammatory Edema, Periodic Swelling, Urticaria Tuberosa)

228. Nature and Pathology.—This is a vasomotor neurosis. The immediate cause is either a local inhibition of the vasoconstrictors or a reflex stimulation of the vasodilators, resulting in a retardation of the blood-current and serous exudation. Those that suffer from it are, as a rule, of neuropathic constitution. Intestinal disorders and toxic agents, as alcohol, tobacco, and malaria, act as exciting causes. Most cases occur in early adult life. The attacks come on most frequently in the early morning, without regard to the season of the year.

229. Symptoms.—There is usually no warning; within a few minutes a circumscribed swelling develops on the face, arms, or hands, and reaches its full extent in a few hours. It is usually pale and waxy, and does not pit easily to pressure. The swellings may be multiple. They are attended by a feeling of tension, stiffness, scalding, burning, and itching, lasting from a few hours to 2 or 3 days. There is no actual pain. Occasionally, the tongue, pharynx, lungs, stomach, or genital organs may be involved. There is a dull, numb feeling over the affected area for a time after the swelling subsides. The attacks recur in a few days to months, and, in the intervals, the patient may feel perfectly well. Only when the throat or lungs are involved do the symptoms become alarming.

230. Treatment.—Strychnin and atropin are indicated to stimulate and regulate vasomotor control. Baths and douches are helpful. Cascara sagrada or saline laxatives should be given, with a view of eliminating toxic agents. Colchicum, the salicylates, or quinin should be given, if gouty, rheumatic, or malarial causes are evident. The general health should receive attention. Nerve-tonics, such as arsenic and the phosphates, should be used, if needed, and the intestinal action may require the use of mineral acids with nux vomica or other simple bitter stomachic tonics.

231. Electrotherapeutics.—The anode of the direct current will stimulate vasomotor contraction, act cataphorically

on the exudate, and be sedative to the nerve-irritation. The induced current from the secondary high-tension coil will stimulate contraction of the blood-vessels and allay irritation. The general health may be promoted by the influence on general nutrition brought about by the static insulation or the high-tension, high-frequency currents.

HYPEREMIA OF NERVES.

(*Acroparesthesia.*)

232. A congested condition of one or more nerves may result from some disturbance of nutrition or may be due to deranged functional control, such as occurs not infrequently during the menstrual period in women. The condition may be followed by neuritis.

233. Symptoms.—The symptoms are mainly sensory and trophic. There is a sense of numbness and burning in the region of the affected nerve. The disturbance is usually first in the extremities. The fingers have a numb, crawling, prickling feeling as if "asleep" on waking in the morning, passing off when the hands are used. Later, the numbness extends to the arms and shoulders and involves the lower extremities. It may come on at the moment of falling to sleep upon retiring at night, or when the patient lies down in the daytime. It then lasts for a longer time. In bad cases, the feeling may awaken the patient from sleep and force him to get up and exercise or apply friction to the part to relieve it. The condition may be painful, but rarely is there tenderness along the course of the affected nerves. General flushings, profuse sweating, with clumsiness and some muscular weakness of the parts may be present. The patient is generally nervous and restless. There is increase in the quantity of urine with an excess of phosphates or urates.

234. Treatment.—The treatment advised is ergot, salt-baths, and massage and electricity at the time of the attack; also, tonics such as iron, quinin, and strychnin, with change of climate to counteract the tendency.

235. Electrotherapeutics.—Static insulation and the friction spark daily, or the faradic brush-application over the affected area by means of the secondary-coil current should be given. General faradism will prove helpful as will the alternating magnetic fields. (Plate XI.)

ERYTHROMELALGIA.

(Red Neuralgia of the Feet, Congestive Neuralgia.)

236. Nature and Pathology.—In this disorder we have a still more marked degree of vasomotor disorder than in the preceding, amounting almost to a paralysis of the vasoconstrictor nerves. The condition is one bordering on a neuritis, in which it sometimes terminates.

237. Symptoms.—It begins in the heel or ball of the feet, with an intensely red swelling. At first there is aching, then burning pains in the feet on attempting to walk. The redness increases and the veins distend, the arteries throb, and the extremities become purple in color. The pain is increased by exercise and is worse at night. The feet become so tender that walking is difficult and painful. The hands also may be affected. In bad cases, the parts most affected take on a dull, dusky, mottled redness, with some swelling. Blisters and ulcers are apt to occur. The pain is increased by heat; it is worse in warm weather, and decreased by cold and recumbency. There is some elevation of the skin temperature.

238. Treatment.—Recumbent position, elevation of the extremities, application of cold, bandaging, all aid in decreasing the congestion. Codein internally, anodyne liniments, and menthol applications assist in relieving the pain. General nerve-tonics containing strychnin are indicated, and hydrotherapeutics in some form may prove beneficial. Salicylates, if rheumatism is present, or antidiabetic diet, if this is indicated, as it is in some cases, are useful.

239. Electrotherapeutics.—The local application of the induction-coil current is suitable, stimulating, as it does, the contraction of the blood-vessels. The induced current from



PLATE XI.

General Faradism.

the long fine-wire secondary is also sedative, and allays the pain. The selection of the electric modality to counteract the malnutrition that underlies the disorder, as rheumatism or diabetes, will depend on the conception formed of the pathology. Either static insulation or high-tension, high-frequency currents would prove serviceable in aiding nutrition.

NEURITIS.

240. Nature and Pathology.—Inflammation is one of the most common forms of disorder to which nerves are subjected. It is brought about by many different causes, and, according to the cause, it may be slight or severe in its effects, may involve but one filament or many nerve-trunks, may be evanescent or permanent in its destructive results. There is a radical difference in the character and progress of the neuritis, according as it involves the nerve-tissue proper or the connective tissue that surrounds, protects, and holds together in bundles the nerve-fibers; in other words, according as it is parenchymatous or interstitial. Broadly speaking, the latter produces what is ordinarily treated of as *simple* neuritis, while the former gives rise to *multiple* neuritis.

SIMPLE NEURITIS.

241. *Simple neuritis* involves a single nerve-trunk or the nerves of one plexus, part, or limb. As has been said, the adventitious or interstitial connective tissue composing the nerves is the primary seat of the inflammation, the nerve-tissue proper being affected, if at all, only secondarily. The changes taking place differ somewhat, according as the inflammatory process is acute or chronic. There is hyperemia, congestion, serous exudation into the tissue composing the nerve, extravasation and migration of leucocytes, hyperplasia of the connective tissue which may result in compression and more or less destruction of the nerve-fibers proper. The nerve-fibers suffer little if the inflammation is limited to the sheath. If, however, the interstitial tissue is also inflamed, the nerve-fibers may suffer, but not always.

242. Symptoms.—These differ according to the extent and character of the onset of the inflammation. Usually there is some constitutional disorder, such as weakness and ill-feeling. There is pain in the inflamed part of the nerve and throughout its distribution, sometimes in the whole limb. The pain is boring, burning, and at times intense; it is usually worse at night, and increases by movement. There is soreness and pain caused by pressure on the nerve, especially where it passes over bony prominences, through a muscle-sheath, or emerges from a foramen. Where the inflammation is confined to the motor branches of a nerve, the pain is slight or absent. The skin over the affected area is often hyperesthetic, red, and edematous. In the beginning, spontaneous sensations arise in the affected nerve; later, the sensations are perverted and lessened. Even complete anesthesia may result. The muscles supplied by an inflamed motor nerve are weak, tender, and exhibit fibrillary twitchings. The pain may inhibit muscular contractions, and, not infrequently, the muscles atrophy, and if nerve-degeneration results, the muscle shows the reaction of degeneration. Other trophic changes, such as eruptions, increased or deficient perspiration, thickened or thin and glossy skin, may result. The bones may atrophy, the nails drop off, the hair fall out, and an edematous condition of the subcutaneous tissues take place.

243. In the more chronic form of simple neuritis, the constitutional symptoms are less pronounced, and the onset and course of the local trouble are less severe. Acute attacks of neuritis are very likely to pass into a chronic condition, unless complete restoration of the nerve is brought about by appropriate and persistent treatment.

DISSEMINATED NEURITIS.

244. Simple neuritis, that is, neuritis affecting primarily and chiefly, if not exclusively, the connective-tissue elements of the nerve or nerves, may involve more than one nerve-trunk or plexus, or the nerves of more than one part of the body. A non-symmetrical but quite extensive or general involvement of

the nerves of the body by simple or interstitial neuritis may be properly designated a *disseminated neuritis* in distinction from *multiple neuritis*, which is generally regarded as a symmetrical affection involving the parenchyma of the nerve. The constitutional disorders are more severe in proportion as a larger number of nerves are involved in the inflammation. Or, in other words, the greater extent of the neuritis is an expression of the greater degree of constitutional disturbance, so that a disseminated neuritis is more protracted in course and less favorable to complete recovery than a local simple neuritis. The pathological features in other respects are similar, differing only in extent and degree.

LEPROUS NEURITIS.

(*Anesthetic Leprosy.*)

245. Leprous neuritis is neuritis involving primarily the connective tissue of the nerve-bundle. Both the perineurium and the interstitial structure take part. It is irregular in distribution, and is therefore a disseminated neuritis. There is a hyperplasia of this connective tissue resulting in a secondary destruction, more or less complete, of the nerve-fibers, and of the tissues depending on them. The bacillus of leprosy is found in the nerve-tissue. Mutilations and deformities of the extremities and face are a result of the nerve-impairment.

246. Sensory Symptoms.—The sensory symptoms are more prominent. There are irregular patches, mainly in the extremities and face, exhibiting various paresthesias, tingling, formication, numbness, and seldom severe pains. All forms of sensibility are affected to some extent, but touch and pain usually suffer most. There is discoloration of the skin resulting from the *trophic* changes, dark maculæ form, and tuberous swellings result from the connective-tissue overgrowth. Then follow atrophy and necrosis, resulting in loss of tissue. Portions of the fingers and toes and parts of the face are thus destroyed. Anchylosis of the joints may occur.

247. The *motor symptoms* consist in muscular wasting and weakness, but less in degree than in some other forms of

neuritis. It is greatest toward the extremities of the limbs, where the nerves are most affected. The reaction of degeneration may be found in the severest forms of muscular impairment.

RHEUMATIC NEURITIS.

248. Rheumatic poison is responsible for a large percentage of the cases of both simple and disseminated neuritis. It is credited by some authors with producing a symmetrical parenchymatous multiple neuritis. But our opinion, formed from a somewhat extensive experience, is that this cause seldom produces a strictly symmetrical neuritis, and that its first changes are those in the adventitious and interstitial tissue of the nerve. Repeated attacks and a chronic state of inflammation seem to be required to develop the appearances of symmetrical distribution and give rise to the symptoms of degeneration of the parenchyma of the nerve. An acute attack of rheumatic neuritis yields promptly to appropriate treatment, and permits a prognosis much more favorable than would be the case if it were a neuritis of the parenchymatous variety.

MULTIPLE NEURITIS.

249. *Multiple neuritis* is understood to be a form of inflammation in which the nerves in corresponding locations on the two sides of the body are synchronously affected. The interstitial and adventitious structures of the nerves may be involved, but also, and chiefly, the nerve-tissue, proper, suffers. The causes that may affect the nerve-tissue in this manner are various. Some of these causes act by preference on motor nerves, others on the sensory neurons. A determining influence also resides in the location of the nerves in the body, as, for instance, in multiple neuritis due to lead poisoning, the musculospiral nerves of the upper extremities are most readily affected, while, in alcoholic neuritis, the peroneal nerves of the lower extremities suffer first and chiefly. Since the parenchyma, or nerve-tissue proper, is directly attacked by the causes that produce multiple neuritis, and the disease is a symmetrical one, the cause operates through the blood or nutrient fluids of the

body and is either an extraneous toxic substance, an autotoxic substance, or some vitiated state of the nutrient fluids. The degree to which injury may be carried by the producing cause depends on its nature and the length of time to which the nerves are subjected to its influence, as well as to the resisting capacity of the neurons attacked.

250. Symptoms.—Generally speaking, the onset of multiple neuritis is that of an infectious disease. Chill, fever, malaise, headache, apathy, etc. are common. Aches and pains in the lumbar region and along the larger nerve-trunks are usually present. Among the *motor* indications is an early loss of power, generally beginning in the lower extremities, but it may begin in the arms and hands. The tendon reflexes are soon decreased in activity, or lost. The muscles become flabby and wasted. The electrical excitability is at first increased but soon decreases and reaction of degeneration may be present. Ataxia is seen in some cases, and deformities result from a disturbance of the balance of power in muscular action.

251. Sensory Symptoms.—The sensory symptoms are at times only subjective, such as hyperesthesia, numbness, tingling, prickling, or formication. The hyperesthesia is accompanied with spontaneous pains, which may be dull, acute, or burning, when referred to the nerve-trunks, the joints, or the deeper parts of the limbs. Tenderness along the nerve-trunks is always present to a greater or less degree. When the sensory neurons are involved in the inflammation, there is some anesthesia of touch and impairment of muscular sense. Reflex action from the skin varies according to the stage and degree of involvement. It may be at first slightly increased, but later is impaired or lost.

252. Vasomotor and Trophic Symptoms.—The vasomotor and trophic symptoms are various: edema, redness of the skin, eruption, dryness, or profuse sweating may occur in the early stages; later, the skin may become glossy, the nails and hair dry and brittle, the epidermis of the soles of the feet and palms of the hands may peel off, arthritic adhesions may take place, and perforating ulcers may form on the feet.

ALCOHOLIC NEURITIS.

253. This is a typical form of symmetrical or multiple neuritis. At the onset, the temperature is elevated. There is tachycardia. The capillary circulation is bad and there may be diarrhea.

254. Sensory Symptoms.—The sensory symptoms are at first those of hypersensitiveness. There is pain, prickling, like pins and needles, or violent and tearing hyperesthesia or hyperalgesia. Later, there is anesthesia in patches, the tactile sense is blunt, while pain and temperature senses are slow in transmission. The muscular and articular senses are lost. The skin reflexes may be feeble, slow, or lost entirely. There is tenderness over the nerve-trunks and muscles.

255. Motor Symptoms.—The motor symptoms are those of paresis, then paralysis, and, finally, atrophy. The nerves innervating the muscles of the feet are generally first affected. Extensor movement becomes weak and is then lost, resulting in "foot-drop." The tendon reflexes are lost. There is incoordination of movement. The affected muscles show at first quantitative and then qualitative ($R\,D$) changes in reaction to the direct electric current. The nerves supplying the muscles of the trunk and thorax may become involved. The nerves of the arms may be affected, but they escape oftener than those of the legs. The third, fourth, and sixth cranial nerves may be attacked, causing diplopia and nystagmus. Optic neuritis occurs in a few cases. The phrenic nerves may be involved, impairing the action of the diaphragm, and the inflammation or degeneration may extend to the medulla, involving the hypoglossal or facial nerves. A muscular tremor is often seen in this form of neuritis.

256. Mental and Trophic Symptoms.—The mental symptoms are often quite pronounced. There may be hallucinations with delusions in the beginning, and, later, an apathetic state with memory for recent events confused and impaired. Insomnia is frequent. Trophic symptoms, such as redness,

edema, or smooth and glossy appearance of the skin, rough and brittle nails, eruptions, profuse sweating, or perforating ulcers, have been observed.

DIPHTHERITIC NEURITIS.

257. Neuritis not infrequently follows an attack of diphtheria, and is thought to be due to a diphtheritic toxin. This may act locally at the seat of the diphtheritic inflammation in the throat, and the neuritis may be confined to the nerves of this vicinity, or the virus may become more widely diffused and affect the nerves of the extremities, usually in a symmetrical manner. The parenchyma of the nerve appears to be primarily attacked by the diphtheritic toxin.

258. Sensory, Trophic, and Motor Symptoms.—The sensory symptoms are insignificant. There is slight hyperesthesia or anesthesia over the distribution of the affected nerves. The muscular sense is impaired. At times, there is some pain in the limbs. Trophic changes occur in the muscles supplied by the affected nerves. Occasionally, there are skin eruptions with pigmentation. As to motor symptoms, the paresis or paralysis is usually first noticed in the muscles of the pharynx and larynx. The voice changes, deglutition is difficult, liquids regurgitate in the attempt to swallow them. The eye-muscles are affected next in frequency, the impairment of the third nerve causes loss of accommodation and diplopia. If the neuritis becomes more generalized, the motor nerves of the legs and arms are affected, causing weakness in walking or standing and in some cases rendering the patient helpless. The trunk muscles may be involved, weakness of the bladder and rectum, and loss of sexual power. Occasionally, the pneumogastric nerve is seriously affected and sudden death may result from this cause. The muscles supplied by the nerves affected become soft and atrophied, the knee and elbow reflexes are lost. There is usually a tendency to spontaneous improvement in these cases, but appropriate treatment will not only hasten the improvement but will insure its being more complete.

MALARIAL NEURITIS.

259. Neuritis arising from malarial poisoning is not infrequent, and it often takes a symmetrical form. The impaired state of the blood affects the nutrition of the neuron proper.

260. Symptoms.—The sensory symptoms are not usually very severe. There is some pain in the limbs. Sensation to touch is decreased over the affected area, and there is muscular tenderness accompanying the tenderness of the nerve-trunks. The trophic changes consist of skin eruptions, pigmentation, and wasting of the affected muscles. The motor impairment is chiefly confined to the legs and feet. There is, in some cases, complete paralysis of these parts. The knee-jerk is diminished. The motor nerves of the arms, trunk, and cranium may also be involved so that respiration may be disturbed and deglutition and speech rendered imperfect. These cases commonly end in recovery if the cause is removed and the conditions are favorable.

TYPHOID NEURITIS.

261. A neuritis following an attack of typhoid fever is of quite common occurrence, presumably due to the deleterious effects of the toxins generated in the system during the progress of the disease. These poisons appear to select, by preference, the motor neurons of the lower extremities, although the sensory neurons do not wholly escape. Usually, the neuritis is bilateral, but it may be unilateral and the parenchyma of the nerve is chiefly affected.

262. Symptoms.—The chief sensory symptoms are severe pains at times in the course of the affected nerves in the legs. There is much atrophy and more or less paralysis (in some cases complete), with reaction of degeneration of the affected muscles. The motor weakness is chiefly exhibited in the legs. There is loss of knee-jerk. Occasionally, the vocal cords are paralyzed. These cases are, as a rule, slow in recovering, but the majority get well.

DIABETIC NEURITIS.

263. The deranged blood-state present in this disease gives rise to neuritis in a great many instances. The neuritis affects chiefly the sensory neurons of the extremities, especially the feet and legs, but is not strictly symmetrical in its distribution. Trophic and vasomotor changes are very common, such as edema, vasomotor paresis, bullæ, and necrosis. The neuritis is but a minor incident in the course of the systemic disease, and but little benefit can be derived from local treatment, unless improvement can be brought about in the constitutional state.

NEURITIS FROM CARBONIC OXID.

264. This form of poison seems to possess a selective affinity for the peripheral neurons, both sensory and motor. Severe carbonic-oxid poisoning often causes numbness, impaired tactile sensibility, and pain in the extremities over the affected nerves and muscles. Redness of the skin, edema, and herpes over the area of distribution of the affected nerves may occur. There are local palsies that are irregular and variable in distribution. There may be foot- or wrist-drop, or the paralysis may be hemiplegic or paraplegic in character.

NEURITIS FROM LEAD.

265. Lead-poisoning is a very common cause of neuritis. The sensory disturbances are slight or wanting, with the exception of the colic pains, which are oftentimes very severe from this cause, and may be due to neuritis of the abdominal sympathetic. There may be slight pain and tenderness along the course of the affected nerves and in the joints. The pain is dull and deep-seated, and occasionally there is some anesthesia within the areas involved. There is tingling, numbness, and cold feelings. There is swelling about the joints at times, especially the wrists. Atrophy of the affected muscles is common, with partial or complete reaction of degeneration. The motor symptoms are chiefly shown in paresis or paralysis of the extensor muscles of the feet and hands, chiefly the latter, causing

a characteristic "wrist-drop." The musculospiral nerve is therefore primarily involved in the disease, but it has often been remarked that the supinator longus and extensor ossis metacarpi pollicis muscles escape paralysis. The affection is usually bilateral. The deltoid and biceps muscles of the upper extremities are occasionally involved, as well as the brachialis anticus and supinators. The disease, when severe, extends to the homologous extensors of the feet and legs. Cramp in the muscles of the arms and legs is not uncommon, and quite often a tremor is seen in the affected muscles. The tendon reflexes are lost. With the cause removed, the disease tends to recovery, but the progress is slow and can be very greatly aided by appropriate treatment, such as will eliminate the poison from the system and promote nutrition of the weakened neurons.

ARSENIC NEURITIS.

266. This form of metallic poison ranks next to lead in the frequency with which it causes inflammation of nerves. There are usually some acute gastric symptoms preliminary to the nerve-disorder. The sensory symptoms are more abundant than in neuritis from lead. There are shooting, darting pains in the limbs, with various paresthesias. Anesthesia is common over the distribution of the affected nerves, and the muscular sense is impaired. The trophic symptoms are also quite pronounced in the form of skin eruptions and other changes. The motor disorder is chiefly in the extensor nerves and muscles of the lower extremities, though it is not so distinctly localized as in lead neuritis. The knee-jerks are impaired and ataxia is present. While this form of paralysis resembles that of alcoholic neuritis, there is a lack of the mental symptoms of the latter. The history of the case would also serve to distinguish them.

BERIBERI NEURITIS.

267. This a form of multiple neuritis, infectious and contagious in nature, is due to a micro-organism found in the blood. It is presumed that a virus is generated in the system by the

action of this organism, causing the nerve-inflammation. The disease attacks by preference the nerves of the legs and the cardiac branches of the vagus. It is prevalent in the East Indies, Japan, and China. An exclusive diet of white rice is thought by some to act as a predisposing cause.

268. Symptoms.—The general symptoms are those of dropsy, lessened quantity of urine, weakness of the circulation, palpitation of the heart with dyspnœa. The edema is first noticeable along the edge of the tibia. It affects not only the subcutaneous tissue but all cavities of the body. The face has a stiff, pasty appearance. If the cardiac nerves are not involved in the neuritis, symptoms of dropsy do not appear. There is anemia, epigastric oppression, anorexia, and general malaise. Among the sensory symptoms there are dysesthesia, sensations of touch lessened or lost, and temperature sense diminished. The cardiac weakness and weakness of the legs are early motor symptoms. Nearly all the motor nerves of the body may be affected in some cases, including those of the face, so that the muscles become paretic or paralyzed, waste, and, in some cases, exhibit reaction of degeneration. There is tenderness along the course of the nerves and over the muscles involved in the disease. The tendon reflexes are decreased or absent. This form of neuritis is not infrequently fatal, especially so in those cases in which the cardiac nerves are involved.

269. Treatment.—In whatever form the neuritis is found, whether simple, disseminated, or multiple, if the causes are still active, steps should be taken to remove or counteract them. Simple and disseminated neuritis are oftentimes much benefited by local treatment, such as moist heat, wrapping the part in cotton wool, or cold applications over the course of the inflamed nerves. Counter-irritation, soothing liniments, or ointments containing menthol, chloroform, cocain, or aconite, and massage, are of service.

270. A rheumatic or gouty condition of the system is so often responsible for the attacks of simple and disseminated

neuritis that elimination by means of saline laxatives is the first essential, and this should be followed by the prolonged use of salol, salicylate of soda, colchicum, cimicifuga racemosa, or some other of the antirheumatic remedies. If pain is severe and there is elevation of temperature, one of the coal-tar derivatives, such as phenacetin or exalgin, can be given with the antirheumatic. A canthus blister applied over the course of the main nerve-trunks at the seat of greatest tenderness is of much service in quickly subduing the inflammation. A succession of such blisters should be employed until the tenderness is gone. The general healthy tone of the system requires attention, for the debility is often great. Tonics of iron, quinin, and strychnin are usually indicated, or the arsenate of iron with gentian and nux vomica. In very neurasthenic cases, the valerianates of iron, quinin, and zinc with sumbul is an appropriate tonic. In all these cases of more or less generalized neuritis, rest in bed during the acute stage and the period of prostration is essential. Especially should rest be enjoined and kept up for a protracted period in cases of multiple neuritis where the nerve-parenchyma has suffered severely. The affected neurons are long in regaining their normal vigor, and time must be given for recuperation. During this period of rest, effete matters must be removed by gentle laxative measures; the causes of the neuritis must be allayed, the nutrition of the system must be promoted by suitable general tonics, and the distribution of the nutrient fluids maintained by frequent warm baths, followed by massage and the application of some suitable electric modality.

271. Electrotherapeutics.—There is no kind of nervous disorder in which the use of the various forms of electricity is more serviceable in effecting a restoration to normal condition than in neuritis. Even in the milder attacks of neuritis, where the disease is simple and localized, an increase of connective-tissue elements results from the inflammation, which has the effect of compressing the neuron proper and impeding its action. Even when the inflammation subsides, it is seldom that nature by her unaided efforts clears up completely the débris resultant

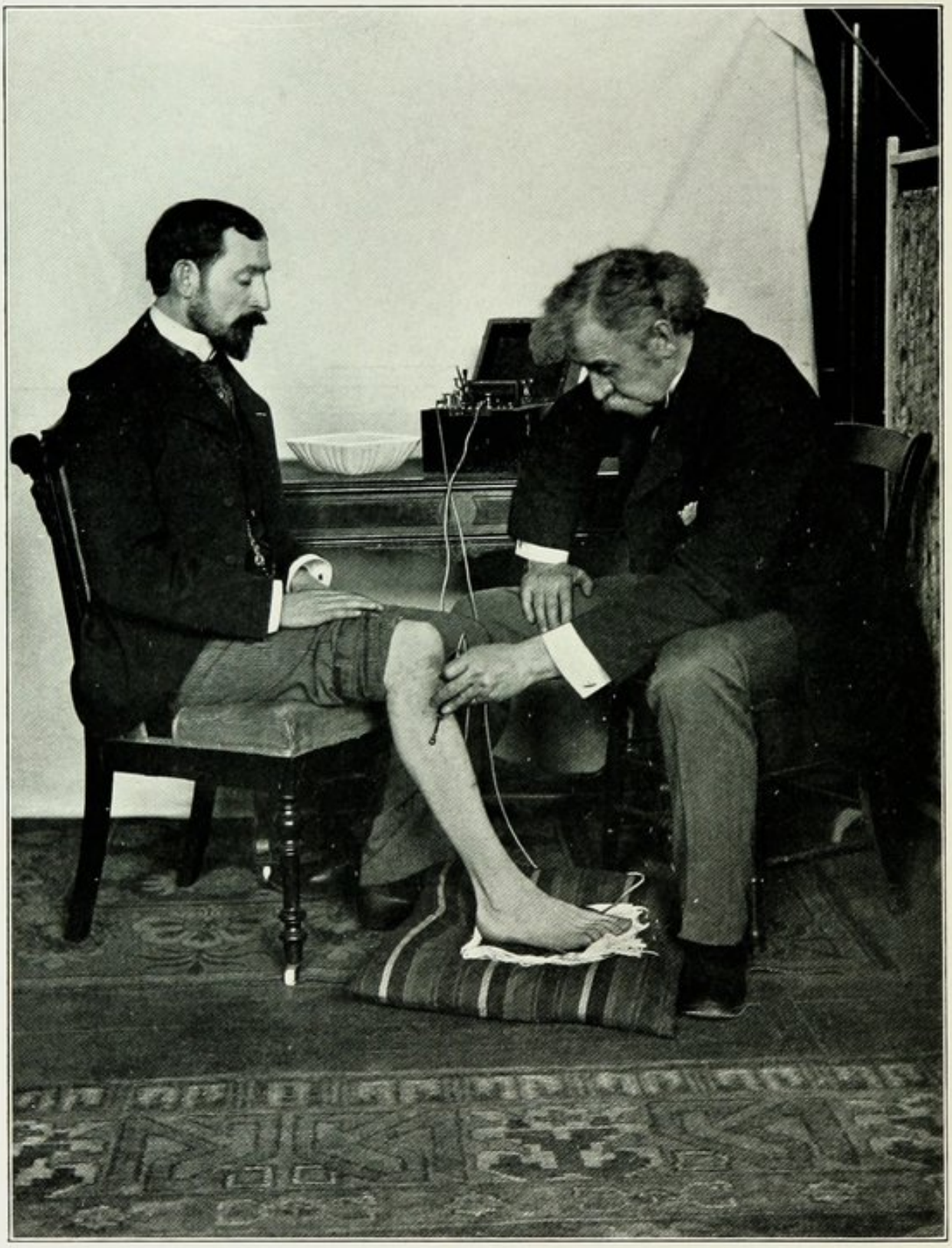


PLATE XII.

Direct Current, Stimulation by Cathodal Application (Peripheral Neuritis).

from this invasion of inflammatory exudates, and, when they remain, it leaves the nerve-trunk in a vulnerable state, prone to a recurrence of neuritis on slighter provocation. Absorbents, such as potassium and sodium iodid, inunctions of mercury, and massage may do much to restore the nerve to a normal condition, but this is greatly aided by the use of the negative electrode of the direct current (Plate XII), applied daily, with a strength of 15 or 20 milliamperes, along that portion of the nerve that has been the seat of neuritis. This should be followed up long enough to insure a return to normal conditions in the nerve. In the earlier stages of a simple or disseminated neuritis, when the congestion is acute and the sensory symptoms severe, the application of the anode of the direct current will assist in bringing relief and will diminish the severity of the inflammation. If the cataphoric effect of suitable remedies, such as cocain or aconitin, is added to the sedative action of the direct current, the relief will be still greater. In the later stages, when the effects of disordered circulation and defective nutrition retard the recovery of the neurons, the faradic or induced current, applied both in a local and general way, will prove serviceable in hastening restoration of nerve-function.

272. In the treatment of multiple neuritis, those electric modalities that are best calculated to invigorate and quicken general nutrition are the most helpful. In these cases, therefore, it is best to employ general faradism, the static insulation (Plate XIII), the high-tension, high-frequency currents, and alternating magnetic fields. Any one of these modalities, given in connection with suitable diet, general tonics, and massage, are the measures that have proved most helpful.

ATROPHY AND DEGENERATION.

273. Any cause that seriously impairs the nutrition of the peripheral neurons is liable to cause atrophy of the structures that are innervated by them, and leads to the degeneration of the neurons themselves. The nature of these causes, the changes produced by them, and the treatment required to avert their destructive effects have been considered somewhat

under the disorders of peripheral nerves that have been discussed in the preceding pages. In what follows, there will be discovered other causes that may lead to degeneration and atrophy of nerves, and of the tissues that are dependent on them. These conditions of degeneration and atrophy do not arise of themselves. They are but the necessary results of the devitalizing action of toxic substances, anemia, inflammation, overaction, etc. They are not to be regarded as disease entities, but only as incidents in the pathological process marking the stage to which it has progressed. Such treatment as tends to reestablish normal nutrition will be required to counteract the degeneration and institute new growth to replace the atrophied tissue.

TUBERCULOSIS AND SYPHILIS.

274. A neuritis of special character may be excited in nerve-tissue by either of these causes, although the instances are somewhat rare. The syphilitic irritant generally gives rise to a simple neuritis. In connection with posterior spinal sclerosis of syphilitic origin, a multiple neuritis may occasionally develop. A number of cases have been observed in which a local tubercular inflammation, as, for instance, in the cervical lymphatics, has invaded the perineurium of the contiguous nerves, and a tubercular neuritis of progressive nature has followed. The constitutional and local treatment appropriate to these pathological states should be employed in such cases. For treatment of neuritis in all other respects, the practitioner should be guided by the general rules that have already been laid down.

TUMORS.

275. A true neuroma, which is rare, is a neoplasm that has its origin in the nerve-fiber proper. False neuromata grow from the connective tissue composing the perineurium or the neurilemma; these are more common. These abnormal growths may occur on any nerve in the body. They may be of the nature of glioma, myxoma, fibromata, solitary or multiple,

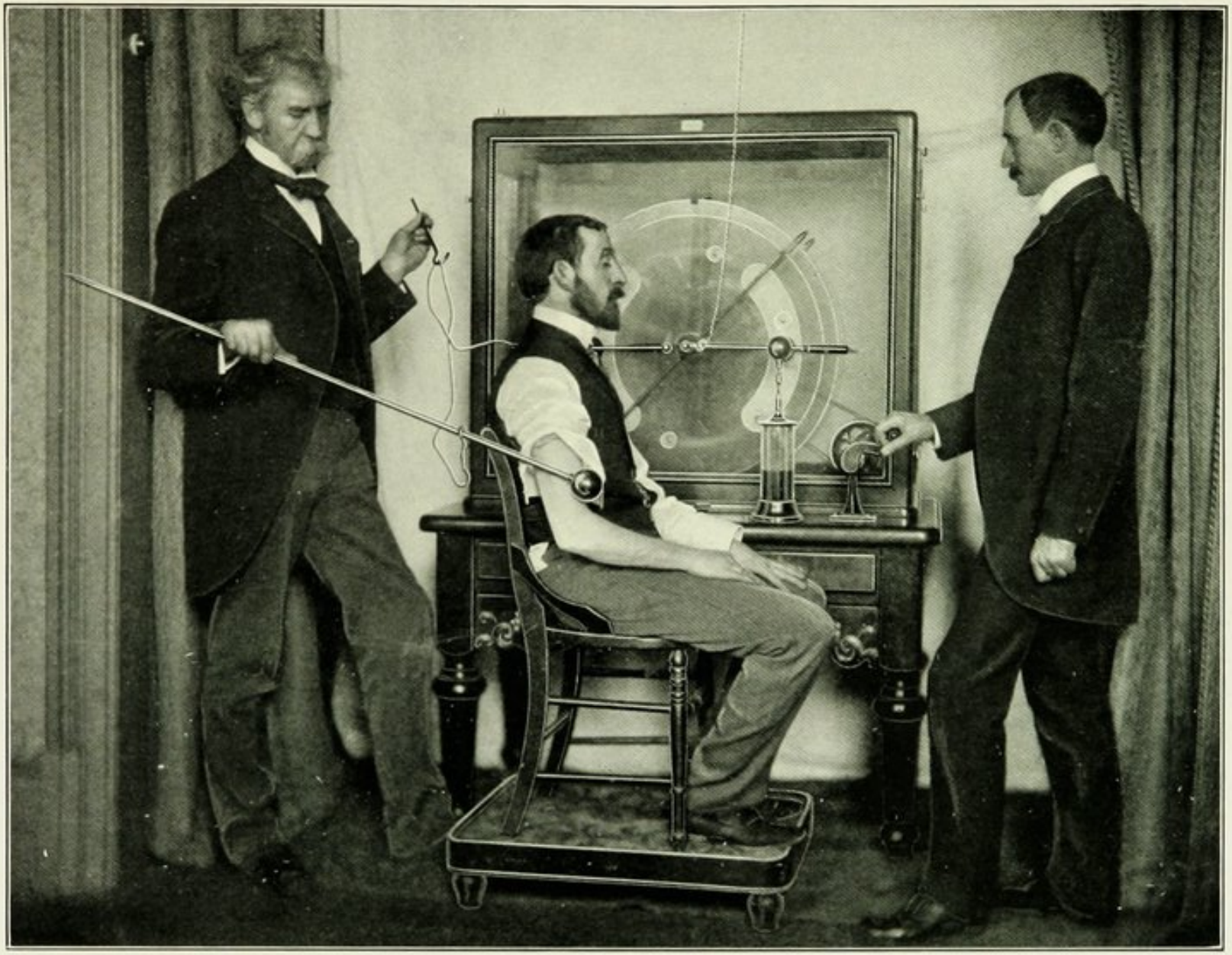


PLATE XIII.

carcinomata, sarcomata. Syphilitic and tubercular nodules may also invade nerve-tissue, and when they affect the extremities of sensory nerves, as they do at times, they are very painful. These growths seldom reach any great size, but they may be very numerous in the same patient, growing on the same nerve in a number of places or on several nerves in different parts of the body. The growths of connective-tissue origin may develop on the sheath of the nerve at one side, and the nerve-fibers may pass by unchanged, or it may involve the interstitial connective tissue so as to widely separate the nerve-fibers and compress them.

276. Symptoms.—The symptoms are those which arise from compression and gradual interference with the function of the nerve. A sensory nerve may for a time be very painful and subsequently numbness and anesthesia result. A motor nerve exhibits weakness with ultimate paralysis. Trophic changes both in the skin and muscular tissue are likely to occur in the late stages.

277. Treatment.—Medicines are of little service except when the growths are of syphilitic nature. Early surgical extirpation is usually necessary when the neoplasm is located where this can be done with advantage. Hypodermic injections of cocain or morphin may be required to relieve pain.

278. Electrotherapeutics.—In some instances, electrolysis may take the place of surgical extirpation with advantage. It can be practiced in most instances with the least destruction of normal tissue. The needle used as the cathode of a direct current of 5 to 8 milliamperes is what is usually required. The sedative action of the anode of the direct current may be employed as a means for temporarily relieving pain.

TRAUMA.

279. Injuries to nerves may arise from a great variety of causes. Blows, falls, cuts, bruises, gunshot wounds, and the like may crush or lacerate the nerve-tissue. If the fibers of the

nerve are injured severely or severed, a process of degeneration begins at once in the peripheral portion. The degeneration may be regarded as a process of parenchymatous inflammation (*Gowers*). The white substance of Schwann undergoes segmentation; granular substance takes its place and in turn gradually disappears. The axis cylinder degenerates throughout the entire extent of the peripheral end. In the proximal end, slight degenerative changes are noticeable, extending from one to two internodal segments. The myelin is at first reduced to fine granules, then the nuclei multiply and increase in size. The axis cylinder remaining intact grows and new fibers are formed. The connective-tissue elements are multiplied. These changes result in a bulbous enlargement of the proximal extremity of the nerve, consisting of nerve-fibers, connective tissue, and leucocytes. Years after the injury there may be some atrophy of the nerve-fiber due to diminished functional activity. The muscles supplied by an injured motor nerve atrophy by reason of granular or fatty degeneration. The part is paralyzed, and deformities in the part or limb result from the disturbance in muscular action and other changes in tissue. The skin of the part atrophies, becoming thin and glossy, and the circulation is feeble. Bullæ and eruptions may occur over the distribution of the injured nerve, the perspiration is deranged, and the skin becomes excessively dry or moist. The bones atrophy and the joints are destroyed or impaired.

An intense neuritis sometimes follows a nerve-injury. Especially is this true when the nerve has been bruised or crushed rather than cut or severed. The condition of the patient at the time of the injury and the septic or aseptic condition of the wound has much to do with determining the secondary neuritis. Trophic changes are more common from the neuritis following injuries than with simple neuritis.

280. Symptoms.—Immediately following an injury to a nerve, there may be excruciating pain in the part, with choreic twitchings or spasms of muscles. In some instances of gunshot wounds, the patient describes the sensation as that of being struck by a stone or stick. At times no pain or

discomfort is experienced. If the nerve is divided, there is, of course, paralysis of function of the parts supplied by it.

281. Treatment.—When the division of the nerve is incomplete, rest, cold or warm applications, surgical care of the wound, and the treatment that would be required for neuritis is indicated. If the nerve is completely severed, immediate suturing should be done, if possible. If the injury is such that this cannot be done at once, it may be possible when the immediate effects of the injury have subsided. Either by direct suture or by grafting, the severed nerve may be again united and in many instances new axis cylinders will gradually develop throughout the peripheral portion of the nerve. If this result is successfully effected, massage and electricity and voluntary effort judiciously employed will succeed in a great measure in restoring the function of the nerve.

282. Electrotherapeutics.—The direct current gently and accurately applied along the course of the nerve-distribution by means of the pointed cathode is best adapted for this purpose. Care should be taken not to overdo this in the beginning, for an overstimulation by means of the electric current will retard rather than promote the nutrition and restoration of nerve-function. Treatment given for 5 minutes, daily, followed or preceded by massage and Swedish movements of the part, will be quite sufficient. The length and vigor of the treatments may be increased as the nerve begins to respond more actively. After function has been in a measure restored, and the nutrition is good, the induction-coil current with slow interruptions can be substituted for the direct current. Gentle muscular contractions in those muscles supplied by the injured nerve should be effected by means of it, and in order to arouse the activity of the sensory nerves, the faradic brush should be passed over the area of sensory nerve-distribution with a strength of current quite perceptible to the patient.

DISEASES OF THE BRAIN.

INTRODUCTION.

283. Brain.—The brain, constituting as it does the main part of the central nervous system, is the seat of the greatest number and variety of disorders having their origin in the nervous mechanism, or deriving their chief symptoms from derangement of that mechanism. Not an inconsiderable number of these disorders of the brain are evolutionary defects, the mechanism never having reached the stage of complete or perfect development. Hereditary endowment, the amount and quality of vital capital furnished the individual germ by its progenitors, is an important element in determining the degree to which the evolutionary process of the brain will be carried. But perhaps no less important are the conditions and influences that surround it at every stage of that evolutionary progress. Observation and reason both teach us that the more favorable are these conditions for normal and healthful development in the embryonic and infantile stages of evolution, the greater is the probability that the brain will reach a complete, uniform, and stabile structure, and thus be able to perform all the functions that pertain to it in the most perfect and satisfactory manner.

284. Certain defects in evolution are primordial, gross, and fundamental. Others date from one or other of those periods at which the structure and function pertaining to some one of the accessory animal or intellectual capacities of man need to be put forth by the individual, but for which the power to accomplish this is found wanting. The result, henceforth, is an incomplete or perverted physical, emotional, intellectual, or moral mechanism. This is found to be the origin of many disorders of the central nervous system, and they are disorders the cause of which resides in the very nature of the nervous structure, and for this reason is not removable.

Only those disorders that arise from causes operating upon a comparatively normal brain give a chance for amelioration or cure for the use of appropriate therapeutic means.

DEFORMITIES AND MALFORMATIONS.

285. Pseudencephalus.—The brain envelopes and vessels are represented by only a few rudiments.

286. Anencephalus (*Absence of the Brain*).—A complete arrest of development of the hemispheres, probably due to pathological disturbance occurring in the forebrain of the embryo.

287. Cyclocephalus (*Cyclops*).—In cyclocephalus there is fusion of the anterior cerebral vesicles. The two orbits and eyes are merged into one, making but a single rudimentary eye. The hemispheric vesicles may be arrested in their development from the first anterior cerebral vesicle, but one may develop so that it, with its corresponding ocular vesicle, may go on to maturity and occupy alone the frontal region. The foregoing conditions are incompatible with viability, the creature, if born alive, seldom living but a few hours.

288. Porencephalus.—This is a congenital defect of the brain likewise arising from pathological causes in the fetal brain. The term is confined to a defect in the cerebrum, in which there is an absence of cortical or subcortical cerebral tissue, either communicating with the arachnoidal space, or shut off from it. The defect of tissue may extend to the endyma of the ventricles or be so far wanting as to leave an opening into the ventricular cavities. This forms a pore or funnel-shaped depression in the cerebrum, hence the name. The defect is confined to the convexity of the hemispheres or to the Isle of Reil. The tissue throughout the hemisphere depending on this defective area lacks development, or has degenerated or atrophied. The hemispheres are usually smaller, and the convolutions and fissures atypic. The primary fissures may be changed in direction. The cerebellum in some cases is smaller than normal. Asymmetry of the cranium results.

In a collection of 96 cases, the seat of the cerebral defect was distributed as follows: In both hemispheres, 32; in left hemisphere, 38; in right hemisphere, 28; in parietal lobe, 17; in frontal lobe, 7; in temporal lobe, 4; in occipital lobe, 3. The

symptoms are of course dependent, in a great measure, on the location of the defect. Idiocy or imbecility is usually the result. Mutism, deafness, blindness, strabismus, hemiplegia, malformations, and contracture of muscles are among the disorders that most frequently attend this condition. The patient may have convulsions and epileptiform attacks.

289. Microcephalus. — Microcephalus is a condition where a whole or any considerable part of the brain is below normal size. The structure of the brain is firmer than normal. There is more connective tissue and a decrease of nerve-elements. The blood-vessels are smaller in size without evidence of disease in them. There is arrest of development of the cerebral vesicles after the fifth month of gestation. Defect shows chiefly in lack of the cortical and subcortical elements. There is evidence of partial acquired atrophy due to compression by meningeal hemorrhage, meningitis, intra-uterine disease, or germinal defect. Disease of the cranial bones and premature closure of the sutures of the skull have been thought by some to act as a cause. The symptoms of microcephalus usually give evidence of mental defect bordering on idiocy. Bilateral weakness, incoordination of movements, athetosis, and slight paresis to paralysis or hemiplegia are among the motor disturbances. Convulsions or epileptic attacks may occur in some cases. An overgrowth of some element or tissue may disturb their relative proportions and so give rise to defect.

290. Hypertrophy, or Hyperplasia.—In this condition there is an increase of the connective tissue of the brain more abundant throughout the white substance. The brain cortex is thickened and the so-called "barren layer" gives evidence of internal pressure. The brain is enlarged. The bones of the skull are thin and the sutures separated. The gyri are flattened and the dura mater is adherent to the vertex of the skull. This disorder gives rise to symptoms variable and uncertain, such as are described in the less severe forms by the word nervousness, but in the graver cases there is idiocy or imbecility, paresis of the extremities, drowsiness, convulsions, and epileptic attacks.

291. Encephalocele.—In encephalocele there is cranial defect together with a hernial protrusion of brain-tissue covered only with the pia mater. In some cases the integument is wanting. It occurs most frequently in the frontal or frontonasal region. The protrusion of cerebral tissue gives evidence of arrested development and also of degenerative change. There is increase of neuroglia with sclerosis in patches, ganglionic areas are either unformed or atrophied, and hemorrhages have taken place followed by local softening. The tumor varies in different cases from 1 to 7 inches in diameter. Pulsation is observed in it corresponding in rhythm to the pulsations of the brain. The symptoms are drowsiness and mental weakness, feeble muscular movements, convulsions, and early death.

292. Meningocele.—Meningocele consists of a protrusion of the meninges through a cranial defect. It is most common in the occipital region, and it is often proportionately large in size and constricted at the base. The symptoms correspond to those of encephalocele.

293. Meningocephalocele. — In meningocephalocele, both meninges and brain-substance enter into the tumor. The symptoms do not differ materially from those of the two preceding conditions.

294. Hydrocephalus Interna (*Chronic Hydrocephalus*). The central cavities of the brain in this malformation are more or less—sometimes greatly—distended with fluid. In the congenital form, the composition of the fluid is the same as the normal cerebrospinal fluid. In the acquired form, it is flocculent and turbid, containing pus and perhaps blood. The increase of fluid expands the lateral ventricles and their cornua, distending also in some cases the aqueduct of Sylvius, the fourth ventricle, and even the central canal of the spinal cord. The substance of the hemispheres is pressed against the inner surface of the skull, thinning it. The fissures and gyri are obliterated, the membranes are attenuated, and degenerative changes occur in both white and gray substances of the brain. There is defective development of the pons, the medulla, and the cerebellum,

and atrophy of the optic tract. The bones of the skull are widely separated, thinned, and expanded, and Wormian bones are formed in the interspaces. Occasionally, the cranial bones are somewhat thicker than normal. The skin of the scalp is thin and glistening, with the veins clearly defined upon its surface. The hair of the scalp is usually scanty and short.

295. Symptoms.—The symptoms of chronic hydrocephalus differ somewhat according to the stage at which it began and the degree to which it has progressed. The head is enlarged, in some cases enormously, especially when the defect is congenital. The measurements of the transverse circumferences in a number of cases range from 24 to 44 inches. The head is globular or somewhat triangular in form. The fontanelles and sutures are open, and fluctuation is detected on palpation. The eyeballs protrude and are directed downwards, the cornea is partly covered by the lid, and, occasionally, there is nystagmus or strabismus. The sight is impaired and the eyes roll from side to side. If the child is able to walk, its gait is quite shambling, tottering, slow, and methodical. On rising, it holds its head in its hands to steady it. The limbs are usually weak, but often there is paraplegia or complete paralysis, and in some cases only hemiplegia. Tonic or clonic spasms of the extremities, drowsiness, and convulsions may occur. There is an unwillingness of the child to move the head or body, since such motion often causes vertigo or vomiting. The general nutrition is poor, the body is emaciated and wrinkled, the skin is pale, thin, translucent, and moist, especially about the head. The child is usually cross and irritable, and utters a peculiar moan or whining cry. The voice is high-pitched and stridulent. The intelligence is of low order; the child talks little and is backward, or imbecile. Its habits are dirty.

296. Treatment.—Except in a few instances, little benefit can be expected from any form of treatment for the defects or perversions of brain development. Occasionally, surgical treatment for meningocele, encephalocele, microcephalus, or hydrocephalus has been beneficial. If the deformity or abnormal

structure is small in degree in meningocele or encephalocele, surgery may remove the deformity caused by the tumor, check its further progress, and assist in restoring the normal proportion of the several tissues. Much that has been attempted by surgery for the correction of microcephalus and hydrocephalus has been meddlesome and ill-advised, since the causes giving rise to the defect are usually so fundamental as to be in no manner changed for the better by such procedure. Nevertheless, the possibilities of benefit from surgery should always be carefully considered in these cases.

297. Electrotherapeutics.—In the cases of moderate defect, much can be done to stimulate normal development by attention to the general nutrition, tonics, good hygiene, systematic gymnastics, and massage. The object should be to discover the stage of evolution where the departure to abnormal paths began, and attempt to reestablish normal conditions by education of the muscles and special senses and the mental faculties that remain impressionable. In seeking to accomplish this, electrotherapeutics in various modalities will be of much service. The static charge, the alternating magnetic fields, general faradism, or the general application of the direct current will stimulate the nutritive activities as a whole. The quickening influences of the induced currents, or of the cathode of the direct current, applied locally, will aid the growth of damaged areas, provided they retain capacity for development.

DISORDERS OF NUTRITION.

298. Classification of Disorders.—Under the heading of Disorders of Nutrition we will consider the more common of those diseases in which the essential pathological factor appears to be a toxicity of the nutrient fluids, causing a defect in the nutrition of the neurons of the entire central nervous system, or of those occupying certain important areas of the brain. They are as follows: *Neurasthenia*, *megrim*, *chorea*, *tetanus*, *tetany*, *hydrophobia*, *plumbism*, *alcoholism*, *morphinism*, and *cocainism*.

NEURASTHENIA.

299. Nature and Pathology.—The causes of nervous exhaustion are diverse. A vigorous and stabile nervous system may never have developed in the individual in question. The ordinary experiences and demands of every-day life would be enough to tax such a system beyond its recuperative power. Others possessing at one time normal endowment of vigor are subjected to unusual strains or demands on the nervous activities by disease, by anxiety, by worry, or by excesses, so that nerve-energy is unduly expended. Again, toxic conditions of the blood due to faulty climate, hygiene, or malnutrition, or defects in the action of some important blood-making or eliminating organ or system is a common cause, either in originating or maintaining the morbid condition of nerve-nutrition. An immediate cause of nervous exhaustion is often found in a defective control of the circulation, which, in turn, may be traced to weakness or derangement of the nerve-centers, and thus a vicious round of disturbance is kept up. In traumatic neurasthenia, the vascular mechanism receives a shock that secondarily disturbs the nutrition of the nerve-centers. Prolonged nervous exhaustion may produce a permanent change or instability in the nervous structure if it did not exist primarily.

300. Symptoms.—There is deficient capacity for functional activity, associated with undue responsiveness to slight or inadequate cause. The sensory symptoms are early manifested and largely subjective. Most frequent among them are headache and various feelings of discomfort about the head; pains in the spine, dull aching in character; spinal tenderness, especially in the lower cervical and lumbar regions, increased by exertion, standing, or walking; slight, fugitive pains in the limbs, with tingling or numbness. There is cutaneous hyperesthesia and the skin reflexes are increased. The special senses are variously disturbed. There may be olfactory hyperesthesia or paresthesia; asthenopia, muscæ volitantes; gustatory paresthesia or anesthesia; auditory hyperesthesia and tinnitus. The digestive action is deranged. There is loss of appetite, dyspepsia,

constipation as a rule, with occasional diarrhea. The heart-action is accelerated, with low arterial tension, occasionally arhythmia. Palpitations, flushings and pallor, sense of heat and cold and imaginary fever, and a sense of impending giddiness with dizziness are common. Shortness of breath, with sense of oppression at the chest and general visceral discomfort, is often a cause of complaint. There is increased or decreased secretion from the skin, while defective skin nutrition is shown in the presence of acne, and the early loss of the hair and teeth. The urine is subject to various changes from normal. It may be decreased in amount in the 24 hours, with low specific gravity, or it may be increased or concentrated with an excess in phosphates, urates, uric acid, oxalates, or indican. There may be temporary albuminuria or glycosuria. Sexual derangements such as over-excitation or impotence may be present.

301. Motor Symptoms.—The motor symptoms are very pronounced. There is a sense of profound exhaustion, incapacity for work, and the power for sustained exertion is reduced. Fatigue is reached sooner and is more distressing than in health. Even talking wearies the patient, the voice being weak and low. Early in the day there comes on a sense of muscular inertia and powerlessness. Simple acts require an excess of effort. There is slight drooping of the eyelids, with excessive mobility of the iris. There is stiffness in the limbs. Cramps occur in the calves or in the feet. The knee-jerks are exaggerated but easily exhausted, likewise the tendo-Achilles reflex. A general fidgetiness, with muscular tremor and fine twitchings of the face and tongue muscles are often noticed.

302. Mental Symptoms.—The mental symptoms correspond with the physical. All voluntary cerebral processes quickly cause fatigue. There is mental depression, lack of spontaneity of thought, and uncertainty of memory. There is irritability of temper, morbid fears, introspection, loss of sense of propriety, loss of affection, and the emotions are easily

excited. There are peculiarities of speech and writing, both becoming slovenly in execution. Insomnia is a frequent accompaniment.

303. Treatment.—If overexpenditure of nerve-energy is the cause, this should be checked and rest enjoined. In many cases, rest in bed, with systematic methods of management for both the mental and physical conditions, is required, such as are practiced in the Mitchell or Playfair treatment. When rest is required to a degree that interferes with muscular exercise, the nutritive functions can be maintained in an active state by hydrotherapeutics, massage, and some suitable electric treatment. All cause of excessive drain on nerve-energy, whether in habit or occupation, should, if possible, be removed. Prolonged natural sleep is one of the best restoratives, and this should be brought about by physiological measures rather than by means of drugs. A little simple nourishment at bedtime, quiet surroundings, a warm foot-bath or wet pack, quiet and unemotional attendance, gentle massage, and cool applications to the head will often bring refreshing sleep. If hypnotics must be employed, they should be of the least injurious sort, such as bromids, chlorotone, and paraldehyde. Only as a last resort, and then only occasionally, should such remedies as sulfonal, trional, or opium be used as hypnotics. A combination of trional and sulfonal often acts more happily and in less doses than either used separately.

304. Judicious moral management of these cases is most important. For this reason it is essential in most cases that they be removed for a long period from the conditions and surroundings that induced or kept up the overaction of the nervous system, and be placed where the mental and moral influences and physical conditions are of such nature as will tend to calm and allay the excessive excitability, both mental and physical, and where the needed means for treatment are conveniently at hand and can be intelligently applied. In some cases it is sufficient to secure a change of climate and

social conditions for a time, with suitable companionship. A sea voyage or a quiet seaside resort, with salt-water bathing, is sometimes curative. A prolonged change from city to country life, or from the lowlands to a moderate elevation in the mountains acts beneficially with some persons so affected.

305. When the digestive system is much at fault, careful attention to diet is needed. A little readily assimilable food at rather frequent intervals is better for these cases than a greater quantity given less often, since the digestive organs are soon fatigued. There is no routine treatment by drugs to be employed. Such medicines as are indicated should be used in moderation. Among the tonics that are most useful are iron, arsenic, and strychnin. The bitter stomachics, such as gentian, nux vomica, and chiretta, together with nitromuriatic and hydrochloric acids, aid digestion and assimilation. The artificially prepared digestive ferments, as peptenzyme, pepsin, and lactopeptine are useful. The preparations of valerian and sumbul, cannabis Indica, hyoscyamus, and belladonna are needed as sedatives. Elimination must be carefully managed, for the means employed for this purpose must not be exhausting. An abundance of pure water or carbonated mineral water, taken an hour or two before or after meals, will effect this in the best manner. Occasionally, a mild laxative, such as Cascara sagrada, sodium or magnesium phosphate, or licorice powder, may be used.

At times the circulation may need special medication to regulate its action, and nitroglycerin, digitalis, strophanthus, adonis vernalis, or other like remedies can be employed according to the special indications.

306. Electrotherapeutics. — Of all the therapeutic resources, none are more healthful than the various electric modalities, when properly employed, in combating the feeble nutrition and general nerve-weakness exhibited in neurasthenia. Those forms of electricity that act in stimulating the general metabolism of tissues are here indicated. The static insulation

and breeze for 15 or 20 minutes daily are very soothing and beneficial. The static spark to the spine is also of great benefit as soon as these hypersensitive patients overcome the dread and morbid fears that this method of treatment often awakens in them.

The autoinduction effects of the high-tension, high-frequency currents and the alternating-magnetic stresses by means of the reclining chair or lounge are particularly well adapted to the treatment of these cases. If these means are not at hand, much good can be obtained by general faradism or general application of the direct current of 20 to 40 milliamperes strength for 15 or 20 minutes daily, combined with gentle but thorough massage and judicious hydrotherapeutics.

MEGRIM.

(*Sick Headache.*)

307. Nature and Pathology.—The nature of this disorder is as yet obscure. Since heredity plays an important part in it, and the vast majority of patients are affected in childhood and early adult life, there are in all probability fundamental defects in the structure and function of the brain or nervous tissue itself or in that of some of the important blood-making or eliminative organs. An autointoxication is probably present, and this primarily affects the sensory neurons of the brain cortex. The disease takes the form of a somewhat periodic discharging neurosis, giving rise to what have been termed *nerve-storms*, accompanied by vasomotor disturbance of the cerebral arteries. The peripheral nerves that are mainly involved are the fifth, the pneumogastric, and the sensory branches of the upper cervical nerves. The close relation that these nerves bear to each other at their ganglionic origin in the medulla and cervical cord accounts for the association of symptoms that the disease exhibits. Reflex irritation communicated along some branch of the pneumogastric or the fifth nerve is oftentimes an exciting cause of megrim. Thus, eye-strain or gastric or hepatic disorder may act as an exciting cause and precipitate an attack. Megrim bears some relation

to epilepsy, the disturbance in the sensory sphere of the brain resembling that which occurs in epilepsy in the motor and psychical areas. Megrim and epilepsy have in some instances been found to be interchangeable.

308. Symptoms.—An attack of megrim is usually preceded by a sense of depression or malaise for a few hours, or it may be for several days. Chilly feelings, tendency to yawn, spots before the eyes, buzzing in the ears, pressure in the head, and a sense of discomfort and general uneasiness give a premonition of its onset.

The attacks are at intervals varying in frequency from 1 to 4 weeks. In the interval the patient is, as a rule, well. The attack begins in the morning and increases in intensity until the patient has to lie down. The pain usually starts in the left side of the head, the forehead, or the occiput, and may extend over the entire head. The pain is intense, throbbing, blinding, increased by light, noise, or jars. It may be paroxysmal or continuous. The vision becomes dim, there are flashes of light before the eyes, or dark or bright spots float before them. The visual field is restricted, the pupils may be contracted or dilated, the face becomes pale or flushed, and in some cases hemianopsia is present. There is vertigo with ringing in the ears, with nausea, first vomiting mucous and, later, bile. There is confusion of ideas, stupor, and disturbance of memory. The pulse is, in the beginning, small and hard; the temperature, in children, is usually elevated; unilateral smarting may occur, and the limbs are cold. As the pain lessens, sleep comes on. After 24 hours, the headache is generally gone and the patient feels better than before the attack. Not infrequently there are temporary complications, such as transitory aphasia, peculiar odors or tastes, partial oculomotor paralysis, visual spectra, temporary deafness, loss of taste, tingling, numbness, and partial anesthesia, limited to the face, lips, tongue, hand, or arm on one side. Convulsive movements of the body may take place, or a slight hemiplegia may be present. Puffiness of the scalp and ecchymosis may remain for a time in the affected areas. After an attack there is polyuria and the

appetite is much increased. Trophic changes, such as pigmentation of the skin and premature grayness of the hair, often occur. From a succession of attacks the patient may become peevish, ill-tempered, and unsocial. Even transient perversion of the mind may develop when the headaches are very frequent.

309. Treatment.—All causes of reflex irritation, such as errors of refraction and muscular strain, nasal polypi, dyspepsia, hepatic, renal, or uterine derangement, must be sought out and if possible removed. As to the diet, meats, as a rule, should be restricted. Cooked fruits and green vegetables should be used more largely. Fresh air and abundance of exercise, diminished school-work of children, hydropathic measures, change of climate, and correct daily habits of living are requirements in many cases. More thorough and systematic attention to elimination of effete matters from the system, by means of saline laxatives and the free drinking of pure water between meals, does much to ward off attacks. General tonics are also helpful in fortifying the system against attacks. The valerianates of iron, arsenic, and zinc, phosphate of iron, quinin, and strychnin are remedies that are serviceable in this way.

When disturbance of the circulation is a prominent factor, the use of nitroglycerin, belladonna, and cannabis Indica are found to be beneficial. When an attack threatens, it can sometimes be averted by a promptly acting saline laxative and free emesis. Drinking copiously of hot water will either cause prompt vomiting or promote elimination by the intestines. Rest in bed, a darkened room, quiet, cold or hot applications to the head, mustard foot-baths, and a mustard plaster on the nape of the neck are all of service in diminishing the severity of an attack. The drugs that have been found more or less helpful in mitigating the pain are many. Those deserving special mention are caffein, guarana, antipyrin, phenacetin, exalgin, chloral, chloralamid, chlorotone, and the bromids, especially the bromid of lithium.

310. Electrotherapeutics.—For the systemic condition of defective nutrition, a general application of the direct or induced current, and the static insulation or the static spark to the spine are suitable. They should be given daily for some weeks, together with the eliminating and tonic measures just mentioned above. For the relief of the headache at the time of the attack, especially if there is much vasomotor disturbance, the static breeze to the head has been found very efficacious.

CHOREA.

311. Nature and Pathology.—Under the heading chorea are usually grouped a variety of disorders chiefly characterized by involuntary and irregular muscular movements brought about by some derangement of nutrition in the cortical motor centers or the coordinating nuclei in the basal ganglia. The pathological changes that are found in any one of the various forms of chorea are by no means constant.

312. Sydenham's Chorea.—The common form, or Sydenham's chorea, usually affects young children—girls rather more frequently than boys—and the disease, even when not specially treated, tends to recovery. The morbid changes, therefore, in this form of the disease, at least, are not permanent and are evidently due to some derangement of the blood affecting the nutrition of the central motor neurons. So frequently is rheumatism and the effects of it in other parts of the body, as the heart, found in patients troubled with the common form of chorea, that the belief in a rheumatic origin for the disease is very generally entertained. The nutritive change, whatever it is, seems to have some action on the blood-vessels of the brain as well as the neurons, since an intense hyperemia of the gray matter of the meninges, the cortex, the basal ganglia, and the pyramidal tracts has been observed, and infiltration of the perivascular spaces, with round cells and swelling and proliferation of the intima of the small arteries, are conditions verging upon, if not actually indicating, inflammation. Together with these vascular changes an elevation of temperature—as much as

102° F.—is not infrequently present. A subacute inflammation seems, therefore, to form a part of the pathological state in many of these cases of Sydenham's chorea, and the nerve-discharges would of necessity be interrupted by compression of the cortex or basal ganglia neurons due to the exudates.

313. Hereditary, or Huntingdon's, Chorea.—In hereditary, or Huntingdon's, chorea, which is a chronic progressive form occurring in successive generations and making its appearance in the individual between the ages of thirty and forty, the evidences of inflammation are even more constant and pronounced. Miliary, disseminated patches of cortical and subcortical encephalitis are found. There is slight meningitis and accumulation of cell-elements about the vessels and nerve-cells, with an increase of interstitial tissue. But it is very probable that these inflammatory changes are rather the result of the overaction of the nerve-centers than the primary disorder. There is not the close association between rheumatism and this form of chorea that has been observed in the common, or Sydenham's, variety. Neither is the hereditary form as much disposed to spontaneous cure nor as amenable to treatment.

314. Symptoms.—The attack of chorea may be ushered in by some mental depression or a sudden emotional excitation, as fright. Mental irritability and an indisposition for mental work are frequent prodromes. In the common form there may be slight rheumatic pains, anorexia, or other signs of constitutional derangement. The onset may be sudden, but is generally slow. There is general restlessness and fidgetiness, and inability to sit still. The movements of the body are awkward and clumsy. The movements of the limbs, head, or body are jerky, spontaneous, irregular, and incoordinated. The voluntary muscles only are affected, and these may be of any part of the body, the face, shoulders, arms, hands, trunk, or lower extremities, one-half of the body, one-half of the face, or one arm. At first there may not be much interference with voluntary movement; later the muscles are seized in the voluntary act with jerks and spasms

that make it difficult or impossible to carry out the intended movements. This awkwardness excites the patient, and the more he tries to control the movement, the less successful he is. Attention and the presence of spectators increase the difficulty. Purely reflex and automatic movements are not disturbed, but the respiratory rhythm is frequently uneven and the pulse-rate irregular and rapid. There does not seem to be any increase of the sense of fatigue. Paresis is at times more prominent than movements—the so-called *chorea paralytica*—which appears to be more a lack of will-power than a muscular weakness.

The knee-jerk and tendon reflexes may be absent or capricious. The spasmodic movements of the muscles usually cease during sleep. But they may become so violent when the patient is awake as to require measures for protecting him from self-injury. Some tenderness may be found over the spine, and rarely there is soreness along the nerve-trunks. The electric excitability of the muscles may be increased or lessened.

315. Among the trophic changes that occur during the attack are abscesses, herpes, erythema, nodosum, purpuric urticaria, peliosis rheumatica. Bruises and sores heal slowly. The appetite is poor, the tongue coated, and constipation is the rule. There is anemia and loss of flesh. There are functional and often organic heart murmurs. Frequently, endocarditis, and, occasionally, pericarditis, are present. The urine shows high specific gravity, with increase of urea and the phosphates, but a decrease in chlorids. There are marked psychical changes. The patient may become wilful, peevish, irritable, or spiteful. He may be slow at grasping and understanding what one attempts to teach him; he forgets quickly, and interrupted muscular movements in speech may unfit him for work in school. The child is emotional, inclined to tears, and often awakens in the night crying. Headache is common and, in severe cases, mental excitement may increase to delirium.

The symptoms occurring in hereditary chorea are very similar to the above, except that the mental deterioration may be more pronounced and progressive. A loss of pain sense has been observed.

316. Treatment.—With rest of mind and body, some cases may and do get well without special treatment. All causes of excitement and irritation should be removed. All reflex causes of disturbance should, if possible, be allayed. The eyes should be carefully examined for defects in vision or muscular movement. The nasal cavities, the digestive tract, and the genital organs should be looked to for the discovery of any cause of irritation. The strain of school duties or exciting games may act as an accessory cause requiring attention. Seclusion from others, moderate muscular exercise, and rest in bed, in bad cases, are necessary to quiet the excessive muscular movement. This is still further accomplished by gentle massage, cleanliness, the wet pack, warm baths, and a nutritious, easily digested, but unstimulating, diet.

Since the etiology is so obscure, the selection of drugs is somewhat empirical. Among those that have been apparently most serviceable are arsenic (especially the bromid), cimicifuga racemosa, salol, sodium salicylate, valerianate or oxid of zinc, and eserin. As sedatives, antipyrin, hyoscin hydrobromate, monobromated camphor, conium, the bromids of lithium, sodium, ammonium, or potassium, and chloral have proved more or less serviceable.

317. Electrotherapeutics.—This is a form of disorder best adapted for treatment by means of the alternating magnetic fields. The patient can get the benefit of the nutritive modification that this treatment effects combined with the complete bodily rest in the supine position that the patient's condition requires. The noiselessness and sensationless action of this form of electric treatment arouses no alarm or emotional disturbance in children, and thus its benefits are in no measure counteracted. General and local sedative action of either the induced or direct current may also be employed to advantage in patients old enough to submit to it without fear or excitement; or the static insulation might be used to advantage.

TETANUS.

(*Trismus, Lockjaw.*)

318. Nature and Pathology.—Experimental evidence has shown that in this disease the nervous system is subjected to a poison that acts somewhat like strychnin. It is a specific infection that finds entrance usually through a wound and acts chiefly on the pons and medulla through the spinal cord, and the nerves at the seat of the wound may be likewise directly involved.

319. Symptoms.—The symptoms are chiefly those of tonic and clonic muscular spasm. In the beginning there are, in some instances, vague pains in the head, the epigastrium, or at the seat of the wound. Chilliness may be felt. Stiffness of the muscles of the face, the lower jaw, and the nape of the neck soon comes on, spreading so as to involve the muscles of the trunk and abdomen. The jaws are fixed, the eyes staring, the corners of the mouth are drawn back in a sardonic grin. The muscles of the back are contracted so as to bow the spine (opisthotonos). The contractions are painful. The tonic spasms give place to those of clonic nature. The upper abdomen is flat and the muscles hard. The pulse is increased, and respiration is rapid or so impeded as to occasion asphyxia and death. The temperature is at first normal, but rises later to 108° or 110° F. The bowels are constipated, and micturition is prevented. Occasionally, there are traces of albumin or sugar in the urine. Sweat pours from the body during the paroxysms.

320. Treatment.—Injections, hypodermatically, of tetanus antitoxin, or of carbolic acid give the most prompt relief. Chloroform, ether, or nitrite-of-amyl inhalations may be of service. A quiet dark room, with prolonged hot or warm bathing, have a sedative effect. The bromids, the hydrobromate of hyoscin, curare, physostigmin, Calabar bean, cannabis Indica, atropin, chloral, and morphin are among the chief remedies recommended.

321. Electrotherapeutics.—There is but little opportunity for the use of electricity in the acute stage of the disease.

Should the attack not prove fatal, it would be helpful in any one of the various forms suitable for sedative effects and the improvement of nutrition.

TETANY.

(*Intermittent Tetanus.*)

322. Nature and Pathology.—We have in this disorder an alteration in function, and, in all probability, of nutrition also, of the motor neurons. An autointoxication of some kind is probable, affecting the cortex of the brain, though the changes in nutrition may not be confined to the nervous structure of the brain alone. An infectious origin is believed in by some authors.

323. Symptoms.—There are some premonitory symptoms, such as headache, malaise, pain in the spine, and cerebral vomiting. There is a feeling of stiffness in the arms. There is increased irritability of the sensory nerves indicated by tingling and formication when pressure is applied. There are slight drawing sensations in the arms and a feeling of coldness. The motor nerves respond with undue promptness to mechanical stimuli. Stroking the face produces spasm of the facial muscles, and pressure on the large nerve-trunks of the arm causes local muscular contractions. There is increased electric irritability of both nerves and muscles.

An attack comes on in the form of a tonic muscular bilateral spasm, affecting especially the upper extremities. The fingers suffer first and then the arms. The muscles of the lower extremities are rarely involved; in severe cases they may be, as well as the muscles of the abdomen, chest, neck, and face. At times the muscles of the pharynx, esophagus, and bladder may be affected. The flexor muscles are most affected. The fingers are bent at the metacarpal phalangeal joints and extended at the others so as to form the "accoucheur's hand." In the legs, the knees are extended, the thighs adducted, rarely flexed. The tonic spasm renders the muscles firm and hard, interfering with movement. Fibrillary twitchings of the muscles may be seen.

As a rule, several paroxysms occur daily, but the interval may be days, weeks, or even months. The attacks last from 1 to 10 minutes. The spasm may continue during sleep. The tendon reflexes are sometimes exaggerated, but may be wanting because of the spasm. During the attack, there is profuse sweating, and the disorder may give rise to trophic changes in the skin, such as edema, herpes, urticaria, pigmentations, dryness, and brittleness of the hair and nails. Muscular atrophy has resulted. Transient albuminuria and glycosuria have been observed. Psychical disturbances are rare. There is no impairment of consciousness as a rule, but epilepsy has occurred in some instances.

324. Treatment.—The treatment consists in removing, if possible, any source of infection or autointoxication by change of abode or climate and careful attention to diet and elimination. Rest, with blood-and-nerve tonics to tone up the general health, is indicated. Many cases seem to recover without any special treatment. During the paroxysm, the sedative influence of warm baths, ice to the spine, the bromids and hyoscin are of service. Chloroform or ether inhalations may be employed if the attack is severe.

325. Electrotherapeutics.—The disturbed functional condition, if it is due to defective nutrition, can be much relieved by the use of the direct and induced currents in general or local applications. The static insulation and the spark to the spine and along the course of the nerves chiefly affected would be appropriate methods of treatment.

HYDROPHOBIA.

(*Rabies.*)

326. Nature and Pathology.—This is an infectious disease in which the virus is transferred by inoculation and is best propagated in the nervous system. The brain cortex, the medulla, and the glossopharyngeal, pneumogastric, and hypoglossal nerves are the seat of its most intense effects. The result of its action is at first stimulating, and then depressing.

After death, the blood is found to be dark and fluid, and the brain and spinal cord, the pharynx, spleen, and kidneys are congested. There is vascular dilatation, minute hemorrhages, clots in the small vessels, infiltration of leucocytes, and miliary abscesses about the nerve-roots. The nerve-cells are swollen and granular. The changes in the spinal cord are, as a rule, less intense than in the brain, though myelitis may occur. The lungs are often congested and edematous. These changes are looked upon as the effect rather than the cause of the disease.

327. Symptoms.—The symptoms may, with more or less variation, be grouped into four stages: (1) the initial stage of excitement, succeeded by depression; (2) respiratory spasm; (3) mental disturbance and convulsions; (4) paralysis or exhaustion. The symptoms of one or another of the stages may predominate in any case, characterizing the attack.

As a rule, there is an interval of some days between the time of inoculation, the bite of the mad dog, or other animal, and the symptoms of hydrophobia. In the initial stage, there is pain or an unpleasant sensation at the seat of the wound and radiating from it, headache, slight fever, and disturbed sleep. There is a feeling of malaise, and the patient is irritable. Anorexia may be present. Profound feelings of depression follow. Severe spasms of the throat then set in, with choking sensations, spreading to the muscles of respiration. There is inability to swallow liquids. The mere contact of water to the lips, the sight of it, or its sound or verbal suggestion is sufficient to excite spasm. The spasms soon become more general, involving the muscles of the spine, trunk, and limbs. They are tetanoid, causing opisthotonos, or coordinated as in hysteroid convulsions. The skin reflexes and knee-jerks are exaggerated. There is now great mental depression. The patient has a dread of excitants. The mental disturbance leads to delirium, in which the patient at one moment attempts to bite the attendant, at the next, beseeches him to keep away so as to avoid being hurt. He makes use of indecent language, and at once deplores it. He has delusions during the paroxysms, imagines he sees dogs in the room, or imagines he is himself a

dog, and imitates one in his conduct. As the mental disturbance increases, the spasms in swallowing and in respiration usually lessen. The convulsive attacks may also cease. Exhaustion may bring on a paralytic state, which may be so extreme as to cause death; or death may occur from the violent convulsions causing asphyxia or heart-failure. There is great thirst, burning in the throat, and salivation. The temperature is generally elevated, ranging from 100° to 105° F. The urine may contain albumin or sugar.

328. Treatment.—There should be immediate surgical care of the wound. Pasteur's method of inoculation should be employed as soon as possible. The patient should be placed in a dimly lighted room, kept quiet, and be fed by peptonized enemeta. The drugs that have proved of some service are mercury, curare, Calabar bean, chloroform inhalations, chloral, potassium bromid, and morphin. Artificial respiration may be needed.

329. Electrotherapeutics.—There is no place in the treatment of this disorder for electricity unless in those cases that survive but remain exhausted and paretic. Restoration to normal vigor and function may be aided by the stimulating action of electricity on nutrition.

PLUMBISM.

330. Nature and Pathology.—We have considered plumbism, or lead-poisoning, as a cause of peripheral neuritis. Its first effects are usually first seen in the nerve-affection, but a more prolonged exposure or a more intense saturation of the system with the poison causes derangement of the tissues of the central nervous system, both of the spinal cord and brain. Post-mortem examination has given evidence of lead in the brain-tissue. Chronic meningeal changes occur; there is brain atrophy, and atrophy of the optic nerve with evidences of interstitial neuritis are seen. Degeneration of the cells in the anterior horns of the spinal cord takes place. There is increase of connective tissue and thickening of the walls of the vessels.

331. Symptoms.—Aside from the symptoms that arise from the inflammation of the peripheral nerves that always attends lead-poisoning to a greater or less degree, and has been fully described elsewhere, there are symptoms that depend on the impairment of nutrition of the central nervous system. A general anemia and evidences of general disturbance of nutrition are first noticed. There is general muscular weakness. A blue line on the gums close to the teeth is observed. Severe abdominal pains occur. There is constipation, vomiting, retarded pulse with increase of arterial tension. Endocarditis may occur. Some chronic cases show degeneration of the cardiac valves. Gout develops in middle or later life. Kidney disease may be present, or, without actual disease of the kidneys, the urine may contain albumin. As a rule, the temperature is normal, but occasionally there is an elevation. The cerebral symptoms are a general cephalalgia, vertigo, tinnitus, hysteria, hallucinations of hearing and of sight, diplopia, restlessness, and insomnia. Delirium with acute mania may develop, or conditions resembling general paresis. Melancholia with delusions is not infrequent. These disturbances may be preliminary to general cerebral or spinal affections of more pronounced or degenerative character. Hemiplegia may occur, with rather more serious loss of sensation than of motion. Chronic or subacute poliomyelitis of the cord with sclerosis of the columns at times takes place.

332. Treatment.—Removal of the patient from the conditions that led to the poisoning is the first step, and then the elimination of the lead from the system, by the use of magnesium or sodium sulfate and potassium iodid and sulfur baths, strychnin, nitroglycerin, and nitrite of amyl will assist in maintaining the nutrition of the central nervous system. Iodid of iron, the phosphite of zinc, arsenate of iron combined with the bitter tonics will need be employed to promote nutrition. Opium in some form may be required to allay pain, either cerebral or abdominal.

333. Electrotherapeutics.—The various forms of electricity are of much service both in aiding elimination of the

poison and in restoring the normal vigor of nutrition. The anaphoric use of the direct current can be employed with great benefit in the treatment by means of the sulfur baths. The general application of the direct current through the head and spine assists in quickening the catabolism by which elimination is brought about and the nerve-centers furnished with better nourishment. The induction-coil current is an aid to the local as well as the general nutrition of the impaired and wasted muscular tissue. The static insulation, high-tension, auto-induction, and alternating magnetic fields may be employed with advantage in promoting the vigor of nutrition in all the enfeebled tissues.

ALCOHOLISM.

334. Nature and Pathology.—As is the case in plumbism, the central neurons suffer, as well as the peripheral nerves, from the effects of alcoholism. In the acute form of alcoholism, the central nervous system shows disturbance of nutrition of the cells of the cortex and of the medulla. There is little, however, in the way of pathological change that can be demonstrated except congestion, and in some cases indications of acute meningitis. In the chronic forms, the tissue changes are more marked. There are evidences of pachymeningitis, either simple or hemorrhagic. The vessels show atheromatous patches. The cortical cells and association fibers are degenerated. The spinal cord may exhibit inflammatory changes.

335. Symptoms.—The defective nutrition caused by alcohol gives rise to a variety of premonitory symptoms before any acute disorder or permanent breakdown of the brain takes place. The sleep is disturbed by bad dreams, there is loss of appetite, restlessness, the pulse is small and frequent, and the temperature is elevated, ranging from 103° to 105° F. Acute alcoholism causes a tremor of the muscles of the face, tongue, and extremities. Ataxia affects the muscles of the upper and lower extremities, and also of the eyes, causing vertigo. The reflexes are lost. There is mental excitement with hallucinations of sight and hearing, or sensory disturbances causing illusions of insects or reptiles crawling over the body. There is delirium,

with constant talking to imaginary persons. Versatility of false ideas is quite characteristic. Stupor or coma may come on with stertorous breathing. From this, the patient can usually be roused, but soon returns to unconsciousness. The pupils usually react to light, but may be abnormally contracted or dilated. The skin is cool, clammy, and anesthetic. Vomiting may occur. Death may result from syncope, or convulsions may set in, ending in death, or the coma may change to a natural sleep and the case may recover. In the chronic form there is irritability, restlessness, disturbed sleep, with mental debility tending toward dementia. There are sudden starts of the body, muscular tremor of the lips, tongue, and hands. The mind is prone to delusions of persecution, dread of poisoning, and suspicions of infidelity on the part of husband or wife. Epilepsy may result from meningeal trouble.

336. Treatment.—In the acute attack, sedatives and some physical restraint may be necessary. The patient should be kept as quiet as possible. The cold-sheet pack and cold to the head may accomplish both of these objects. Abstain from the use of alcohol. Give liquid food at short intervals, to which digestive preparations, as pepsin, peptenzyme, or lactopeptin have been added. The bromids, chloral, hyoscin, Indian hemp, or opium may be effective as sedatives. Trional, sulfonal, or paraldehyde assist in securing sleep. The circulation will need to be sustained by the use of strychnin, digitalis, strophanthus, and remedies of like nature.

In the chronic form, the continual craving for alcoholic stimulants will require to be counteracted by the use of bitter tonics such as gentian and nux vomica. Nourishing diet with digestive aids should be carefully prepared. Nerve-tonics, as strychnin, the phosphates of iron, quinin, and zinc will be needed for a prolonged period. The temporary or occasional use of hydrochlorate of cocain may be serviceable.

337. Electrotherapeutics.—In the acute stages, electricity is not indicated in any form. In chronic alcoholism, such modalities as act in improving the general nutrition are of service.

MORPHINISM.

338. Nature and Pathology.—The chief effects of a prolonged or habitual use of morphin are witnessed in defective action of the central nervous system. There are no known structural changes due to this cause, but the function of the cortex cells, especially, is much deranged.

339. Symptoms.—The sensory symptoms are those of diffuse neuralgic pains, vesical and rectal tenesmus, and an inconquerable longing for morphin. The motor symptoms are muscular weakness and tremor, increasing, as the use of the drug increases, to ataxia and paresis. There is generally an unstable condition of the nervous system. Mentally there is lack of energy, apathy, vacillation, and procrastination. The will-power is lost and the patient becomes forgetful, unreliable, and untrustworthy. His moral nature becomes degraded so that to procure the drug he will not hesitate to lie or steal. Any great excesses may give rise to acute maniacal symptoms, hallucinations, and delusions of persecution. On withdrawal of the drug, there is intense anxiety, insomnia, dread of impending evil, restlessness, maniacal manifestations or depression, and thoughts of suicide. Ultimately, a form of dementia is reached, with chronic delusions of persecution. The pupils are usually contracted. There is constipation or diarrhea. The general nutrition fails and emaciation results. The pulse is rapid and compressible. Profuse sweating occurs. Trophic changes, such as edematous swellings and abscesses, take place.

340. Treatment.—The withdrawal of the drug is imperative. It must be done either (1) immediately, (2) rapidly, that is, within a few days, or (3) gradually, by daily decreasing the dose. Each of these methods may be successful. The diet and digestion will need attention. The depressed circulation must be sustained by digitalis, strychnin, strophanthus, and other suitable cardiac tonics. Institution treatment and management is usually required for these cases.

COCAINISM.

341. Nature and Pathology.—Locally applied, the hydrochlorate of cocain causes almost immediate paralysis of both sensory and motor nerve-tissue. When introduced into the blood, it generally, at first, produces some cerebral excitement. Its prolonged or habitual use results in a degeneration of the coats of the arteries, and defective nutrition of the cortex of the brain, medulla, and spinal cord.

342. Symptoms.—The primary effect of a sufficient dose of cocain is to cause cerebral excitation, the person becoming lively in manner and apparently brilliant in conversation, from the lack of inhibitory control. The pupils are dilated, the pulse becomes rapid and feeble. Profuse sweating occurs. The continuous use of the drug brings about a loss of mental and moral control, a disregard of the passage of time, hallucinations of the special senses of sight, hearing, and smell. Delirium and delusions of persecution are likely to develop. The disorder may end in some form of insanity, as paranœa.

343. Treatment.—The treatment consists in withdrawing the drug, either at once or gradually, and restoring the weakened nutrition of the nervous system by the use of the phosphates of iron, quinin, and strychnin, sulfate of strychnin, the oxid of zinc, or the arsenate of iron with nux vomica. Digitalis, spartein, or strophanthus may be needed as cardiac stimulants.

In the treatment of any one of these debilitating drug-habits, whether it be alcoholism, morphinism, or cocainism, hydrotherapeutics and massage are most helpful in assisting the removal of effete matters and restoring normal nutrition, while electrotherapeutics, in the form of general faradism, general direct-current treatments (general galvanism), the static insulation or breeze, the autoinduction currents of the high-tension apparatus, or the alternating magnetic fields, would be serviceable adjuncts to the medicinal and moral measures that are found necessary.

CIRCULATORY DISORDERS.

344. The more important of the disturbances of the brain that occur in connection with the meningeal or cerebral vessels are hyperemia, anemia, aneurism, embolism, thrombosis, meningeal hemorrhage, and cerebral hemorrhage.

HYPEREMIA.

345. Nature and Pathology.—A congestion of the cerebral blood-vessels, acute or chronic, active or passive in nature, is not of uncommon occurrence. It is seldom primary in origin, but dependent on impairment of vasomotor innervation often due to toxemia. Cerebral neurasthenia is usually attended by a passive hyperemia. The capillaries are distended throughout the cortex and centrum ovale. Some extravasation of the blood-serum appears to result at times, and perhaps the escape of corpuscles takes place to a slight degree. Proper nutrition of the cerebral structure is so much impaired as to derange function, but the symptoms indicate that structural changes are slight and evanescent. When serious or permanent changes in cerebral structure occur, it shows that the pathological process has progressed beyond a simple hyperemia.

346. Symptoms.—Acute cerebral congestion causes heat in the head and face, throbbing of the temporal and carotid arteries, buzzing of the ears, and headache. The countenance may be purplish red in color, and the conjunctiva congested. There may be some fever. Considerable psychical excitement is usually present, with photophobia, vertigo, nausea, hallucinations, illusions, nocturnal delirium, irritability, or there may be somnolence with mental dullness. The attacks may take a convulsive form with epileptic attacks followed by temporary unconsciousness. Symptoms of hemiplegia may ensue, occasioning pseudo-apoplexy, not followed by the permanent disabilities due to cerebral hemorrhage. The chronic or passive

form has symptoms similar in nature, coming on less suddenly and continuing over a longer period.

347. Treatment.—When the condition arises from an autotoxemia, elimination, proper diet, and exercise will do much to correct it. In the acute attack, elevation of the head, cold applications to the head, hot foot-baths, sinapisms to the feet and back of the neck, dry-cupping or leeches to the temples, and mastoid processes or cathartics will be serviceable. Rest and quiet should be enjoined.

Lithium, sodium salicylate, colchicum, potassium iodid are indicated where there is a gouty or rheumatic diathesis. Aconite, digitalis, veratrum viride, belladonna, or hyoscyamus may be needed to regulate the circulation. The bromids or coal-tar preparations will relieve the headache.

348. Electrotherapeutics.—The general nutritional defects will require the use of those electric modalities that tone the nutritive functions and bring about a more normal action. The sedative application (positive pole to the head) of the direct current will often bring relief. So, also, the current from the secondary coil of the induction-apparatus. Vasomotor control is brought about by the static insulation; and the congestion is often promptly lessened in this manner, thus relieving the headache and other distressing symptoms, while if the hyperemia is due to defective nutrition, this is likewise modified beneficially by this and other forms of electric action, and permanent benefit results.

CEREBRAL ANEMIA.

349. Nature and Pathology.—Cerebral anemia is at times due to a neurosis of the cerebral vessels, resulting in a prolonged stimulation and contraction of the small arteries, due to irritation of the local vasomotor centers.

The causes that produce acute cerebral anemia are not well known. It is not often a primary disorder. In chronic states of cerebral anemia there may be degeneration of the nerve-cells and vessels. Some effusion of serum takes place. Blood-disorders, such as chlorosis or pernicious anemia, or excessive

loss of blood from hemorrhage, may cause cerebral anemia as a part of the general condition.

350. Symptoms.—The acute symptoms of cerebral anemia are paleness of the face, cold perspiration over the face and body, mental confusion or apathy, dizziness, nausea, ringing in the ears, vomiting, spots before the eyes, things look black, the pupils are at first contracted, then dilated, and there is dullness and drowsiness with some headache. The pulse is small and rapid, the heart-action is weak. When a large quantity of blood has been lost there is complete loss of consciousness, generalized spasms may occur, the pupils are dilated, and the reflexes annulled.

Acute attacks of cerebral anemia often occasion syncope. This may be the result of a temporary spasm of the cerebral vessels as a result of defective cardiac action or a reflex effect of strong emotion. Painful sensory impressions, terror, or anxiety may result in this manner.

Chronic anemia of the brain is more common as a result of general conditions impoverishing the blood, as chlorosis or pernicious anemia, or after repeated hemorrhages. The symptoms are heaviness of the head, drowsiness, apathy, ringing in the ears, impaired memory, vertigo, syncope, and sleeplessness. The patient is relieved by the reclining position.

351. Treatment.—When the condition is acute the patient should be kept in the horizontal position with the head even lower than the body. Bandaging of the extremities will still further increase the amount of blood in the brain. Stimulants, as spirits of camphor, ether, ammonia, or amyl nitrite may be needed to excite the cardiac action. When the condition is more chronic and dependent on general anemia, or constitutional or local defects, the treatment must be of a nature that will correct or counteract these causes.

352. Electrotherapeutics.—The induced current may be used as a powerful cardiac excitant in acute cases of cerebral anemia, either by direct application to the cardiac region, to the cervical spinal centers, or to the medulla. Vitiated blood-states and feeble nutrition, which are conditions attending

chronic cerebral anemia, are benefited by the use of general applications of induction-coil currents, by the static insulation and friction, spark, and by general galvanism.

ANEURISM.

353. Nature and Pathology.— Dilatation of one or more of the cerebral arteries may occur as the result of trauma, endoarteritis, primary defect in structure, or embolism. The resulting tumor is often minute in size, and of these there may be many in the course of the same vessel. Single aneurisms are never large in this locality, seldom exceeding the size of an English walnut. In shape they may be round, oval, or fusiform. The damage they cause to surrounding cerebral and other structure is determined by their location. The pressure caused by them may erode bone, compress the cerebral structure or the cranial nerves, and cause softening, atrophy, and degeneration. The aneurism may rupture and the hemorrhage occasion compression and destruction of the contiguous cerebral tissue.

354. Symptoms.—There are certain general symptoms that may arise as the result of cerebral aneurism, especially if it has dilated so as to cause much pressure. Among these are headache, which is usually of a pulsating nature, either continuous or paroxysmal, mental dullness or irritability, giddiness and possibly convulsions. Occasionally a murmur or bruit may be detected on auscultation. Motor or sensory paralysis, due to compression of the cranial nerves, or certain centers or tracts of the brain will usually serve to locate the lesion, and the symptoms vary greatly in accordance with this location. Aneurisms may form in the course of any one of the cerebral arteries, but those most commonly affected in this manner are the internal carotid, the vertebral, the basilar, the posterior middle, or anterior cerebral, and the posterior communicating.

355. Treatment.—The treatment of cerebral aneurism is the same as for aneurism elsewhere when the dilated portion of the vessel is not directly accessible. The internal carotid, or

vertebral artery, may be tied. All causes that tend to elevate blood-pressure should be avoided, such as stooping or severe muscular exertion. Violent emotions or stimulants that excite the heart-action are injurious. The bowels should be kept open. Some benefit appears to follow the use of potassium or sodium iodid. The injection of a solution of gelatin or the direct application of anodal electrolysis to the aneurismal sac, which have been successfully practiced on thoracic and other aneurisms within recent years, are not applicable in the majority of cases of cerebral aneurism because of their inaccessibility. Neither is there any place in this disorder for the use of electrotherapeutics in any other form.

EMBOLISM.

356. Nature and Pathology.—The complete or partial obstruction of a cerebral artery by means of a fragment separated from the cardiac valves or cavities as the result of endocarditis, atheroma of the arteries, or specific endoarteritis, may give rise to thrombi, and these in turn may disintegrate and form emboli. Certain diseases, such as the acute infectious fevers, phthisis, and pyemia favor coagulation of the blood, and may form thrombi, while the vessel walls remain intact. Chlorosis, leucocythemia, and cardiac weakness, causing retardation of the blood current, are conditions favoring the formation of thrombi.

Emboli are usually arrested at the bifurcation of an artery, most commonly in the middle cerebral artery and its branches, especially the left. Next, in frequency, the left vertebral is affected, and occasionally the internal carotid and deep cerebral. Emboli may be firm and colorless and become adherent to the vessel's wall, or they may disintegrate and the particles carried away by the blood-current to obstruct still smaller vessels, or to meet with still further disintegration and removal. Not infrequently a thrombus may form by coagulation of the blood at the seat of an embolus, and by the disintegration of such thrombi secondary emboli may be produced. In certain cases emboli or thrombi may contain micro-organisms that create

their specific foci of inflammation at the points where they are arrested. Closure of the lumen of an artery causes softening of the corresponding cerebral area, when collateral circulation cannot take place. As many of the cerebral arteries, especially those supplying the white substance of the interior of the brain, are terminal arteries, softening of the cerebral structure is a common result of embolus or thrombus. The region that is thus rendered anemic, or is deprived of its blood-supply, is surrounded by an area of engorgement where, by reason of the congestion of contiguous vessels to this area, the tissues become swollen, and minute hemorrhages may occur. If blood-stasis takes place in the obstructed area, a red softening results, which later becomes yellowish or white by changes in the blood-constituents and by absorption. The final result may be a cicatrix or a cyst at the seat of the necrosed area. Or, if the embolus contained microbes, a local encephalitis may occur or an abscess form.

357. Symptoms.—Occasionally there are premonitory symptoms of embolus, such as headache, vertigo, some disturbances of circulation, prickling feelings in the limbs, or a sense of numbness over certain peripheral areas.

The onset is sudden, often with spasm and immediate loss of consciousness. The coma is usually more transient than in hemorrhage; giddiness or delirium may take the place of loss of consciousness. Some form of aphasia is usual if the embolus has invaded the left middle cerebral artery. On examination a flaccid paralysis of one leg, arm, or side of the face may be found. Conjugate deviation of the head and eyes may be observed, or it will be found that there is hemianopsia or hemianesthesia. Later, the tendon reflexes are exaggerated on the affected side, there is more or less permanent hemiplegia or monoplegia, and other disorders of movement, choreoid or athetoid in character, are likely to develop. Indications of mental failure usually ensue, such as loss of memory and emotional disturbances.

358. Treatment.—All influences leading to endocarditis, as rheumatism, infectious fevers, etc. should be counteracted

by appropriate remedies. The action of the heart and circulation should, when weak, be strengthened by the use of strophanthus, cactus, digitalis, and kindred remedies, or if the arterial tension is high, aconite, veratrum, or nitroglycerin should be used. In plethoric persons, local blood-letting is helpful.

At the time of the attack the patient must be kept at rest, and heat should be applied to the feet and trunk, with sinapisms to the back of the neck. It is well to administer a quick-acting cathartic, and the depression may require a stimulant. Ammonium carbonate, both as a stimulant and with a view of increasing the alkalinity of the blood, is a suitable remedy. The action of the heart, bowels, and kidneys should receive attention, and the bladder should be evacuated, if need be, by means of a catheter.

A light diet should be enjoined for some time following the attack. The patient should be kept quiet and not allowed to put forth much effort, either mental or physical. Threatened inflammation should be met by ice to the head, phenacetin, aconite, and bromids. Cleanliness must be observed to avoid bed-sores. Later there will be need of tonics, such as quinin, strychnin, hypophosphate of soda. It would be well, for a time, to use potassium or sodium iodid.

359. Electrotherapeutics.—After a few weeks, massage, and electrotherapeutics in the form of induced currents, should be used in the treatment of the impaired muscular areas. The negative electrode of the direct current, applied with a current-strength of from 20 to 30 milliamperes over the area of the cortex in which defective nutrition has occurred, has appeared, in some instances, to aid the removal of debris and the more complete and rapid recovery of function.

THROMBOSIS.

360. Nature and Pathology.—The conditions that give rise to *thrombosis* are, in most instances, similar to those that cause embolism. Disease of the arterial walls or changes in the blood, or both, are the most frequent causes. Traumatism often gives rise to the formation of thrombi in the cerebral

arteries and sinuses. Septic fevers and infectious diseases, changing the character of the blood and impairing the nutrition of the vessels' walls, favor the formation of thrombi. Syphilis may create such changes in the vessels' walls as to cause a thrombus to form.

361. Symptoms.—Premonitory symptoms are rather more common than with embolus. They may exist for months previous to the onset of acute symptoms. They consist of dull general headache, giddiness, local tingling, or numbness, a slight weakness in one-half of the body or in one limb, which may or may not be the seat of later paralysis. There is likely to be some mental dullness, somnolence, transient aphasia, impairment of memory, or irritability. Occasionally there is severe headache.

The onset of obstruction to the cerebral circulation is usually gradual, though at times it may be sudden. Loss of consciousness in the beginning is rare. In other respects the symptoms very closely resemble those of embolus.

362. Treatment.—The treatment of this disease is similar to that for embolism.

MENINGEAL HEMORRHAGE.

363. Nature and Pathology.—Hemorrhage may take place from some one of the meningeal vessels, due either to injury or diseases of the vessels' walls. The middle meningeal artery, because of its wide distribution over the lateral surface of the cranial vault, is most frequently the seat of injury, and disease quite as frequently attacks this vessel as any other. Either the arteries or the veins, or both, may be the source of the hemorrhage. The escape of blood may be either supradural or subdural. The supradural hemorrhages are most frequently due to injury or disease of the cranial bones. The majority of subdural hemorrhages are the result of degenerative changes in the vessel itself.

The current of blood that is poured out is dependent on the size of the vessel involved and the location. A considerable hemorrhage may occur from a rupture of the middle meningeal

artery, and the blood may cause compression and flattening of the convolutions. Hemorrhage from the choroid plexus or vessels at the base of the brain may extend into the ventricles, accumulate in the sulci at the base, or penetrate into the sheaths of the optic, or other cranial nerves, or down the spinal canal, causing compression.

364. Symptoms.—The symptoms are variable, according to the location and extent of the hemorrhage. If the hemorrhage is caused by disease of the vessels, there may be some premonitory signs such as headaches, vertigo, temporary weakness, or paresis of the limbs. There are no necessary distinctions between hemorrhages that are extradural and those that are subdural. In both cases they are at first irritative and then depressive. If the hemorrhage causes considerable instantaneous compression, the symptoms of depression are the most pronounced. There may be pain, headache, photophobia, extreme sensitiveness to noises, variation in the size of the pupils, the one corresponding to the injured side of the head dilated, the other contracted; convulsions or rigidity of one or both legs, or arms, or hemiplegia; aphasia with impaired consciousness, somnolence, perhaps coma, may ensue. The pulse is at first slow, later it may be quickened. The respirations are slow, labored, or stertorous. The temperature may at first be subnormal, later it will rise, and in critical cases it may run very high. Vomiting may occur, and the bowels and bladder be involuntarily evacuated. In moderate hemorrhages, the tendon reflexes are usually exaggerated, but when the hemorrhage is considerable and the depression great, they are lessened or lost. In later stages, if partial recovery takes place, the tendon reflexes are excessive.

CEREBRAL HEMORRHAGE.

365. Nature and Pathology.—The same causes that give rise to meningeal hemorrhages are productive of hemorrhage within the brain. They are chiefly traumatism and disease of the vessels' walls. The latter is perhaps the more frequent causation of hemorrhage from cerebral vessels. Minute

hemorrhages may result from the formation and rupture of miliary aneurisms, or atheroma may obstruct the blood-current and weaken the vessels' walls until the coats finally give way, and a hemorrhage of greater or less amount takes place.

The escaped blood is likely to tear the cerebral tissue and leave a coagulated mass of blood corpuscles, debris of nerve elements, and other tissue. Edema of the soft parts surrounding the mass takes place. If the patient lives, much of the coagulated mass disintegrates and is absorbed. In some cases, an encapsulating wall is formed about it, and this may fill with serum and form a cyst. The absorption at times is so complete as to leave nothing but a scar at the seat of the hemorrhage. As secondary results, the tracts of the brain damaged by the hemorrhage degenerate and become sclerosed.

366. Symptoms.—These, as in meningeal hemorrhage, may be (1) premonitory, (2) apoplectic, (3) postapoplectic, and (4) a period of persistent symptoms. Among the premonitory signs are epistaxis; flushing of the face; a feeling of fulness in the head; spells of dazing, vertigo, dull pains or peculiar sensations in the head; numbness, tingling or weakness in the arms or legs; irregular action of the heart; monochoreic or hemichoreic movements, emotional outbreaks; ringing in the ears; insomnia; bad dreams; loss of memory for words; and the like.

A sudden fulness, pain in the head, and dizziness accompanied by vomiting or convulsions, may usher in the attack. The disturbance of consciousness may vary from slight vertigo to deep coma, according to the location and extent of the hemorrhage. The attack often takes place during sleep. On examination, the patient is found hemiplegic or monoplegic, with disturbances of the eye movements and pupillary reflex. The face may be flushed, pale, or pinched. The muscles of the trunk and limbs are soon relaxed, all the tendon reflexes are lost. The heart-action may be slow and the pulse hard and full, or quick and feeble with a scarcely perceptible pulse. The respirations are usually slow and stertorous. Involuntary discharges of feces and urine take place. The urine may contain

traces of albumin or sugar, temporarily, without there being kidney disease or diabetes. The temperature, at first subnormal, soon rises above normal.

When the patient is rendered comatose this may last from several hours to a day, and then, if the issue is not fatal, there is gradual return to consciousness accompanied by some headache or delirium.

In the postapoplectic stage, the patient returns to consciousness and gives evidence of understanding, though some form of aphasia is likely to remain. The temperature returns to normal. Some paresis or paralysis is found, often a hemiplegia.

The permanent, or chronic, stage results in more or less motor disability with some numbing of sensibility. A hemiplegia or hemiparesis is the result of the damaged pyramidal tracts, and the injured sensory paths cause hemianesthesia, paresthesia or hyperesthesia of certain areas. As a result of the injury to the nerve-elements, degeneration with rigidity and contractions of certain muscle groups occur, due to a lack of cerebral control. The tendon reflexes are increased and spasmodic, athetoid, or choreic movements in the muscles may develop. A tremor is noticed occasionally. Tropic changes of a variety of forms ensue, such as edema of the affected parts, the temperature is lowered, as compared with the normal side. Vasomotor changes with cyanosis, and a moist and clammy condition of the skin or increasing growth of hair on the impaired area are often present.

The mental condition is likewise changed. The mind is afterward weakened. The memory fails. Emotional outbreaks are frequent. The patient often suffers from insomnia. Epilepsy and even insanity may result.

367. Treatment.—The treatment of both meningeal and cerebral hemorrhage can be considered together. When the cause has been a traumatic one the treatment is of necessity surgical. Even when the hemorrhage has been caused by diseases of the vessels, there are instances where a surgical operation to remove the clot and close the ruptured vessel will be the wisest course. This is possible only when the symptoms

permit the location of the clot to be fixed, and the location is accessible. The damage to the cerebral structure can, within these limits, oftentimes be very greatly mitigated by judicious surgical treatment.

For persons predisposed to cerebral hemorrhage there are prophylactic measures that should be observed. The life should be tranquil; the diet nutritious, but light; coffee, alcohol, and all stimulants should be avoided; diuretics and saline aperients should be given at frequent intervals; the exercise should be regular but moderate, both outdoors and indoors; severe muscular exertion must be avoided.

At the time of attack the patient must be kept quiet, free from all excitement, in bed, with the head and shoulders elevated. Catheterize the bladder and empty the bowels by enema, later by elaterium, calomel, croton-, or castor-oil. Maintain cleanliness, cold to the head, and heat to the feet, and sinapisms to the nape of the neck. If the pulse is full and the arterial tension high, veratrum virid or aconite may be given; or, if there is much depression, the aromatic spirits of ammonium or ammonium carbonate in some other form. Later, potassium or sodium iodid may be given with the view of aiding the removal of the coagulum.

368. Electrotherapeutics.—Electricity, in any form, is of little service in meningeal or cerebral hemorrhage, except to aid in the removal of the debris or to assist in the restoration of the functions of the damaged neurons. There is reason to believe that the use of the cathode of the direct current over the seat of the hemorrhage is of some service in disintegrating the coagulum and securing more complete absorption. This may be done daily for 10 or 15 minutes with a density of current of 1 milliampere to a square centimeter of surface. Within 2 or 3 weeks after the attack, electric stimulus, either in the form of the cathode of the direct current or the induction-coil current, should be applied to the nerves and muscles that are paretic or paralyzed with a view of restoring their function, or, at least, of maintaining them in the most responsive state until the nutritive processes have had time to clear up the

debris in the brain. Secondary degenerations are, no doubt, prevented by such electric treatments, when they are judiciously given in connection with massage and suitable hydrotherapeutics. For the stimulation of sensory areas that have been rendered anesthetic, the faradic brush or static friction spark are very efficient remedies.

INFLAMMATIONS.

369. It will be impossible within the limits of a Paper of this size to give a full discussion to all the varieties of inflammation that are known to attack the brain or its membranes. We must content ourselves with the selection of a few typical forms, such as are of most frequent occurrence. From the symptoms, pathology, and treatment of these the reader may gather those general principles that will guide him in the recognition and management of those varieties that are less commonly met with.

The following are the forms of inflammation with which we are most familiar involving the intracranial structures:

Pachymeningitis.

- External { Acute. / Chronic.
- Internal { Purulent. / Serous. / Hemorrhagic.

Leptomeningitis.

- Simple { Acute. / Chronic.
- Simple { Serous. / Purulent.
- Tubercular.
- Syphilitic.
- Cerebrospinal.

Encephalitis.

- Acute (non-suppurative).
- Chronic (interstitial).
- Suppurative (brain abscess).

PACHYMENINGITIS EXTERNA.

370. The acute form of external pachymeningitis occurs as a result of injury to the skull, and its treatment is wholly surgical.

CHRONIC PACHYMENINGITIS EXTERNA.

371. Nature and Pathology.—This form of inflammation is rarely a primary affection, but is an extension from inflammation involving the bones of the skull or its envelopes. In some instances, the inflammation has resulted in supplying plastic exudates, and organization of this with a thickening of the dura, and adhesion of it to both the skull and pia mater has taken place. In such cases the cranial bones at the seat of inflammation are thickened and the diploe has disappeared. In other cases, the conditions are such as to favor a formation of pus, which is diffusely infiltrated in the outer layers of the dura. Other cases have been observed where the process of absorption has gained ascendency and the cranial bones have become thinned while the dura is intimately adherent to the bone, and on its inner surface are seen numerous reddish granulations. In this inflammatory process in the external layers of the dura there is redness and edema of the tissues, which become swollen as they are infiltrated with blood-serum and the new formed corpuscles. The death or organization of these new elements determines the character of the inflammation.

372. Symptoms.—The onset is gradual with local headache, fever, nausea, vomiting, some mental obtuseness, with, perhaps, delirium. At times there are convulsions with subsequent paralysis. Unconsciousness deepening into coma indicates an extension of the inflammation and pressure due to its products.

373. Treatment.—The symptoms may be so localized as to indicate trephining or active counter-irritation by blistering or the cautery. The bowels should be opened freely, the bladder kept from over-distension. The strength of the patient must be maintained by nutritious diet in liquid form in small quantities at frequent intervals. When there is reason to believe that the inflammation has subsided, such means as will

remove the inflammatory debris and aid in the restoration of impaired function should be kept up for a prolonged period. In this, much assistance may be rendered by the use of the direct and induced currents of electricity.

PACHYMENINGITIS INTERNA.

374. Nature and Pathology.—Three forms are met with, the purulent, the serous, and the hemorrhagic. *Purulent pachymeningitis* is of septic origin. Unless the inflammation has extended to and involved the pia mater, the purulent deposit, which is seldom very extensive, is confined to the inner layer of the dura. In *serous pachymeningitis* there is an accumulation of serous exudates in the arachnoid space that may be so extensive at times as to compress the cerebral convolutions and expand the cranium, causing what has been termed external hydrocephalus.

The *hemorrhagic* form, which is known by many names, such as hematoma, meningeal blood-tumor, arachnoid cyst, etc. appears, at times, to have been primarily a hemorrhage that became encapsulated. At other times, the inflammation precedes, causing a newly formed connective tissue stroma, quite vascular, into which a hemorrhage or a succession of hemorrhages takes place. The final result is a succession of layers of extravasated blood that are partially organized and encapsulated by a connective tissue stroma adherent to the dura mater. The accumulation is such, in some instances, as to greatly compress the adjoining cerebral structure. This form of inflammation is prone to affect persons suffering from cerebral diseases of a chronic inflammatory nature as *paralytic dementia*, *chronic hereditary chorea*, and *senile dementia*. It is often observed in *chronic alcoholism*. In those diseases produced by a hemorrhagic diathesis, such as pernicious anemia, leucocythemia, scurvy, and purpura are likely to occur. It is also incident to childbirth in cases where there is both injury and blood dyscrasia.

375. Symptoms.—In the purulent form of pachymeningitis there is headache, vertigo, septic fever, drowsiness, spasms, rigidity, pupilary changes, pressure, paresis, or paralysis.

In the *serous* form, in addition to the pressure and irritative symptoms, there is likely to be some enlargement of the head, since this form of the disease occurs most commonly in the young before the sutures are closed. There are irregular periods of pyrexia and redness of the scalp. Sometimes the mental deficiency is quite marked, and in children there is often an associate enlargement of the spleen.

The onset of the hemorrhagic form is often very insidious, the symptoms that might call attention to the condition being masked by the other pathological conditions present in the case. There are instances, however, where the onset resembles an apoplectic attack. Headache, somnolence, vomiting, and pupilary changes may be followed by loss of consciousness deepening into coma. There may be epileptic attacks, paresis, hemiplegia or diplegia, nystagmus, choked disk, optic neuritis, conjugate deviation of the eyes or aphasia. These symptoms are somewhat paroxysmal and periodical in their occurrence, but repeated formation of the hemorrhagic layers will, in many instances, result in profound paralysis, coma, and death.

376. Treatment.—In the treatment of the several forms of pachymeningitis, we are to be guided by the symptoms and indications in each case. In general, it may be said that rest in bed with the head elevated and the patient guarded from disturbing light and sound are precautions always to be observed. Also, the bowels should be acted upon by calomel, castor-oil, or some equally efficient means. Cold to the head in some cases is helpful, and where the patient is plethoric, leeches to the mastoid or temporal regions, or other means of blood letting, may be advisable.

In the *serous* form, relief from pressure may be gained by lumbar puncture, which may also serve to confirm the diagnosis. In the hemorrhagic and also, at times, in the purulent form, benefit may follow a surgical operation.

When the patient survives the attack and the efforts are directed to restoring impaired functions caused by the disease, electrotherapeutics is of signal service, but there are no indications for it in the stages of the inflammation.

LEPTOMENINGITIS.

377. Nature and Pathology.—Acute simple inflammation of the pia mater is generally diffuse in distribution. Though found, especially, upon the convexity and the base of the brain, it is not necessarily confined to one of these areas. The intimate relationship of the pia mater to the brain-tissue causes the latter to be involved in most inflammations of this membrane, so that the proper designation in most cases would be meningocephalitis.

There are some cases of acute leptomeningitis in which at the autopsy a cloudy appearance of the pia and arachnoid with congestion of the meningeal vessels and some softening and tumefaction of the cerebral structure are the only noticeable pathological changes.

378. In the *purulent* form the membranes are covered with a layer of greenish-yellow or whitish-yellow pus at the convexity or at the base of the brain, or both. The exudate may extend down the cord as far as the cauda equina. Pus is found in the sulci, around the nerve roots, and along the veins. The ventricles may be dilated and filled with turbid fluid. Rarely, the inflammation is limited to the ventricles. The surface of the brain is often softened and edematous, the convolutions are flattened and capillary hemorrhages occur in the brain substance. Purulent meningitis is caused by organized carriers of infection. The pneumococcus of Fraenkel and the meningococcus of Weichselbaum are both credited with causing the disease, and by their inoculation in animals meningitis has been produced. Streptococci and staphylococci have also been found in the exudate. The micro-organisms may reach the membrane from contiguous purulent foci or through the blood or lymph from a general infection or distant foci.

379. A *serous* form of exudate is most common in patients that have been addicted to the use of alcohol, or in infants or young children where a perverted increase of cerebrospinal fluid or some interference with its normal distribution has occurred by reason of obstructive adhesions in the ventricles or arachnoid spaces.

Such excess of serous exudate, especially in the young, causes dilatation of the ventricles, flattening of the convolutions, and separation of the cranial bones, occasioning enlargement of the head (internal hydrocephalus).

380. Symptoms.—It may be found convenient to group the symptoms as they occur in the prodromic, irritative, and paralytic stages of the disease. Among the prodromic symptoms may be mentioned: malaise, hebetude, headache, languor, vertigo, irritability, peevishness, loss of appetite, vomiting, chills, and fever.

During the irritative stage these symptoms are more constant and pronounced. The headache is severe, there is hyperesthesia of the skin and of the special senses, restlessness, delirium, even maniacal excitement, rigidity of the neck, retraction of the abdomen, nausea, vomiting, irregular fever, the temperature varying in a few hours over a wide range; ordinarily it is 102° to 103° F., but it may drop to 99° or reach 107°. The pupils are contracted or unequal. There may be optic neuritis or local paralysis of the cranial nerves. The pulse may be slow, rapid, or intermittent. The respirations are quickened and irregular. The tongue is furred, the bowels constipated, the urine albuminous and scanty with retention. At times the urine contains sugar.

The onset of the paralytic stage is indicated by moodiness, obtuseness, somnolence, apathy, stupor, or coma. The pupils dilate, there is trismus and rigidity of the muscles of the trunk and limbs until near the end. The skin becomes moist, there is rapid general emaciation, herpetic eruptions, and bed-sores form, and there are involuntary evacuations from the bowels and bladder.

It is possible by means of the character or preponderance of symptoms to determine whether the inflammation involves the membrane at the convexity or the base of the brain. Usually in inflammation of the convex surface, delirium, convulsions, and paralytic symptoms are prominent with mental dullness, some form of aphasia, and hemianopsia. When at the base, the delirium is less, the mental disturbance is less, vomiting

and retraction of the head are more frequent, and irritation or paresis or paralysis of some of the cranial nerves with signs of optic neuritis occur.

381. Treatment.—Since the treatment of all forms of leptomeningitis differs but little, it will be left until the close of the discussion of the remaining varieties.

CHRONIC LEPTOMENINGITIS.

382. When we exclude the syphilitic and tubercular forms, which will receive special mention, chronic leptomeningitis is a disease of very rare occurrence.

TUBERCULAR LEPTOMENINGITIS.

383. Nature and Pathology.—The specific cause of the meningitis, the tubercle bacilli, is here present, resulting in the characteristic formation of tubercles that are miliary in size, as a rule, and usually are found in the greatest numbers at the base of the brain contiguous to the arteries and accompanying them in their distribution to the vortex. Occasionally the tubercles are massed at some point on the base, or convexity, or form, en masse, within the substance of the cerebrum or cerebellum. A serofibrinous, gelatinous, rarely purulent, exudate is found at the base near the pons and extends from here into the Sylvian fissures and backwards to the basal surface of the oblongata and cerebellum, even involving the membranes of the spinal cord. Band-like strata of this exudate are also found along the vessels of the convexity of the brain. The tubercles are fine, grayish-white, translucent nodules. They may be seen along the course of the middle meningeal artery in the dura. The choroid plexus is usually invaded and the ventricles contain a cloudy bloody serum. This may be of such quantity as to cause internal hydrocephalus. The cranial nerves or their sheaths are reddened, swollen, and covered with exudate. Small hemorrhages are observed in the pia mater and foci of softening about the basal ganglia. A slight diffuse or disseminated encephalitis of the cortex is probably the rule

rather than the exception. The tubercle bacilli are both in the tubercles and the exudate. Young children are most commonly the victims of this disease; although it may occur in adults, it is rare beyond the middle period of life.

384. Symptoms.—Its onset may be acute or chronic. Ordinarily certain prodromes are noticeable, such as languor, apathy, general clumsiness, general loss of strength, and loss of flesh, mental irritability, peevishness, wilfulness, restlessness at night, headache, drowsiness, vertigo, vomiting, diarrhea, or constipation. Many of these symptoms are but the precursors of the stage of irritation in which they are more constant and pronounced. The headache, vomiting, and drowsiness give place to local muscular twitchings or to general convulsions. There is pain in the chest and abdomen, sinking in of the abdominal walls, constipation. The thirst is great, extremities cold. The countenance is pale, sickly, and pinched. The patient utters a peculiar involuntary outcry at frequent intervals. There is slight irregular fever with respirations variable, rigidity and retraction of the neck, rigidity of the limbs, irritation or paralysis of the cranial nerves causing gritting of the teeth, trismus, strabismus, ptosis, pupilary changes or impairment of vision. The skin shows eruptions and gives out a peculiar odor.

In the stage of depression there is a loss of sensation, paralysis, hemiplegia, tropic changes in the skin, with extreme decubitus, ending in death. The disseminated form of the disease in adults presents essentially the same symptoms except that general convulsions are less frequent, the third nerve is seldom but partly involved; ptosis is more common.

SYPHILITIC MENINGITIS.

385. Nature and Pathology.—The specific virus causes the membranes, especially at the base, to become the seat of more or less extensive gummatous formations. At times the gumma are large and show caseous degeneration or they may be dense and fibrous. The distribution is quite irregular, the

pia and dura become adherent in places, the nerve sheets are involved, and the coats of the vessels show a proliferation of the newly formed tissue so extensive, in places, as to obliterate the lumen. The process is chronic in its progress.

386. Symptoms.—When the specific new formation is greatest at the base, as is common, often there are crossed hemiplegia, basal headache—more severe at night, optic neuritis, and interference with the function of the cranial nerves. When the changes are more extensive on the convexity, convulsive attacks, monoplegia, local tenderness on pressure or percussion of the cranium, somnolence, and mental impairment are the prominent symptoms. The history of a syphilitic lesion and the chronicity of the disease aids in making out the nature of the disease.

EPIDEMIC CEREBROSPINAL MENINGITIS.

387. Nature and Pathology.—It is very generally conceded that this disease is due to the presence of a microorganism, but it has not been definitely settled which one is the offender. Fraenkel's pneumococcus and the diplococcus intracellularis of Heubner and others have been found in these cases. The epidemics occur generally in winter and spring, occasionally in the warmer season. It attacks, by preference, children and young persons, seldom affecting those as old as thirty. The poor and those grouped together in asylums, prisons, almshouses, or soldiers in barracks, are especially in danger. One attack does not render the individual immune.

388. Symptoms.—Cases vary much as to the promptness and severity with which the symptoms develop. They may be fulminating or explosive, acute, subacute, or intermittent in their onset and course. Certain prodromes as malaise, pain in the neck and limbs, headache, vomiting, and nausea, often usher in the attack.

In a typical acute case the onset is sudden with a chill, or chilly sensations, violent headache, vertigo, vomiting, and, perhaps, delirium. Soon there is fever, which may be intermittent, or continuous. The temperature varies from 103° to 109° F. The pulse is, generally, quick, the respiration

varies. In young children, general convulsions occur at the onset, muscular twitchings are frequent with all cases. There may be epistaxis. The face is pale and shrunken. Disturbances of the cranial nerves are common, as anosmia, photophobia, ptosis, optic affections, unequal pupils, nystagmus, tinnitus aurium, hyperesthesia or anesthesia of the face, facial paresis or paralysis. If the convexity is much affected there are monoplegia, hemiparesis, or hemiplegic and psychical disturbances in addition.

The spinal symptoms are stiffness of the neck and back, retraction of head and neck, difficulty in swallowing, spinal tenderness or pain, spasmodic or paretic conditions of the limbs, retraction of the abdominal walls. The tendon reflexes vary. They may be increased, diminished, or lost. There is flexor contracture (Kernig's sign), inability to extend the leg when the patient is in a sitting posture. The skin reflexes are at first increased. Disturbances of secretion and excretion are common. Either constipation or diarrhea may be present. There may be polyuria or scanty secretion with albuminuria. Jaundice is present not infrequently. Purpuric spots causing a purplish mottling of the skin on the face, chest, abdomen, or limbs so commonly occurs as to give rise to the name *spotted fever*. Herpes on the lips and elsewhere, urticarial erythema, roseola, and pemphigus are other forms of eruption that are often seen.

In fatal cases the stupor deepens into coma, emaciation progresses, the urine and feces pass off involuntarily, the pulse fails and intermits, the temperature rises or drops to subnormal, and death occurs at the end of the second or the beginning of the third week.

The symptoms in the cases that recover are generally mild from the first. Coma does not occur or is incomplete, the temperature is inconstant and not high at any time. In the course of the second week improvement begins, though relapses not infrequently occur.

At times a chronic condition follows in which the symptoms continue with moderate intensity and paralysis in some form develops.

Recovery from this disease is often incomplete, certain disabilities continuing for a long time or permanently. Chronic headache, hydrocephalus, contractions, or local palsies, keratitis, deafness, blindness, aphasia, mental changes, neuralgias, spinal irritation, or chronic spinal meningitis are among the unfortunate sequelæ of the disease.

389. Treatment of Leptomeningitis.—While there are general principles of treatment that apply to all forms of meningitis, special treatment is needed for conditions peculiar to the variety of the disease in hand. Quiet, rest in bed, freedom from all sensory excitation, the head kept high, and the shoulders raised. The food should be light but nutritious, and should be given at frequent intervals and not much at a time. In many cases it will be advisable to remove the hair so as to apply cold to the head in the form of an ice cap or effusions, or cold sponging of the body. In severe and plethoric cases leeches or venesection may be practiced. Mustard baths should be applied to the extremities as a blood-derivative. Any adjacent disease, as otitis media, erysipelas, and so forth, acting as a source of aggravation of the meningitis, should be treated. In the more chronic cases, as the syphilitic or tubercular, counter-irritation to the occiput or over the entire scalp may be helpful, mercurial inunctions in the former, iodoform in the latter case.

Purgatives as castor-oil, calomel, or senna are needed. For the vomiting, bits of ice in the mouth, carbonated water, champagne, mustard on the back of the neck and epigastrium, oxalate of cerium, bismuth subnitrate, or cocain may aid in checking it. Aconite, veratrum viride, salacin, antipyrin, phenacetin or acetanalid may be used, together with judicious hydrotherapeutics, to combat the injurious effects of high temperature. The severe headache and pain must be controlled by bromids, cannabis indica, chloralamid, opium, codein, morphin, together with the removal of the causes of sensory excitation. Careful feeding must be attended to in order that the strength will be maintained, and the heart may need the aid of digitalis, strophanthus, or nux vomica. In the convalescent stage, iron and general tonics will be needed.

In tubercular cases, opening the skull and washing out the membranous spaces with iodoform and glycerin or other germicidal solutions has been followed by some improvement in certain instances. Lumbar puncture, for the purpose of diagnosis, removal of excess of serum, or for medication has its advocates.

Much can be done in the prevention of a spread of an epidemic of cerebrospinal meningitis by rigorous sanitation.

The treatment of the sequelæ of meningitis must be adapted to the indications. Careful and persistent treatment by appropriate means during the progress of the inflammation or in the period immediately following its subsidence, will do much to prevent the serious impairments of function that so often remain as an inheritance from leptomeningitis. The inflammatory exudates that compress the nerve and brain structures and obstruct the circulation of nutrient fluids can be more completely removed by the use of potassium or sodium iodid, or the syrup of hydriodic acid. A prolonged use of mercurials and potassium iodid is usually of service in the syphilitic form.

In these later stages, as an aid to convalescence and the reestablishment of the functions, electrotherapeutics is most helpful. The negative electrode of the direct current applied at the seat of the inflammation aids in the disintegration and absorption of the debris, and stimulates the nutrition of the nerve-elements. General faradism, static insulation, or the alternating magnetic field quickens, generally, the nutritive processes and aids the physiological functions in regaining their energy. The faradic brush or the static spark corrects the vasomotor disturbances and relieve the spinal irritation and neuralgias, while the direct application of the induced or direct current to the impaired nerves and muscles, limits the amount of atrophy and paralysis that would otherwise occur.

ENCEPHALITIS.

390. Nature and Pathology.—Various authors describe a variety of forms of inflammation affecting the brain-structure proper. No two writers exactly agree in their classification of these. It is evident, both from pathological and clinical data,

that the brain substance may be the seat of a focal or a disseminated inflammation that in either case may be acute or chronic in nature, and, in some instances, it may be non-suppurative; in others hemorrhagic; and in still others suppurative.

We will content ourselves with a description of the *acute*, *chronic*, and *suppurative* forms in general, since the majority of practical considerations, as regards diagnosis and treatment, will thus be best covered in the brief space allotted to the subject.

391. Acute Encephalitis.—This is frequently hemorrhagic in character, and may be confined to the medulla and pons, the basal ganglia, or the cortex, and so be designated as a *polio-encephalitis inferior*, *superior*, or *cortical*, as is done by some authors.

In its pathology it is characterized by a red softening due to distension of small vessels and points of extravasation of the blood, and to the disintegration of the brain-tissue by the effused liquids. The affected area is swollen, the consistency of the adjacent tissue lessened. At the margin of the degenerated area the ganglion cells pass into a stage of cloudy swelling and atrophy, or become pigmented or undergo vitreous degeneration. Generally some visible damage persists. A cavity is formed that is filled with fluid. Occasionally a reticulated stroma remains in the softened area, the cavities formed contract and a fibrous cicatrix remains with adjacent atrophy.

The cicatrix may contain a nucleus of fatty debris and hematoidin crystals. If the process is intense, lymph corpuscles are so numerous that the softened area is purulent and the formed cavities contain pus. If the process is very acute and malignant and affects an extensive area, there is rapid infiltration of leucocytes, and suppuration occurs with acute sloughing of tissue. A more disseminated form of inflammation occurs in connection with erysipelas, diphtheria, typhoid fever, scarlet fever, septicemia, etc. Here there are minute spots of softening. In some cases micrococci are found about the vessels and in groups throughout the brain.

392. The symptoms of the acute form of encephalitis are in a great measure dependent on the extent and location of the

inflamed area. The onset is sudden, with feelings of malaise, headache, nausea, fever, and irritability. The pain and fever are not so severe as in meningitis. There is apathy and somnolence. When the motor areas are affected, there are convulsions beginning locally and extending, and the corresponding limbs are heavy and weak. After a few days, or perhaps hours, the apathy may pass into stupor or coma, which alternates with periods of restlessness or even delirium. There is likely to be optic neuritis, mydriasis, with other cranial nerve affections. There may be rigidity of the muscles of the neck with tetanoid symptoms. The reflexes are diminished and the sphincters impaired. The pulse is feeble and frequent, the respirations shallow.

Where the inflammatory process has not been very severe or long continued, recovery may, in a great measure, take place, though some residual impairment of functions is the rule even though the patient recover. Among the residual symptoms are monoplegia, hemiplegia, at times diplegia, spasmodic, athetoid, or clonic muscular action, contractions, arrest of development of limbs, speech affections, chronic unilateral convulsions, exaggerated reflexes, greater or less mental defect.

393. Chronic Encephalitis.—There are various forms of subacute or chronic interstitial inflammation of the brain-tissue resulting in sclerosis that may be uniformly diffused in patches or single areas. There is an increase in the consistency of the affected brain-tissue. It cuts like a piece of tough leather. There is an hyperplasia of the neuroglia and connective tissue-structure with degeneration and atrophy of the neurons.

Some authors regard paralytic dementia as primarily an inflammatory process of this nature while, by others, it is looked upon as a degenerative process from the beginning. That evidences of brain inflammation may attend this degeneration in this disease is undoubted.

394. The symptoms of this disease are a slow onset, headache, optic neuritis, slight pyrexia, irritability, delirium, successive periods of increase, partial subsidence, and a stationary state, motor irritation as epileptiform convulsions, general

or lateral, single twitchings of muscles, rhythmic or choreic, hemiplegia or monoplegia, a gradual deterioration of mental capacity until dementia. These symptoms are variable in degree, continuing over several months, perhaps ending in death within two years. Recovery from the disease may take place, but leaving permanent mental or physical defects, or both.

395. Suppurative Encephalitis (*Abscess of the Brain*). A collection of pus in the brain is the result of a focal encephalitis, usually due to the presence of micro-organisms. The exciting cause may be in part a traumatism, recent or remote, doing damage to the brain-tissue and rendering it vulnerable to the attacks of pathogenic bacteria. The infectious material may come from a nearby or distant collection of pus in the system. The injury that has favored the development of brain-abscess may have been apparently slight and long forgotten before the symptoms of the abscess make their appearance. Chronic inflammation of the middle ear is by far the most frequent source of brain-abscess. The otitis may have been present for years previous to the development of the encephalitis.

Suppuration of the tympanic cavity and the cavities contiguous to it, especially the cells of the mastoid antrum and caries of the petrous bone, are the conditions that most frequently endanger the brain. Acute exacerbation of a chronic suppurative otitis and arrest of the evacuation of pus from granulation is especially dangerous. The parts of the brain immediately adjacent to the bony walls of the auditory structure are those that become infected and inflamed, the temporal lobes from the upper part of the tympanic cavity, and the cerebellum from the mastoid process. The micro-organisms find access more or less deeply into the brain substance by way of the perivascular lymph spaces or thrombosed veins of the pia mater. They may also find a channel of communication through the sheaths of the acoustic or facial nerves.

In addition to the intracerebral suppuration there is oftentimes an extradural collection in the middle or posterior cranial fossa, or in both, complicated with thrombosis of one or more sinus. Traumatic and otitic abscesses of the brain are usually

solitary, varying in size from a walnut to an apple, or even larger. Metastatic abscesses are of smaller size and more numerous. The pus has generally a green or greenish-yellow color, a fetid odor, and often contains degenerated debris from the brain-tissue.

Old abscesses are, as a rule, encapsulated, a pyogenic membrane having formed, which in some cases permits of the collection of pus remaining latent for years until from some cause, spontaneous or external, the process again becomes active. The pus within the capsule, by absorption, often becomes thick and cheesy. The pyogenic membrane may grow quite vascular, and phagocytic action tends to dispose of the contents of the abscess. Or vigorous granulations may displace the membrane and the abscess increases from within out until it bursts through its walls. If it ruptures into the brain-structure, a second abscess cavity, with a communicating sinus, may form. Or the rupture may be into the ventricles, or through necrosis of the floor of the skull into the nasal fossa, the orbit, or pharynx.

396. The patient may give a history of an injury or a chronic otitis. There may be a latent and then an active period. The symptoms are both general and focal. Frequently, local headache, increased by movement and position, nausea, vertigo, vomiting, constipation, local tenderness of scalp, variable pulse, irregular fever; later may have subnormal temperature, rigors, sweating, convulsions, local or general; the cranial nerves may be affected; optic neuritis is exceptional; there may be a ptosis on the same side as the abscess. The cerebral affections accord with the location of the abscess. There is paralysis of the opposite side progressing step by step, often a hemiplegia. As to the mental condition there is apathy, somnolence, stupor, or coma. The patient is pale and loses flesh. There may be some signs upon the scalp, such as redness or bogginess, indicating the location of the cranial or subdural focus of pus. Occasionally there is a purulent discharge from the ear, nose, or throat through a sinus communicating with the abscess.

397. The treatment, other than surgical, is for encephalitis very similar to that required for meningitis. The patient should be kept quietly in bed, free from disturbing light, sights, and sounds. Cold should be applied to the head, purgatives, such as calomel, castor-oil, or croton-oil, used. In suitable cases, extraction of blood by leeches or cupping may be practiced. The irritative symptoms may be relieved by aconite, bromids, chloral, chloralamid, cannabis indica, or morphin; the fever combatted by antipyrin or phenacetin; the sleeplessness in the irritative stage by trional or sulfonal. In chronic encephalitis, mercury and the iodids will be indicated, as they are likewise, to some extent, in the later stage of the acute form. Where there is good reason for believing that an accumulation of pus is present, the only course is to reach and evacuate it, and establish thorough antiseptic drainage.

Should the patient recover, there is, as a rule, some impairment of the brain functions as a sequel, and this must be counteracted, as far as may be possible, by good hygiene, hydrotherapeutics, properly devised gymnastics, massage, and electrotherapeutics. Much can be done with the negative electrode to remove the inflammatory debris and stimulate the nutritive activity of the neurons that are injured but not destroyed. General faradism, the static breeze, and magnetic fields will assist the general nutritive processes, and the paralyzed or paretic groups of nerves and muscles will be aided in recovery, as far as this is possible, by the local application of the direct and induced currents, aided by massage and judicious exercise.

ATROPHY AND DEGENERATION.

398. We have included under the heading of atrophy and degeneration a few of the more frequently occurring disorders affecting the cerebral structures in which a degeneration of the neurons is apparently the initial morbid process. It must be presumed that in some instances a defect of some sort in the nutrient fluids antedates the degeneration and atrophy, or it may be that the vital energy in the neurons themselves is the

beginning of the retrograde change. Among the representative diseases of this class are *chronic progressive softening, disseminated sclerosis, bulbar paralysis, paralysis agitans.*

CHRONIC PROGRESSIVE SOFTENING.

399. Nature and Pathology.—This is a primary softening nearly always affecting the white substance of the hemisphere, though the gray matter may be involved secondarily. The process is a simple white softening. The extent of the lesion varies considerably in different cases. In the cerebellum the gray matter is more apt to be affected than the white (*Gower*). The disease is most frequent between the ages of 60 and 70.

400. Symptoms.—The symptoms are of gradual onset, hemiplegic in distribution, and both motor and sensory. There is a weakness beginning in one part, gradually spreading to the whole of one side, without great sensory loss. Slight irritative symptoms, such as numbness, tingling, and formication in the limbs may occur; and there may be paroxysmal pains in the extremities. At the onset there may be muscular rigidity, which disappears later. The patient may have occasional attacks of giddiness. The intellect may be but little affected or the patient may be dull, and toward the last of the disease, comatose. Generally before this stage the cerebral symptoms have attained their height, and then have remained stationary. Death is usually due to some intercurrent disease.

401. Treatment.—The treatment consists of general measures regarding rest, nutritious diet, and fresh air for the patient. Attention should be paid to elimination, and nerve and cardiac tonics may be prescribed.

DISSEMINATED SCLEROSIS.

(*Multiple Sclerosis, Cerebrospinal Sclerosis.*)

402. Nature and Pathology.—This is a degenerative disease in which there are islets, nodules, or patches of sclerosis scattered through the nervous system. The primary change, which may be due to an inflammation of a low type, is in the

interstitial tissues in these localities, and the damage to the nerve-fiber is secondary as a result of compression and interference of circulation. These, in spite of the widely varying involvement of the nervous system, are constant enough to form a characteristic symptom group.

403. Motor Symptoms.—There is muscular weakness with rigidity, taking a hemiplegic, paraplegic, or monoplegic form. This weakness may progress to paralysis. A tremor may affect the arms, neck, head, trunk, legs, or face. This tremor is an "intention" tremor. It ceases on rest and is increased by effort, motion, or attention. Nystagmus, inequality of the pupils, loss of accommodation, and transient diplopia are motor eye symptoms. There is "scanning" speech and, in some cases, difficulty in swallowing. The seventh nerve may be affected. The knee, wrist, and, possibly, jaw-jerks are all exaggerated, and ankle-clonus is present.

404. Sensory Symptoms.—Before the onset the patient may have dull pains for a year or two. There is numbness in the hands and feet; and actual loss of sensation may occur and then pass away. Prickling, tingling, and formication may be present. There may be girdle pain. On the part of the special senses we may find the sight impaired in one or both eyes, and often there is an irregular contraction of the field of vision. Optic neuritis or optic atrophy may be present. Hearing and taste are often disturbed.

The general nutrition of the patient is impaired. There is an increase of subcutaneous fat, the sweet secretion may be altered, and local edemas may develop. Localized muscular atrophies may be found. Trophic changes take place in the nails, and the hair; and herpetic eruptions occur. Bladder troubles may be present, as also sexual weakness. Glycosuria is sometimes found. The mental symptoms consist of an undue complacency and contentment, failure of memory, and emotional and hysterical outbursts.

405. Treatment.—The treatment is similar to that of chronic myelitis. Silver nitrate, double chlorid of gold and sodium, potassium iodid, hydriodic acid, and mercury are

among the remedies used. For the tremor, solanine or hydrobromate of hyoscin are recommended to allay tremor. Strychnin, arsenic, silver nitrate, and the phosphates are indicated as general nerve-tonics.

CHRONIC BULBAR PARALYSIS.

(*Labioglossopharyngeal Paralysis.*)

406. Nature and Pathology.—This disease is a primary degeneration of the motor nuclei of the medulla. This degeneration may be interstitial or parenchymatous. The nuclei affected are the hypoglossal, vagus-accessorius, facial, glossopharyngeal; and, sometimes, the fifth. The nuclear cells entirely disappear or are greatly atrophied, the connective tissue is increased, and the walls of the blood-vessels traversing the nuclei are thickened. The degeneration extends to the nerve-fibers and in time to the muscles that they enervate. The pyramidal fibres of the crus, pons, and medulla, the posterior longitudinal bundle, and the fibers of the raphe have been found involved in some cases.

407. Symptoms.—There may be premonitory symptoms of pain in the neck and head and attacks of vertigo. The onset of the disease itself is gradual. There is weakness of the tongue. The pronunciation of linguals and of linguopalatine consonants *d*, *c*, *l*, *r*, *n*, *t* becomes difficult. The lips next lose their power and *o*, *u*, *b*, *f*, *m* are difficult of pronunciation. The patient cannot whistle, he drools because of inability to close his lips and because of an increase in the secretion of saliva. There is difficulty in mastication and swallowing. The palate becomes weak, increasing the difficulty in speech and adding a nasal tone to it. In the attempt to swallow, liquids regurgitate through the nose. Later, the tongue becomes large, flabby, atrophied, and rugose. The mouth remains open, the lips waste, the nasolabial folds deepen, and there is lack of expression in the lower part of the face. The voice is faint and the tone monotonous. The trouble increases until speech is unintelligible and there is inability to take solid foods. A fibrillar tremor is present in the affected muscles; and there may be a

gross tremor of the lips on attempting to speak. The reaction of degeneration may be found in the affected muscles. The pharyngeal and laryngeal reflexes are weakened or disappear. Occasionally the jaw-jerk is exaggerated. The patient complains of a tired feeling and uncomfortable sensations of dryness and stiffness about the throat. There may be some impairment of taste; there is tinnitus and a gradual impairment of hearing. In some cases there may be tachycardia and respiratory disturbances. Glycosuria has been found present, and the patient has a look of distress or astonishment, and is very emotional.

408. Treatment.—Physical and mental rest, baths, massage, and artificial feeding for the general condition of the patient; and, then general nerve-tonics, such as arsenic phosphorous, and strychnin is the usual treatment.

PARALYSIS AGITANS.

(*Parkinson's Disease, Shaking Palsy.*)

409. Nature and Pathology.—Until recently this has been classified with the functional disorders, but the latest investigations have shown changes of a degenerative character in both the cord and brain. The changes are similar to those of senility. There is an atrophy of the nerve-fiber and an increase of the interstitial tissues. The primary condition seems to be an endoarteritis or periarteritis, the surrounding tissues becoming involved secondarily. The cord is most affected, and that most frequently at the cervical and lumbar enlargement. Changes have been noted in the anterior horn cells, in those of Clarke's column, and in the white matter of the lateral and posterior tracts. Brissand suggests that the lesion is in the region of the peduncles. In old cases, fatty changes in the muscles are found.

410. Symptoms.—The symptoms are with slight exception motor, the sensory symptoms consisting of only subjective feelings of heat and disagreeable sensations. The disease begins with a weakness of the extremities, followed soon by a slight tremor, which at first occurs only temporarily. This is more

marked in the upper extremities, especially the right side, involving the fingers. The tremor may be noticed in the legs, and, exceptionally, in the head. A hemiplegic distribution of the tremor is rare. The tremor consists of uniform oscillating movements, few in number. It is present during rest, usually disappearing on voluntary motion, though occasionally it increases on forced motion, passing into a regular shake and making the patient's movements very awkward. The tremor as a rule does not cease during sleep. The tremor is shown in the handwriting—all the lines are tremulous, and the characters are cramped and small.

Later in the disease, the muscular strength is much diminished so that the patient tires easily, but there is never more than a paresis. Then a rigidity develops, which influences the position of the body and extremities at rest as well as when in motion. The speech is modified, becoming slow and monotonous, and the voice is piping. The patient hesitates at first, and then hurries through a sentence. The patient may become taciturn. The movements of association and accommodation are interfered with by the muscular rigidity, and the ocular globes become fixed. A characteristic facies develops. The nasolabial folds and lines of expression are obliterated so that the patient is described as wearing a mask. The gait is disturbed. The steps, short and tripping at first, become quicker and longer, and the patient moves forward with such force that he often falls. This has been called "propulsion," and with the opposite condition, "retropulsion," where the patient tends to rush backwards, constitutes the "forced movements" of Charcot.

The characteristic attitude of the body is one in which the head and trunk are bent over, the arms flexed at the elbows, closely applied to the trunk, the thumb resting against the fingers so that the hand assumes the writing position, and the fingers flexed at the metacarpal joints. The knees are close together so that walking is interfered with. The legs are slightly flexed at the knees. The trophic disturbances are a transient purpura in some cases. The sweat secretion is increased. There is slowing of the mental processes, but, as a rule, no especial loss of mental power.

411. Treatment.—Active medication in this disease is oftentimes more harmful than beneficial. Bland but nutritious food, little or no alcoholic stimulants, mild hydrotherapy, warm baths at bedtime followed by general massage, and physical and emotional quiesence are the measures most helpful to the patient. Erb recommends liquor potassii arsenitis, tincture of nux vomica, and aqua foeniculi in equal parts in doses of 6 to 12 drops. Spartein has been found serviceable by Podak.

To lessen the tremor, tincture of veratrum virid with tincture of gelsemium is used by Oppenheim, hyoscin hydrobromate by Charcot, and duboisin sulfate by Mendel. The injurious effects of such poisonous drugs used for a prolonged period must not be forgotten. To secure sleep resort must be had to the hypnotics, trional, sulfonal, paraldehyde or even morphin.

The treatment by mechanical vibration suggested by Charcot has not been of much benefit, though some patients seem to be helped by railroad or carriage travel.

412. Electrotherapeutics.—Electrotherapeutics of the degenerative forms of disease is important. Since the defect in the organism leading to senile changes, atrophy, and degeneration is apparently a lack of vigor in nutrition, it is natural that some benefit should be expected from treatment by some form of electric energy. There is no doubt but that a temporary benefit and retarding influence is possible in these diseases by the judicious use of general galvanism, general faradism, static insulation, or the magnetic fields. But, in order that the effects of such treatment should be as helpful as possible, they should be begun early in the disease and applied daily over a prolonged period, since the cause that is to be combatted is one that is continuous in its action. There is no doubt but that the physiological forces are strengthened and enabled to do their work more efficiently with the assistance given by the electric energy, and when such treatment can be readily used without too much of a tax upon the patient's strength or resources, there is abundant evidence that it retards at least the

progress of the disability. A marked quieting and rejuvenating effect has been observed upon patients suffering from paralysis agitans after they have received treatment by means of static insulation, general faradism, or the alternating-magnetic field.

TUBERCULOSIS AND SYPHILIS.

413. Nature and Pathology.—The brain is the seat of neoplasms of tubercular or syphilitic origin, other than those that have been described under inflammations due to one or the other of these causes. Tumor-like growths, syphiloma (gumma), and solitary tubercle are found in various parts of the brain, and at first glance very closely resemble one another in appearance. They are usually small tumors of the size of a hazelnut or walnut, though a tubercle may be much larger. They seem to be made up of granulation tissue about the periphery, and are non-vascular, but toward the center they are caseated and the tubercle not infrequently purulent. Gummata have their origin, as a rule, in the meninges, and the connection between the solitary growth and the specific changes in the meninges can be seen.

A tubercular mass is not infrequently found in the interior of the cerebrum or cerebellum without any evidence of the disease in the meninges, though an eruption of miliary tubercles in the vicinity may reveal its presence. Solitary tubercle favors the pons, cerebellum, and cerebral cortex. Syphiloma is rare in the cerebellum and still rarer in the central ganglia. Sudden proliferation and regressive metamorphosis is particularly characteristic of it, while tubercle may enlarge rapidly, but may, however, remain stationary for a long time and undergo degenerative changes. Several tubercular or syphilitic masses are frequently found in various parts of the brain at the same time, multiplicity rather being the rule as compared with other tumor formations, such as glioma or sarcoma. In the attempt to make a positive distinction between syphiloma and tubercle, the bacteriological examination is the most reliable means; the tubercle bacilli can usually be found in the tubercular mass.

414. Symptoms.—When a solitary or multiple neoplasm of the brain of either syphilitic or tubercular origin is uncomplicated with inflammation of the brain or its meninges, the symptoms arising from it are similar to those that occur with brain-tumor of other forms similarly located. These symptoms will be considered under the discussion of brain-tumor that follows. The history of a primary syphilitic lesion, or of hereditary syphilis, or the presence of tubercular deposits in the lungs, intestines, or other organs of the body, will aid in determining the nature of the encephalic growth.

415. Treatment.—The general treatment of tubercle or syphiloma of the brain is similar to that which would be suitable for counteracting those diseases elsewhere. Oftentimes the neoplasms may be arrested in their development and caused to undergo caseation or calcification by appropriate treatment begun early, and vigorously and persistently continued. Aside from the specific treatment indicated by the nature of the growth, the measures required for the relief of pain, counteracting paresis, or paralysis, etc. are the same as would be required for other forms of brain-tumor and will be considered under that subject.

TUMOR OF THE BRAIN.

416. Nature and Pathology.—Aside from the abnormal growths that occur in the brain caused by tubercle or syphilis, it is a favorite seat for many other forms of neoplasm. Among these, glioma and sarcoma are the most common, carcinoma being next in frequency, while fibroma, osteoma, lipoma, and parasitic growths are occasionally found. The tumor may be circumscribed or diffuse. In its growth it directly destroys adjacent nerve-tissue, though small growths may in some places simply displace the neuron elements and not interfere seriously with their function. When the growth is of large size it causes pressure upon distant, as well as immediate, parts of the brain. It causes irritation both by pressure and by vascular disturbance. Glioma grows to the largest size, and is found most frequently in the white matter of the cerebrum. Sarcoma occurs

most often at the base of the brain, originating in the periosteum or the dura. Carcinoma is generally secondary to a similar growth elsewhere, though it may be primary.

417. Symptoms.—The symptoms are both general and local. Headache is one of the most common of the general symptoms. It may be dull, heavy, diffuse, constant, intermittent, or exacerbating with frightful severity. Hysteria, neurasthenia, epileptic convulsions, and various psychical disturbances may occur. Insomnia is common and attacks of syncope are frequent. The mental processes are retarded, hallucinations intervene, familiar surroundings appear strange to him, he is bewildered, and unable to appreciate the details of daily life. His features become dull, and his movements slow and awkward. Unilateral or bilateral convulsions may occur, apoplectiform attacks, or general apoplexy. He becomes careless in his habits, even failing to attend to the calls of nature. Dementia may gradually increase to a state of coma, and finally death. In other cases the intellect may remain intact for a long time, only memory being uncertain. During the early stage the patient is likely to exhibit irritability, and periods of excitement alternate with drowsiness or depression. The speech is often slow, uncertain, and monotonous. The pulse is slow at first, but later it may become quite rapid.

Vertigo and vomiting are among the most common symptoms. The vomiting takes place on the slightest provocation, a mere change in position or slight movement of the head being sufficient to cause it. Optic neuritis, with choked disk, is also a diagnostic symptom, being present in the majority of cases when the intracerebral pressure is increased. Early blindness, epileptiform amaurosis, hemianopsia, and other defects in vision are common. There is likely to be obstinate constipation and polyuria. Anemia, with loss of flesh and strength, usually occurs. Remissions in the symptoms, with increased severity on their return, is a feature of some diagnostic value.

As to the local symptoms, they vary according to the situation of the neoplasm. They are at first those of irritation, and later paresis or paralysis of the brain area that is compressed

or destroyed by the progress of the growth. At times there may be no focal symptoms at all. Especially is this true when the growth is in the right frontal, or right parietal, lobe of the cerebrum.

418. Treatment.—The treatment cannot, in most instances, be other than palliative. A syphilitic neoplasm, if recognized early and vigorously treated with the iodids and mercury, may disappear, or the symptoms largely abate. These same remedies often bring about some improvement in tumors that are not luetic in origin. Cod-liver oil, creosote, guiacol, or iodoform may be tried where the growth is found or suspected to be of tubercular origin. There are no drugs that are positively known to check the development of glioma, sarcoma, or carcinoma.

Occasionally, with solitary tumors, the location is such as to admit of a surgical operation for its removal. Generally speaking, about 5 per cent. of brain-tumors are amenable to surgical treatment. But a successful discovery and removal of the neoplasm does not, in the majority of instances, result in other than temporary relief. Yet, when we consider the hopelessness of the condition if untreated, the patient should be given whatever chance of benefit a surgical operation has to offer.

For the relief of the pain and headache that are often most distressing, resort must be had to antipyrin, phenacetin, caffein, the bromids, cannabis indica, codein, morphin, or opium.

The sleeplessness may be controlled by these or by trional, sulfonal, chloralamid or paraldehyde.

Counter-irritants are sometimes of service in relieving the pain, headache, and congestion. In plethoric persons, leeches or venesection may do good. The emaciation and loss of strength must be met by the most nutritious foods, and by tonics directed to the blood and nerve-tissue.

419. Electrotherapeutics.—Much temporary relief is obtained in some cases of brain-tumor by the static breeze, or the application to the head of the high-tension current of the secondary induction-coil or the positive electrode of the direct current.

It would not seem improper to use the disintegrating action of electrolysis on these growths, which are quite, if not more, accessible to the steel needle than to the scalpel, and, considering the benefit that has resulted from this mode of treatment on carcinoma and sarcoma elsewhere in the body, it is safe to predict that it will not be long before some venturesome surgeon will be thrusting his insulated and aseptic electrolytic needle through the skull cap into tumors of the brain, deep-seated or at the base, cutting off their blood-supply by the coagulating action of the anode or disintegrating their cellular structure by anode or cathode, and so retarding their growth if not completely curing them. In this advanced use of electrolysis, Roentgen rays will play an important part in fixing the exact position and limits of the growth.

INJURIES TO THE BRAIN.

(*Trauma.*)

420. It is not within our province to discuss here such injuries to the brain as require surgical treatment mainly or exclusively. Gross lesions of this nature may in their sequelæ furnish defects such as paresis, paralysis, or neurosis that place the patient properly in the care of the specialist in nervous diseases for further treatment, but primarily they are surgical cases. There are certain nervous affections, however, that develop immediately as a result of trauma unattended by gross lesion, and the treatment of which belongs more properly to the neurologist than to the surgeon.

A shock or injury to the brain or the entire central nervous structure may follow a severe surgical operation, an accident causing severe injury to parts of the body outside of the central nervous system, or a concussion or reflex influence may so seriously affect the action of the nerve-mechanism as to bring about a train of symptoms indicative of serious and protracted defect. The changes thus produced may be what are termed functional in their nature, but, when the symptoms are genuine and not feigned, they are indicative of grave disorder, which produces protracted invalidism and, not infrequently, are the

precursors of some form of degenerative disease of the brain or spinal cord. The representative of this class of nervous affections is what is now termed traumatic neurasthenia.

TRAUMATIC NEURASTHENIA.

421. Nature and Pathology.—This disease has often been classified among the *neuroses*, and by the name neurosis is signified a disorder of the nervous system in which a pathological basis for the diseased condition has not yet been found. It is generally believed, however, that in these so-called functional disorders that show no gross or microscopic changes in structure at the autopsy there are molecular changes sufficiently constant in nature that have so far escaped detection and demonstration. Some observations have shown that shocks which did not produce a gross lesion of the central nervous system were sufficient to cause disease of the cerebral vessels, especially of the capillaries, an endoarteritis, hyaline degeneration, or even arteriosclerosis, which may have been the pathologic basis of the disordered function. Marked vasomotor disorder is a common condition in the traumatic, as in other forms of neurasthenia, and the defective nutrition of the neurons that this might occasion would in itself account for many of the symptoms that arise.

The fact must not be overlooked, however, that in the majority of persons that become the victims of traumatic neurosis, the psychic element is a prominent factor in the etiology, and that fear, apprehension, a vivid imagination, and a tendency to self-inspection have much to do with the development and the maintenance of the condition. Moreover, there is in many individuals a latent tendency to disease or disorders of nervous action that needs but a physical or mental shock to render it apparent and active. This is true of those disposed by heredity to nervous weakness or debility, or to those that have acquired a susceptibility to such disorder through syphilitic or tubercular infection.

422. Symptoms.—The general appearance is often that of abated vigor, with an anxious expression of countenance and

attitude of the body expressive of weariness and languor. In many instances, a wasted and anemic condition is present. The skin is usually cool and moist, especially on the palms of the hands and soles of the feet. When irritative symptoms are pronounced, the patient sweats easily and profusely, but otherwise the skin is unusually dry. The nutrition may be poor, the hair falls out, the teeth readily decay, the finger-nails and toe-nails are dry and brittle. There is likely to be some dropsy of the eyelids, hands, feet, and ankles; as well as a faulty action of the sebaceous glands.

423. Digestive System.—There are usually symptoms of gastric irritability, appetite poor, tongue furred, bad taste in the mouth. Atonic dyspepsia is the rule, the digestion is feeble and attended with acidity and flatulence, epigastric uneasiness, and distension. A torpid or "neurasthenic" liver is common. "Nervous diarrhea" or mucous enteritis may be present, but as a rule the bowels are constipated.

When the symptoms of indigestion arise from nervous exhaustion alone, they are not serious and readily yield to treatment, but more persistent and protracted disturbance along the alimentary tract arises when to the neurasthenia is added abuse of the digestion by sweets, tobacco, alcohol, improper diet, or overeating, or where the abdominal walls are weakened, permitting prolapse of the viscera, or where the stomach and intestines have become permanently distended (*Dana*).

424. Circulatory System.—The heart-action is weak and irritable, usually more so in women than in men, with lessened inhibition, arhythmia, and palpitation. The pulse is rapid. Pressure on a painful spot, as in the spine, may suddenly quicken the pulse 20 or 30 pulsations and maintain it at the accelerated rate for several minutes (*the Mannkopf symptom*). The symptoms of cardiac irritability are greater in the young and in those who have used freely tea, coffee, alcohol, or tobacco.

Rapid or frequent changes in arterial tension occur. There is loss of vasomotor control, as is shown by cold hands and feet, flushings or pallor of the face, or of the skin in patches

elsewhere. The skin may be "dermographic" from the same cause. Disordered vasomotor action, such as spasm or paresis, may account for such symptoms as sudden weakness or fainting, dizziness, fulness in the head, noises in the head, spots before the eyes, and headache, and possibly for much of the spinal irritation when it is present. The patient may be anemic, but no characteristic changes in disproportion of the corpuscular elements of the blood or in the amount of hemoglobin have been observed.

425. Respiratory System.—The respirations are often shallow and deficient, and it is with apparent effort that the patient inflates the lungs fully. The voice is atonic, variable in force, often faint and husky.

426. Temperature.—The results of our observations as to the temperature of neurasthenia differs from that usually recorded by authors. While some speak of it as variable and at times subnormal, it has been our experience that the temperature is usually in some manner abnormal. A subnormal temperature in the early morning has been found to be very common, as low as 97° F., and later in the day rising to 99° or a little more. Such a range of temperature might readily be regarded as normal if taken at the customary hours only. But in order to test this, the temperature of hospital patients has been taken at frequent intervals both during the day and night, with the result stated. A temperature of this nature is indicative of lowered vitality and toxemia.

427. Genito-Urinary Functions.—The sexual vigor is lessened and fitful; impotence is not uncommon. In women, menstrual disorders are the rule, amenorrhea and dysmenorrhea being the more common. Even the ordinary menstrual flow is a serious drain to a woman in this condition of nervous exhaustion. The bladder and urethra are frequently irritable. The urine is variable in amount, the specific gravity usually being low. The phosphates are in excess, especially in young persons. In older people the oxalates, urates, and uric acid are increased as well, especially if there are digestive and hepatic disorders. Indican may be present in abnormal amount.

428. Sensory Conditions (*Special Senses*).—There is occasionally morbid sensibility or disorder of the sense of smell, especially in cases with hysterical symptoms. If the sight is not defective, the eyes tire quickly, astigmatism or hypermetropia being common. Muscular insufficiency, especially of the internal recti, is not infrequent. Great mobility of the iris, dilatation, variability, or even inequality of the pupils, and eccentricities of accommodation are not rare symptoms. There is often defective visual memory, which can be explained by the mental state. There is no limitation of the visual field in simple neurasthenia unless there is organic disease, but the visual field is readily fatigued, and vision is then less distinct at the periphery of the field. "Foerster's shifting type" of the visual field may be present. A dulled or perverted sense of taste is not infrequent. Ringing in the ears is common, and may be due to anemia or hyperemia, or to actual middle-ear disease, or disease of the cerebral vessels. There may be hyperesthesia to either discordant or musical sounds. The patient is usually very intolerant of the least noise. There may be attacks of dizziness of aural origin.

429. General Sensations.—Women complain more than men of sensory and irritative symptoms. Neuralgic pains are common; headache, ordinarily frontal or occipital, usually diurnal only, but persistent and chronic, is present; pressure or burning or numbness on the vertex, sense of contraction about the temples, and tenderness of the scalp are also common. There is pain in the spine, upper and lower cervical, mid-thoracic, and lumbar; oftentimes it is excessively sensitive to touch or pressure in these localities. Numbness or prickling of the hands or feet are common. There may be a moderate degree of anesthesia, either general or local. The cutaneous sensibility to the electric current is variable, but usually heightened unless the prostration of the patient is extreme.

430. Motor Symptoms.—There is a lack of volitional muscular power; if not shown in the primary effort, it fails to be sustained. The general muscular and nerve-power is diminished. The patient tires quickly from slight exertion. Reading,

speaking, or writing speedily bring on fatigue. There is ordinarily loss of weight. The cutaneous reflexes are variable, but likely to be exaggerated unless voluntarily inhibited, or the patient is unusually exhausted. The patellar tendon reflex is usually increased, and often can be as readily brought out by tapping the limb both above and below the patella as on the tendon directly. There is often muscular tremor, which is usually fine and rhythmic, and occurs most frequently in the hands, face, eyelids, or tongue. This may be caused or aggravated by the excessive or even moderate use of alcohol, tobacco, tea, coffee, or medicines, or by effort or mental excitement.

431. Mental Characteristics.—It is in this class of symptoms that the genuine neurasthenic usually exhibits the most marked change from his normal condition. There is a lowering of emotional tone. Life seems to him a greater burden than he can bear. He indulges in morbid introspection and retrospection, has foreboding of evil, fears of impending poverty, insanity, or paralysis; worries constantly when unrestrained by the presence of strangers. This depression of feeling is worse, as a rule, in the early morning. There is a decrease of the power of voluntary attention; sustained thought is difficult or impossible. Tasks once easy and agreeable are now irksome and performed with difficulty. Social and business demands are intolerable. There is a loss of constructive and executive power, and the memory is unreliable. He is uneasy, restless, excessively irritable, a source of disquietude to his family and friends. He is troubled with insomnia, and when he falls asleep, distressing dreams disturb it. Later there may be diminished sensitiveness to mental and physical impressions, while dullness and languor may supervene, a condition that has been termed by Cowles "anesthesia of the sense of fatigue."

432. Treatment.—The treatment that has been suggested for neurasthenia arising from other causes is equally appropriate to this form. Of greatest importance are those measures directed to the morbid psychical state. A change of scene from a locality where the suggestions are constantly

causing the mind of the patient to dwell upon his morbid state, is most desirable. His companionship should be cheerful and diverting. While indifference should not be shown toward his ailments, they should not, after a thorough inquiry has been made, be allowed as a frequent topic of conversation. The diet should be simple, well cooked, and nourishing. Tea, coffee, alcohol, or other stimulants or narcotics should be interdicted or used very sparingly.

An outdoor life in a sedative climate, country life, a sea voyage, prove oftentimes beneficial. It is best, in many cases, for the patient to have some occupation that can be pursued without fatigue so as to occupy both mind and body. Tonics directed to the cardiac and vasomotor action, the digestive system, and to improving the nutrition of the nerve-tissue are indicated.

433. Electrotherapeutics.—As has been said, when the treatment of neurasthenia was under discussion, that there are few disorders of the nervous system in which the various forms of electricity are as beneficial to the patient as this. The energy that is furnished the system by static insulation or the magnetic fields seems to aid in restoring the stability of the central nerve-nutrition. The disturbed vasomotor action is corrected by means of the static spark and the faradic brush, while general applications of the anode of the direct current are both sedative to the over-excitability characteristic of the disease and helpful in improving the cellular nutrition.

THE NEUROSES.

434. Diseases of this class are sometimes classified as functional, meaning thereby that there are no demonstrable morbid changes in the nervous structure from which their symptoms emanate. They often have their origin in hereditary or congenital predisposition. Faulty education and environment during the developmental period may result in an acquired instability of the nerve-centers. Whatever may be the cause, there is, in disorders of this nature, a lack of proper interplay and adjustment among the higher activities of the

brain, where the mental and the physical forces are wont to cooperate. We will consider as representatives of this class *hysteria*, *epilepsy*, *hysteroepilepsy*, *catalepsy*.

HYSTERIA.

435. Nature and Pathology.—This is the most perfect type of a functional disorder. There is no known anatomical basis for it. A change in the finer nutrition of the nerve-elements probably underlies it, producing a disturbance of the psychical equilibrium. There is a loss of the due balance between certain higher functions of the brain and a derangement of lower centers.

436. Symptoms.—These are infinite in variety and simulate those of almost every organic disease. They are characterized by the suddenness of their onset without due cause, their wide range, variability, and sudden disappearance. No part of the nervous system is exempt. A characteristic mental attitude prevails. The patient is lacking in will-power, is vacillating, untruthful, tends to exaggerate, is often sly and crafty, lacks power of concentration, though there may be seeming brilliancy of mind. There is a tendency to dwell upon his or her condition, and to attempt to excite sympathy; and the patient is often thoughtless and inconsiderate. There may be frequent outbursts of anger. In some cases there are temporary hallucinations; in others, hysterical sleep. As cerebral symptoms we may have apoplectiform attacks followed by hemiplegia and hemianesthesia. Every cranial nerve may be affected.

On the part of the special senses, we generally find anesthesia or paresthesia. Most frequently, smell or hearing is affected. They are impaired or overactive. Affections of the optic nerve give rise to sudden blindness, decreased acuity of vision, or complete or partial loss of color sense. Taste may be lost, perverted, or give rise to hallucinations. There may be headache, megrim, or the hysterical clavus from involvement of the fifth nerve. Affection of the seventh nerve gives *tic-convulsive*, or facial paralysis. Neuroses of the vagus and associated nerves in the medulla account for the occurrence of spasm of the

glottis, aphonia, change in the respiration, paroxysms of laughing or yawning, rapidity of the heart, globus hystericus, and singultus. More rarely from this involvement we find persistent anorexia, dyspepsia, vomiting, hematemesis, and hemoptysis.

The spinal symptoms are both motor and sensory of all distributions, often suddenly appearing and disappearing. The motor paralyses are of a flaccid type and not complete; but the will to use the muscle seems lost. There are involuntary movements, clonic muscular spasms, and tics. Contractures are common, appearing suddenly, and disappearing under chloroform anesthesia. In the upper extremities the contractures are those of flexion, in the lower, of extension.

The anesthesia, partial or complete, may be present over all parts of the body, including even the mucous membranes, or it may be in circumscribed spots, or of a segmental distribution. Anesthetic zones may be found on the back, hands, or other parts of the body, or there may be an hemianesthesia suddenly appearing and disappearing. In circumscribed areas, in the internal organs, or about the joints, hyperesthesia may be found. Hysterogenic zones, pressure upon which may excite an hysterical attack, are found on the back, chest, extremities, in the region of the ovaries, testicles, submammæ, etc. There may be neuralgiform pains in the joints of the hip and knee, and these joints may be tender on pressure if attention is directed to them, otherwise not. In some cases atrophy and swelling of the joints have been noticed. Spinal irritation may be present. Phantom tumors not infrequently occur in hysteria.

The secretory symptoms are on the part of the kidneys mainly. Ischuria or polyuria may be present. There is local sweating or the skin may be dry. Trophic symptoms of edema are not infrequent. The edema is a white edema, the skin pitting upon pressure, or a hard, blue edema, the surface temperature being lowered and the skin mottled. A hysterical fever may be found, also an anemia.

With this general condition the patient is subject to paroxysms, or hysterical attacks, occurring at irregular intervals. There may be mental prodromes. A change of disposition or

great depression, vague pains, ructus, yawning, or hysterical globus occur as premonitory symptoms. With few exceptions there is no loss of consciousness. The patient falls or glides down to the floor, then there are violent respiratory movements, spasms of laughing, screaming, weeping, or barking, and as a climax a muscular convulsion resembling epilepsy. There may be opisthotonos. The paroxysm lasts from ½ to 1 hour, and is followed by a short period of general depression. Polyuria follows an attack.

During the attack the patient generally appreciates what is going on, and will respond to a stern order or to pressure on some part of the body that provokes pain, i. e., one of the hysterogenic zones mentioned above. After a paroxysm of this sort the various paralyses, motor or sensory, may be found. The cutaneous reflexes are diminished, the tendon reflexes may be diminished or exaggerated, a spurious ankle-clonus may be demonstrated. Tremors of all kinds are found. The hysterical seizure may be merely a shivering, a loss of sensibility over the body and conjunctiva, a few rhythmical movements, or a rigidity, or the patient may lie down and go to sleep. In children, the attacks are associated with the noise and movements of animals. The attack may take the form of trance, lethargy, catalepsy, amnesia. or cerebral automatism.

437. Treatment.—Much may be done by prophylactic treatment to prevent the full development of hysteria. The individual should be early taught self-restraint, and habits of industry, and the value of proper exercise and right living. The hysterical state being established, mental and moral treatment, even more than medicinal, are required. The will power, which is lessened, must be regained; too much sympathy must be guarded against, and the patient must be encouraged to exercise self-control and to recognize the proper relation between self and surroundings. These cases do much better under institutional treatment, removed from the indulgence of the family and subjected to a strict régime of life.

All sources of irritation should be removed by appropriate methods. Nerve-sedatives, as the valerianates, asafetida,

sumbul, with zinc and iron, are serviceable. Hydrotherapy, massage, a partial rest-treatment, or in other cases regular exercise, are all helpful measures. Counter-irritation may be applied to the spine if it is irritable. The convulsions may often be aborted by pressure on the ovarian, or other painful areas, or by the use of strong cutaneous faradization at these points. A cold-water bath or douche, a stern reproof, an emetic, a whiff of spirits of ammonia or of amyl nitrite, and similar measures and remedies will often be sufficient to arrest the attack.

438. Electrotherapeutics.—Electrotherapeutics is of service here in correcting the faulty nutrition, aiding elimination of effete matters, and toning up the vasomotor mechanism, which is so often unstable. As in neurasthenia, the alternating magnetic fields, the static insulation, breeze, or spark, general faradism, or the faradic brush locally applied have each the range of service in this disease. Yet, every medicinal or mechanical aid used must be subordinated to the moral management of the patient, which must aid to establish a self-respect and self-control that will eventually bring the physical actions of the patient into well-regulated subjection to the mental and moral faculties.

EPILEPSY.

(*Falling Sickness, Morbus Sacer.*)

439. Nature and Pathology.—Though a degeneration of the cortical cells in various parts and a proliferation of the neurogliar tissue have been demonstrated in some cases of epilepsy, no change is constant, and it remains today in the class of functional disorders. Various theories explanatory of the occurrences of the attacks have been propounded. All recognize an underlying instability of the nerve-cells with a periodical explosion or liberation of nerve-force. The disease may be divided according to the character of the attacks into *epilepsy major*, or *grand mal; epilepsy minor*, or *petit mal;* and *Jacksonian epilepsy.*

440. Grand Mal.—There may be premonitory symptoms called the aura, which warn the patient of an attack and often

furnish aid in deciding upon the exciting cause of the attack. The aura may be psychical, on the part of a special sense, or somatic. The psychical aura may be merely a sudden quietness on the part of the patient, or an excitement or bewilderment, or an irresistible desire to run. There may be vertigo, confusion of thought, impairment of consciousness, or a sense of something wrong. Any one of the special senses may give rise to the aura. The somatic aura are motor, sensory, or vasomotor. The attack itself is ushered in by a cry or noise. The patient loses consciousness, falls, there are tonic muscular contractions, the head is drawn back, or to one side, the jaws are set, the back spasmodically curved, the fingers clenched over the thumb, respiration ceases, and the face becomes cyanotic. Then a convulsive tremor runs over the body, and twitchings of the muscles of the face and extremities appear, the head is rolled or knocked about, the tongue is alternately protruded and drawn in, and often injured by the teeth. The eyeballs are deviated, the pupil dilated and inactive. The arms and legs are the seat of violent irregular jerkings; there is foaming at the mouth. Respiration is rapid, the temperature is raised .5° to 1°. There may be voluntary evacuation of urine and feces, and perhaps semen. Vomiting at the onset is rare, but it is frequently terminal. The body is gradually covered with sweat, the convulsions become less violent, the limbs relax, the cyanosis disappears, the respiration is easier, and the coma gives place to a deep sleep or complete consciousness.

The attack lasts from ½ to 2 minutes, the tonic stage occupying 15 to 30 seconds, and the clonic stage 30 seconds to 2 minutes. The sleep that follows the attack may last several hours. In some cases one attack succeeds another rapidly, giving rise to the "status epilepticus," which, if continued very long, proves fatal through exhaustion of the patient.

After the attack, speech disturbances, as motor or sensory aphasia, or stammering, may be noted for an hour or so. A difference in the size of the pupils and a concentric contraction of the field of vision are after-effects on the eye. There may be symptoms of motor irritation, contractures, or paralysis. For

a few seconds after the attack the knee-jerk is lost, and also the plantar reflex; then there is a transient increase of the patellar tendon reflex and an ankle-clonus. Headache is common after an attack, and there may be a condition of double consciousness, or of languor, exhaustion, despondency, or irritation. Muscular pains or sensory discharges may occur. There is transient albuminuria, and polyuria; the earthy phosphates are increased. There is a distinct lessening of the hemoglobin of the blood.

441. Petit Mal.—The symptoms are of countless variety. There may be an aura. There is a brief loss of consciousness so slight it seems merely absentmindedness; the patient suddenly stops whatever he is doing, the eyes are turned up, are staring, the features are fixed, face pale, pupils dilated, slight twitchings of the facial muscles, or convulsive movements of certain muscles of the extremities or body. Or the attack may be made up of disturbance on the part of the special senses, or general sensation, or of disagreeable epigastric or cardiac sensations. At times the attack consists of a sudden sleepiness or fainting.

442. Jacksonian Epilepsy.—This is a symptomatic form of epilepsy caused by a direct irritation of one or more of the cortical motor centers. It follows injuries to the skull, and is a frequent symptom of cerebral tumors or hemorrhage. The symptoms consist of convulsive attacks affecting a single group of muscles or of a limb, the muscles being involved in a certain order. Generally there is no loss of consciousness.

443. Treatment.—This should be directed toward the establishment of a more stable condition of the nervous system and the removal of irritations. The latter condition will vary with each case, and hence the treatment. As general measures, the diet should be non-irritating, containing little meat, and plenty of water should be drunk in the intervals between meals. Out-of-door life, physical exercise, and congenial mental occupation aid in recovery. General nerve-tonics, arsenic, the phosphates, and iron are indicated.

The bromids, belladonna, chloral, antipyrin, with numerous other remedies of the same class, have all been used to lessen the number of attacks. They all are more or less effective through their depressant action upon the motor system, but they serve merely to mask rather than to exercise a curative effect upon the disorder. Continued for any length of time, they seriously depress the mental and physical condition of the patient. To prevent an impending attack, some voluntary muscular effort or sensory excitation, or the use of amyl nitrite, chloroform, or ammonia by inhalation, is serviceable. Spirits of lavender, ammonia, or alcohol may be given internally. The treatment of Jacksonian epilepsy is surgical.

444. Electrotherapeutics.—Where the exciting cause of the disorder is a toxic state of the blood, due to defective excretion or imperfect catabolism, the several forms of electric modality that stimulate the nutritive processes, static insulation and spark, general faradism and galvanism, and the alternating-magnetic fields are of much service in treatment. When the nature of the aura is such as to indicate that the starting point for an epileptic attack is a disturbance of some localized sensory area, a treatment of the neurons distributed to the area by induced or direct currents or by the static spark for 10 or 15 minutes daily has in some cases that have been under our care appeared to diminish the frequency of the attacks, improve the general condition of the patient, and in a few instances seems to have been instrumental in effecting a cure of the disease. It cannot be claimed that electricity in any of its forms exercises direct curative influence upon the unstable cerebral mechanism that is the primary cause of epilepsy.

445. Hysteroepilepsy (*Hysteria Major*).—This is a combination of hysteria and epileptoid attacks.

446. Symptoms.—These consist of convulsive attacks, which may be preceded by prodromal symptoms of malaise, irritability, or depression, mental disturbances, and hallucinations. The attack itself, generally ushered in by a cry, may be divided into four stages:

1. Epileptiform, in which the body is suddenly shaken,

respiration stops, patient lets fall anything he holds, is thrown to the ground, and there is a general convulsion, or of the extremities. The movements seem purposive.

2. Grand movements, in which the patient passes through a phase of contortions and grand movements, a common one of which is pisthotonos. There are flexions and extensions of the body and limbs, or rotation of the head. In this stage the patient may scream, bite, scratch, etc.

3. Passionate attitudes. The patient in this stage seems to be acting a dream, and in accordance with this dream is affected by varying emotions and takes the corresponding attitudes.

4. Delirium. This is a continuation of the stage of passionate attitudes. The patient talks, may be happy, sad, or obscene, and the language is in keeping with the mood.

The hallucinations finally subside and the patient soon recovers the former conscious state. The duration of the attack varies from 1 minute to 2 hours. There may be from 10 to 100 attacks in a day. The attacks may be induced or aborted by pressure upon the region of the ovaries.

447. Treatment.—The treatment for this affliction is the same as that for hysteria.

CATALEPSY.

448. Nature and Pathology.—This may be a symptom of hysteria or of various psychoneuroses, or may occur as a primary condition. There is deficient control of the motor centers of the cortex so that they overact in response to sensory impulses. The location and exact character of the lesion, if one exists, are unknown.

449. Symptoms.—There may be premonitory symptoms, as headache, giddiness, and hiccough. The disorder is characterized by periodical paroxysms of sudden onset, accompanied by complete or partial loss of consciousness, and a rigidity of the muscular system in whole or in part. At first the rigidity is considerable, movement being resisted, but shortly the limbs can be moved and then they remain in any position in which they are placed. The rigidity yields slowly to gravitation.

This condition is called *catalepsia cerea*. The countenance is expressionless. Substances placed back in the mouth are slowly swallowed. The sensory condition varies. In profound cases sensibility to touch, pain, and electricity is lost, and the reflexes, both motor and sensory, are wanting. In other cases there is only partial loss of sensation, and the reflexes are present. Rarely there is a paroxysmal hyperesthesia. Respiration and cardiac impulses are weak, and the temperature is lowered. An attack lasts from a few minutes to several hours, and recovery is gradual or sudden. At times there is inability to speak at first. In the intervals between the attacks there may be headache, giddiness, or hysterical manifestations, or the patient may be perfectly well.

450. Treatment.—The treatment of the attacks consists of attempts to arouse consciousness. Snuffs, emetics, and the faradic current may be used for this purpose. In the interval the treatment is that of hysteria.

GENERAL ELECTROTHERAPEUTIC TECHNIQUE.

INTRODUCTION.

451. Skill in handling electrotherapeutic appliances can be acquired, as in all other arts, only by practice added to a knowledge of the fundamental principles of the science of the subject. There are, however, a few suggestions that may be made to the beginner, or less experienced operator, which may aid him to acquire the necessary skill more rapidly than he otherwise would, and will warn him against certain blunders that would do injury to his patient or retard the efficiency of his service.

TECHNIQUE OF THE DIRECT CURRENT.

452. It is taken for granted that the source of current is free from defects and that the operator is informed as to the voltage and range of current-capacity in the patient's circuit.

CONDUCTING-CORDS AND CONNECTIONS.

453. Applying the Current.—In carrying the current from the current-source to the patient, flexible metal conductors covered with some insulating material are used. These are ordinarily made of fine strands of copper wire, braided or twisted together and covered with cotton or silk. The metal strands may be broken by accident or frequent handling, and yet the broken ends may, in some positions of the cords, be in contact so as to convey a current, while at other times the current may be broken. This is a source of much annoyance to the patient, for the current reaches the body fitfully, and subjects it to sensory shocks and muscular jerks that are hard to bear. The cords that are in use should be frequently examined and tested as to their conducting capacity, and the most convenient and satisfactory way to do this is for the operator to attach them to an induction-coil and take the current through his own body and thus learn whether it is gradual in its increase and decrease and uniform in its action.

454. Defective Connections.—Defects at binding-post, such as imperfect contacts or corrosions, will give rise to similar difficulties in conveying currents. The screw-threads of the binding-posts soon wear off and impair the contact with the cord-terminals. The screws of the binding-posts drop out and are lost. These annoying occurrences are so frequent that they become serious impediments to successful work. It is better to dispense with binding-posts and screw-connections wherever this is possible, and adopt, instead, the universal cord-tip, Plate XIV (*b*), and receptacle suggested by the American Electrotherapeutic Association. In this tip, the contact is made by a sliding movement of the cord-tip into the slot of the post, which not only grips it firmly, but the metal surfaces are burnished by the movement, insuring a good contact surface. By using the universal cord-tips, which are detachable, the operator can himself readily renew his conducting-cords when they become worn, by keeping on hand a supply of silk-covered conducting-cord such as is used for extension lights in electric-light wiring, and which can be purchased by the yard.

POLARITY OF THE CURRENT.

455. Determination of Polarity.—In direct-current applications, the direction in which the current is flowing determines in a great measure its therapeutic effect. The operator should never be in doubt as to this feature in the treatment. No matter what the source of current, it is most convenient to be able to determine the polarity at the extremities of the conducting-cords, for it is here that the application to the patient is made, and if the polarity is all right at this point, it does not matter so much how the conducting path may have been modified farther back along the line. It is always feasible to have some litmus paper at hand. This, moistened in pure water and made a part of the path of the current (by placing the conducting-cord tips upon it a little distance apart), will soon show a blue discoloration at the negative pole and red at the positive. Should litmus paper not be at hand, a little water in a glass or porcelain dish may be used for the same purpose. The current, if strong enough, will decompose the water, and the bubbles of hydrogen gas gathering at the negative pole will be in excess of the oxygen at the positive, and thus reveal the polarity.

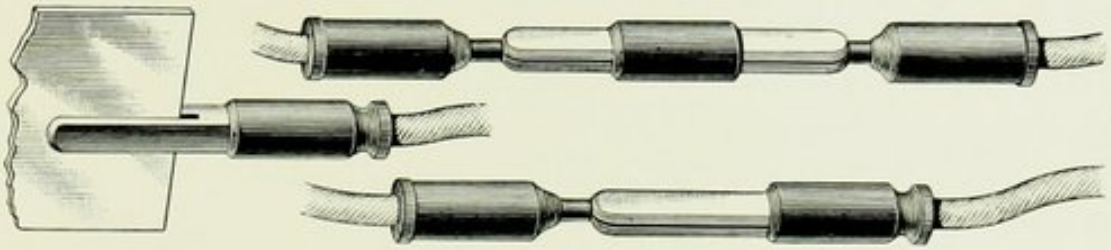
ELECTRODES.

456. Uniformity of Connections.—If the electrodes and binding-posts are constructed so as to be used with the universal cord-tips, very little trouble will arise at these points in the circuit. A thing much to be desired at the present time is a greater uniformity in the manner of making the connection between cord-tips and electrodes and between cord-tips and binding-posts. The electrodes must of necessity vary according to the work to be done with them, and this makes them almost infinite in shape and variety. An operator, who has accumulated any number of electrodes to meet the requirements of his practice, is daily confronted with annoyances due to this lack of uniformity in electrode connections. All electrodes and binding-posts should be adapted to the universal cord-tip, thus dispensing with special handles, odd forms of connection, and binding-screws. This change would be in the interest of

both manufacturer and operator, just as uniformity in the construction of microscope fittings has proved beneficial to both those that make and those that use them.

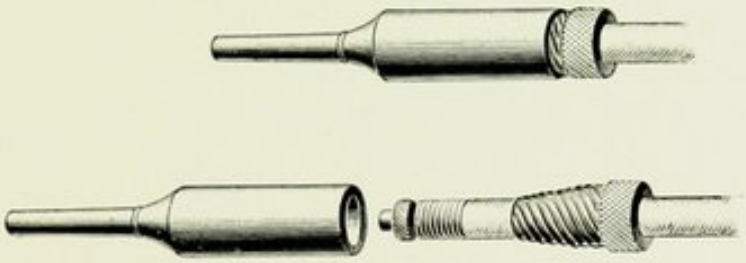
457. Dispersing Electrode.—The indifferent, or *dispersing, electrode* should be of comparatively large size, easily adapted to the part to which it is applied, and covered with a material that can be kept uniformly moistened with a 1-per-cent. salt solution. The most convenient material from which to construct these electrodes is perforated brass, cut in suitable sizes with amadou for covering. The pieces of perforated brass can be made any size or shape. It bends readily and will thus conform to the surface of the body. The perforations in it furnish a convenient means for attaching to it any kind of covering desired. By the use of a universal connector, such as is shown in Plate XIV (*a*), connection can be made with this sheet of brass at any point on its margin, which is both more convenient and less expensive than a special provision.

458. Amadou.—Amadou, which may be used for covering these sheets of perforated brass, comes in layers of suitable thickness for the purpose, and can be cut to any desired size. It takes up water readily and retains it more tenaciously than sponge. When moistened, it has a velvety softness and elasticity, and adapts itself admirably to the contour of the body. A number of sheets of perforated brass of different sizes covered with this substance may be kept in a flat porcelain dish containing a weak antiseptic solution, so that they are always moist and ready for use. A thin clean napkin or a layer or two of sterilized gauze moistened in salt solution can be spread over the surface of the amadou when it is applied to the surface of the body, and thus all the requirements of cleanliness in individual treatments may be met. A dispersing electrode of large size prepared in this way will be found to be quite as serviceable, more convenient, and much less mussy than the clay electrodes or other more elaborately constructed electrodes for dispersing the strong currents sometimes used in gynecological work.



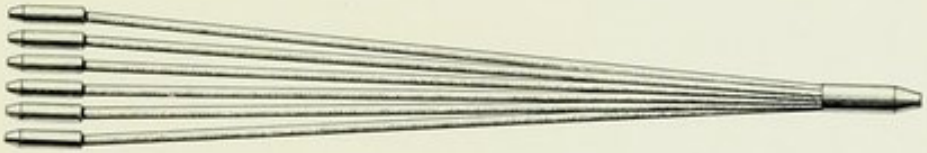
(*a*)

Universal Connector.



(*b*)

Universal Cord-Tips.

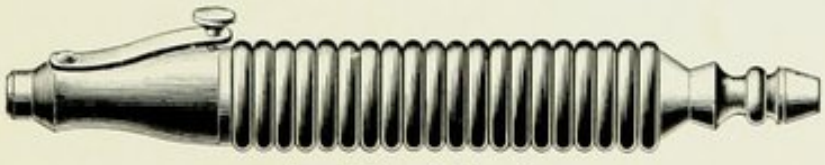


(*c*)

Leash for Needles in Electrolysis.



(*d*)



Break-Circuit Handle.

PLATE XIV.

459. Position of Electrode.—It is oftentimes a matter of no great importance at what point on the body the dispersing electrode is placed. When this is the case, the most convenient place, or that part which requires the least exposure or annoyance to the patient, as the back of the neck or the palms of the hands, may be chosen. At other times, the path of the electric current through the body is to be carefully considered, since its effect on certain tissues, as nerve-centers or ganglia, or important organs, as the heart, might prove an important factor for or against its beneficial effect. The position of the dispersing electrode must not for this reason become a matter of routine, but must in each case be considered with reference to the condition of the patient, and the result that the operator is seeking to obtain from the treatment.

460. Active Electrode.—The active electrode is made of any size, shape, and material that the work to be done with it requires, so that little can be said of it in a general way. There are very few cases, however, wherein the universal method of connection of this electrode to the conducting-cord would not be suitable. It is simple, secure, and efficient.

When the active electrode is used to convey the current to parts beneath the surface of the body, local action on the surface is to be avoided. Two requirements at least are to be met: *first*, the electrode must be composed of some substance that is not readily corroded by the current; and, *second*, the resistance at the surface contact must be reduced as much as possible. Carbon is a good material for the electrode when it is to be used for this purpose, and, over the carbon disk at the time of application, a smooth layer of absorbent cotton can be placed and held in position by a rubber band; or a piece of sponge or amadou can be fastened on the face of the carbon disk. Any one of these coverings, well moistened, will furnish a uniform conducting surface, and if the current-strength is not disproportionate to the size of the electrode, the density will at no point be sufficient to electrolyze the tissues at the surface of contact. Care should be taken to avoid this electrolytic action on the

tissues in contact with the electrode, unless this is the effect that is wanted.

461. Corrosion of Electrode.—When metals are used for the active electrode, corrosion of the metal soon takes place underneath the covering, and, as a result of this corrosion, substances accumulate on the surface of the electrode that may irritate the skin. Some of the metallic salts thus formed may be conveyed by phoresis into the tissues and produce an unintentional and undesired local medication. If, therefore, metals are used for the active electrode, the surface of the metal should be kept bright and free from the results of corrosion when the object is to transmit the current to parts at some distance beyond the electrode.

462. Active Electrode for Electrolysis.—When the active electrode is used for electrolytic purposes, the result will be more effectual according as the electrolytic action is located with precision in the part to be treated. The electrode should be well insulated, therefore, except at the point where this action is wanted. Rubber tubing for covering unnecessary parts of the electrode, a coating of shellac, or hard rubber melted and molded on the electrode, leaving bare that portion of its surface that is meant to be active, are means for locating the electrolytic action that the operator in electrotherapeutics will need to employ so as to make his work efficient.

463. Difference Between Positive and Negative Polarity.—In order to do skilful work in electrolysis, the difference in action of the positive and negative polarity of the direct current must be borne in mind—the drying, styptic, coagulating effect of the positive pole on the one hand, and the softening, liquefying, relaxing effect of the negative on the other. It must be remembered, also, that the oxygen and chlorin set free in the vicinity of the positive electrode attack the baser metals and form compounds with them. When the treatment is of a kind not needing these salts, or where the desire is to avoid their formation and their secondary action on the tissues, the electrode used must be made of carbon, or of gold or platinum, or iridoplatinum substances, which do not

readily enter into composition with oxygen and chlorin. A steel instrument heavily plated with gold or platinum will, for a time, serve the same purpose as if made entirely of one of the more expensive metals.

464. Positive Electrode for Electrolysis.—When the positive electrode is being used for electrolytic purposes—as when, in the form of a lance or needle, it has been thrust into some abnormal growth, or in the form of a sound or probe, it has been passed into some tube or canal of the body, as the nasal duct or urethra—it may be found at the termination of the treatment that the electrode cannot be readily disengaged, owing to the coagulation and drying of the tissues about it. It will then be well to turn off the current and reverse the polarity and turn it on again for a few seconds. This change of polarity to the negative serves to moisten the tissues about the electrode and it can then be removed without difficulty.

When in electrolytic work one needle or one puncturing-electrode will serve the purpose, it is most convenient to fix this into some one of the many forms of needle-holder, but very often it is more advantageous to act on the structure at several points at the same time, and then a leash of needles attached to the conducting-cord will answer better, for, by means of them, the part may be punctured at any point, at any angle, and to any desired depth. In the divided circuit that is thus formed, Plate XIV (*c*), a stronger current will be required than when one needle is used. It may be found during a treatment with a leash of needles that certain of the needles engaged are not doing the share of work that the operator wishes them to do. In that case these may be left in place for a time after the others are withdrawn, when the current will be concentrated along their paths and the desired action will soon be obtained.

465. Pliable Electrodes.—It is always helpful to have some electrodes at hand composed of a soft metal like pure tin, lead, or copper, which can be readily bent or molded into the shape needed to adapt them to the special requirements of treatments. An urethral or uterine canal may have an unusual curve, a nasal septum may take an unwonted deviation, and

these unusual conditions could be easily met oftentimes by a slight modification in the shape or curve of the electrode if the material would admit of it. Thin sheets or plates of such malleable metals will be found serviceable in the treatment of irregular contours—like the joints of the limbs—when it is the wish of the operator to apply the current uniformly over considerable surface at the same time.

466. Metallic Electrolysis.—When the method of metallic electrolysis is employed, the metal used for the electrode, copper, zinc, etc. should be as pure as possible, and its surface should be brightly polished with fine emery-paper before each treatment. A little amalgamating fluid can be kept at hand, and when the operator wishes to employ mercury as the metal for metallic electrolysis, it is only necessary to dip the copper or zinc electrode into the amalgamating solution to obtain a coating of mercury upon it, which is then ready for use after a little rubbing is given it with a clean cloth, to remove the excess of acid.

GRADUAL VARIATION OF CURRENT.

467. Precautions.—Every precaution should be taken to prevent sudden, startling, and disagreeable shocks and sensations to the patient when such effects are not intended. All the connections should be carefully made and the electrodes placed in position before the current is turned into the patient's circuit. The current should be turned on slowly, by means of a finely graduated rheostat, until the maximum amount determined for the treatment has been reached, and, at the close of the treatment, the withdrawal of the current should likewise be gradual, not sudden. The patient must be cautioned against any movement during the course of the treatment that will break the circuit connections or displace the electrodes. Any eruptions or abrasions of the skin underneath the electrodes will increase the current-density at these spots and will cause pain and perhaps electrolysis. Such spots should be avoided when possible, but if it is necessary that the electrodes be placed over them, they should be carefully protected by bits of rubber tissue or adhesive plaster, or by a coating of vaseline.

REACTION OF DEGENERATION.

468. Tests.—When nerves and muscles need to be examined by means of the direct current, with a view to determine, by the character of the response, the condition of their nutrition, more than ordinary care is necessary in order to guard against false conclusions. In the normal nerve and muscle, a response is obtained first when the negative electrode is placed over the motor nerve at some point in its course or at the place of its entrance into a muscle; that is, under normal conditions, the weakest current that will be followed by a contraction will produce it with the negative employed as the active electrode. Should the positive electrode take precedence of the negative in obtaining a muscular contraction with the weakest current, when applied either to the motor nerve or directly to the muscle, this is the *reaction of degeneration.*

In making this test, the aim should be to have no varying element in the process other than the change of polarity. If the electrodes are raised from their points of contact on the body, if the pressure of one or the other electrode is varied during the test, or if electrodes of different surface area are used in making the test with the negative polarity at the nerve or muscle from those employed while testing the action with the positive polarity, the result will be inexact. Even a variation in the degree of moisture of the cotton or amadou covering of the electrodes might lead to error in conclusions in a case where the degeneration changes were but slight.

In making these tests for determining positively the condition of nutrition of nerves and muscles, too great care cannot be taken, since, when accurately made, they furnish information that is of great value both for diagnosis and prognosis, information that cannot be obtained in any other way. An arrangement of apparatus that we have recently suggested for the control and measurement of the direct current, when it is to be used therapeutically or for diagnosis, overcomes many of the difficulties that the operator has had to contend with in the past when attempting to do accurate and satisfactory work with this form of electric modality.

UNIVERSAL METHOD FOR USING DIRECT CURRENTS.

469. The arrangement of the apparatus shown in Plate XV is as follows: *A* and *B* are binding-posts for the wires connecting the instrument with the source of direct current, which source may be primary batteries, secondary batteries, or a dynamo circuit of 110, 220, or 500 volts; *C* is the cut-out, or switch, by turning which the current is admitted or shut out from the board; *F* is a graphite rheostat connected *in series* in the main circuit and *in shunt* for the patient's circuit; *D* and *E* are a voltmeter and a milliamperemeter, respectively, so connected as to give the reading of electromotive force and current on the patient's circuit, no matter in which direction the current is traveling; *G* is a pole-changer, which indicates also the direction of the current; *H* and *I* are the binding-posts for the connections to the electrodes, or, in other words, the binding-posts for the patient's circuit; *L*, L^1, L^2, L^3, and L^4 are lamps, or places for lamps, be used, if needed, when the source of current is such as to require more or less resistance to modify it for electrotherapeutic use.

Let us assume that we have for a source of current fifty or seventy Leclanché cells. The voltage of these will be 1.4 per cell, or, when coupled in series, from 70 to 100 volts for the series. None of the lamps need be used in this case, but the connections may be made directly from the binding-posts to the switch and the graphite rheostat. The direct resistance of the rheostat is 10,000 ohms, so that, when the switch is closed and the battery of cells is delivering its current through the rheostat, the resistance in the circuit is high enough to prevent a short circuit and a rapid waste in the cells. The resistance in the patient's circuit, which is in shunt with the main circuit, may be made much less than 10,000 ohms by moving the movable radius of the rheostat, which is a part of the patient's circuit, and thus the amount of current given to the patient can be varied at will.

Should the source of current be the 110-volt dynamo circuit, lamp L^2 can be connected in shunt with the rheostat and thus divide the current with the rheostat and at the same time light

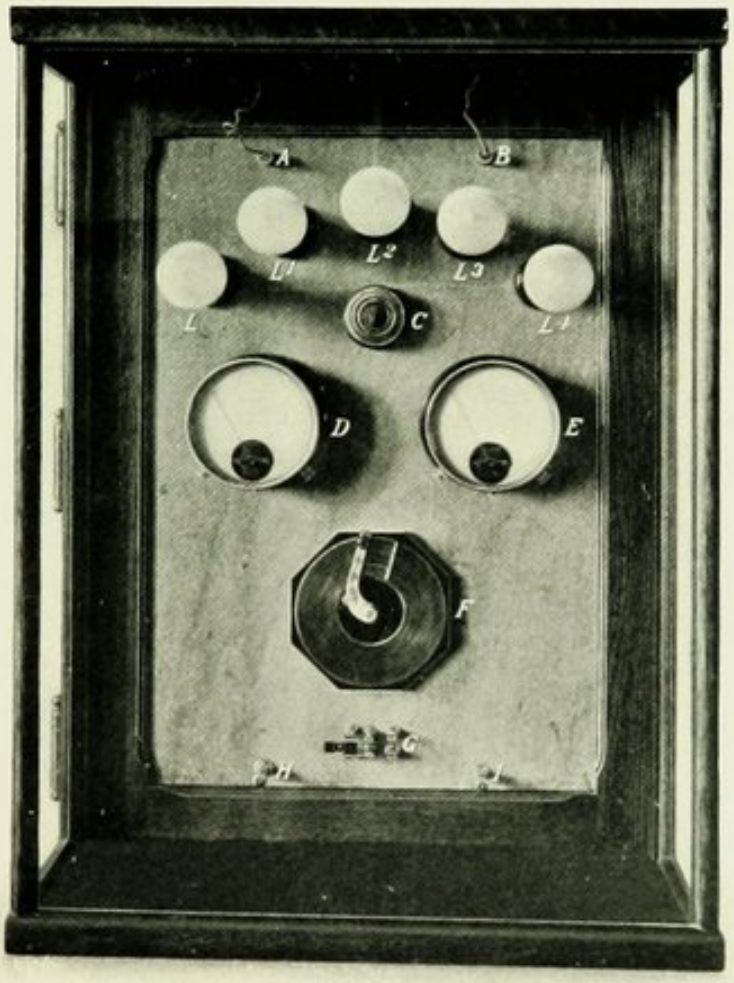


PLATE XV.

Herdman Universal Switchboard.

the board. This lamp is a convenient indicator for the presence of the current on the board.

Should the source of current be the 220-volt circuit, the wiring from the upper binding-posts should include lamp L^2 in shunt as before, and another lamp in series, as L^1; or both lamp L^1 and lamp L^3 could be connected in series with the rheostat and thus light the board symmetrically, provided the two latter lamps used are but one-half the voltage of the lamp used in shunt at L^2.

Should the source of current be the 500-volt circuit usually employed for trolley-cars or for supplying power, a form of dynamo that would in most instances be most convenient for physicians' use, then lamp L^2 could still be connected in shunt with the rheostat and lamps L, L^1, L^3, and L^4 connected in series. This would cause a drop of potential sufficient to make a safe current and voltage for the patient's circuit.

Thus it is seen that the use of this arrangement of appliances requires only a little change in the preliminary wiring of the board for any one of the sources of current mentioned. After this is done, the action of the remaining parts is the same for all. The board is thus adapted for all these and many other sources of current, and permits of uniformity in the control and measurement of direct currents for therapeutic use where now there is great diversity.

470. This arrangement for controlling direct currents also possesses two notable advantages that should be especially mentioned here, as they are very essential to a successful direct-current technique. The shunt rheostat of graphite, which is of very high resistance, permits a very gradual admission of the current into the patient's circuit when it is closed for the treatment, and a very gradual withdrawal of the current when the treatment is ended. In dealing with sensitive patients, this feature is one of great advantage. Again, the pole-changer in the patient's circuit, which enables the operator to reverse the current in the direction through the patient, without disturbing the position of the electrodes or modifying the arrangement in any other particular, meets the demand referred to above

in making tests for diagnosis, and adds much to the accuracy of the result. The care with which the current is reversed and measured is likewise very helpful in treatments by electrolysis in which a reversal of the polarity and, at the same time, a knowledge of the current-strength are often needed. A simultaneous record of the electromotive force and of the current enables the operator to determine at any moment, by the product of these two amounts, the number of watts that are being expended in the treatment, and the additional record of the time during which the current flows will furnish the means for determining the exact amount of energy to which the tissues have been subjected by each treatment.

BREAK-CIRCUIT HANDLE.

471. In making an electric diagnosis, and in some treatments, it is convenient to have the active electrode attached to a *break-circuit handle*, Plate XIV (*d*). Some of these are made so that the circuit is always closed through them except when the finger of the operator opens it; others have the circuit always open except when the operator closes it. The first of these two forms of break-circuit handle is thought by some to be much less liable to give the patient sudden unintended shocks of current, even when the operator has become accustomed to the use of both forms. This may be due to the "personal equation" of the operator, however, rather than to the construction of the handle.

GRADUATED DIMENSIONS FOR ELECTRODES.

472. Standard Sizes.—In singling out separate nerves or "motor points" for diagnosis or treatment, it is best to make use of electrodes of standard sizes, so that the results of one treatment of a patient can be compared with another. The sizes of electrodes that have been suggested by Erb have been very generally adopted by instrument-makers both in Europe and America, so that a uniformity of practice in this respect, if it is wanted, can be readily brought about.

TECHNIQUE OF THE INDUCTION-COIL.

473. The physical and physiological actions of induction-coil currents are limited in their range of influence on animal tissues as compared with the direct currents. Since they possess but little, if any, electrolytic or phoretic action, their efficiency is exhibited chiefly within the range of the physiological responsiveness of the tissues. The therapeutic capabilities of the physicians' induction-coil consist in the variation of electric potentials of no very great difference in degree (0 to 300 volts), with a frequency in these variations determined by the structure of the apparatus and the will of the operator.

474. Variety of Instruments.—The variety of patterns of induction-coils made for physicians is so very great that it is embarrassing to attempt to say much in a general way of induction-current technique. It is eminently desirable that instrument-makers agree upon some standard for construction and arrangement of the physcians' induction-coil. Its capacities as a therapeutic device have been set forth time and again, yet no attempt has been made by any manufacturer or set of manufacturers to combine in one instrument the best features that have been evolved from the myriad varieties that have been made.

We will assume that the operator who seeks to gather hints from what is about to be said possesses an induction-coil in which the amount of current in the primary coil may be made to reach at least 1 ampere, in which the frequency of interruptions of the current can be varied at the will of the operator and in which the electromotive force in both the primary and secondary circuit can be conveniently modified. It is surprising what an amount of valuable therapeutic work can be done with a satisfactory induction-coil possessing these essential features.

The same suggestions as to conducting-cords, connections, shape and size of electrodes that have been made under the heading of Technique of the Direct Current apply to their use with the induction-coil. There is not the danger of causing eschars in the use of the induction-coil currents that is always to be guarded against when the direct current is employed, but

an equable distribution of the current over the entire surface of the electrode is here quite as essential to accurate treatment. It is well to adopt the custom of using the graduated standard sizes of electrodes in all cases where the applications of electricity are made directly to the body, no matter what modality is employed.

MODIFICATION OF CURRENT-STRENGTH.

475. Modification by Means of High-Resistance Rheostat.—When the current is ready to be applied and the electrodes are in place on the body, the current can be let into the circuit most conveniently by means of a high-resistance rheostat, arranged either as direct resistance or in shunt. By the movements of the arm of this rheostat, the amount of current can be increased to the desired quantity, which should never be so great as to be intolerable to the patient. But even the most sensitive patients will permit stronger currents to be used when they are applied in this manner than when a sudden or abrupt flow takes place. This rheostat method of control or gradual increase or decrease of current can be adapted to the needs of both the primary- and secondary-coil circuit, and is for that reason the best and simplest plan to adopt for modifying the strength of the induction-coil currents.

476. Varying the Strength of Magnetic Field. Another method frequently used to modify the strength of the currents is to vary the strength of the magnetic field. For the primary circuit this may be done either by closing the circuit between the ends of the secondary coil and then moving it over the primary coil, or by moving the iron core in and out of the primary coil. Neither of these ways permits you to start at a zero of current in the primary circuit, which is sometimes desirable.

The withdrawal of the soft-iron core from the primary or secondary coils decreases the strength of the magnetic field so that the inductive effect on both the primary and secondary coils can be modified by moving this core back and forth. Some of the faradic coils made by the English and German manufacturers are arranged in this manner.

When the secondary-coil circuit is closed, the current flowing through the primary-coil circuit induces currents in the secondary coil that have a "choking effect" on the current in the primary circuit, and it is by virtue of this reacting influence of the induced currents in the secondary coil that the primary-coil current may be modified by moving the secondary coil back and forth over it. The strongest choking action takes place when the primary coil is completely covered by the secondary.

477. Still another method, and one that is used in a large number of the induction-coils now sold to physicians, is to surround the soft-iron core with a tubular shield of brass, which can be withdrawn or moved back and forth. When this shield covers the core, a large share of the magnetic lines of force are diverted to it and thus do not cut across the turns of wire in the primary and secondary coils external to it. By moving this shield in or out, the strength of the currents in the coils is increased or decreased to a certain extent.

VARIATION OF INTERRUPTIONS.

478. When the intensity of the current has been arranged to the satisfaction of the operator, the frequency with which it is interrupted is an important factor in the treatment to be considered. If the treatment is given with a view of maintaining the nutrition, or of arousing better nutritive action in muscles that are weakened or impoverished, the muscle or muscles must not be made contract with such frequency as would still further exhaust them. A very rapid repetition in the current impulses would cause almost continuous muscular contractions, which would strain and fatigue the muscles, doing more harm than good. Slow interruptions, to which the muscle or muscles could respond with a complete and uniform contraction, and in which there would be an interval of rest between each contraction, meet much better the physiological need in such conditions. This can be secured by the use of the break-circuit handle. With this the operator can break the circuit with such frequency as in his judgment seems best. Or one of the forms of slow interrupter can be used and set for the number of

interruptions per second that will best suit the conditions of the case. The more rapid interruptions are not suited for the treatment of muscular structure in which the nutrition is sluggish or seriously altered. They should be reserved for the general toning-up action of the current on all the musculature and the protoplasmic structure of the body or part of it, or for the sedative action on sensory nerves.

SENSORY STIMULATION.

479. Where there is a torpid action of the nerve-terminals in the skin or mucous membranes, affecting nutrition or function, the induction-coil currents may be used to arouse the nutritive activity. A comparatively dry electrode will serve this purpose best, since the increased resistance due to lack of moisture at the contact surface intensifies the current-action at this point. The wire-brush electrode is well adapted for stimulating the sensory-nerve endings, when numbness or defective nutrition, as in many skin disorders, are the conditions present, or when a counter-irritant effect is wanted, as in spinal irritation.

MUSCLE STIMULATION.

480. Accurate Application of Electrode.—When the purpose is to apply the electric stimulus to a single muscle, the active electrode must be applied accurately to the "motor point" on the muscle or to the motor-nerve filament supplying the muscle. Care must be taken to prevent the current from reaching muscles that should not be stimulated. Oftentimes, in attempting to correct a deformity, the necessary requirement is the strengthening of one or more muscles that by reason of their weakness or paresis do not do their share of work. If, then, the stimulating or strengthening action of the electric current is applied indiscriminately to both weak and normal muscles, the condition of deformity may be made worse rather than better.

481. When a muscle is caused to contract by means of an electric current at the moment the current is applied, the origin and the insertion of the muscle should be as near together as possible; in other words, the muscle should not be

on the stretch but in a state of relaxation. When a muscle is caused to contract, or makes the effort to contract, and yet is in a position in which contraction or movement cannot take place, the energy is expended not on the part that the muscle is meant to move, but on the muscle-tissue itself, and overstretching or laceration of the fibrils of the muscle and its tendons may take place. A disregard of this very important rule in stimulating muscles makes the treatment not infrequently harmful rather than beneficial.

DIAGNOSIS BY INDUCTION-COIL CURRENTS.

482. The brevity of each impulse of an induced current with slow interruptions, and the rapidity with which such impulses follow each other with rapid interruptions of the current, furnishes electric modalities differing from those obtained from the direct and more continuous currents. The physiological relationship of nerve and muscle to these special modalities gives to the induction-coil currents a diagnostic value peculiar to them. If there is much degenerative change in motor-nerve or muscle structure, they fail entirely to respond to the brief and sudden impulse of the induced current, while the slower and more gradual onset of the direct current will bring out a response. If a muscle or nerve is found, therefore, to respond to the induction-coil current, this of itself is evidence that the muscle is not as yet undergoing degeneration.

The intensity of current and the rapidity of vibration that are required to obtain nerve and muscle responses differ greatly in the varying states of health and nutrition of the body as a whole or parts of it, and thus the induction-coil or faradic tests are a valuable aid to diagnosis in diseases of the nervous system especially, but also in diseases of other organs or systematic diseases as well.

483. In using electricity for the diagnosis of diseases in children, as in infantile paralysis, where it is very necessary to know the exact condition of motor nerves and muscles as a guide to treatment, difficulty may be experienced in getting the child to submit to the necessary tests, as the currents used are at times quite uncomfortable, even painful. There is no reason,

so far as the results of the tests are concerned, why the child should not be anesthetized during the examination, and often this will be advisable.

In commencing electric treatment with a child or a nervous, apprehensive person, whether the current is either the direct or the induced, it is a good plan for the operator to use his hand as the active electrode until the patient becomes accustomed to the unusual and peculiar sensation, and until all fear of the electric treatment is allayed.

DURATION OF TREATMENTS.

484. The length of time to which a patient should be subjected to electric treatment depends on the nature of that treatment and the object sought by it. The direct-current and induction-coil treatments given with a view to stimulation or sedation should seldom exceed 10 or 15 minutes duration at one time, but may, if it is found necessary, be repeated several times each day. A treatment given with the view of electrolyzing a part should be continued until the polar effect is obtained over the extent of tissue that it is thought best to destroy at one time. It should be remembered that extensive electrolysis, immediately produced, is liable to result in considerable sloughing. The treatment of a limited area and a repetition of this at frequent intervals is the safer plan to adopt for electrolytic treatments.

Treatments by means of the high-tension, high-frequency currents depend for the proper duration on the quantity of current that they induce in the patient. If the current is small, that is, but a few milliamperes, the treatment may be continued much longer than when it is greater. Such treatments may therefore vary from 5 to 30 minutes, according to the strength of the current. The same may be said of treatments by means of alternating magnetic stress. If the lines of magnetic force pervading the field are few, the time during which the patient may be subjected to them with safety and benefit can be much longer than where the density is greater. A patient may be subjected to an alternating magnetic field furnishing 20 to 30 lines of magnetic force to each square inch

of cross-section for as much as 2 hours daily. If the magnetic field is much stronger than this, the length of each treatment should be proportionally lessened.

TREATMENT OF PATIENTS BY LAYMEN.

485. Electricity in all its modalities employed in therapeutics is a potent agent, capable of bringing about demonstrable chemical, physical, and physiological changes in the body of the patient; therefore its capacity for doing harm must not be ignored. Whenever it is used for the treatment of disease, if the application is not made with a definite aim to relieve some recognized pathological condition or modify some perverted physiological action of which the operator has a fairly clear conception and knowledge, he had better not employ it at all, for it is more than likely he will do harm with it rather than good. The proper and efficient use of electricity in therapeutics, then, demands, on the part of the operator, both a working knowledge of the agent itself, as well as a professional understanding of the disease that he undertakes to treat with it. It is at once seen that only the well-educated physician possesses these requisite qualifications, and that no layman, whether trained nurse, bath attendant, masseur, or unmedical electrician, is a suitable person to be entrusted with the selection of modality, place of application, or dose of an electric treatment. Quite as reasonable would it be for the errand boy of the pharmacy to compound the prescriptions—yes, even to write them—as for an unqualified person to undertake the treatment of disease by electrotherapeutics. Yet some physicians are slow to recognize this fact, and countenance gross abuse of this efficient therapeutic agent. It is even not an unusual thing for some physicians to suggest to their patients that they purchase a battery of some form and use it *ad libitum*. Such advice is never given by one that has much knowledge of the use of electricity in the treatment of disease or has become personally acquainted with its capacities, nor does the adoption of such suggestion ever result in benefit to the patient, but, on the contrary, it has been known in many instances to operate to his injury.

Electricity in Surgery.

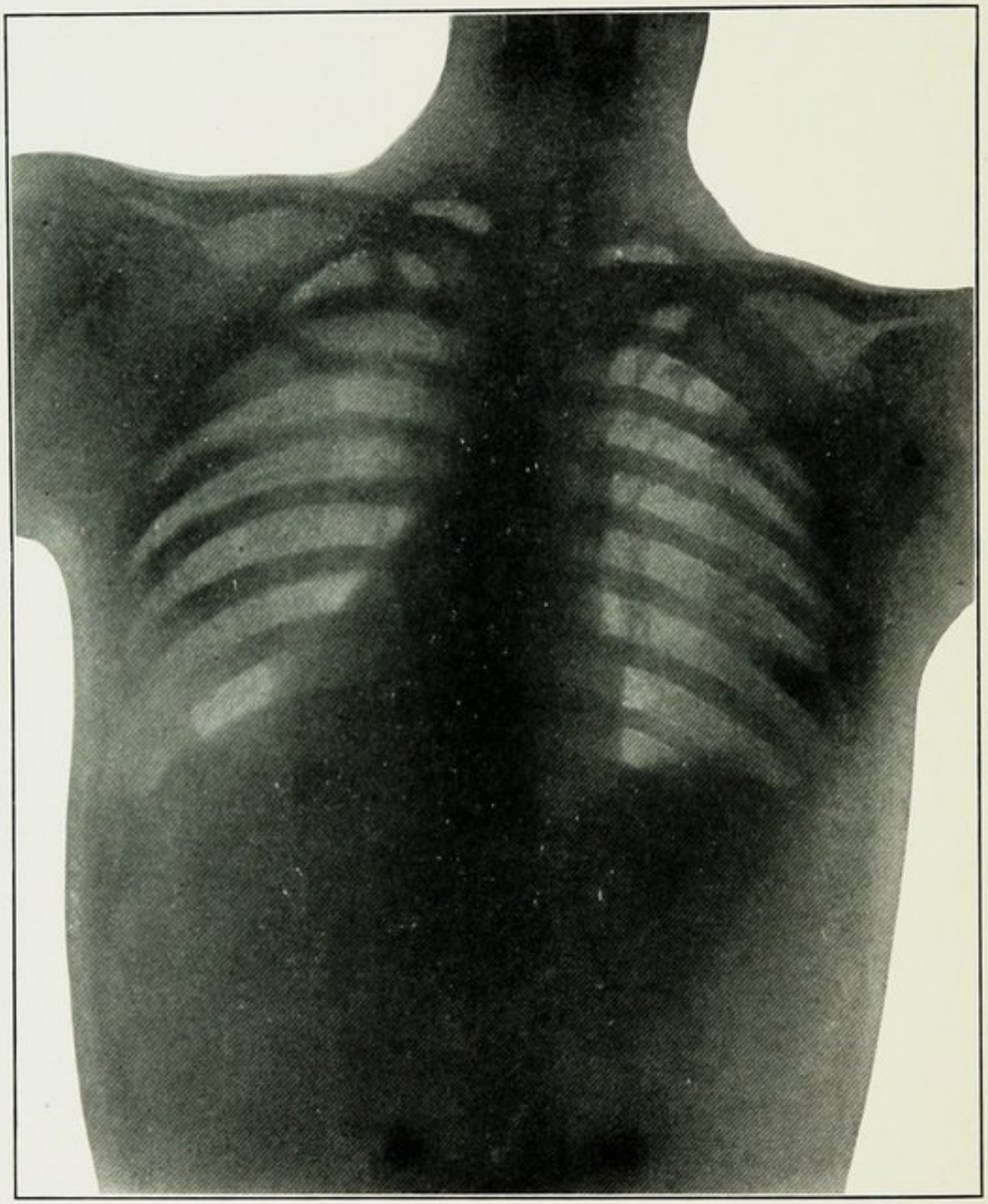


PLATE I.

Taken With Static Machine.

Electricity in Surgery.

SURGICAL USES OF ELECTRICITY.

ELECTRICITY AS AN AID IN DIAGNOSIS.

1. Deformities or defective action of the trunk or limbs are brought to the surgeon for advice and treatment. These deformities may be either congenital or acquired, or they may be the result of disease or accident. Impaired action in nerve or muscular tissue enters into many of these cases as an important element. In such instances, one of the first things to be determined by the surgeon is the condition of the nerves and muscles involved in the deformity. Are the nerves and muscles that do not act as they should destroyed, or are they wholly or partly degenerated, or only prevented from action by opposing forces? By means of the direct and induced currents of electricity, properly applied, these questions may be decisively answered and the state of the nerves and muscles clearly demonstrated. Where a cut, laceration, or burn of a limb, hand, foot, or other part of the body has resulted in a deformity, the method adopted by the surgeon to correct such deformity and the result he will expect to obtain depend, in a great measure, on the condition in which he finds the nerves and muscles.

2. In operations on the brain, especially when such operations involve the motor areas of the cortex, as is the case in the surgical treatment of Jacksonian epilepsy, electric stimulus to the denuded brain surfaces furnishes the safest and most

accurate means for determining the brain-centers and guiding the operator in his work.

3. The electric light in the form of exploring lamps adapted for various passages and cavities of the body are now indispensable to surgical practice. The Roentgen rays, which can be obtained only by means of electric currents of high tension, are even more in demand, and an examination of the osseous structures of the body in case of disease, fracture, or dislocation, or a search for the presence of a foreign body in the cavities or tissues, is not complete until the surgeon has employed this excellent aid to diagnosis. These latter uses of electricity will subsequently receive more extended mention.

ELECTRICITY AS A SOURCE OF ROENTGEN RAYS.

4. The surgeon was among the first to take advantage of the remarkable radiations discovered by Roentgen. He saw, in their capacity to pass unchanged through certain animal tissues while they are intercepted by other tissues—as bone, cartilage, and other substances, especially glass and most of the metals—the help they could afford him in getting more exact knowledge of things heretofore hidden from view.

The service rendered the medical profession by such a discovery was at once apparent. It remained for the members of that profession to work out in daily experience the range of that service, to determine the limitations of these new found rays in disclosing to the eye that which hitherto was made known, if at all, by senses less acute. These limitations have not yet been fixed, but enough has been done to show that not only every practitioner of surgery, whether general or special, as well as every practitioner of medicine, can, through a familiarity with the technique needed to generate and use Roentgen rays, largely increase his efficiency and render more valuable service to his clients.

The means for obtaining Roentgen rays are at present three: (1) *induction-coil*, (2) *Tesla coil*, and (3) *static machine*.

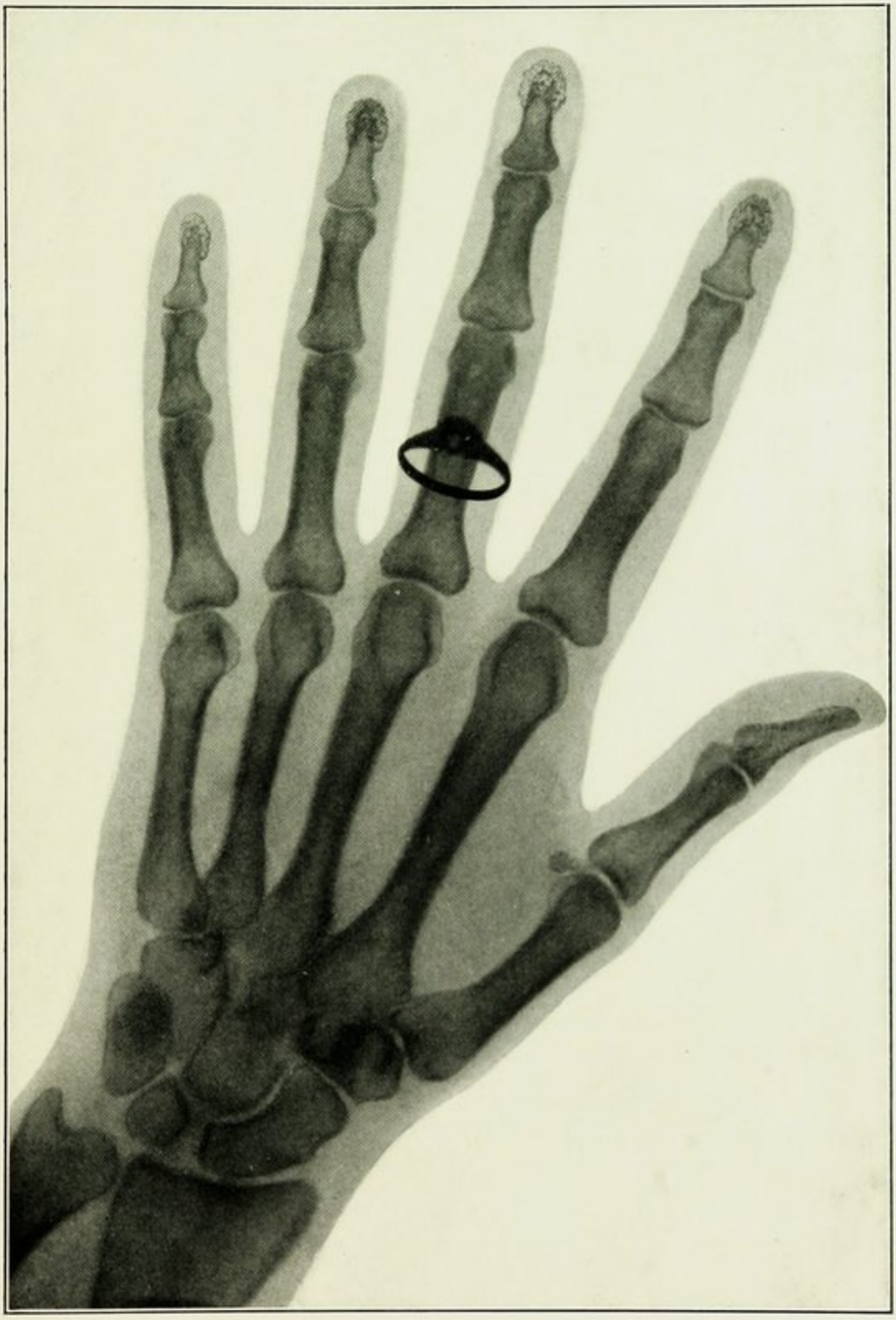


PLATE II.

Taken With Static Machine.

INDUCTION-COIL.

5. The form of induction-coil employed for this purpose is of large size, with a secondary coil composed of many turns of fine wire. This form of induction-apparatus is known as the Ruhmkorff coil. The secondary coil is often wound in several spools, placed in series on the core, the windings on adjacent spools running in opposite directions so as to decrease self-induction. The primary coil contains but a few turns of heavy wire that is capable of carrying a current of several amperes

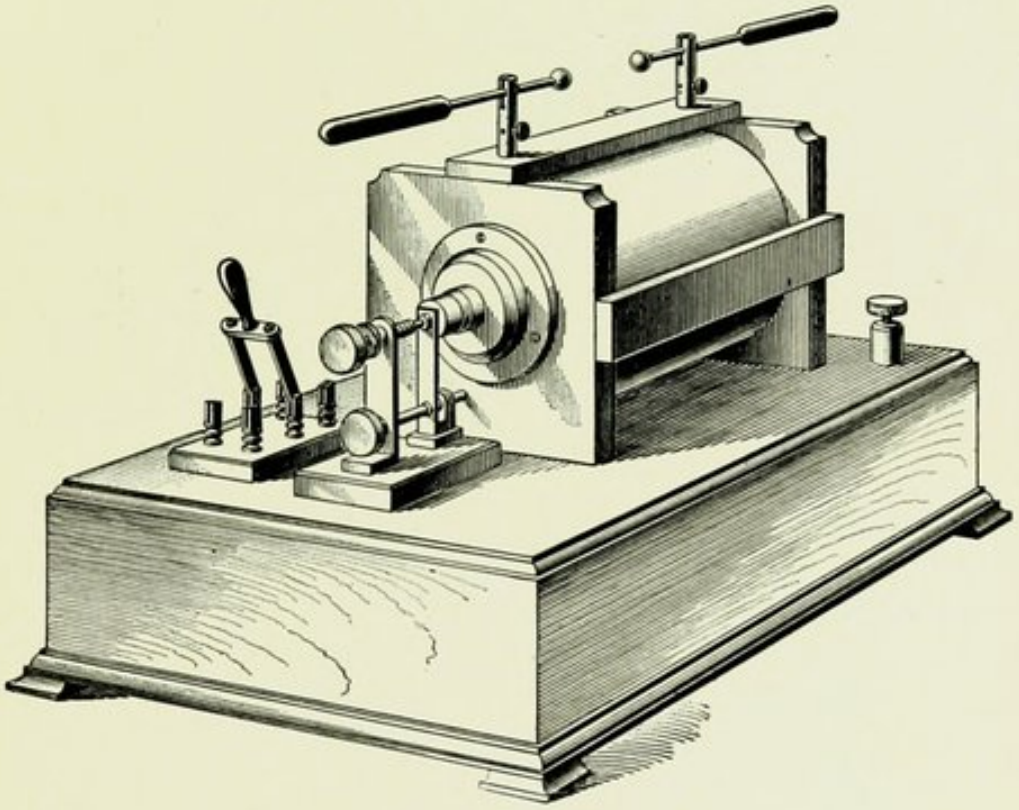


FIG. 1.
Ruhmkorff Coil.

without heating, and which surrounds a soft-iron bar that acts as a temporary or electromagnet. The weak point in the ordinary Ruhmkorff coil when it is used for creating Roentgen rays is the automatic *break* by means of which the direct current used to excite the induction action is interrupted.

This "break," when consisting of a steel spring that is alternately attracted by the bar electromagnet and set free by the interruption of the current and its own elasticity, is far too slow and irregular in action, in most instances, to excite the

vibration sufficiently in the Crookes tubes that give rise to X-rays. A more rapid and uniform break is needed, and in order to furnish this, many ingenious contrivances have been devised. Most of these contrivances are both complicated and expensive, which not only adds to the difficulties in operating

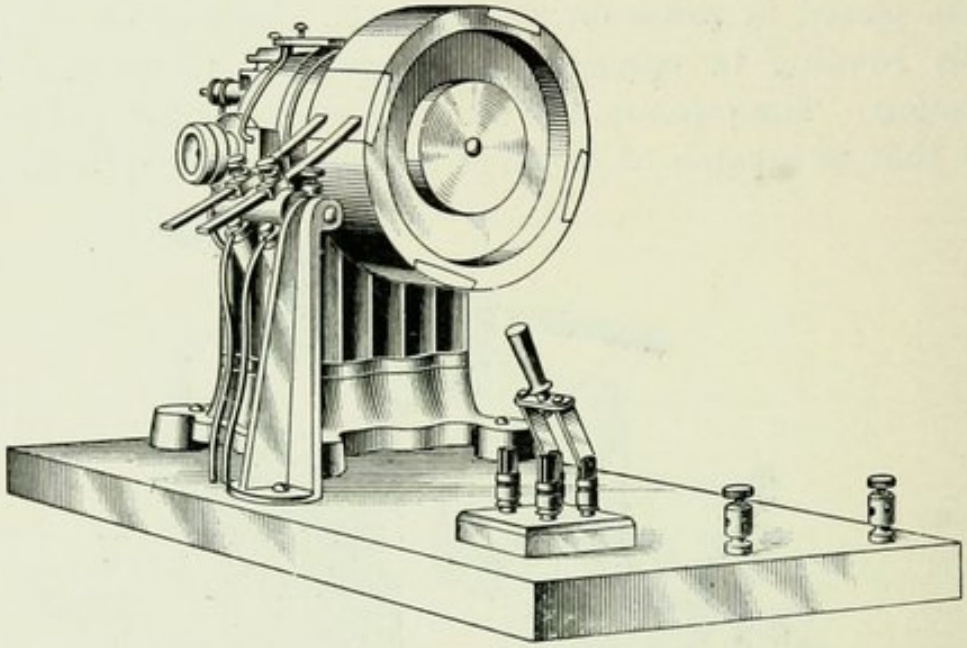


FIG. 2.
Special Form of Break.

the coil but likewise limits its ownership to few persons. The current derived from the secondary coil has a preponderance of negative polarity and can be used with single-focus tubes.

TESLA COIL.

6. The Tesla coil is also a complicated apparatus. A special form of break operated by a motor is used, and the coils, in order to obtain perfect insulation, are immersed in oil. The Crookes tubes suitable for use with this coil must be of the double-focus form, and must be especially designed for the coil with which they are used. The X-rays obtained from this form of apparatus are abundant, but they are diffused over considerable space, crossing each other at various angles and thus give impressions on the fluorescent screen and sensitized plate that are not very sharply defined at the margins. Up to the present time, neither the Ruhmkorff coil nor the Tesla coil

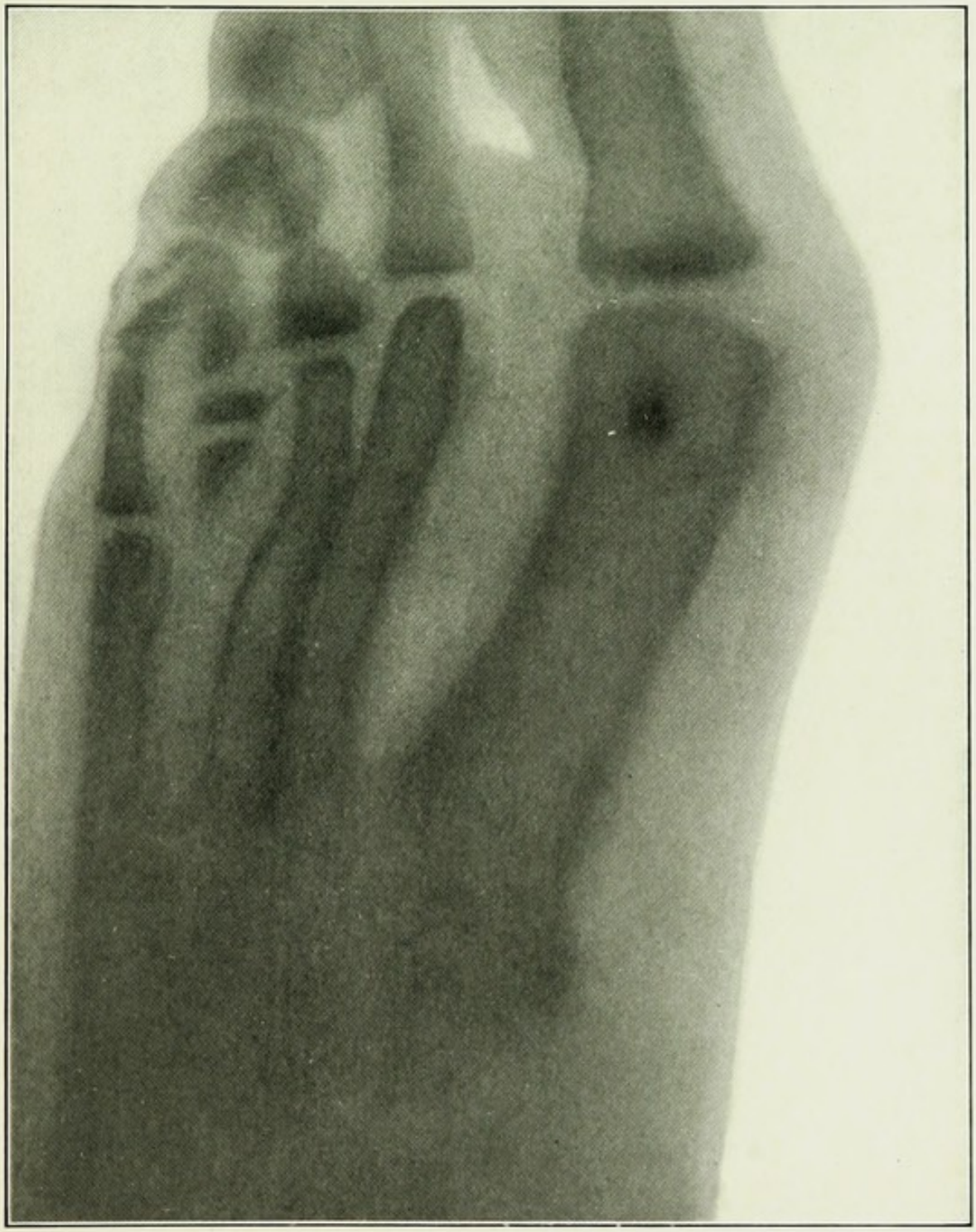


PLATE III.

Taken With Induction Coil, Ordinary Interrupter.

has been used to any extent in electrotherapeutics, except for the production of X-rays. They are rather expensive and

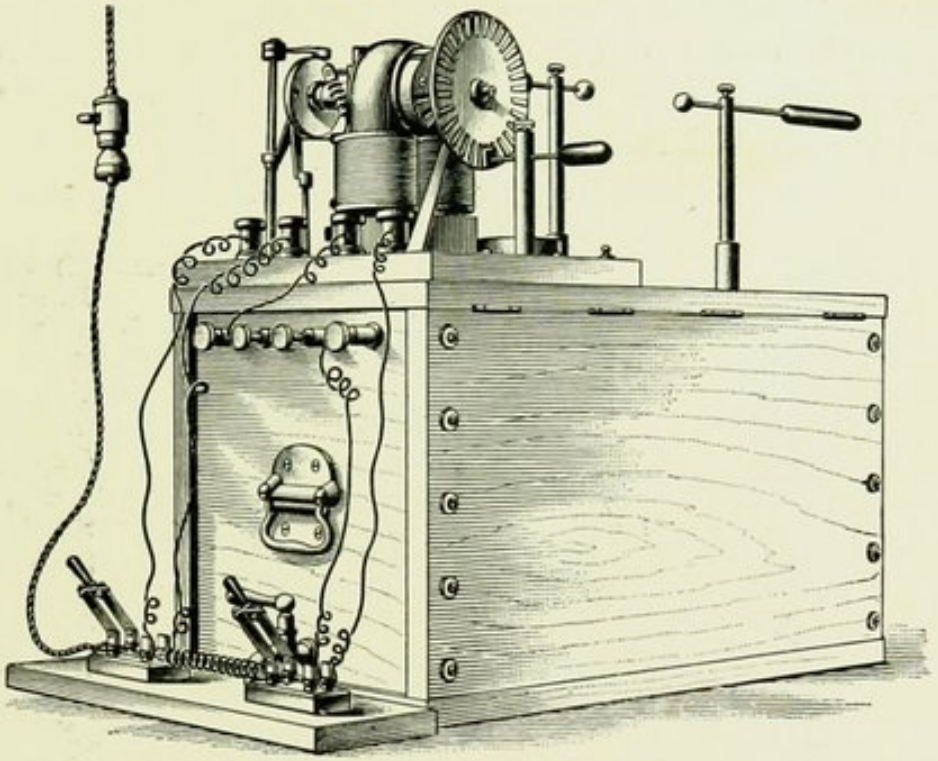


FIG. 3.
Tesla Coil.

troublesome investments, therefore, when we consider the small amount of service they render the surgeon.

STATIC MACHINE.

7. As a generator of Roentgen rays, a good static machine has no superior. But it must be a machine of good workmanship and of sufficiently large size to generate abundant current. A static machine capable of doing good X-ray work must contain at least six or eight plates (glass) that are from 24 to 30 inches in diameter. It should be propelled by an electric or water-motor and should be furnished with adjustable Leyden jars, or condensers.

A good static machine is always ready for use in X-ray work. There is but little about it to get out of order. When it is run by a motor it can be kept in uniform action indefinitely and will require little or no attention while the surgeon is engaged in examining his patient with the fluoroscope or in taking a

skiagraph. With it there is but little heating of the tube and but little danger of causing X-ray burns on the patient's skin. Moreover, the static machine serves many other therapeutic requirements and is a very useful piece of mechanism in the surgeon's office aside from its capacity to produce X-rays. Patients needing a stimulus to general or local nutrition are helped by it. Sluggish circulation is aroused, indigestion and

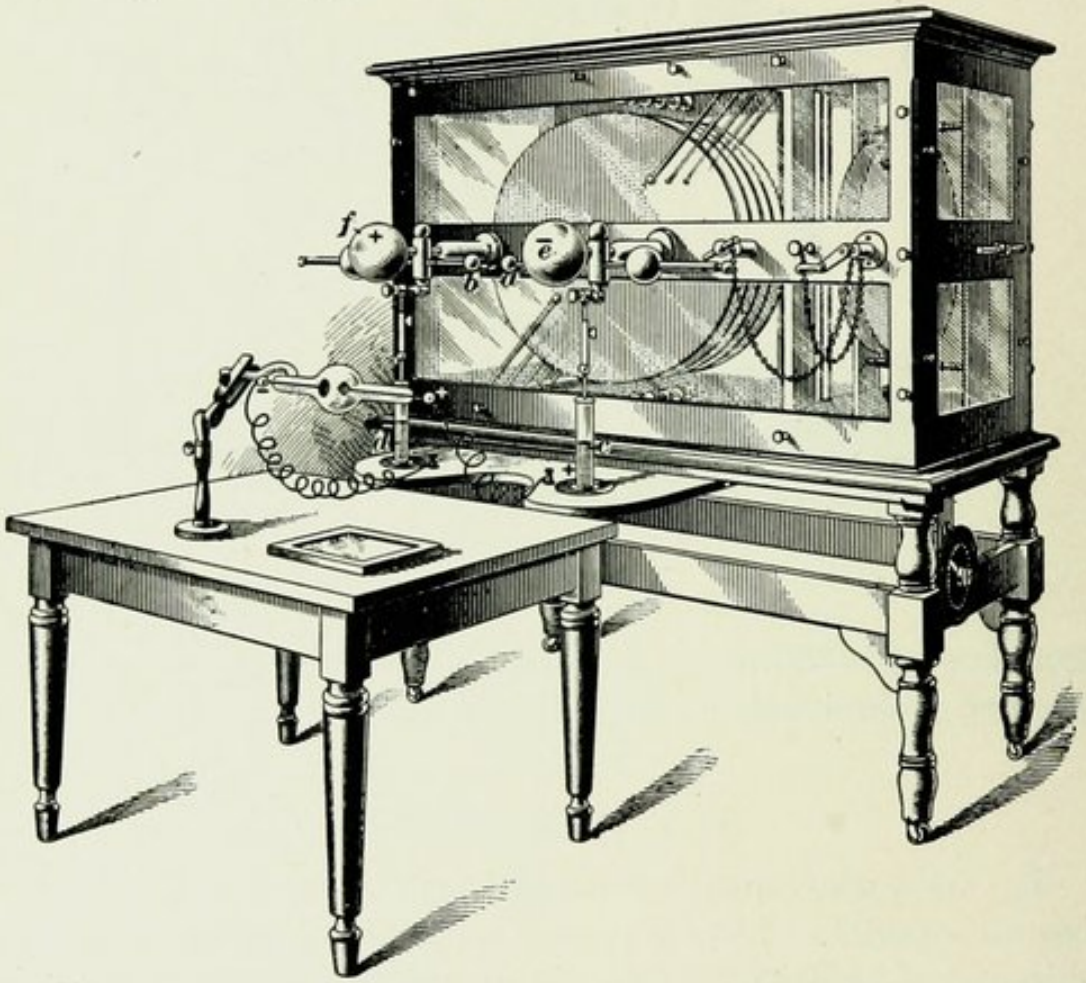


FIG. 4.
Static Machine With X-Ray Outfit.

defective excretion are relieved, and many of the disordered conditions that the surgeon has to treat are benefited by this form of electricity. For these reasons, the static machine would seem, at present, to be the instrument for producing X-rays that the surgeon would find most convenient and serviceable.

8. Use of Static Machine.—In using the static machine for exciting the X-ray tube, the positive prime conductor must be connected to the positive electrode of the tube and the



PLATE IV.

Taken With Tesla Coil.

negative prime conductor with the negative electrode. The balls on the extremities of the prime conductors of the machine should be separated several inches. When in proper action, the tube should exhibit a bright, uniform, golden glow of light in advance of the plane of the disk that forms the inner extremity of the negative electrode. Small Leyden jars or condensers must be connected to the prime conductors in order to secure the best effects in exciting the tube. The tube should be placed as close to the part of the body to be examined as is consistent with the comfort of the patient. If it is too close, sparks may pass from the tube to the patient; if too far away, the rays are not sufficiently concentrated on the part to give a clear and distinct picture in the fluoroscope. The distance from the body at which the tube is placed varies from 3 to 8 inches. A tube that generates rays abundantly can be placed at the greater distance.

9. Position of Fluoroscope.—The fluoroscope, or photographic plate, should be brought into the closest possible contact with the surface of the part undergoing examination that is opposite the tube, so that the rays reaching the fluoroscope, or sensitized plate, will not only be as abundant as possible, but will have been given little chance for divergence. The size and position of that which appears represented on the screen, or plate, will thus be more nearly exact.

In many cases there will be little difficulty in bringing the part to be examined into proper position with reference to the tube and fluoroscope. At times, the patient is too feeble to maintain the sitting or standing posture; or the fracture, the dislocation, the location of the foreign body, or disease requires that he be kept in a reclining position during the X-ray diagnosis. A simple stretcher can then be used for his couch and the tube can be placed underneath it at any point desired. With little discomfort to the patient, he can then be examined very leisurely by means of the fluoroscope or a skiagraph, or a series of skiagraphs can be taken.

10. Many elaborate methods in X-ray work for locating exactly the position of a foreign object or morbid product in the

tissues have been devised. But in the vast majority of cases, such appliances are neither practical nor necessary. As a rule, a good fluoroscope and a soft black lead pencil, the graphite of which makes a very dark shadow in the fluoroscope screen, will enable the operator to locate the position of an object with sufficient accuracy for most surgical work.

11. Prevention of X-Ray Burns.—X-ray burns, which are in all probability not due to the rays at all but to minute particles of matter driven off from the tube by the electric action and carried forcibly into the skin, can be effectually prevented by placing a screen between the tube and body of the patient so as to intercept these particles. A screen made of pasteboard coated on one side with aluminum paint and then grounded by means of a wire to the earth makes a perfect protection against injuries of this sort. When prolonged exposure of the body to the action of the tube is necessary, a screen suitable for furnishing this protection should be used.

ELECTRICITY AS A SOURCE OF HEAT.

HEAT AS A THERAPEUTIC AGENT.

12. Value of Artificial Heat.—Heat is a therapeutic resource of well-recognized value. There is no condition of animal tissues more essential to their well-being than a uniform temperature. Any considerable departure either above or below the average heat of the body (98.4° F.) indicates disease, or is the cause of it. When the tissues fail, for any cause (as surgical shock), to maintain a sufficient amount of heat in the body as a whole, or in any part of it, artificial heat is prescribed as a temporary therapeutic measure. When tissue activity is accelerated to an abnormal degree in any part of the body by reason of some irritation, and an inflammation threatens, as at a focus of infection, the congested state of the blood-vessels may be relieved, absorption of exudates promoted, and the danger of abscess or necrosis arrested by the relaxing action of artificial heat applied to adjoining tissues.

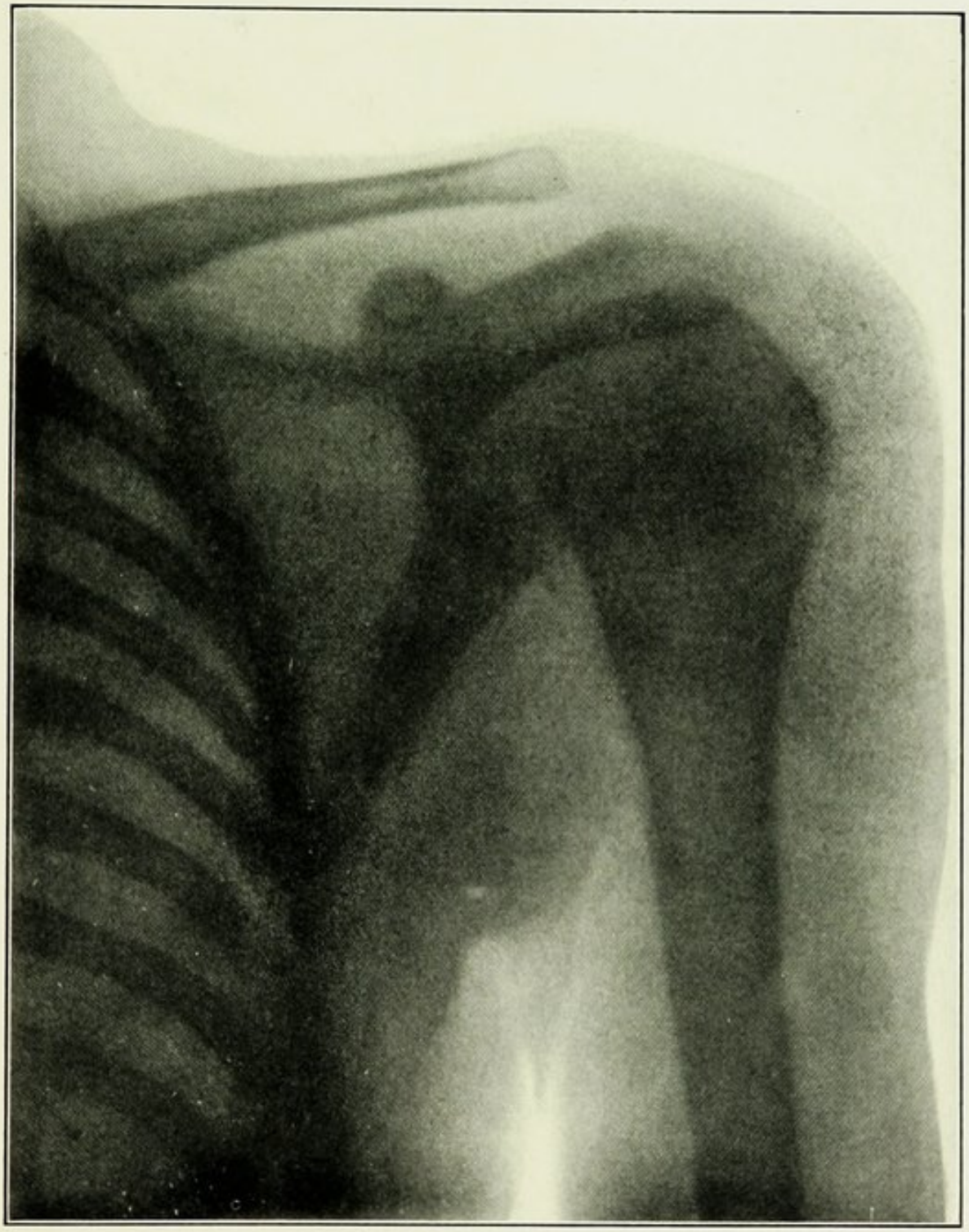


PLATE V.

Taken With Induction Coil and the Wehnelt Interrupter.

ELECTROTHERMS.

13. Forms of Artificial Heat.—It is a great advantage to have the means for maintaining at a uniform temperature for any length of time the artificial heat thus applied. Poultices, hot-water bottles, heated soapstones, and such like thermal appliances hitherto much used for this purpose leave much to be desired. The various forms of electrotherms now available and which are adapted to any form of industrial current, direct or alternating, furnish a far superior means for applying artificial heat in hospitals eligibly located, and in many private dwellings. Electrotherms are made in many forms. One of the most useful is a pad composed of a netting of highly

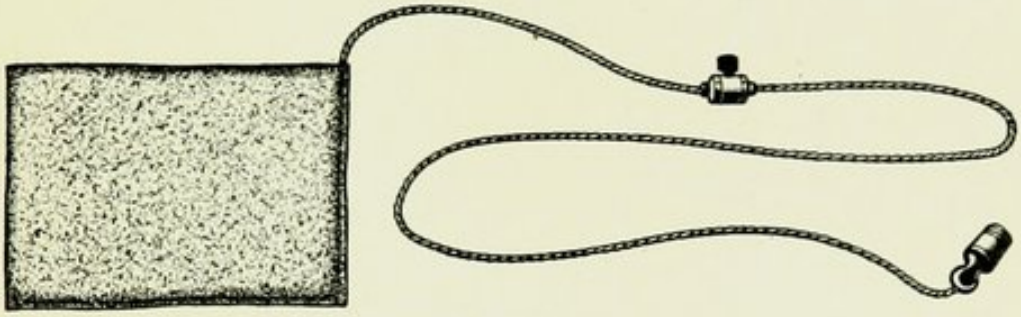


FIG. 5.
Electrotherm.

resisting wire through which the electric current passes, the resistance of the wire transforming the electricity into heat. The degree of heat is regulated by the amount of resistance the wire netting furnishes, and this is constant. The wire netting is covered by asbestos, and this again by a flannel or other cloth, which can be removed when soiled. By means of such a thermal pad, which may be made of any size or shape desired, the whole or any part of the body can be kept at a uniform temperature for an indefinite period. Heat combined with moisture, so often applied in the form of poultices, may be obtained by placing the thermal pad external to a thick layer of absorbent gauze that has been dipped in hot water or some medicated solution, and placed in contact with the diseased surface.

The superiority of the electrocautery over all other forms of cautery is generally acknowledged when the method for heating it has been made simple and reliable.

ELECTROCAUTERY.

14. Heating by Means of Storage-Battery.—The storage-battery, when in good condition and skilfully handled, is an admirable way for heating the electrocautery. The storage battery has the advantage of being transportable, and thus permits of the cautery being used at the patient's bedside as well as in the office. But the storage-battery requires much care and watching in order that it may be in readiness when needed. It should be recharged often and with regularity to prevent it from deteriorating, for not infrequently, and usually when most needed, the quantity of current is found to be insufficient.

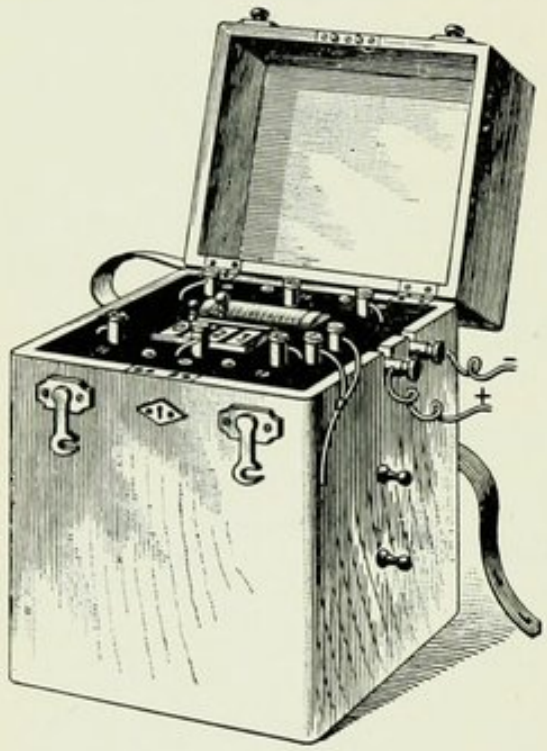


FIG. 6.
Storage Battery.

15. Using Dry Cells. For heating small cauteries such as are oftentimes required for nose and throat work, some of the forms of dry cells furnish a sufficient current for a short time. Several of the larger sizes of these cells, coupled in multiple, furnish a current of several amperes, but the internal resistance is an obstacle to their prolonged usefulness.

16. Advantages of Dynamo Current.—The most satisfactory source of current for the electrocautery is the dynamo current. If the current is a direct one, it can be changed to the alternating by means of a rotary transformer. If it is already an alternating current, it needs but a static transformer properly arranged for leading off the current from various points to the cautery circuit in order to adapt it to the heating of any size of cautery and for any length of time desired. For office or hospital practice, when a dynamo circuit is available, all

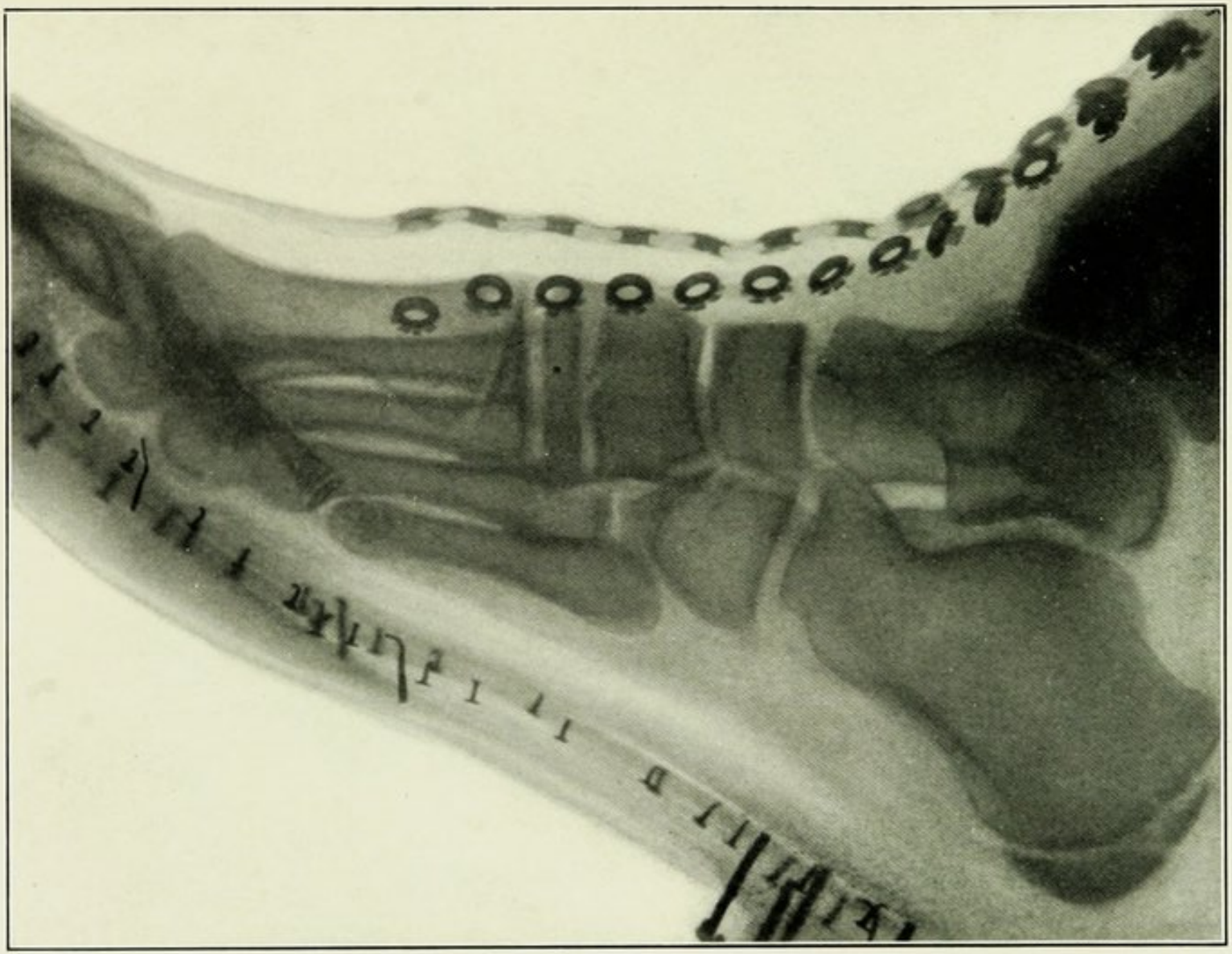


PLATE VI.

Taken With the Induction Coil and the Wehnelt Interrupter.

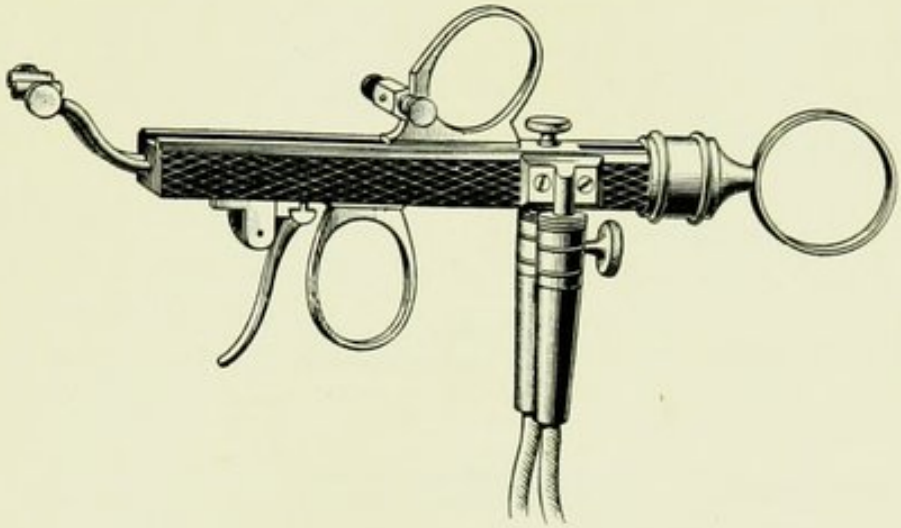


FIG. 7.

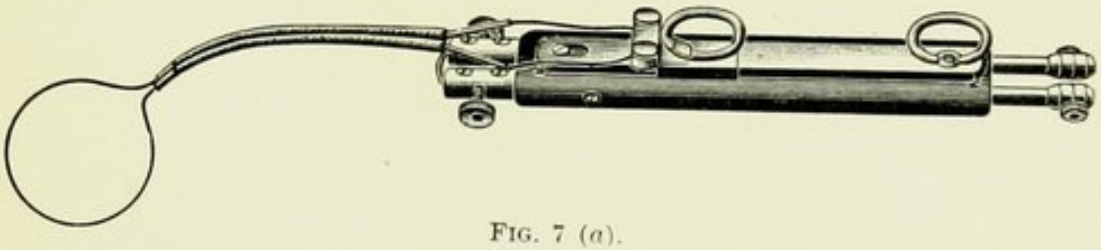


FIG. 7 (*a*).

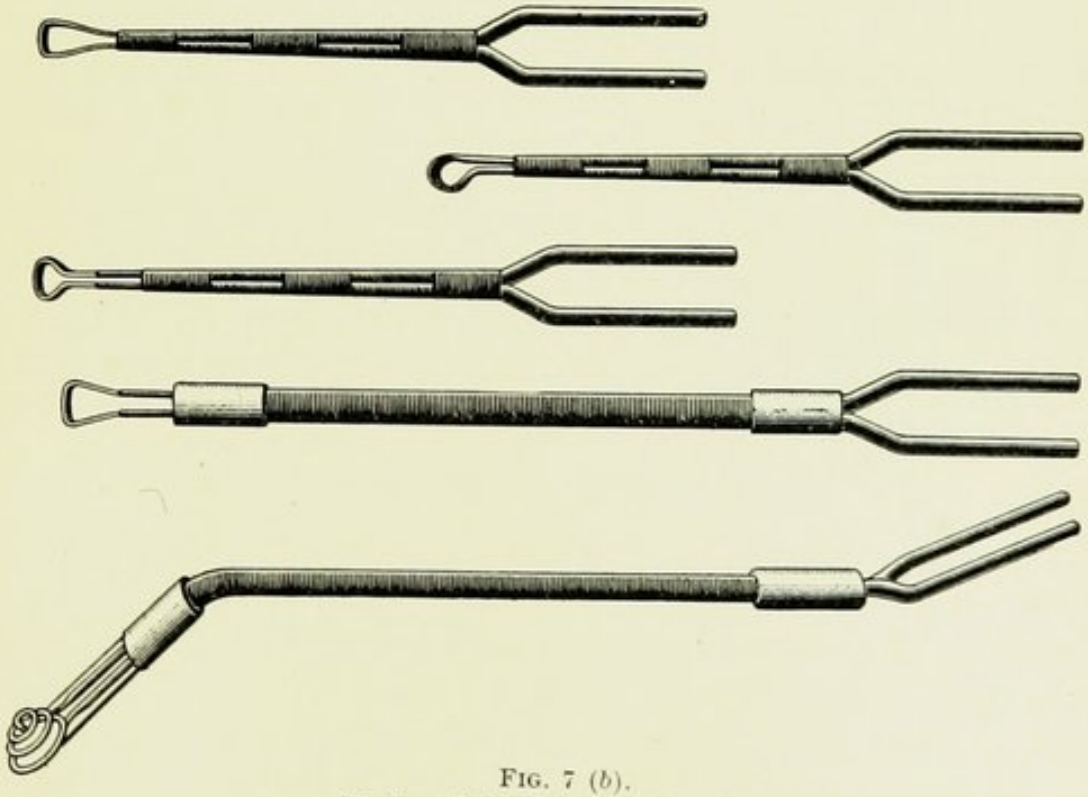


FIG. 7 (*b*).

Fig. 7 and 7 (a) Cautery Handles.
Fig. 7 (b) Cautery Blades.

difficulties that have hitherto attended the use of the cautery are removed by means of it, for it can now be made efficient, convenient, and reliable.

17. Advantages of Electrocautery.—The chief advantages of the electrocautery over all other forms of cautery are: (1) The shape can be fashioned to meet the requirements of the morbid tissue. (2) The size can be large or small. (3) It can be maintained at the required temperature for any length of time without difficulty. (4) It can be used in canals and cavities inaccessible to other forms of cautery. These advantages make it useful in surgery of the eye, ear, nose, throat, larynx, bladder, urethra, uterus, vagina, and rectum, as well as in a great variety of morbid conditions on the surface of the body and in wounds for the arrest of hemorrhage.

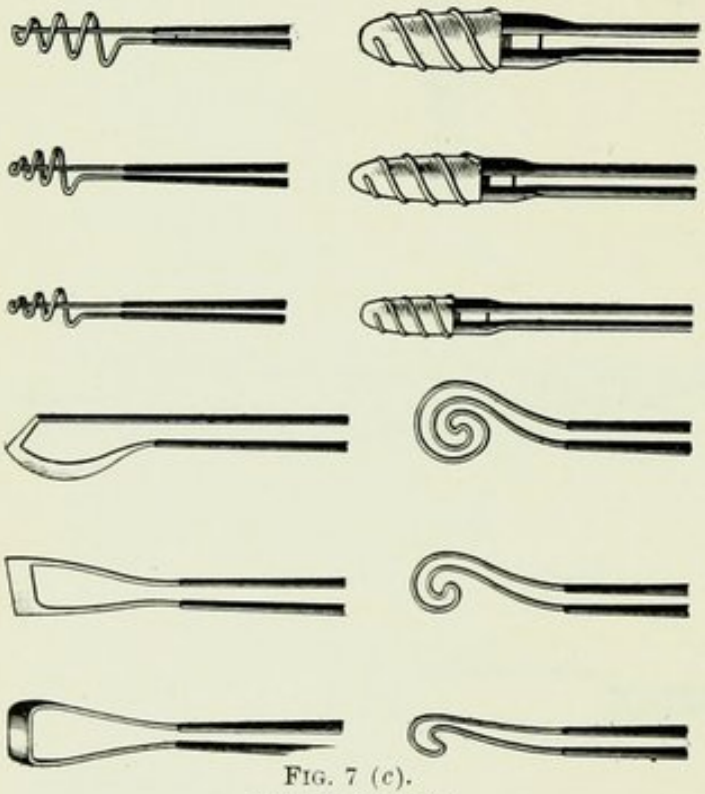


FIG. 7 (*c*).
Cautery Burners.

ELECTROHEMOSTASIS.

18. Hemostasis in Modern Surgery.—Heat as a means for arresting hemorrhage—the searing or charring of a bleeding surface to stop the flow of blood from a wound—is a procedure that has the sanction of antiquity. But it required the conveniences of modern methods of heating to perfect this method of arresting hemorrhage, retaining all of its advantages and clearing away its disadvantages.

Modern surgery has exhibited remarkable ingenuity in devising ways for closing severed blood-vessels securely and aseptically, and as the attempts at visceral surgery have become bolder and the operations on the contents of the cavities of the

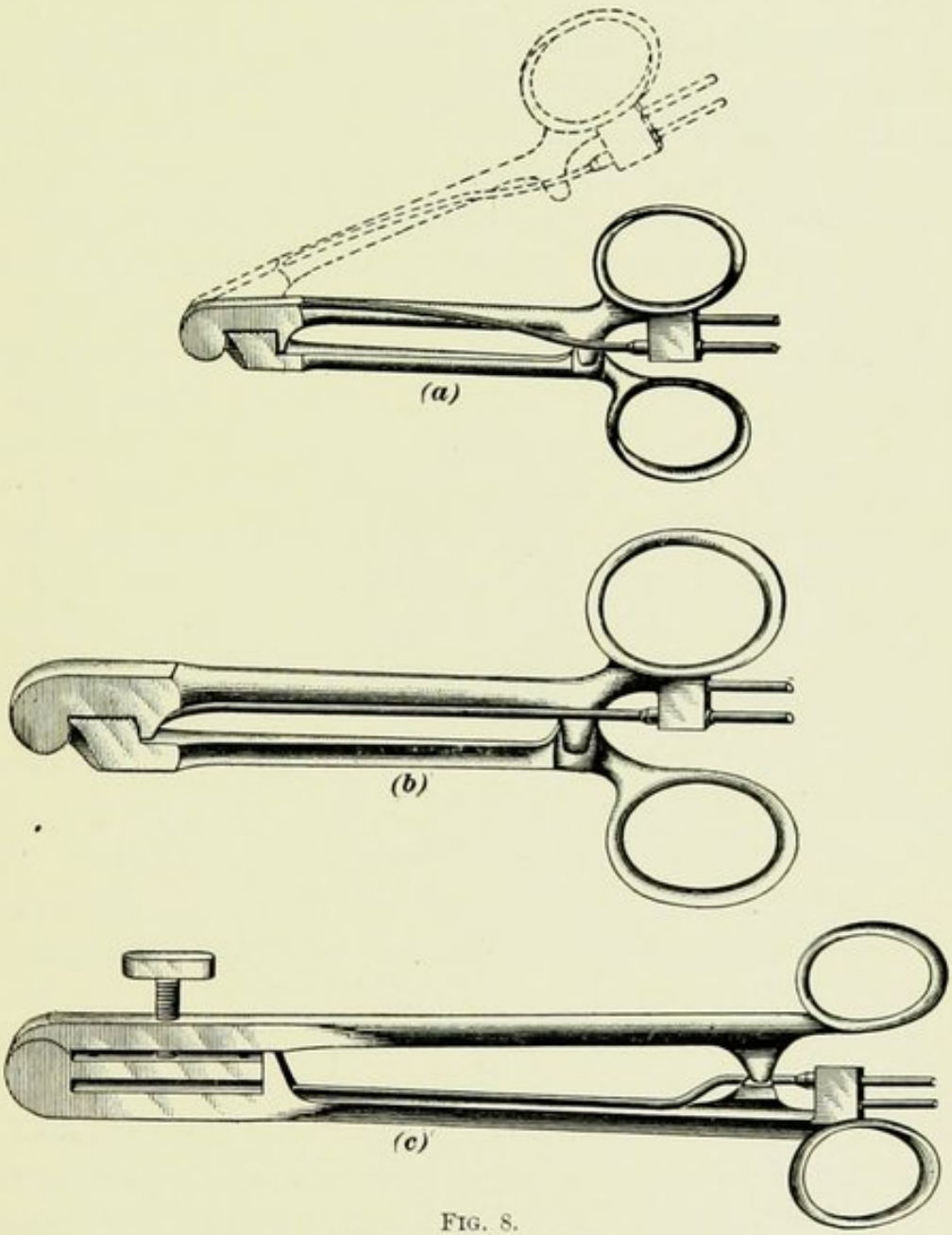


FIG. 8.
Electrohemostatic Clamps.

body, once thought to be beyond the reach of surgical interference, have become more extensive and radical, the necessity for an unobjectionable method for surely and permanently avoiding hemorrhage has increased in proportion. In surgery of the abdominal viscera, and especially of the pelvic viscera, the

ligature, of whatever form or material, has given rise to no end of trouble, and the anxious surgeon is continually on the search for something better. Some believe they have found this in the electrohemostatic forceps and clamps.

19. Hemostatic Instruments.—These instruments for arresting hemorrhage were brought to the attention of the medical profession by the able and well-known surgeon, the late Dr. Alexander J. C. Skene, of Brooklyn, N. Y. In the introduction to a treatise on the subject of Electrohemostasis in "Operative Surgery," recently published by him, after a

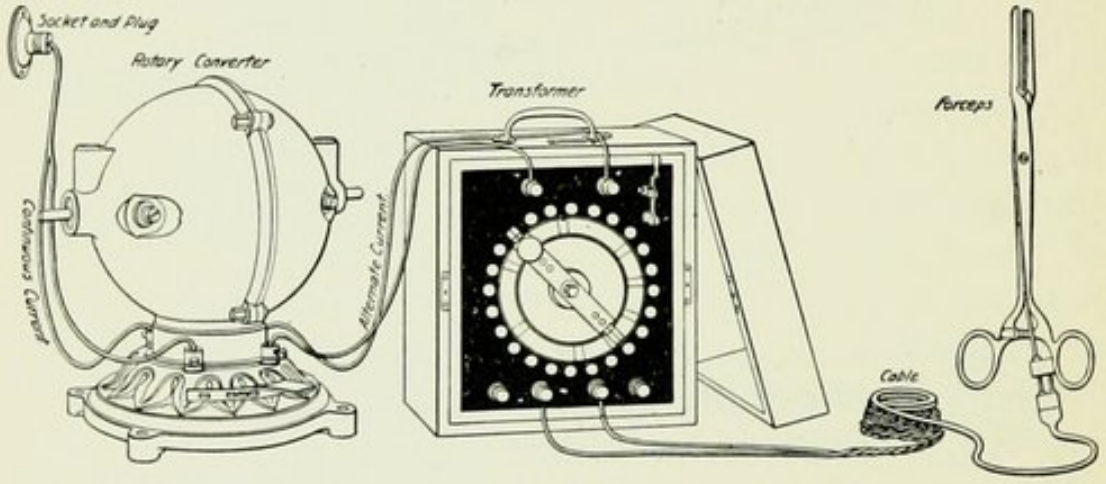


FIG. 9.
Relation of Hemostatic Instruments to Current Controllers.

careful review of the various methods of closing wounds by ligature and the difficulties and accidents attending them, he concludes as follows:

"Having observed these disappointing actions of ligatures, I naturally looked for something better in surgical hemostasis. This I found in the work of Dr. Thomas Keith, who taught me his method of treating the pedicle in ovariotomy by the clamp and cautery, which in theory and practice was most satisfactory. No doubt this feature of his operating contributed largely towards making him the most successful ovariotomist of his time. The experience of years and a large number of operations in which his method was used has fully confirmed my confidence in this way of controlling hemorrhage. The method of treating the pedicle of ovarian tumors employed

by Dr. Keith and his followers was never adopted by surgeons in general. Apparently this was due in part to ignorance of the principles of the method, but more especially to the difficulties in the technique of the procedure. Many believed, and still believe, that it was necessary to char the stump with the cautery in order to stop the bleeding; but the fact is, Keith applied a clamp with broad jaws to the pedicle and compressed it strongly, and then applied a large cautery iron to the *upper side of the clamp* until the instrument was heated sufficiently to dessicate the tissues and not to char them. This required much time and large experience in handling the cautery iron, in order to obtain the degree of heat necessary and to know the length of time it should be applied. In other words, to treat a broad-ligament pedicle in this way required a knowledge and judgment that but few had the patience to acquire.

"I confess that I was not sure of my work in my first operations, and sometimes applied a light ligature to feel safe before I dared return the stump into the abdominal cavity. When ovariotomy became improved so that better results were obtained and material for ligatures was made aseptic and more appropriate, I gave up the clamp and cautery and used the ligature; but I was never satisfied with the results, and earnestly sought to overcome the objection to the clamp and heat to control hemorrhage—namely, the application of the heat supply. While thinking of how to overcome these difficulties, my attention was called to the use of electricity in heating laundry smoothing-irons. It then occurred to me to adapt the same heating power to surgical instruments, such as the clamp and forceps."

This, with the aid of skilful electricians, Doctor Skene succeeded in doing, until now an excellent line of electrohemostatic clamps and forceps, together with suitable electric generators and controllers for heating them, are readily obtainable, adapted to the control of bleeding in all surgical operations.

These electrohemostatic instruments in the hands of the originator and those that have faithfully followed his directions and mastered the technique, have proved of invaluable service.

20. Advantages of Electrohemostasis.—The advantages that may be fairly claimed for the method are as follows: (1) It is certain and reliable in closing isolated vessels or those imbedded in masses of tissue. (2) All lymphatics are sealed up, preventing septic absorption. (3) The tissues of the stump are reduced to the smallest possible size. (4) There are no raw surfaces left to form adhesions. (5) There is no foreign substance left in the tissues to cause mischief. (6) Vessels in tissues too friable to hold a ligature are closed. (7) Nerves accompanying vessels are devitalized, causing less pain and irritation. (8) The heat sterilizes the parts involved.

Doctor Skene gives the following directions in regard to using the electrical forceps. (Plate VII.)

DIRECTIONS FOR USING THE ELECTRICAL FORCEPS.

21. Arresting Hemorrhage.—The method of arresting hemorrhage with these forceps consists in firmly compressing a portion of the bleeding tissues or the end of a vessel between the jaws of the instrument, in order to expel as much of the moisture as possible, and then desiccating the compressed tissues by heat generated in the jaws by the electric current. In this way the walls of the arteries become united and hemorrhage is effectually prevented. The temperature required for desiccation is from 180° to 190° F., which is not high enough to char or burn the tissues, but simply to desiccate or cook them.

22. Sterilizing the Forceps.—The forceps are sterilized in the same manner as the ordinary instruments, but after removal from the sterilizer it is not advisable to place them immediately into cold water, while they are hot, as the contraction of the heated air inside may eventually cause water to enter at the insulated terminals. After sterilizing, a little sterilized vaseline, or similar preparation, is rubbed over the inner faces of the jaws of the forceps to cover them with a thin film, which will prevent the tissues from adhering to the instrument. The rubber-covered end of the electrical cable is sterilized in boiling water and afterwards wrapped in a

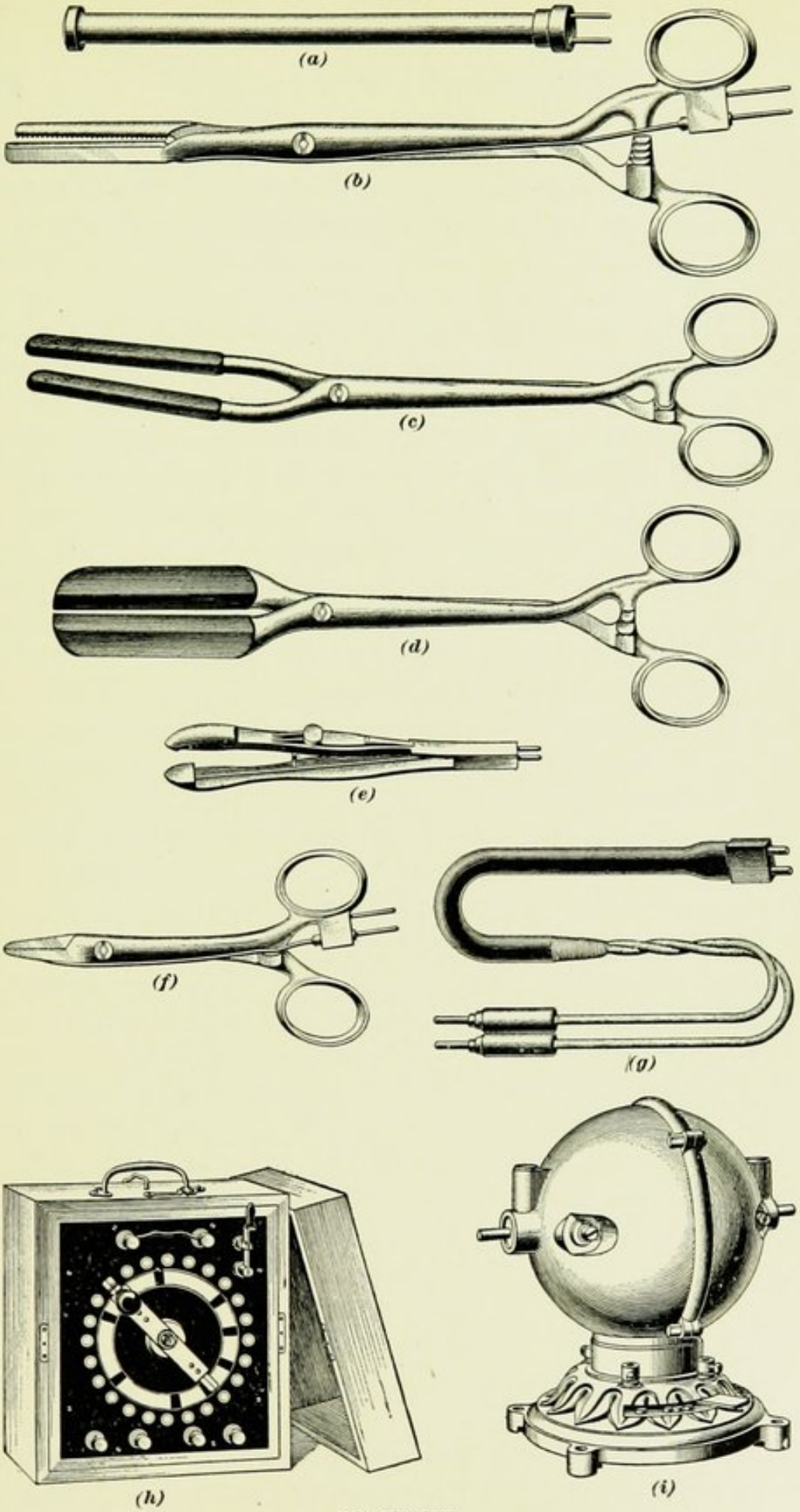


PLATE VII.

Instruments for Electrohemostasis.

(*a*) *The Dome.* (*b*) *Compression Forceps.* (*c, d*) *Shield Forceps.* (*e, f*) *Artery Forceps.* (*g*) *Conducting Cords.* (*h*) *Static Transformer.* (*i*) *Rotary Converter.*

sterilized towel or immersed in an antiseptic solution, such as a 5-per-cent. carbolic solution, until needed. Bichloride of mercury should not be used, as it attacks the metal sleeves at the end of the cable.

23. Applying the Forceps.—In applying the forceps, all the tissues to be treated should be firmly compressed between the heated jaws of the instrument, for if a portion extends beyond, a second application will be necessary. Before the electric current is turned on, a piece of gauze or a shield is applied where needed between the forceps and the adjacent tissues to protect them from injury by contact with the hot instrument. Tissues that do not touch the jaws require no protection. The two connector sleeves at the end of the flexible cable are then slipped over the two terminals on the end of the forceps, and pushed firmly into place to make a good electrical connection. If the electric current has been previously turned on, the putting of the connector sleeves into place completes the circuit and establishes the current; but if this has not been done, the current should now be turned on.

The precaution that is given as to coating the blades of the forceps with a sterilized oil or vaseline before applying them to the tissue, is one that must be carefully observed, otherwise much of the desiccated tissue will cling to the corrugated surface of the forcep blades when the attempt is made to disengage them.

With the simple and reliable methods of obtaining a suitable current from the lighting or power circuits now coming into general use, the employment of these hemostatic forceps in office and hospital practice is attended with scarcely more difficulty than the use of the ordinary forms.

BOTTINI'S METHOD.

24. Form of Cautery.—The next most notable and perhaps the most serviceable application of the electrocautery at present is that known as Bottini's method of treating hypertrophy of the prostate gland. This consists in using a peculiar form of

electrocautery devised by Enrico Bottini, of Italy, and used by him for more than twenty years. The instrument has recently been modified with advantage by Freudenburg, of Berlin. It is similar to a lithotrite in shape and size and has a male and female arm, the shank being 26 centimeters long. The beak of the female arm forms almost a right-angle with its shank, and has in its concave surface a deep groove. The extremity of the male arm ends in a platino-iridium blade, which is the cautery burner. This blade is concealed when the instrument is closed, but is moved out of the groove by turning a wheel that works a screw at the end forming the handle. The instrument, while in use, is kept cool by a stream of water conducted through the handle and the entire length of the female shank to the beak and back again to the handle. The shaft of the male arm between the wheel and the handle is graduated, thus showing the distance the cautery burner is withdrawn from the groove.

A heavy copper wire, well insulated, runs through the center of the male shank for the purpose of conducting the electric current to the cautery blade. The current returns by way of the metal sheath of the male shank, which is firmly riveted to the convex part of the blade. The insulating material is a cement that is not affected by heat, water, or sterilization. The cable conveying the current to and from the instrument consists of two parts insulated from each other but united in one cord by a covering of silk. This is attached to a contact tip so arranged by an insulating division that when it is slipped over the extremity of the male shaft and fixed by a binding-screw the circuit is complete. A current source capable of furnishing 40 or 50 amperes of current is needed for this cautery.

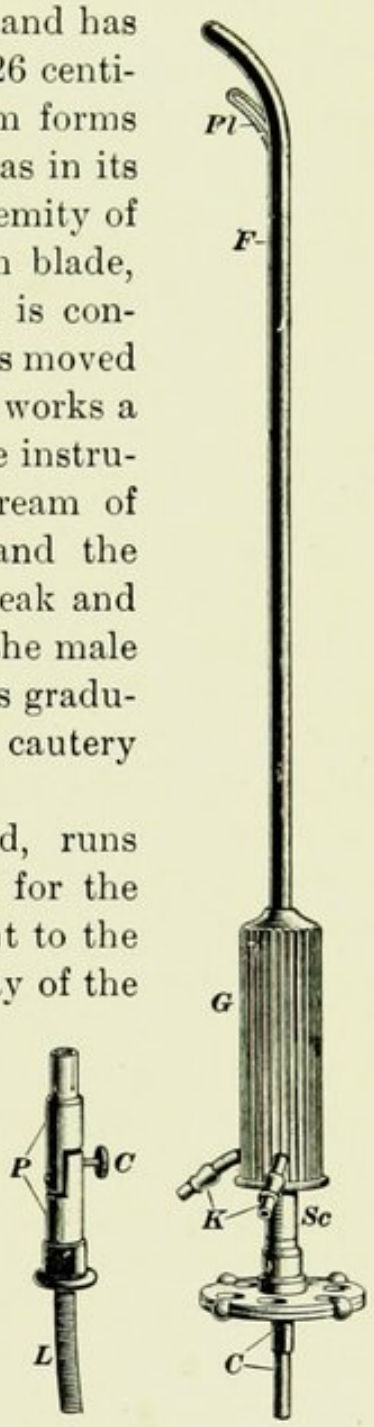


FIG. 10.
Bottini's Incisor.
(Freudenburg's Pattern.)

If a storage-battery is used, it must be devised especially for the purpose, and a rheostat attachment and an ampere-meter are necessary accompaniments.

25. Technique of Method.—The technique of this operation consists in a careful inspection of the bladder and prostate so as to determine the nature and shape of the prostatic enlargement. The absence of vesical calculi must be determined and examination made by all approved methods of diagnosis, including, if possible, the cystoscope.

The urine should be drawn and the bladder irrigated with boric-acid solution. No general anesthetic is needed, but a few drops of 4-per-cent. solution of cocain is distributed along the prostatic urethra. When the cocain has had time to take effect, a few ounces of a 2-per-cent. boric-acid solution is thrown into the bladder; then the instrument, with the cautery blade well in its groove, should be introduced in the same manner as a steel sound or a lithotrite. The beak of the instrument, when well within the bladder, must be turned in the direction in which the incision is to be made, which usually is first downward so as to burn the first channel along the floor of the urethra. When the beak is finally hooked over the posterior margin of the obstructing tissue, the water stream for keeping the instrument cool should be turned on, and kept running during the entire time of the operation. The cable connection is now made and the electric current slowly turned on. The best result is obtained when the cautery is maintained at a cherry-red heat, and the quantity of current necessary to effect this should be determined in advance by testing the action of the cautery on a wad of wet gauze or absorbent cotton. The instrument is now held with its beak firmly in contact with projecting lobe of the prostate, and, noting that the ampere-meter indicates the proper degree of current, the wheel is slowly turned by the operator so as to move the cautery blade forward through the tissues. The burning should be done slowly, not only that the tissues may be thoroughly divided, but so as to char them on either side of the cut. This insures a better channel and guards against hemorrhage. Some operators leave

the current on while the blade is being returned to the groove, which is done by a reversal of the screw movement.

26. After the electric current has been turned off, the instrument is placed in position for another cut, which in all probability would be the anterior one. The beak is turned so as to be directed toward the pubes, and brought firmly in contact with the anterior ring of prostatic tissue. The cut is made in the same manner as before, except that it is shorter. A third or lateral cut may be made if the circumstances of the case require it. The length of the cuts to be made will depend on the extent of the prostatic enlargement, which must be determined by the exploration made in advance of the operation. The posterior cut averages about 3 centimeters in length, and the anterior about 2 centimeters. The length of time consumed in making the cuts varies from $\frac{1}{2}$ to $1\frac{1}{2}$ minutes.

27. After-Treatment.—Very little after-treatment is required in these cases. Where there has been much vesical irritation, 6 or 8 grains of urotropin three or four times daily is advised and salol in 8- or 10-grain doses has been given to guard against sepsis. The introduction of the catheter or irrigation of the bladder are to be avoided, unless such interference becomes imperatively necessary. The pressure of the urine into the wound is quite sufficient ordinarily to keep the channels open and prevent adhesion.

28. Results Achieved by Bottini's Method.—The present state of this subject has been clearly set forth by Dr. Willy Meyer, of New York, in a recent address, "Bottini's Operation for the Cure of Prostatic Hypertrophy," delivered before the Medical and Library Association of Detroit, Feb. 26, 1900, in which he says: "Bottini's operation for the cure of prostatic hypertrophy has come to stay. The experience of the originator of the method, covering a period of more than twenty years, and of many operators all over the world during the last three years, has proved the value of the procedure beyond the shadow of a doubt. If properly carried out in a suitable case, Bottini's operation *can* cure the patient afflicted with

prostatic hypertrophy. It can cure such a patient in a comparatively simple way at a stage of the disease when even the most enthusiastic advocates of prostatectomy would not propose that operation, and the patient surely would refuse to submit to it; it can cure when prostatectomy might be impossible, on account of, for instance, the too great softness of the gland, or of the too far advanced age of the patient. What remains to be done is to give to Bottini's operation its proper place among the various radical operations for the relief of prostatic enlargement, to determine its proper indication."

The same author sets forth the results of this operation so far obtained, as follows: "They have demonstrated (1) that the urinary troubles of prostatics are not dependent on a weakness of the muscles of the bladder due to arteriosclerosis (Guyon and Lannois' theory), but are the direct result of a true mechanical obstruction to the normal outflow of the urine at the neck of the bladder—the enlarged prostate gland; (2) that we are able to overcome this mechanical obstruction in a comparatively simple manner, namely, by the multiple-division of the swollen gland with the electrocautery knife, which latter is a part of a modern and reliable instrument; (3) that we can generally accomplish this without any additional operation on the cords, testicles, or bladder; (4) that we have every reason to expect that, if the desired result of the operation be once thoroughly obtained, the cure will in most cases be a permanent one."

ELECTRICITY AS A SOURCE OF LIGHT.

29. Use of Light in Diagnosis.—The electric light has greatly facilitated and refined the methods of diagnosis. This is due to the readiness with which this method of illumination adapts itself to the various conditions under which light is required. If it is desired to illuminate the retina of the eye, an electric light can be placed on the examiner's forehead, on a convenient side-stand, or held in the hand and tilted in any manner suited to the requirements of the case. If the patient is one needing an exploration of the nasal fossa, the light may

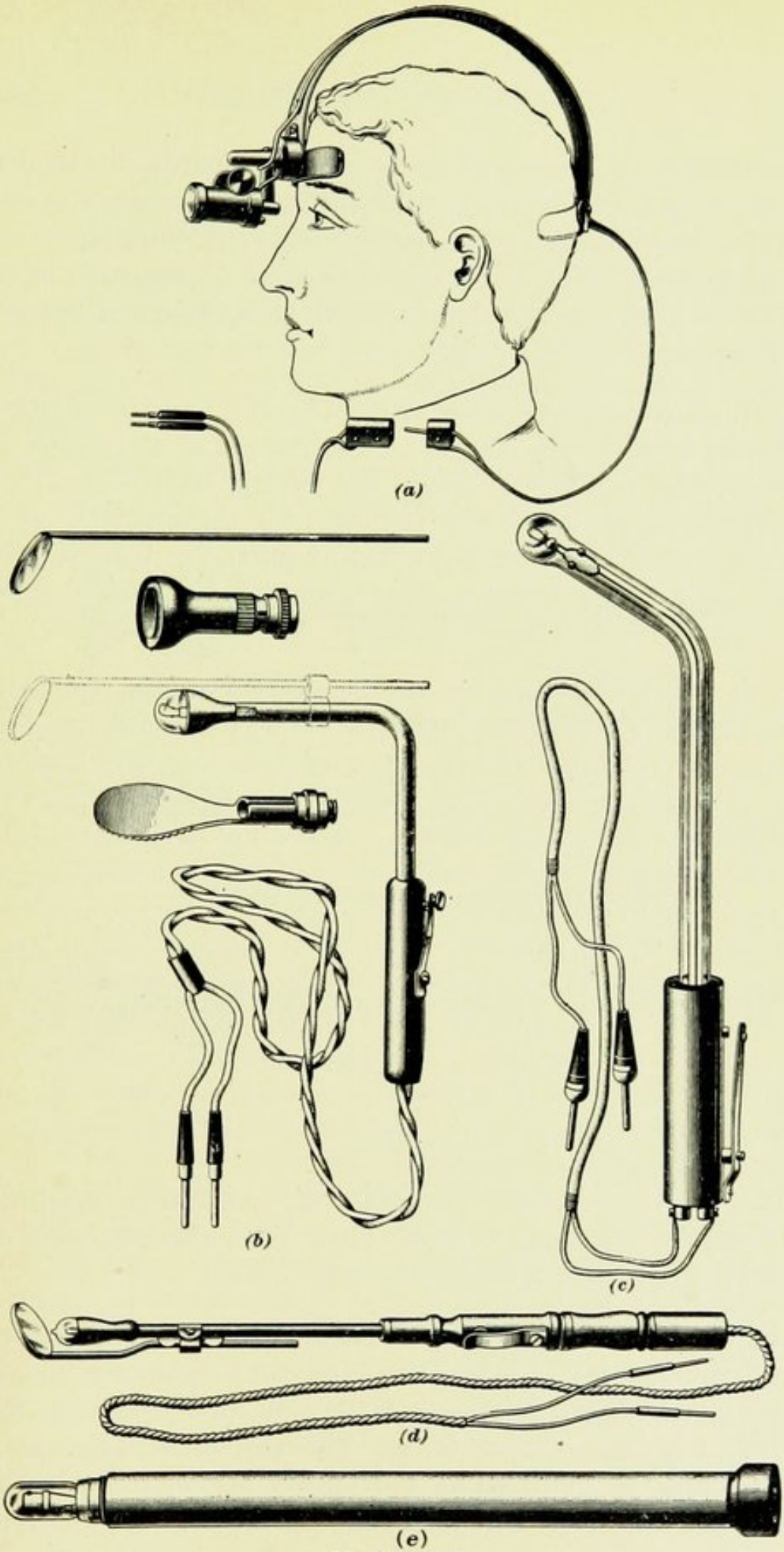


PLATE VIII.

(a) *Headlight.* (b, c) *Oral or Nasal Lamps.* (d) *Laryngeal Mirror.*
(e) *Rectal or Vaginal Lamp.*

be conveyed by means of an appropriate handle through the mouth to the posterior openings and thus illuminate the nasal cavities from behind. The light thus carried into the oral or nasal cavities aids, by transillumination, in determining the condition of the frontal sinus, the orbital cavities, and the antra of Highmore. (Plate VIII.)

30. Internal Uses of the Electric Light.—Direct or reflected electric light can be used to illuminate the larynx and the external auditory meatus. An electric lamp with its connections can be as readily carried into the stomach as the stomach-tube, and once there it will assist, by transillumination, in locating foreign objects, abnormal growths, or the boundaries of the stomach's walls.

31. Examination of Rectal and Vaginal Cavities. The rectal and the vaginal cavities are more thoroughly inspected by means of the electric lamp than by other means of illumination. To the genito-urinary surgeon, the advantages that this method of illumination offers have proved of inestimable value. By means of the electro-endoscope and electro-cystoscope, the hidden mysteries of the urethra and bladder have been revealed. No longer is the surgeon compelled to make exploring operations in order to determine with certainty the morbid condition within the urinary passages, or bladder. The seat and extent of an ulceration, the size, shape, and location of a calculus, and the form and degree of a prostatic enlargement can all be accurately made out by means of the well-devised electric illuminating apparatus that is now available.

Catheterization of the ureters for the purpose of diagnosing and treating affections of these tubes or of the kidneys is rendered possible by employing the cystoscope.

32. Maintenance of Current.—The conditions attending the maintenance of a current such as will keep an incandescent lamp at the proper degree of brilliancy differ somewhat from those attending cautery work. The carbon filament of the lamp may be compared to the burner of the cautery. The resistance of the filament varies from 3 to 200 ohms, depending

on its length and thickness. The resistance of the small incandescent lamps used in illuminating the cavities of the body varies from 6 to 30 ohms. When the carbon filament becomes heated, the resistance is slightly decreased, but the difference is not so great as to be taken into account, and it is not necessary, therefore, to provide for a great variation in the amount of current to be supplied to the lamp, as is the case for cautery burners.

33. Strength of Current.—The current needed to raise these lamps to a white heat varies, according to the resistance,

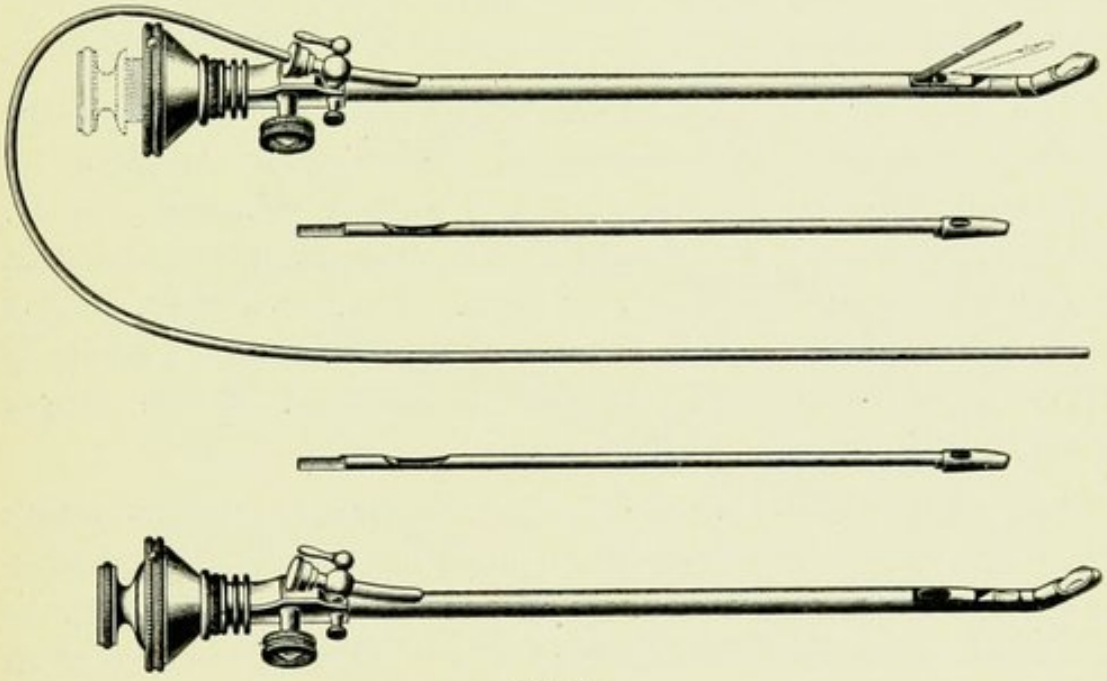


FIG. 11.
Cystoscopes.

from .3 to 1.6 amperes. It will be seen, therefore, that if a primary battery is to be used to furnish this current, its arrangement and capacity must be determined by the resistance of the lamp and the strength of the current required to light it. The least resistance offered by any lamp is still far in excess of the resistance of any cautery burner, so that higher electromotive force and less current is required for lighting lamps than for cautery work. A group of 50 Leclanché, Law, or Laclede cells with an electromotive force of 1.4 volts per cell and an internal resistance of .5 ohm, each, if connected in series, would light a lamp having a resistance of 25 ohms for a

few minutes, assuming the current required is .75 of an ampere.

$$C = \frac{1.4 \times 50}{(.5 \times 50) + 25} = \frac{70}{50} = 1.4 \text{ amperes.}$$

But polarization would soon take place to such a degree as to greatly increase the internal resistance in these cells, and then the current would not be sufficient to light the lamp. It would require a battery of 20 bichromate cells in series, having an electromotive force of 1.9 volts per cell, and with an internal resistance per cell not exceeding 1 ohm, to give a serviceable current for lighting such a lamp.

$$C = \frac{1.9 \times 20}{(1 \times 20) + 25} = \frac{38}{45} = .84 \text{ ampere.}$$

The number of cells could be reduced somewhat if the internal resistance were decreased, which might be done by increasing the size of the zinc and carbon elements and by using chromic-acid solution, which is a better depolarizer than either bichromate of potash or soda. But, even then, such a battery would be cumbersome, and troublesome to keep in order. The current can best be maintained at the proper strength by means of a rheostat.

34. Source of Current.—A secondary, or storage-battery offers the same advantages when used for electric illumination as it does for cautery work. This source of current would be the most convenient and useful for this purpose because of its portability, were it not for the uncertainties that attend it and the difficulty there is in keeping it in order.

The dynamo, except that it is not transportable at the will of the operator, is the most satisfactory of all sources of current, and, when at hand, either as a direct or alternating current, can be readily adapted to the resistance of lamps by the assistance of a suitable rheostat or transformer.

TRANSILLUMINATION OF THE STOMACH.

35. Origin of Internal Illumination.—Mikulicz more than twenty years ago constructed a gastroscope from which he obtained very good results. But his methods and appliances were too cumbersome and did not come into general use. Even

previous to this, as early as 1867, Milliot transilluminated the stomach and rectum of dogs by means of a glass tube in which a loop of fine platinum wire was rendered incandescent. But this form of instrument was not convenient for use in examining the human stomach. It remained for Einhorn, of New York, to devise an illuminator suitable for this purpose. The gastrodiaphone that he had in use, and which he described, in the latter part of 1889 consists of a soft-rubber stomach-tube supplied with an incandescent light at the end intended to reach the stomach. Within the tube are insulated conducting-wires for connecting the lamp with the source of current, which may be a primary battery, storage-battery, or dynamo circuit. The

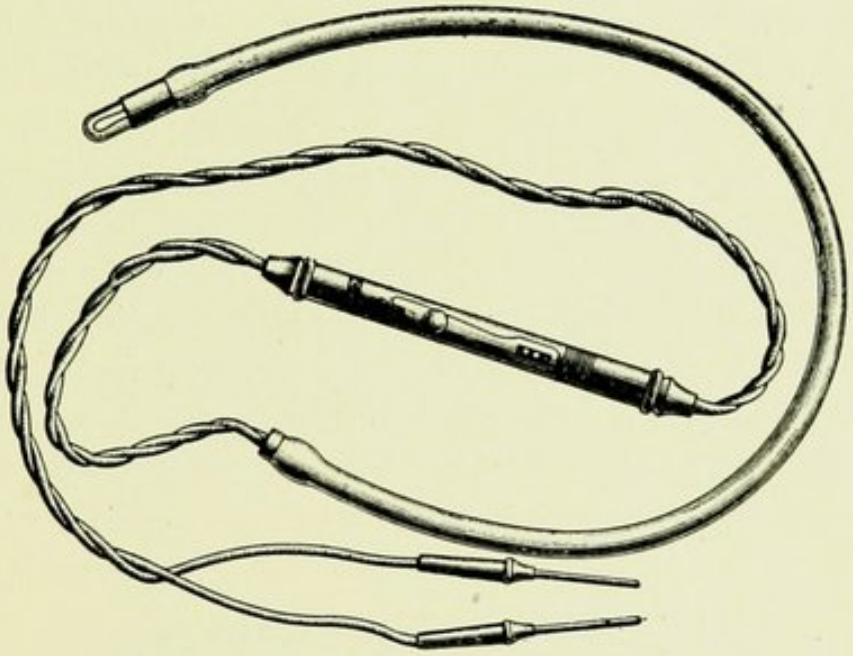


FIG. 12.
Einhorn's Stomach-Lamp.

tube is passed into the stomach in the same manner as a stomach-tube. According to Aaron, to whom we are indebted for much of the matter concerning this illuminator of the viscus, the following directions should be observed:

1. The stomach should be thoroughly cleansed of all remains of food, before transillumination is attempted.
2. The bowels and bladder must be thoroughly emptied.
3. The room should be darkened.
4. The intensity of the stomach-lamp should not exceed 4 candlepower.

5. The light should not be turned on until the lamp has reached the stomach.

The patient may be in either the sitting or reclining posture. In the reclining posture, the stomach recedes from the anterior abdominal wall, carrying the light with it, so that the result is often not so good as when he is sitting erect. The thinner the tissues over the stomach, the better is the definition obtained. Fat produces refraction of the light, and this may be misleading. By slowly moving the lamp, the boundaries of the stomach are made out. The right and left lobe of the liver forming the upper boundary of the stomach are not penetrated by the light, and form a dark-border at the upper margin of the illuminated zone. The movements of the normal stomach due to respiratory action can be seen in the shifting of the illuminated zone.

36. It is claimed that by this method of transillumination, (1) the precise position of the stomach can be determined, Plate IX; (2) the size of the stomach can be made out; (3) dilatation and gastroptosis can be seen; (4) the respiratory displacement of the organ can be shown; (5) a vertical stomach can be distinguished from a loop-shaped organ; (6) variations in the thickness of the anterior wall are made apparent, thus assisting in the diagnosis and location of tumor.

URETHROSCOPE AND CYSTOSCOPE.

37. The Urethroscope.—The use of the urethroscope for the purpose of diagnosis and for facilitating treatment of the urethral canal when it is diseased as a result of gonorrhea, or other cause, has been brought to great perfection by Fred. C. Valentine, M. D. This author has given minute directions as to the technique of anterior and posterior urethroscopy in his recent work on "The Irrigation Treatment of Gonorrhea" to which we refer the reader who is especially interested in this use of the electric light. Doctor Valentine claims that the instrument that he uses effectively does its work, is simple in construction, easy of use, not likely to get out of order, and always reliable. (Plate X.)

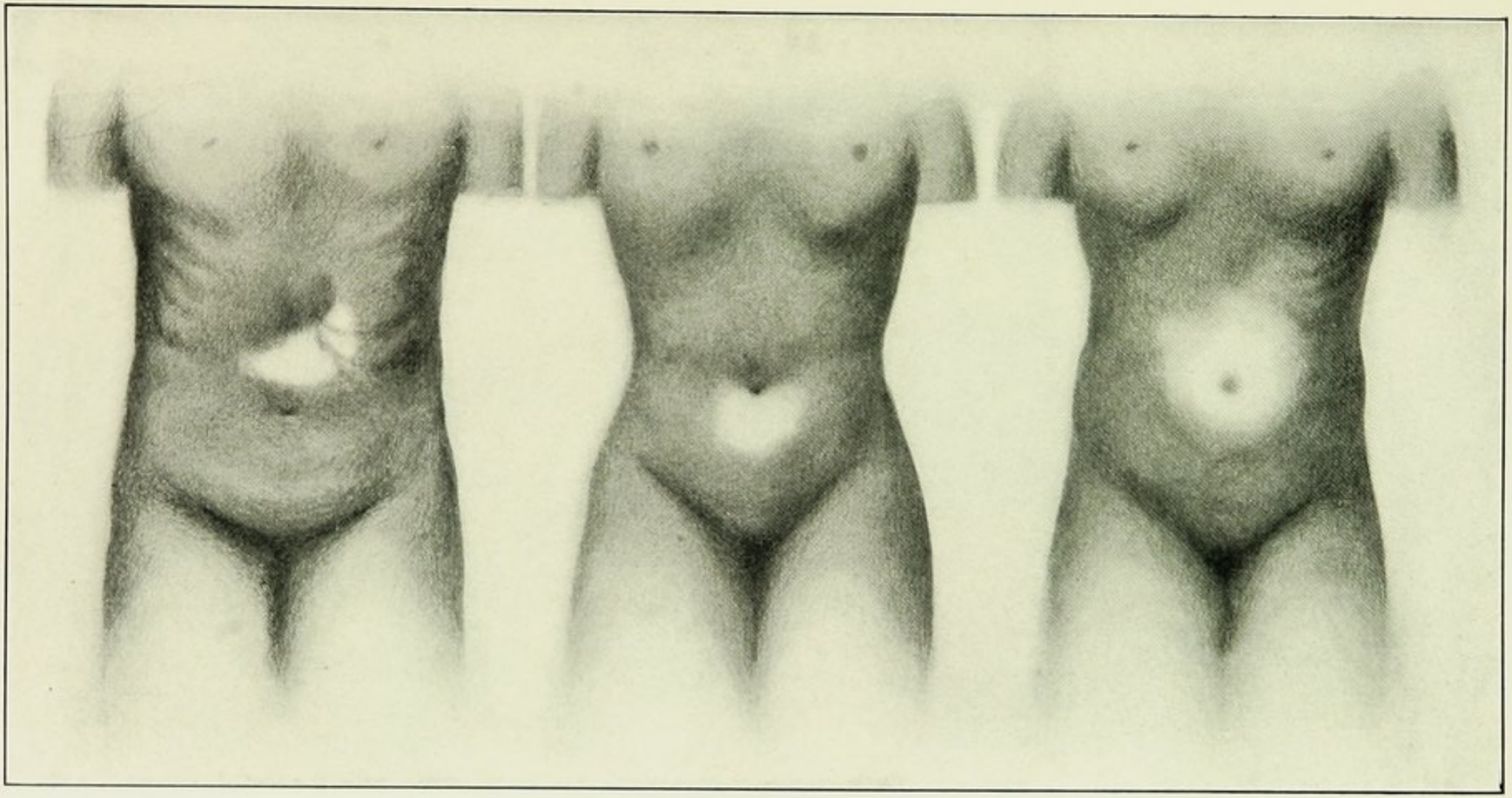


PLATE IX.

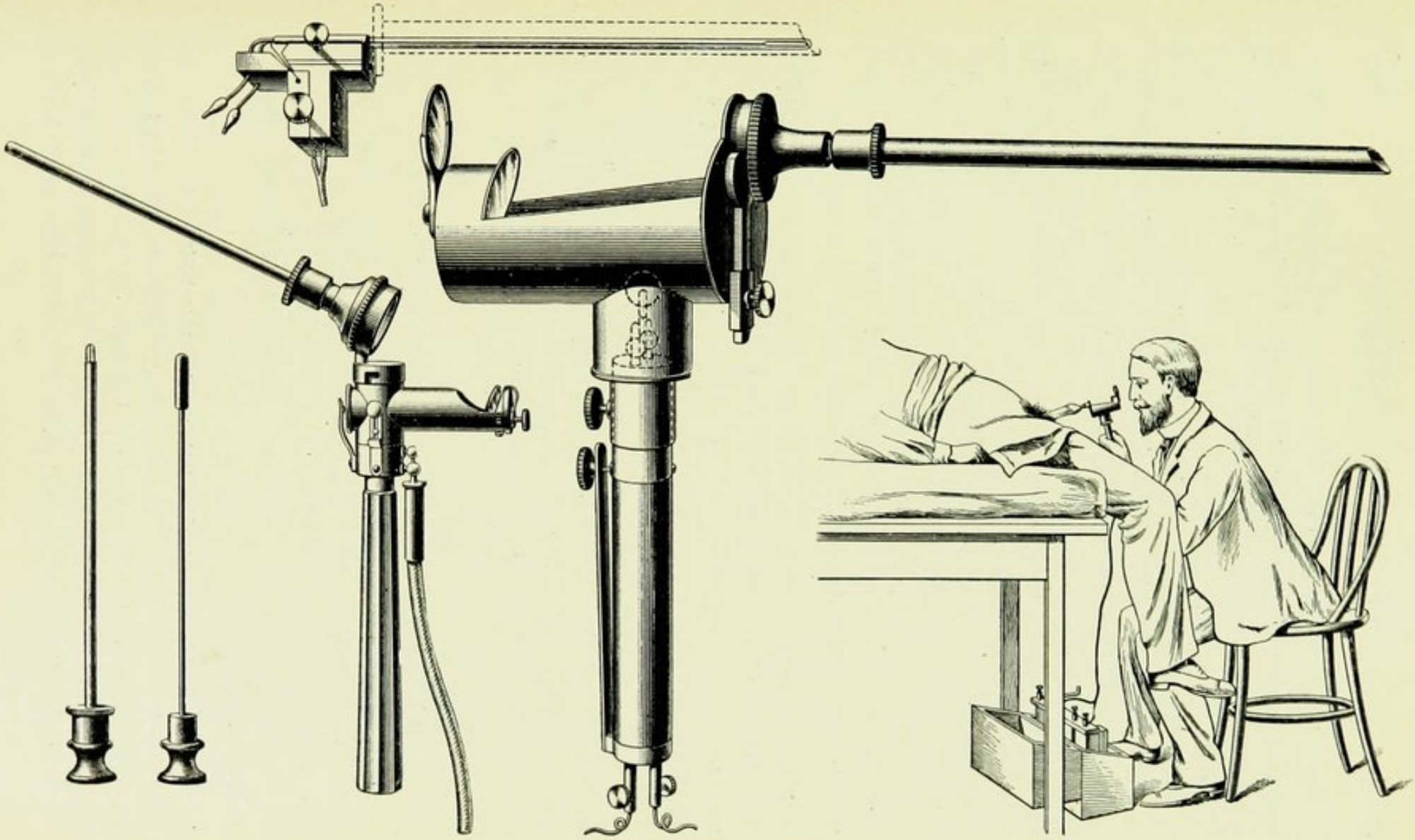


PLATE X.

Endoscope.

38. The Cystoscope.—To the genito-urinary surgeon, any aid to more accurate diagnosis of the various, and, in many instances, extremely obscure, affections of the bladder or kidneys has been a godsend.

The cystoscope in its present perfected form is an instrument of great usefulness; for, while it may not be possible to employ it universally in diseases affecting the urinary passages, it can be brought into requisition very often and can be made to supersede the more formidable and less satisfactory method of digital exploration. Whenever a sound or catheter of medium size can be conveyed into the bladder, the cystoscope may be used. By means of it, the walls of the bladder can be seen, the openings of the ureters located, and these tubes catheterized. Thus, abnormal conditions both of the bladder and of either kidney can be more accurately determined.

39. Both urethroscopy and cystoscopy cannot be successfully practiced by the mere tyro. Much knowledge and skill are required to expose to the eye and to rightly interpret the appearances that these instruments reveal, and it is probable that the specialist, only, will have the opportunity, patience, and perseverance to acquire this knowledge and skill. But even with him, the fundamental knowledge and skill necessary relate to the control of the electric currents by means of which these instruments for better diagnosis are made available.

ELECTRIC LIGHT IN THERAPEUTICS.

40. But there are other benefits that the surgeon can derive from the use of the electric light aside from its aid in diagnosis. The electric light has a value in therapeutics of a nature akin to that of sunlight, with the advantage that the electric light is more manageable.

41. Electric Light Quickens Growth.—It has long been known as a fact that plants and animals robbed of sunlight have but a feeble growth, and are dwarfed and otherwise defective in their development. Recent experiments, especially those that have been conducted by Professor Bailey, of Cornell

University, have demonstrated that the electric light can be made even more effective than ordinary sunlight in accelerating the growth of plants. And what is true of plant life in this regard can be safely predicated of animal life, and in a recent monograph by Franz Schonenberger, "*Der Einfluss des Lichtes auf der Thierischen Organismus*," Berlin, 1898, is given a record of experiments on animals to determine the degree of influence that electric light can exert on their physiological action, showing this to be a most interesting and profitable line of investigation. In the correction of abnormal tissue action by means of the electric light, much has been accomplished within recent years both by means of the general and the local electric-light bath.

ELECTRIC-LIGHT BATH.

42. The general electric-light bath has been used for the treatment of defective nutrition with more or less benefit by enclosing the patient in a cabinet where he is surrounded by clusters, or rows, of incandescent lamps. The cabinet is arranged, in some instances, so that certain banks of lamps may be used independently of others, and thus treating certain portions of the body separately.

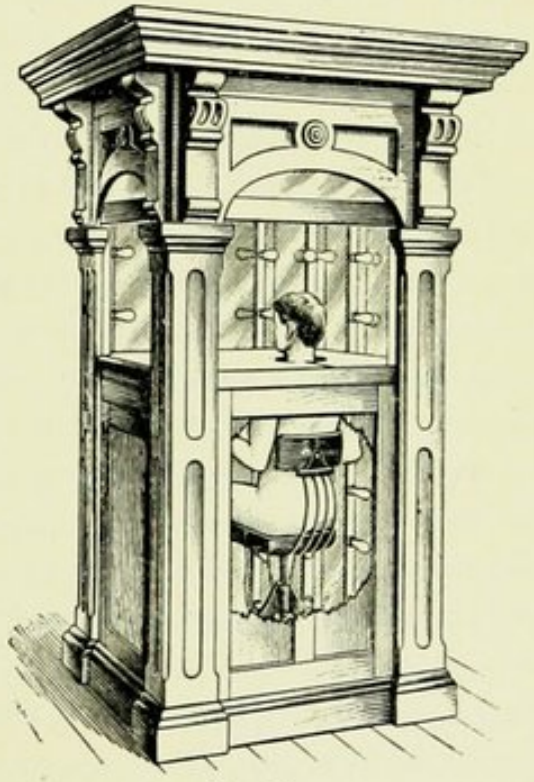


FIG. 13.
Electric-Light Bath.

Or an entire room occupied by the patient may be brilliantly illuminated with arc or incandescent lights so as to subject him to its stimulating influence. Those that have had most experience with electric-light therapy claim for it beneficial effects in the following particulars: (*a*) It has proved serviceable in all forms of disease in which sweating or increase of elimination by

means of the skin is required. (*b*) It is effective in the relief of pain (painful joint affections and neuralgias are soon relieved by it). (*c*) As a means of applying heat, it has a decided advantage over other methods, since the rays penetrate the tissues deeply and are readily transformed into heat in the deeper layers. (*d*) When white light that contains both the heat and actinic or chemical rays is employed the therapeutic effects produced seem to be due to the peculiar activity of both these influences on the tissue metabolism, the thermal and chemical. In defective states of the system, therefore, as in chlorosis, anemia, Bright's disease, diabetes, and various forms of dyspepsia, these combined effects of light bath on tissue-metabolism have proved to be stimulating and a tonic, as well as eliminative, and a better state of nutrition has resulted.

FINSEN METHOD OF TREATING LUPUS.

43. Some notable results of the therapeutic value of concentrated electric light have been reported from Denmark during the past few years. In 1897, Professor Finsen, of Copenhagen, who had previously shown the possibility of preventing pitting in variola by excluding the actinic light rays from the patient, began the treatment of lupus vulgaris by focusing upon the diseased area the actinic rays of sunlight. This he did by means of hollow lenses filled with a solution of cobalt blue. He was so well pleased with the results obtained that, when the solar conditions proved unfavorable, he substituted arc-light for sunlight and found this to be equally beneficial. So popular has this method of treatment become, that an institute for the accommodation of a large number of patients has grown up at Copenhagen under the direction of Professor Finsen, who is aided by a large corps of assistant physicians and nurses. From a letter written recently to the "Philadelphia Medical Journal," by one who has visited this institute, the following particulars are obtained:

"The institute at present consists of several unpretentious, small, one-story buildings, used variously as a laboratory, reception-room, a room for the treatment of the mucous

membranes, and two rooms for the light treatment itself, and tables and stands for sun-condensers outside for the sunlight treatment. In the electric-light rooms are five strong arc-lights of 60 to 80 amperes. From each of these run four tubes containing the light condenser, which are directed upon the part to be treated. Four operating tables are placed about each lamp, on each of which a patient is placed, making 20 patients under treatment at one time. At each table stands a nurse, whose duty it is to press a hollow disk of glass filled with cobalt-solution on the spot previously marked out by an assistant and through which the light is directed. The disk is kept firmly pressed down so as to push out the blood in the affected part and thus favor deeper penetration of the light. The light shines so brilliantly on the spot that nothing can be seen by the naked eye except a white dazzling area, so that in order to be able to inspect it satisfactorily and also to protect the eyes from the constant exposure to the light, the nurses wear very heavy dark glasses.

"The medical assistants pass around from time to time to see that the treatment is being given properly. One hour and a quarter is alloted to each set of 20 patients—one hour for treatment and the extra quarter for time necessary in changing the patients, adjusting the rays, etc. From conversation with assistants, the conclusion seems to be that the arc-light is preferable to sunlight. It is stronger in action, and, therefore, the immediate reaction is sharper than by the sunlight treatment. The number of lupus cases that are here for treatment seems to be legion. The operating tables are occupied from half-past seven in the morning until nine in the evening, with the exception of one to two hours in the afternoon that are given for the resting of the assistants, nurses, etc. The treatment seems to be successful. I saw several cured cases and many cases that were steadily improving. Recurrences seem to be rare so far, and are readily managed. I saw and conversed with a few patients, in whom the lupus involved the whole face and neck, who had had a daily sitting for more than a year, but even these were satisfied with the progress that was being made."

ELECTROLYSIS IN SURGERY.

44. Action of Current on Tissue.—A direct current when passed through living tissues causes, at the point of contact of the *positive electrode*, or *anode*, provided the current is of suitable strength, an accumulation of oxygen, chlorin, and the acids. These, by combining with the albuminoids in the adjacent tissues, cause coagulation, a drying and shrinking of the tissue in immediate contact with the electrode. This effect can be brought about in any structure, therefore, when such an action is likely to prove helpful.

45. About the *negative terminal*, or *cathode*, on the contrary, the alkalies and hydrogen accumulate and these have the effect of softening and liquefying the tissue adjacent to the electrode. There are many abnormal conditions met with, requiring surgical interference for relief, which this action will meet.

46. Derangements of Blood-Vessels.—Local derangements of blood-vessels, such as nævi, cirsoid aneurisms, aneurisms of larger vessels, hemorrhoids, hemorrhagic mucous membranes, or abnormal vascular growths of whatever sort, can have the excessive blood-supply, which here is the main pathological feature to contend with, cut off neatly and easily, and without a resulting scar tissue, by the styptic effect of anodal electrolysis.

REMOVAL OF ABNORMAL GROWTHS.

47. Any abnormal growth may be arrested or removed by robbing it of its blood-supply, and we have in electrolysis a simple and efficient means for bringing this about. Such growths, when treated in this manner, gradually shrink and are absorbed, leaving in most instances no evidence of their former presence.

48. Use of Cathodal Electrolysis.—The softening and liquefying effect of cathodal electrolysis is especially serviceable in the removal of non-vascular, dense, horny, or warty growths, or bony and cartilaginous tissue. Cicatricial tissue resulting from burns, wounds, or inflammations is of this dense non-vascular

kind and is oftentimes nature's best effort at repair. But it not infrequently happens that cicatricial tissue, by its very nature, since it is less pliable and elastic than the normal tissue it has replaced, is itself a serious obstacle to the performance of the proper functions of the organ in which it occurs. Especially is this the case when it forms along the course of a duct or canal, as the nasal duct, the Eustachian tube, the esophagus, the urethra, or the uterine canal, and by forming dense and unyielding bands or patches at one or more places, causes constriction or strictures of the lumen of these canals. Such strictures, as we know, are oftentimes serious obstacles to proper function, and grave derangements may result from them. The customary surgical methods for relieving such strictures are forcible, slow, or immediate dilatation, or cutting. Either of these methods must result, in the vast majority of instances, in the subsequent formation of still more cicatricial tissue through nature's efforts at repair, and the stricture is renewed, perhaps made worse than before.

Negative or cathodal electrolysis, when properly employed, meets the conditions necessary for relief in most instances of cicatricial stricture of canals, in a much more scientific and efficient way than by the other methods now employed. A suitable electrode, insulated except at the point where action is desired, is passed into the canal so as to locate the electrolytic action in the vicinity of the constricting band or patch; the electrode is made the negative pole of the current, which is then carefully turned on and not increased beyond 3 or 5 milliamperes. The anode may be placed at any convenient spot, such as the breast, back of the neck, hand, thigh, or abdomen, but such spot should be large and kept well moistened. At the cathode, with a current of this strength, the alkalies, potash, and soda, together with free hydrogen gas, begin slowly to accumulate, and, by cataphoresis, an increased quantity of moisture is brought to the spot. Through this combination of influences the cicatricial patch or band is softened, rendered lax and yielding, and experience has shown it to be well absorbed, in part at least, after a succession of such applications; the change in conditions brought about by such interference

aiding the physiological processes to remove it. Certainly in electrolysis we have a method for dealing with strictures that is superior to cutting or forcible dilatation.

49. The same softening, liquefying action of the cathode may be employed where fibroid, cartilaginous, osseous, or non-vascular epithelial growths require removal. The change started in such morbid growths by cathodal electrolysis seems to be just the aid needed to enable the nutritive action present to resume its normal course.

50. Not the least among the advantages offered to the surgeon that adopts electrolysis for the removal of such abnormal growths as are suited to this method is the fact that, when properly done, it leaves no scar, nor is there any excess in tissue destruction beyond that which is desired. Again, since the electrodes may be adapted in size and shape to suit any part that is to be treated, the method is of service to every specialist.

Each experienced operator will recall a number of conditions in his special field of operation wherein a styptic, or softening, and, at the same time, a thoroughly antiseptic instrument, made such by the electricity it conveys, would meet his needs better than any other, and especially if it is an instrument capable of adapting itself to growths large or small, whether located on the surface of the body or deep within the tissues.

51. Choice of Polarity.—A very important thing to be remembered by those that wish to make use of electrolysis in surgery, is the directly opposite effects on the tissues caused by the action of the anode and cathode when employed as the active electrode. The polarity must always be chosen with reference to the work to be done and the nature of the tissues to be operated on, and the success of electrolysis, as an aid to surgery, is mainly dependent on a right choice of the direction of current.

The most recent works on electrotherapeutics have failed to sufficiently emphasize this fact, for a large percentage of the failures of those that have attempted to use electrolysis in surgery and that have abandoned and condemned it, can be

traced to ignorance or neglect of the physical, chemical, and physiological effects of polarity in the application.

52. Appropriate Treatment. — When the surgical removal of certain forms of abnormal growth becomes necessary, the electrolytic method of accomplishing this possesses advantages that make it preferable in many instances. And while this method is less destructive to normal tissue than the knife, it is, in suitable cases, no less efficient in removing the diseased tissue. It is not claimed that the electrolytic method of removal is suited to every form of abnormal growth, for there are certain growths, such as lupus in various localities, carcinoma of the breast, leiomyoma of the uterus, and osteosarcoma of the long bones (especially when they have reached any considerable size) where there is no substitute for the scalpel, and there are others, such as polypi of the nasal mucous membrane or of the uterus (with very slender attachments to the surface) that may be as successfully, and much more promptly, removed by the scissors, the scalpel the ecraseur, or the snare. But between growths of such size and shapes there remains another class, both benign and malignant in nature, that, mainly by reason of their location but partly for other reasons, are best adapted to the electrolytic method of treatment. We should include in this class all growths of moderate size, whether malignant or benign, that are so situated that the extensive removal of tissue that would be required to thoroughly extirpate them by a cutting operation would seriously damage the integrity of the part from which they grew so that its function would be impaired or its appearance marred to a much greater degree than would result if the electrolytic method were used. Such growths occur about the eyelids, nose, and lips; in the nasal fossæ, mouth, pharynx, and larynx, and in the urethra, bladder, vagina, uterus, and rectum.

53. As for growths upon the cutaneous surface, those occurring on the face and neck are best suited for electrolytic treatment, chiefly because, when properly employed, it is much less likely to leave a disfiguring scar than are other methods.

ADVANTAGES OF ELECTROLYTIC METHOD.

54. The main advantage of the electrolytic method when skilfully employed is that it effects destruction of the abnormal tissue and nothing else. It is capable of insinuating itself along that narrow line of demarcation between the normal and abnormal tissue, and directly destroys the vitality of certain of the abnormal cells, while the nutrition of others is cut off by the destruction of the blood and lymph channels that supply them. A gradual disintegration and absorption is the result, leaving the normal tissue in possession of the field with an opportunity to repair damages with a minimum amount of cicatricial tissue.

As the electrolytic action is applied by one or more needle points, the extent of tissue that can be acted upon at one and the same time is at the will of the operator. If it is desired to protect the overlying skin or mucous membrane from the electrolytic action, the needles may be coated, except at their points, with an insulating coat of varnish or vulcanite.

With the industrial electric circuit now furnishing the direct current at every door, and with most admirable apparatus for conveniently modifying and controlling it for this purpose, the difficulties are now entirely overcome that formerly stood in the surgeon's way who otherwise might have wished to employ electrolysis.

The following illustrative cases have been chosen from among many, because the locality of the disease in each case is one that offers peculiar difficulties to surgical operation, and because the diseases dealt with are those that usually require the most radical surgical measures for their removal in order that the possibility of recurrence *in situ* may be prevented.

MYELOMA OF THE SUPERIOR MAXILLARY BONE.

55. The patient G. P., of Howell, Michigan, farmer, age 56, of good habits. Three years ago he first noticed a small growth in the roof of his mouth, that grew rapidly, until it was 1½ inches long, 1¼ inches wide, and protruded downward

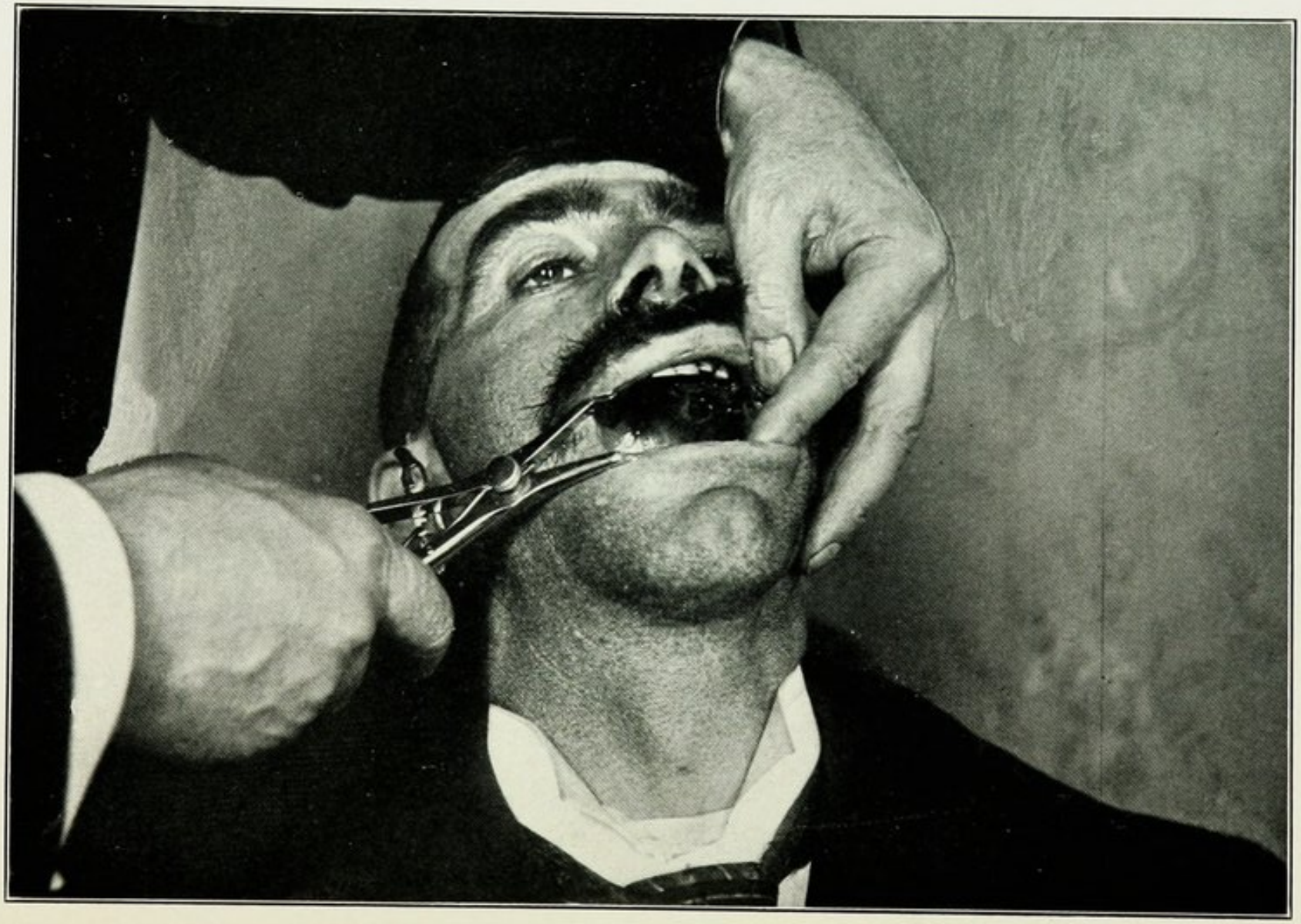


PLATE XI.

against the tongue, so that for some months previous to treatment, the patient was unable to close his mouth. When seen in December, 1896, the growth gave all the clinical evidences of a myeloma. The patient was anemic, haggard, had lost flesh, and was living on liquid food, as he was unable to close his jaws to masticate. The case was one that ordinarily would have been subjected to extirpation by the knife. (Plate XI.)

But as that method would have required, as is well known, a somewhat formidable operation involving anesthesia, considerable loss of blood, some hazard of shock in his feeble health, and would in all probability have resulted in serious deformity of the mouth, nasal fossæ, and pharynx, it was suggested to him, and to his son, who accompanied him, that he submit to the electrolytic method of treatment, which it was thought would at least arrest the further progress of the growth and perhaps effect disintegration and cause it to disappear. To this proposal he consented, and at intervals of 2 or 3 weeks, beginning about December 1, 1896, he was given in all seven treatments, the needle being made the positive pole of the current because the tumor was exceedingly vascular. The needle was first introduced at the margin of the growth near its junction with healthful tissue, and, as nearly as could be judged, at the entrance of the feeding vessels. Only four or five introductions of the needle were made at each sitting, and as the shrinking from the margins became evident, the needle was at later treatments plunged into the center of the growth, sometimes to the depth of ¾ inch or more, at such points as vascularity and cell-proliferation seemed to be greatest.

The interval between treatments seemed to be long enough for the normal tissue to recover its control and get rid of the disintegrated tissue, and a steady diminution of the growth was noticed after the third or fourth application. From that time, without any untoward results, the growth has gradually decreased until the surface has now resumed almost its normal level. The patient has recovered his health and strength, and never, as the result of the treatment, was he incapacitated for an hour.

SQUAMOUS EPITHELIOMA.

56. The following case is typical of a number, of similar character, that have yielded to treatment:

H. J. B., age 38, farmer, always enjoyed good health. No history of malignant disease in his family. Lost the front teeth of his upper jaw some years ago and wore an artificial plate that did not fit well, producing some irritation. About a year ago he noticed a swelling in the gums, which caused some pain and soreness. This swelling increased slowly, though steadily, in spite of caustic applications made with a view of checking it. At length, it became so large as to prevent the closing of the lips and interfered seriously with the mastication of food. When, at last, he applied to a physician for treatment, he was advised to try the electrolytic method, which advice was accepted and treatment begun at once. (Plate XII.)

A pledget of absorbent cotton saturated with a 4-per-cent. solution of cocain was applied to the surface of the growth for a few minutes. A gold-plated steel needle forming the anode of a direct current was then inserted at the base of the growth and made to penetrate to the depth of ½ inch.

A broad rectangular piece of perforated sheet brass covered with amadou well moistened with a 1-per-cent. salt solution was used for the dispersing electrode. Upon this the patient placed one of his hands. The current was then passed into the circuit by means of a shunt graphite rheostat until the milli-ampere-meter registered 20. The current was allowed to remain at this strength for about 1½ minutes, or until the tissues in the vicinity of the needle were blanched and somewhat shriveled. The rheostat arm was then returned to zero, the pole changer reversed so as to make the needle the cathode, and the current again turned into the circuit for a few seconds. This was done so as to slightly liquefy the tissues about the needle and facilitate its withdrawal.

The needle was then removed from this puncture and inserted at another point at the base of the growth remote from the first, the object being to so impede the blood-supply as to retard the growth and cause it to atrophy, but without such immediate

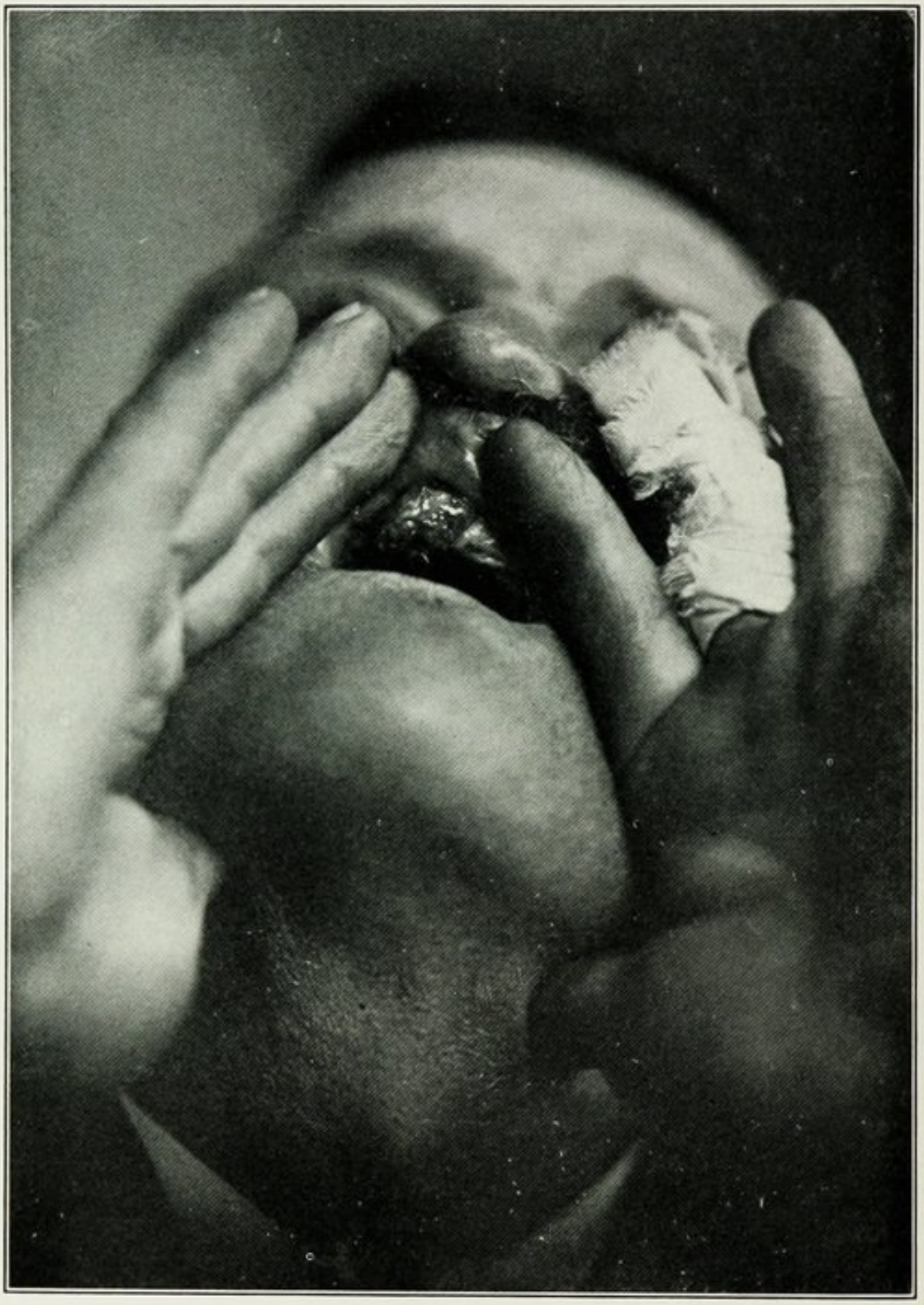


PLATE XII.

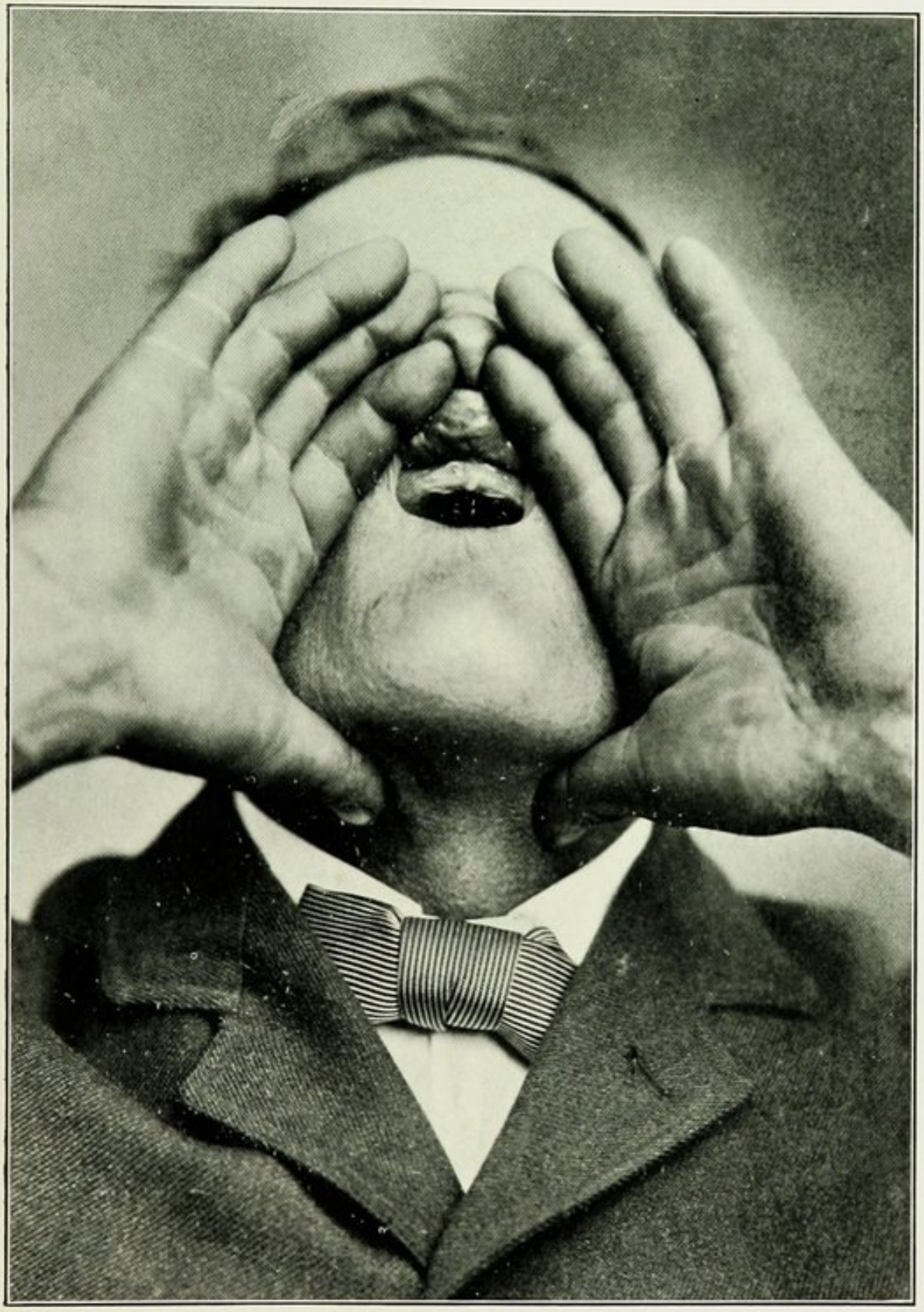


PLATE XIII.

destructive effect as to cause extensive sloughing or do serious damage to normal tissue.

Three or four insertions of the needle were made at each treatment, which was about once a week. In the interval between treatments he was about his farm and attended to his accustomed duties without interruption. No treatment was given him in the intervals between the electrolytic applications except a mouth-wash of euthymol, which he was directed to use several times daily. He experienced but little suffering from the electrolytic application. He improved in general health while he was under the treatment (for he had had some stomach irritability and indigestion) and after each application marked diminution in the size of the growth took place. Five applications in all were made. The growth entirely disappeared, the alveolus from which it sprang resumed a healthy appearance, and the contour was normal except for a slight depression where the abnormal tissue involved the bone. Some months have since elapsed and the surface has now become normal in appearance and resistance so as to permit a new well-fitting plate to be worn. Plate XIII represents the present appearance of the alveolus.

ELECTROLYSIS OF RECTAL NEOPLASMS.

57. Abnormal growths in the rectum, both malignant and benign, are not of infrequent occurrence. These may be of the nature of epithelioma, carcinoma, polypi, villous, hypertrophies, or hemorrhoids. If malignant in nature, the disease may have progressed so far that a choice of method of operation is no longer afforded, resection offering the only hope of relief. But let us presume that the growth, if malignant, has been discovered early, and that it is still confined to a limited area of the rectal wall, or that it is benign in character, with no tendency to progress or disseminate itself into the adjoining tissues. It may be that it is located high up in the rectal pouch; that its origin sinks deep between folds of normal mucous membrane; that it is extremely vascular. Such are the conditions that attend not infrequently the early stages of epithelioma, the most frequently occurring form of malignant

growth that is found in this locality. The difficulties that beset one in the attempt to get at and successfully remove such growths are oftentimes insurmountable without a free posterior incision through the rectal wall, requiring the temporary, if not permanent, sacrifice of the sphincters and perhaps the removal of the coccyx. Such growths are often broad at the base; they are not infrequently extremely vascular, fed by large vessels freely anastomosing; their origin may be inaccessible to knife or ligature by reason of intervening folds of normal mucous membrane; they oftentimes are remote from the surface, preventing the operator from using any form of cutting instrument easily, and when he attempts this, the profuse hemorrhage hides everything from sight. The incision must include a wide margin of normal tissue about the base of the growth, if it be malignant, in order to preclude the possibility of return; and so likewise must the ligature, to be effectual, embrace all that is abnormal, and more. The resulting cicatrix from these methods is likely, therefore, to cause stricture or adhesions that seriously impair the function of the gut. Good surgery aims to accomplish its end by checking the abnormal with the least possible damage to the normal, and just in proportion as it succeeds in this does the science of surgery progress.

58. Advantages of Electrolysis.—Anodal electrolysis brought about at the base of such a growth through the agency of an insulated needle and a regulated constant current successfully overcomes all these difficulties. The blood-vessels that nourish the growth are destroyed by coagulation and the shriveling of the tissues at the point where they enter it. No hemorrhage obstructs the view and there need be no loss of normal tissue. There is no danger from secondary hemorrhage; no raw surfaces to favor septic infection; no stitches to remove; and no ligatures to slough away. The patient in many instances need not be confined to bed a day, and in but few cases does this method of operating require the use of an anesthetic. In this statement of fact, you will recognize advantages, that need but to be mentioned to be appreciated, in this method of procedure over any and all others.

59. Before giving the details of a case of rectal disease treated in this manner, we wish to venture a suggestion that appears to be worthy of very general adoption. It relates to a method for exposing the rectal walls by means of a wire speculum and the lithotomy position. For this idea we are chiefly indebted to Mr. Richard Davy, of Westminster College, London, in whose clinic we first saw it applied. The advantages of this speculum over any other in use are at once apparent. Its shape makes it a wedge-shaped dilator of the sphincters as it is gently pressed into the anus. When in place it is self-retained, and can be readily made more so by a tape carried from its projections to a waist band. It therefore requires no assistance to hold it in place and gives free space about the orifice for sight and operation. And last, but by no means least, it permits a wad of cotton or sponge to be placed at its apex to remain there undisturbed by the most violent peristaltic action of the bowels, and successfully prevents the discharges from reaching and obscuring the field of operation. With this instrument in place and the patient in the lithotomy position, the perplexities that so commonly delay the operator when attempting to place a stitch or find the mouth of a bleeding vessel in this locality are effectually banished.

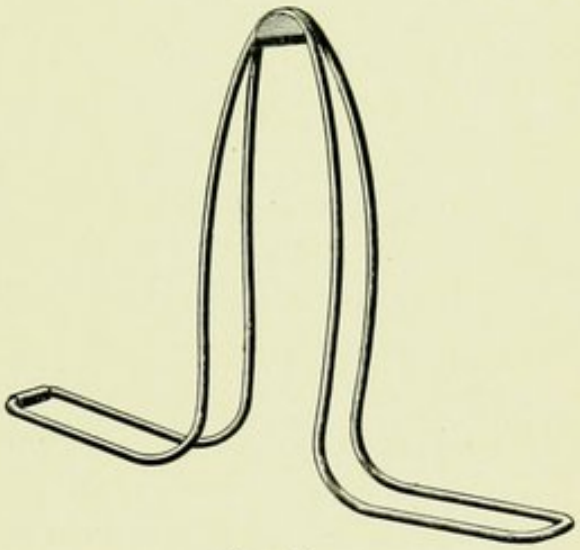


FIG. 14.
Rectal Speculum.

EPITHELIOMA OF THE RECTUM.

60. Miss J. D., age 24, was troubled with obstinate constipation and frequent hemorrhages from the bowels, presumably due to internal piles. Examination disclosed a soft vascular mass, 2 inches in diameter, with a somewhat constricted base on the posterior rectal wall, its lower margin fully 2 inches above the upper margin of the internal sphincter. The mucous

membrane formed a fold across the rectum, below the growth, so that it was difficult to expose the margin of the growth at its base. At this time it was decided to remove the growth by transfixion and the double ligature. The patient was anesthetized, and the operation was successfully performed, although the hemorrhage was frightful, and it was 2 weeks before the ligatures all came away and the part was sufficiently healed to permit the patient to leave her bed. In 3 months the growth had returned almost as large as before. It was then determined to try anodal electrolysis, as all the facilities for it were at hand and it could not be attended by such alarming hemorrhage. Again the patient was anesthetized, placed on the operating chair in the lithotomy position, and the wire speculum placed in position. The base of the tumor was easily reached by a long stout curved needle, held in an electrode needle-holder, and the base of the growth was pierced in half a dozen directions while a current of about 6 milliamperes, with the needle as the anode, was passed for a period of 12 to 15 minutes until the tissue at the base was pretty thoroughly coagulated at a number of points. The patient walked away from the office within an hour after the operation, returned in a month for examination, at which time it was impossible to discover the least evidence that such a growth had ever been present, the mucous membrane appeared entirely normal and there was no contraction; the rectum was acting properly, and has continued to do so ever since—now three years.

EPITHELIOMA OF THE PENIS.

61. H. A. D., age 22, a student, recently married, stalwart, well-proportioned, muscular, a superb specimen of manly vigor, was brought for diagnosis and treatment August 7th, 1897. His family and personal history were both good. Three years previously he had been circumcised because of phimosis. The wound had not completely healed, and recently a growth appeared at the upper margin of the wound, where the skin joined the mucous membrane of the glans. This steadily increased in size until at the time of the examination it was as large as the half of an English walnut, with a cauliflower-like

surface, red, and quite vascular. A microscopical examination of a segment taken from the growth, made at the histological laboratory of the University of Michigan, showed it to be an epithelioma. Amputation of the penis, with the consequent sacrifices and discomforts, was discussed, and the alternative offered of treatment by electrolysis. No absolute assurance of cure was given. But the statement was made that it might arrest the growth and possibly cause it to disappear by atrophy and absorption. This alternative was chosen. The patient was anesthetized, since the pain from the insertion of the needle alone in this locality was likely to prove severe, and a needle serving as the anode of a direct current of 15 to 20 milliamperes was passed into the line of demarcation separating the growth from the normal tissue. This was done four or five times at each treatment, the current being allowed to pass from 2 to 3 minutes at each insertion, or until the tissues in the vicinity of the puncture were blanched and somewhat shriveled. For a moment each time before withdrawing the needle, the current was reversed.

62. The treatment consumed about 20 minutes time after the patient was sufficiently anesthetized. At the close of the treatment an antiseptic dressing was applied. An interval of 2 or 3 weeks was allowed to elapse before another treatment, and at the end of this time a very perceptible decrease in the size of the growth had occurred and the pain, which had previously been considerable, was lessened.

At the second and at all subsequent treatments a leash of four needles in the place of one needle was used as the anode. At times these were inserted at the margin of the growth and at other times directly into its most prominent nodules. The needles were made to penetrate to a depth that insured the electrolytic action on the base of the growth; when it was desired to concentrate the electrolytic action at the tip of the needle, a coating of white varnish was placed over the greater part of the needle and thoroughly dried, so as to insulate it, the tip of the needle being protected from the varnish by thrusting it into a cork. When a leash of needles was used

instead of a single one, the circuit was, of course, divided so that the density at any one needle-point was proportionately decreased. This would permit the current, as shown by the milliampere-meter, to be increased to 30 or 40 milliamperes without causing too great a density at any one needle-point. Five or six treatments of this character were given this patient, at intervals varying from 3 to 4 weeks, with the result that the growth gradually shrank and normal epithelium overspread the surface once occupied by the growth, and only small islets of the abnormal structure remained in two or three spots. Only about one-half of the glans structure was destroyed by the epithelioma and as a result of the electrolysis. The urethra was not injured and the patient was so far improved that he indulged quite a number of times in coition in spite of the strict orders he had had as to continence.

He was directed to continue the electrolytic treatment with his home physician, who was quite well prepared to give it; but, owing to the fact that he was so much improved, he neglected to comply with this advice. At the time he stopped treatment, there was no evidence of involvement of the inguinal or other glands, and to all appearances he was perfectly healthy, and the genital organs were performing their functions normally, perhaps in some respects to excess. Some months subsequent to this, this patient developed epithelioma of the inguinal lymphatics, which he had neglected until it was too late for surgical interference. The abdominal viscera became involved and the disease soon ended in death.

There is every reason to believe from a critical study of this case that a persistence in the electrolytic treatment until every vestige of the local disease had disappeared would have resulted in a complete cure, a cure that would have preserved the integrity of the penis for the most part, with full functional capacity.

MOLES.

63. Removal of Moles.—Moles are cutaneous growths of various kinds and structure; "they are round, oval, or oblong, discolored spots or patches, of skin varying in size from the head of a pin to several inches in extent, and frequently

are surmounted with either soft downlike or stiff bristling hairs"; they have a brownish-gray or chocolate color, and may occupy any portion of the surface; they may remain during life without causing any inconvenience, unless situated where they are subjected to friction by the clothing or occupation, when they may inflame and ulcerate. There is an inherent tendency in these growths at times to take on a malignant character. Melanoid carcinoma is especially liable to develop from them. When they are situated on unexposed portions of the body and show no disposition to become malignant, they require no treatment; but, when situated on exposed portions of the body, their removal may be desired by the patient for its cosmetic effect. Electrolysis is peculiarly well adapted for disposing of them. As a rule, negative electrolysis is best suited to destroy growths of this nature, for usually they are not very vascular, being composed for the most part of changed epithelium, which is more readily disintegrated by the alkaline ions brought to the negative electrode. Again, if a steel needle is used, negative electrolysis causes no secondary product with the metal so as to leave an indelible stain in the tissues, as is the case with the steel needle when used as the anode, which is a point that it is well to bear in mind when the operation is done for cosmetic effect.

64. But occasionally these cutaneous growths are not only large in size but are likewise quite vascular, a combination of mole and nævus. They are in such instances elevated above the surrounding surface of the integument, and give an elastic or cushion-like feeling to the touch. When moles have this structure they are best treated by means of the anode, and if they are on exposed parts of the body, the needles used should be of non-corrodable metal, as gold, platinum, or iridoplatinum. A typical case is the following:

65. A Treatment of a Mole.—Mrs. G. E. H., age 33, has a good family history and always has enjoyed good health. From birth she has had a large mole-like patch on the back, between the shoulders. It never, until recently, has caused her any serious inconvenience, although she has noticed that it has

steadily increased in size. Within the past two years, owing to the friction of her clothing, as she has thought, it has become swollen, sore, and tender, and because of this she consulted her medical attendant, who suggested that she try the electrolytic treatment.

On examination, a growth was found beginning, at its upper margin, at the level of the spinous process of the seventh cervical vertebra and extending down 6 inches. In transverse diameter it was $5\frac{1}{5}$ inches. It was of chocolate color, covered with roughened, corrugated epithelium, a thick growth of downy hairs, and dotted with enlarged sebaceous follicles filled with caseous secretion. The skin was elevated above the surrounding surface from $\frac{1}{4}$ to $\frac{1}{2}$ inch, seemingly due to an increase of connective tissue-elements and blood-vessels. The whole appearance of the tissue gave the impression of a beginning malignant change.

To remove this entire patch by the knife meant to expose a very extensive raw surface with innumerable small but active blood-vessels to control, and a prolonged skin-grafting process to follow. The electrolytic method of treatment seemed preferable both to the physician and to the patient. Treatment was begun by using a leash of 4 gold-plated needles as the anode of a direct current of 30 milliamperes strength. These were insulated to near the tip and thrust in to the depth of $\frac{1}{2}$ inch, so as to confine the electrolytic action to the base of the growth. Eight or twelve punctures were made at each treatment, the needles being introduced about an inch apart. The needles were left in place from two to three minutes and the current reversed for a few seconds before their removal. The patient placed her hands on a broad, well-moistened cathode. No anesthetic, either local or general, was used as the pain was not intolerable. There was a perceptible diminution in the size of the growth following the first treatment. The skin over the treated portion sank nearer to the natural level, the epithelium grew less dense, and the glandular structure in the skin appeared more like the normal. Moreover, the skin began to take on its natural color in patches corresponding to the points of insertion of the needles. Six or eight treatments were given

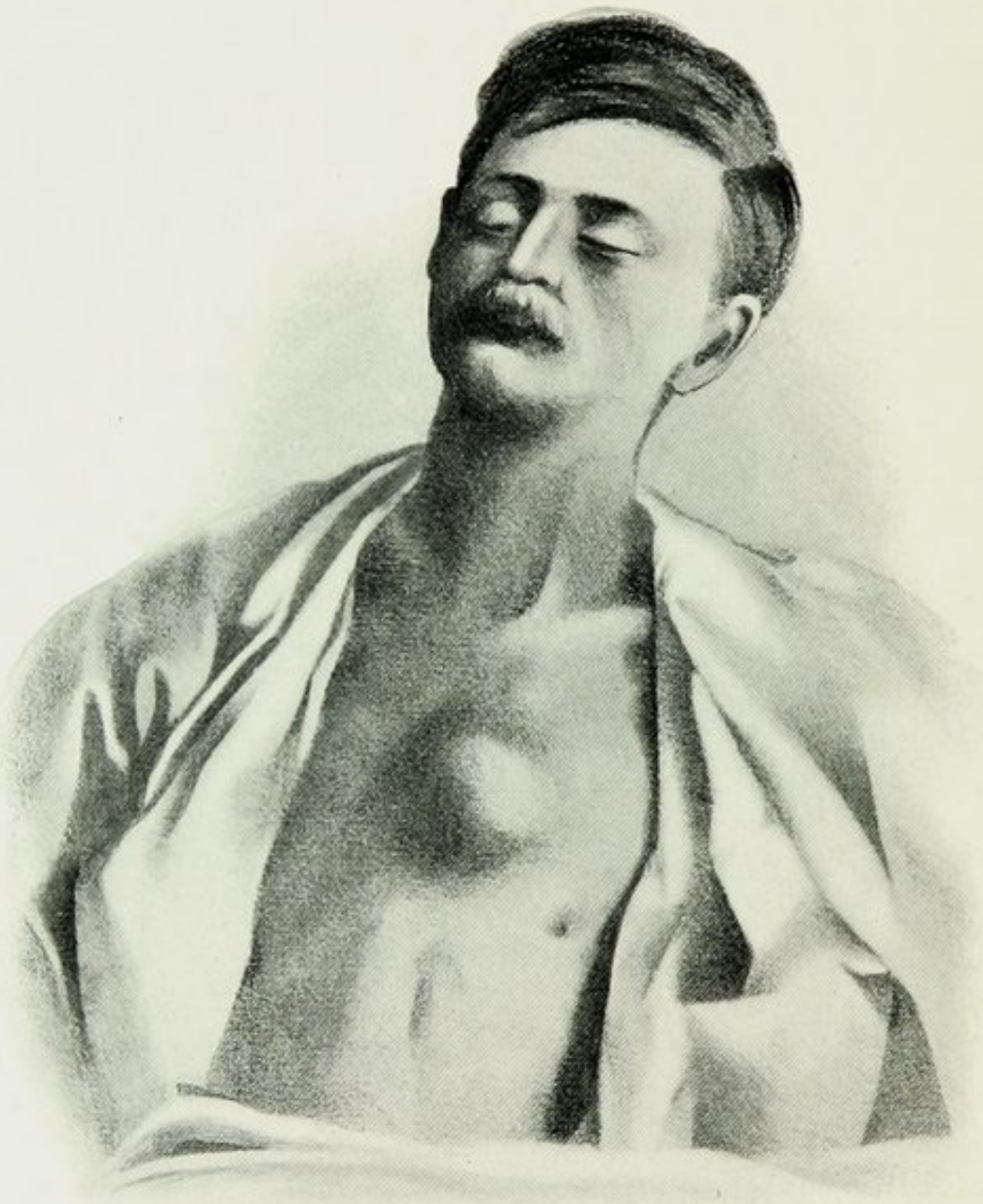


PLATE XIV.

Aneurism of the Aorta.

in all, at intervals of a few days, and were discontinued because all of the unpleasant symptoms that caused the patient to seek for relief had disappeared. The outlines of the growth are much diminished, the surface of the skin is near the natural level, and the structure of the skin is more natural in appearance. The pain and discomfort have wholly disappeared. We are justified in saying from experience with other cases similar in nature to this one, that further treatment would have resulted in an entire disappearance of the abnormal tissue, but in this instance it was not advisable, since it was not necessary either for the safety of the patient or the cosmetic effect.

ELECTROLYSIS OF ANEURISM.

66. Aneurism of Blood-Vessels.—Aneurism of large blood-vessels, such as the aorta, innominate, carotids, or subclavians, offers as a rule a hopeless prognosis. Until anodal electrolysis was employed, surgery was able to hold out but little hope that the disease could be even ameliorated or retarded in its progress. But, owing to the modern development of the electrolytic treatment, much benefit can be looked for from the employment of it in these severe cases of aneurism, provided it is undertaken by skilled operators.

The procedure consists in the insertion of spirally coiled fine gold wire into the aneurismal sac through an aspirating needle. Nine or ten feet of such wire is used in a case where the aneurism is large. The wire is then made the anode of a direct current of from 10 to 100 milliamperes strength, while the cathode is placed upon the back, the thigh, or other convenient part of the body. The current is continued until pulsation ceases and evidence is given that coagulation and solidification of the contents of the sac have taken place. This requires from a few minutes to an hour or more. In some instances, several coils of wire have been inserted at different points of the dilated vessel at the same sitting.

67. Electrolysis of Aortic Aneurism.—Sixteen cases of aortic aneurism treated in this manner have now been

reported. Five of the sixteen cases were very much improved, five were cured, and all were relieved by the procedure. Prof. H. A. Hare, of Philadelphia, has operated upon and reported several of these cases. After reviewing the literature upon the subject in a recent article, he says: "The statistics of this operation are singularly interesting and encouraging, and it is a matter of great interest that in no case, so far as I am aware, has death occurred during operation, and that, notwithstanding the inevitably fatal ending of cases with such a growth if it is not interfered with, the operation gives relief and prolongs life in a sufficiently large proportion of patients to justify or even demand its performance in all suitable cases." (Plate XIV.)

68. The illustrations thus far given have dealt with the range of efficiency peculiar to anodal electrolysis, or the effects that can be brought about in living tissue by means of the positive electrode. But cathodal electrolysis is capable of proving none the less serviceable to surgery. In the field of conservative surgery, it is yet destined to play a very important role.

69. Cicatricial Tissue.—Cicatricial tissue, the result of inflammatory action, is responsible for much human misery. It narrows and occludes and distorts many of the channels of the body. The nasal duct, the Eustachian tube, the esophagus, the urethra, and the cervical canal of the uterus are conspicuous as points where stricture due to this cause are of frequent occurrence. In dealing with such strictures, present methods and results are, as a rule, far from what is desired.

70. Injury to Normal Tissue.—Conservative surgery, as has been said, aims to remove the abnormal with the least possible injury to the normal, but in the majority of methods now employed for the removal of stricture, the normal is made to suffer with the abnormal, and the result is unsatisfactory in proportion as this is the case. After some experience in its practice, in addition to a careful review of the testimony of those more experienced, we are convinced that cathodal

electrolysis has the effect, when skilfully managed, of softening, relaxing, and disintegrating these bands of cicatricial tissue without damage to normal tissue adjacent to them, thus releasing the canal that they have narrowed from their obstructing clutch. If this is true, it can be readily seen what an important stride will be made in conservative surgery as soon as cathodal electrolysis is universally employed for the removal of strictures, pelvic adhesions, fibroid tumors, and the like, which at present give rise to some of the most formidable and fatal operations known to surgery.

71. Results of Cathodal Electrolysis.—The clinical fact is abundantly proved that cathodal electrolysis overcomes the mechanical obstructions, and changes the histological structure of dense fibrous tissue, whether as a result of inflammation or other pathological process. The details of the process by which this is brought about are still a matter for speculation. But it is known and can be demonstrated, that when the cathode of a direct current is brought in contact with living animal tissues, and a current of but 3 or 5 milliamperes is caused to flow, there is soon accumulated, in the vicinity of the cathode, nascent hydrogen and the nascent alkalies soda and potassa. The albuminoid constituents of the tissues are softened, being liquefied by soda and potassa. It is safely presumable that hydrogen gas forming in the tissues tends to expand the interstices of the connective tissue, which is abnormally dense and impenetrable, and that a freer access of nutritive fluids and more favorable conditions for absorption are thus established. Certain it is that after a few minutes of such application of the cathode, resisting bands become less dense and less obstruction is offered to dilating instruments, and that this is not a temporary but a permanent change for the better.

STRICTURE OF THE URETHRA.

72. Cathodal Electrolysis for Stricture.—Cathodal electrolysis for the relief of stricture has been practiced in all probability upon strictures of the urethra more than upon those

of any other locality. Nevertheless, all strictures due to hyperplasia of connective or cicatricial tissue, whether located in the nasal duct, Eustachian tube, esophagus, rectum, vagina, or uterine canal, are equally amenable to this method of treatment. Gonorrheal inflammation of the male urethra resulting in stricture is of comparatively frequent occurrence, and it is this that has given occasion for the large preponderance of operations upon this canal as compared with those of other localities. Wherever the stricture is located, the principles involved in cathodal electrolysis for its relief are the same, the operation differing only in the electrodes employed and the manipulation required to bring the electrode into contact with the strictured portion of the passageway. It is assumed, therefore, that it will not be necessary to describe the process of cathodal electrolysis for the relief of stricture in all of the various localities mentioned. If the process is fully comprehended in its application to conditions present in one locality, it will be readily seen to be quite as appropriate to similar conditions in other localities. The cures that have been reported as having resulted from the electrolytic treatment of urethral stricture now number several thousand, and they proceed from men whose ability as surgeons and whose accuracy in statement is beyond question.

73. Owing to an imperfect understanding of the action of the direct electric current upon the living animal tissues, and also, no doubt, to a lack on the part of some operators of the necessary physical knowledge and skill in technique as well, much bad surgery has been done in the name of electrolysis of the urethral canal, and the patient and the method have had to suffer in consequence. But there is no longer any excuse for bungling work in urethral electrolysis; the means are available, the directions are simple and clear, and the technique can be readily acquired by any one competent to pass a sound or a catheter in a skilful manner. (Plate XV.)

74. Rapid Method of Electrolysis. — There are two methods that have been employed in treating urethral stricture by electrolysis since it was first proposed and practiced by

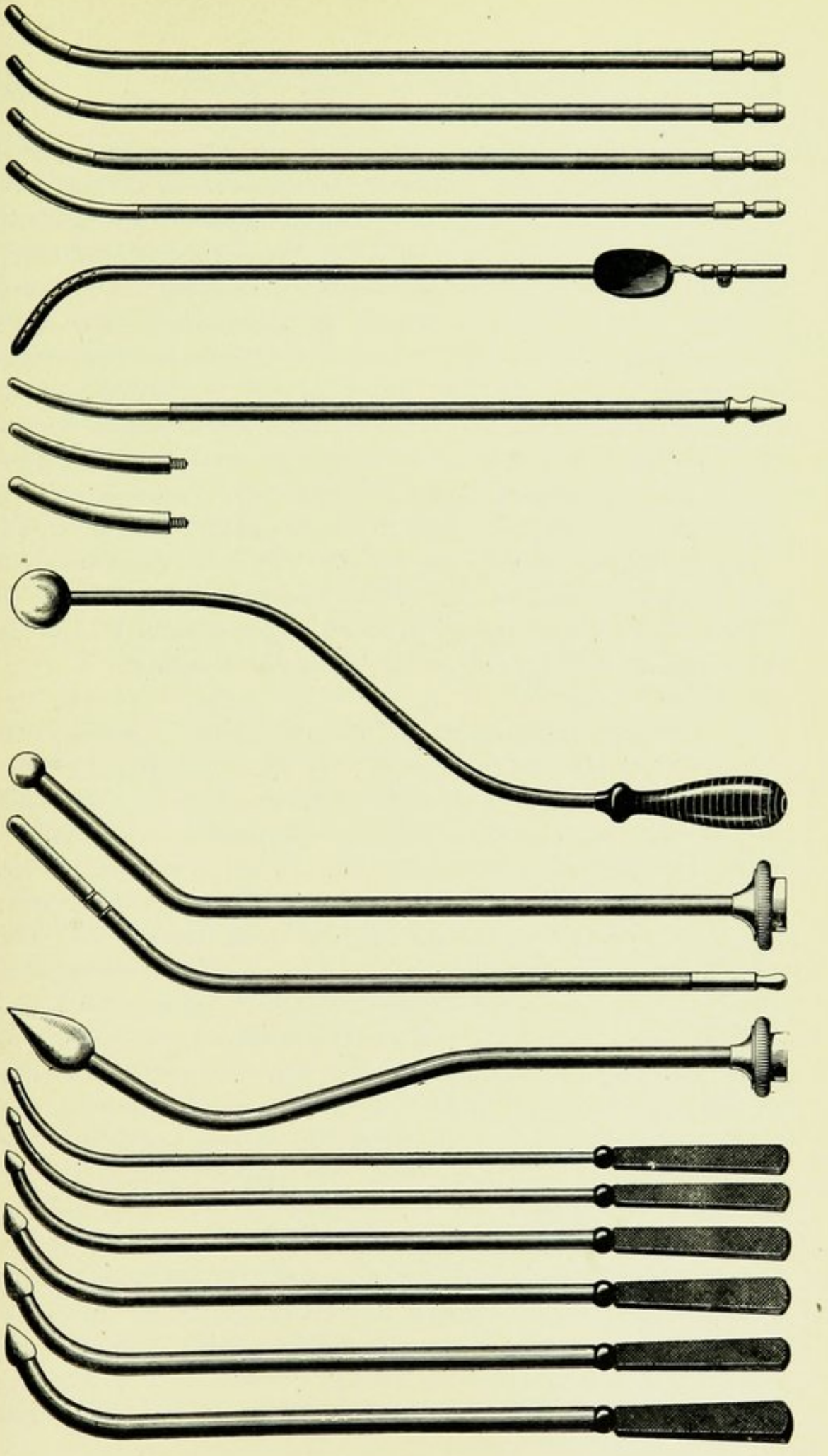


PLATE XV.

Electrodes for Treating Nasal, Urethral, Rectal, Uterine, and Vaginal Stricture.

Tripier—the rapid and the slow method. The first aimed to accomplish the dilatation of the stricture in one or two brief séances by the employment of strong currents of from 20 to 50 milliamperes. This is the method of Tripier and his followers, and has been termed the galvanocaustic method. Its results are bad and its practice should be abandoned. The other method employs a current of but 2 to 5 milliamperes, so that the action is slow, gradual, dissolving, or disintegrating, and treatment with currents of this strength are repeated once a week or at intervals of 2 to 3 weeks with electrodes of gradually increasing diameter, until the size of the normal urethra is reached. This is known as the Newman method, and, according to the testimony of the great majority of both American and European operators, it is, when properly done, devoid of ill effects, and, in properly selected cases, results in cure in those that are faithful in submitting to the treatment.

75. Gradual Method of Electrolysis.—The slow, or gradual method with the use of very weak currents, which is the only electric method that should be employed for the relief of any form of cicatricial stricture, consists in carrying an electrode with olive-shaped tip into the strictured canal so that the metal tip becomes partially engaged in the strictured area, but is two or three sizes too large to pass through it. The remainder of the electrode, except that portion forming the metal tip, should be very smooth, of somewhat smaller diameter, and well insulated. With this electrode in place and attached to its conducting-cord, and with the anode of ample surface, well covered, and well moistened in place on the breast, the back, the hand, or thigh, the current is gradually let into the circuit until the milliamperemeter registers 2 or 3 milliamperes. The tip of the electrode is now kept gently, very gently, pressed in contact with the strictured area by the operator, until, after a few moments, with the current-strength as stated, or perhaps increased to 5 milliamperes, but no more, he feels the tip of the instrument slowly moving onwards until gradually he discovers it has passed the stricture. This may consume 2 or 3 minutes, or it may require as much as 15 or

20 minutes; a longer time would not be advisable, for, if in 20 minutes duration of the application of the current of this strength, the stricture has not been passed, it is well to withdraw the instrument and allow an interval of several days to elapse before repeating the same procedure. In this interval, some absorption and relaxation of the cicatricial band has taken place as a result of the action of the current, and a second attempt to carry the instrument through under similar conditions is seldom unsuccessful. If the electrode chosen finds its way through the stricture in a few seconds or minutes, without the use of any force, it is well to bring it back to the strictured point again for a few minutes and prolong the effect of the electrolysis at the one sitting. By so doing, it will not be necessary to repeat the process in that case very often. If the strictured band is slow in yielding, or if there are several bands at different parts of the canal, it is better not to attempt too much at one treatment, but have the patient return after an interval of 4 or 5 days to a week.

It always insures a more satisfactory result in the end if the treatments are made gently, for a brief time, and with small currents, even though this may prolong the treatment over a number of weeks before the case can be pronounced cured. This course avoids hemorrhage, irritation of the urethra, or eschars, which might otherwise occur. At the same time, it stimulates the natural processes of absorption without impeding them. After one such treatment, it is found at the next attempt that an electrode two or three sizes larger can be used, and in all probability this will pass the strictured area with the same current and as readily as in the first instance. It sometimes happens, however, that the same size of electrode must be used for several successive treatments before it is best to make use of one of larger size. The nature of the constricting band will determine this. If it is thick, dense, and long, or devious in its channel, it is best not to attempt to increase the size of the electrode too rapidly, but give the electrolytic action a longer time to effect absorption.

It is well, both before and after using the sound, to inject an antiseptic solution, as boroglycerin or euthymol, into the canal;

and the electrode, in order to facilitate its passage, should be coated with a substance that offers but little resistance to the current, as a bland pure soap.

76. Construction of Electrode.—It is best to have the electrodes for the treatment of strictures made in one piece, the tip being firmly and permanently attached to the stem. This requires a separate electrode, it is true, for each size, but it makes a much more substantial electrode and one that is not only capable of being kept more thoroughly aseptic, but is void of the danger of a separation of the tip when in use, an accident that sometimes happens to those electrodes made with a universal stem, to which tips of various sizes may be attached by a screw-thread on its extremity. After some use, the threads of this screw become worn and the tips cannot be very firmly fastened to the shaft. Occasionally, also, the metal of the shaft needs to be so slender that when it is still further reduced by the cutting of the thread upon it, a fracture readily takes place. Tunneled electrodes are required when the strictured canal is tortuous. A filiform bougie is first passed as a guide to the electrode, which is then made to follow the bougie and enlarge the canal by cathodal electrolysis.

77. It is claimed by Newman that all forms of urethral stricture are amenable to the gradual method of treatment. This we are hardly prepared to believe, for there are some cases where nothing short of an external urethrotomy is possible. But it is safe to say that, by patience, perseverance, and skill in the use of cathodal electrolysis, the vast majority of those cases of strictures of the urethra where a bougie of even the smallest caliber can be carried into the bladder can be successfully followed by electrodes of gradually increasing size until the urethra is sufficiently enlarged. And this result, in spite of the time required, will be attended with less inconvenience to the patient, is much less dangerous than a forcible dilatation or urethrotomy, and is more certain to be followed by permanent improvement.

FIBROID GROWTHS.

FIBROID TUMOR OF THE UTERUS, FIBROID GOITER, FIBROID GROWTHS IN THE MAMMARY GLAND, FIBROID HYPERTROPHY OF THE PROSTATE GLAND.

78. Electrolytic Treatment of Growth.—In the heading above will be found more of the pathological conditions to which the treatment by means of cathodal electrolysis is found applicable.

It is not every case of uterine fibroma that can be successfully treated in this manner. The growth may be too extensive; it may be so located, as in the subperitoneal or sessile form, that the electrode cannot be brought into close proximity to it; it may give rise to or be associated with other pathological conditions that render this form of treatment inadmissible, as is the case when there is much inflammation or suppuration in the uterus or its adnexa. The excessive hemorrhage that so frequently accompanies the growth of fibroma of the uterus requires for its appropriate electric treatment the use of the anode rather than the cathode in many instances. This hemorrhage may be due to a fungoid change in the endometrium that becomes very vascular owing to the obstruction caused by the fibroma to the return flow of blood.

The anode applied thoroughly for a number of times to this vascular mucous membrane has the effect of a curettage in diminishing its vascularity and controlling the hemorrhage. In conditions such as these, anodal electrolysis, with a view of correcting this drain upon the patient, should precede the more radical attempt to promote absorption of the fibroma by means of cathodal electrolysis.

79. Benefits of Direct Current.—The limitations to the treatment of uterine fibroma by means of cathodal electrolysis as well as by other electric modalities are set forth in detail in *Therapeutic Uses of Electricity in Gynecology*, and need not be repeated here. Much controversy has arisen over the claims that have been made for the utility of the direct current in the treatment of uterine fibroids. But the patient and

painstaking work of Apostoli has not been fruitless, and it now is very generally conceded by those that have faithfully followed his directions as to the proper selection of cases and have put to the test his methods of treatment with the direct current, that the conclusions of Keith are well sustained, viz.:

"This treatment almost always relieves pain. It almost always brings about diminution of the tumor—sometimes rapidly. It almost always stops hemorrhage—sometimes rapidly." As these are the chief symptoms that force the patient with uterine fibroid to seek surgical aid, certainly a method that can in the great majority of cases (nineteen cases out of every twenty) control these symptoms with but little trouble to the patient and no hazard of life, deserves to be offered to her as an alternative to a laparotomy or a vaginal hysterectomy.

CATHODAL ELECTROLYSIS.

80. There are two methods by means of which the disintegrating, absorptive influence of cathodal electrolysis may be brought to bear upon uterine fibroids, fibroids of the mammary gland, hypertrophy of the prostate, or fibrous increase in the thyroid or lymphatic glands.

81. First Method.—By the use of a suitably shaped electrode, the current may be concentrated as much as possible at a point on the mucous membrane or cuticle in the near vicinity of the fibroid growth, while a broad dispersing electrode is placed at some indifferent surface of the body. The strength of current in this case must fall short of an amount that would result in electrolysis of the mucous membrane or cuticle. The very strong currents that were in the beginning used and advised by Apostoli, 250 to 500 milliamperes, did cause eschars due to the electrolysis, which were very annoying complications. Currents of less strength, 30 to 50 milliamperes, applied for a longer time, 8 to 15 minutes, were later advised by Apostoli, and these appear to accomplish equally good results in promoting absorption of the fibrous tissue, and a stronger current-strength than this is now seldom used. Even with currents of this strength, it is advisable to keep the electrode gently moving

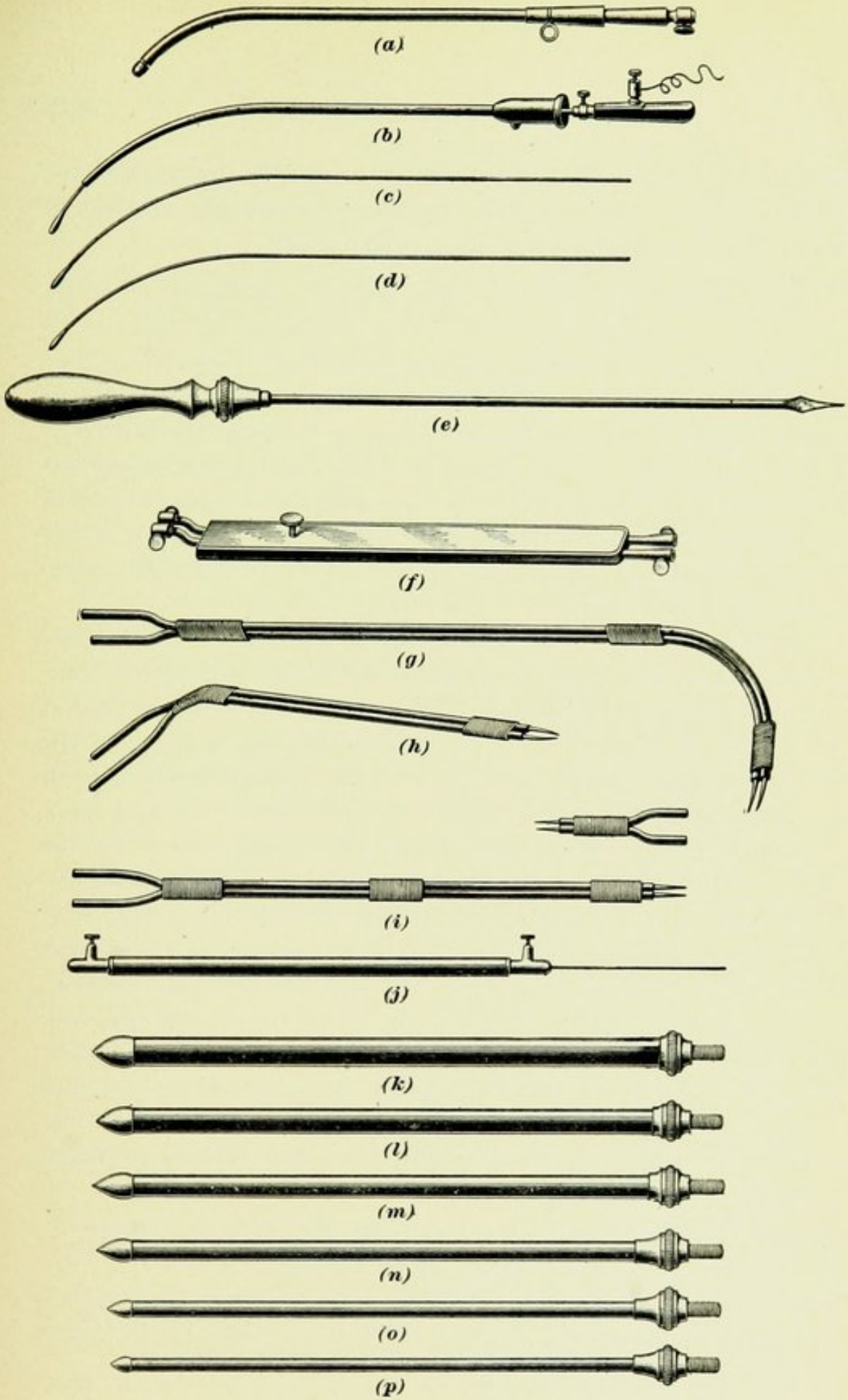


PLATE XVI.

Electrodes for Electrolysis.

(*a*) *Nasal or Laryngeal.* (*b, c, d*) *Lachrymal Duct or Eustachian.* (*e*) *For Uterine or Other Morbid Growths.* (*f, g, h, i*) *For Double Electrolysis.* (*j*) *Epilation.* (*k, l, m, n, o, p*) *For Stricture.*

over a limited area of contact during the application, so that too great density of current may not be continuously applied to one point on the mucous or cutaneous surface.

82. Second Method. — The second method is that by which the disintegrating action of cathodal electrolysis is concentrated at some point within the fibrous growth. This is effected by using a needle or trochar-shaped electrode, which is thrust through the cutaneous or mucous covering and buried in the growth to the desired distance. The instrument should be thoroughly insulated except for so much of the extremity as can be carried entirely within the tumor. By this means, the normal overlying tissues are protected from the destructive action of the current.

By reason of the small surface of this pointed electrode, the current-density is very greatly increased in its immediate vicinity, provided the strength of current remains the same as before, 30 to 50 milliamperes. An immediate destruction of the fibrous tissue surrounding the end of the electrode results from this procedure, and more rapid absorption of the tumor, as a rule, takes place. Much greater care is needed, however, in the employment of this method to avoid unpleasant complications. There is danger of piercing tissues that it is not the intention to injure, and there is likewise danger of destroying more tissue than can be removed by the subsequent absorptive action. Necrosis of a part of the tumor may be the result, and suppuration may ensue if this necrosed area should become infected. There is, of course, much more danger of infection by reason of the puncture and necrosed tissue than is the case in the first method of treatment. Yet, when proper precautions are taken to avoid infecting the wound, and the current used does not exceed 50 milliamperes, for 5 minutes duration, and the puncture is made well into the substance of the abnormal growth without doing injury to surrounding healthy tissue, this method is devoid of danger and causes a rapid diminution in the size of the tumor or hypertrophied tissue.

83. Both methods of cathodal electrolysis have been employed extensively in the treatment of fibroid goiter,

hypertrophy of the prostate, fibroid growths in the mammary gland and fibrous hyperplasia of the lymphatic glands as well as in fibroma of the uterus. The good results of such treatment are found to be proportionate to the thoroughness with which it is carried out. (Plate XVI.)

84. Electric Diffusion of Potassium Iodid.—In the treatment of fibroid hyperplasia by means of cathodal electrolysis, laboratory experience and clinical observation seem to teach that its action can be very greatly supplemented by electric diffusion of potassium iodid. Potassium iodid in some manner favors the disintegration and absorption of redundant connective tissue.

When an electrode, forming the anode of a direct current, is covered with absorbent cotton moistened with a solution of potassium iodid, and this electrode placed in contact with the skin or mucous membrane, and a strength of current such as is customarily employed in electrotherapeutic application is used, the potassium iodid is soon decomposed and the absorbent cotton on the electrode becomes stained by the iodin, which is set free at the anode, and, because of its affinity for the positive pole, is retained there. But if the cathode is the pole used instead of the anode, the potassium iodid, with the same strength of current, is conveyed into the tissues as potassium iodid. In these applications of cathodal electrolysis by the first method mentioned, it is oftentimes feasible to add to the therapeutic effect of the electrolytic action of the direct current the specific local action of potassium iodid by covering the cathode (one made of carbon is preferable) with absorbent cotton soaked in a saturated solution of potassium iodid.

CATHODAL ELECTROLYSIS OF EXOSTOSES, WARTS, MOLES, AND SUPERFLUOUS HAIRS.

85. The above-named defects in tissue growth are samples of some remaining conditions of minor surgical importance that may be most satisfactorily dealt with in many instances by the use of cathodal electrolysis. These defects occur not infrequently in places where any considerable destruction of normal

tissue would result in a scar that would be quite as unsightly as the thing removed. Bony or cartilage overgrowth may occur about the joints, in the vicinity of fractures, in the nasal fossa, and elsewhere.

86. Method of Application.—A retrograde action the reverse of tissue-building can usually be started in these abnormal or redundant deposits by the cathodal action of the direct current. This is best accomplished in tissue of this character by using a needle-like or sharp-pointed electrode, which is made to penetrate the tissue to the desired depth, and through this a current of 20 or 30 milliamperes should be passed for 3 or 5 minutes at a time. The electrode can then be withdrawn and reinserted at another point and several such applications may be made at one sitting. The necessary precautions as to antisepsis should be taken and this treatment repeated at intervals of a few days or a week until the desired result is attained. If for any reason it is thought best to hasten the removal of the growth, several needles attached to the same conducting-cord may be inserted and the current proportionally increased. It is the practice with some operators in using electrolysis for the purpose of removing bony spurs or portions of hypertrophied turbinated bones in the nasal fossa, to concentrate the electric action upon the part treated by using a double-needle electrode, one of which is positive and the other negative, separated by a slight interval so that the current action is confined to the tissue that lies between them.

87. Removal of Warts and Moles.—In the removal of warts and moles by means of cathodal electrolysis, a steel needle can be used. It should be inserted at the base of the growth at the margin of normal tissue in a sufficient number of places to destroy or impair all the cell-structure that gives origin to the abnormal tissue. A liberal formation of hydrogen gas about the needle-point and a blanching of the surface of the growth in the immediate vicinity of the puncture indicates that the electrolytic action has proceeded far enough at that point. This effect should be brought about over the entire surface of the growth. It then requires some days for nature to complete

the work of disintegration and atrophy of the abnormal tissue and to furnish a sufficient amount of normal epithelium to cover the denuded area, and the patient should be cautioned against picking or irritating the spot during this period of repair. A little antiseptic ointment or lotion applied to the spot is an additional precaution against inflammation.

88. Removal of Hair.—For epilation, cathodal electrolysis, though somewhat tedious, is the most effectual method. In destroying hair by cathodal electrolysis, the electrolytic action is brought to bear upon the hair-bulb. A very slender, but blunt-pointed, needle-like electrode is carefully carried into the hair follicle to the bottom of it and a current of 2 or 3 milliamperes turned on until a froth-like formation of gas accumulates at the mouth of the follicle, when it will be found that the matrix of the hair-bulb has disintegrated and the hair can be withdrawn by a gentle pull with the forceps. A hair-bulb operated on in this manner is permanently destroyed.

Hairs that were less noticeable before and that lie contiguous to those removed sometimes seem to be stimulated to growth by this method of epilation, so that it becomes necessary in some cases to go over an area of superfluous hair-growth two or three times before a satisfactory result is attained. But patience and perseverance in this method of treatment will always bring about the desired result.

The X-ray method of epilation gives promise of doing this work in a more wholesale manner and therefore more rapidly. Whether or not it will prove as permanent and satisfactory in its results remains to be proved.

ELECTRICITY AS A STIMULANT TO NUTRITION.

89. Effects of General Galvanism and Faradism. The surgeon has to treat many cases of disease wherein the improvement of his patient is dependent on such means as will tone up the digestive, circulatory, and eliminative functions so that a more healthful state of nutrition may be brought about. When a serious surgical operation must be made upon a patient and there is time for putting the patient into the best possible

condition to undergo it, the judicious surgeon seeks to do this by the best methods available.

It is now well demonstrated that various forms of electric modality act as an aid to acceleration of the various nutritive activities. The effect of general galvanism and of general faradism is to tone up the musculature, both of the voluntary and involuntary variety, and, as a consequence, the nutritive fluids are conveyed about the system with greater activity and the effete matters are more readily and thoroughly eliminated. Electricity in this manner acts as a most efficient adjuvant to hydrotherapy, massage, and dietary measures in bringing about a healthful and reparative condition of the system so essential to a successful recovery after a surgical operation, and especially after one the nature of which is to tax the vital energy severely. The high-tension, high-frequency forms of electric modality, such as those obtained from the static machine or the Tesla apparatus, or the influence exerted upon tissue-metabolism by the agency of alternating magnetic stresses, can be brought to bear upon such cases as show elementary defects in functional activity of the chylopoietic organs. These forms of electric modality are peculiarly adapted to modify and quicken those activities in nutrition that take place within the range of physiological chemistry.

90. Electric Stimulus After Operation.—To put the patient in the best state both for undergoing and recovering from a surgical operation, electric treatment, wisely chosen and applied, can be of much service. The correction of deformities naturally falls to the lot of the orthopedic surgeon. Many of these deformities are due wholly or in part to defective nerve or muscle-action. The object will be, when the mechanical obstruction due to shortened tendons, contracted fascia, or distorted bones has been corrected, to so arouse the nerve-activity and strengthen the muscular action as to restore or create as far as possible normal movement. In seeking to effect this purpose, electricity in the form of induction-coil currents or the direct current of one or other polarity, according to the indications, becomes an indispensable aid.

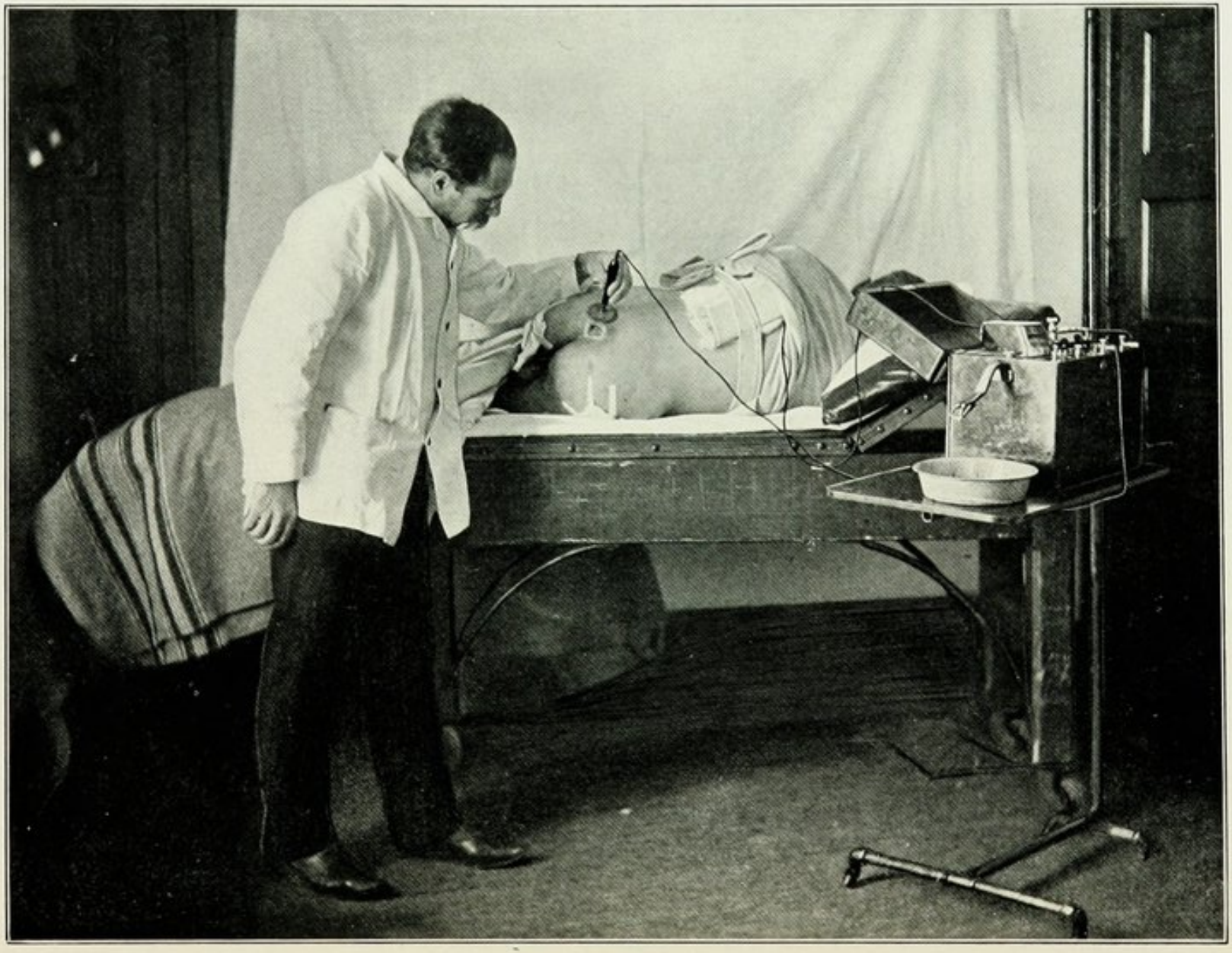


PLATE XVII.

91. Caution in Using Electric Stimulus.—In cases where stimulation is necessary, the electric stimulus must be very accurately and judiciously applied. It must be made to such nerves and muscles as require it to the exclusion of those that do not. It must also be remembered that electric stimulus can be overdone and bring about fatigue in nerve and muscle quite as readily, if not more readily, than overaction caused by volitional effort. Such treatment should not therefore be entrusted to incompetent persons unfamiliar with the anatomical and physiological conditions that are being dealt with, otherwise the electric applications will be productive of more harm than good.

92. These suggestions are offered here for the reason that the correction of deformities is always a slow and tedious process. The surgical operations that such cases require are but preliminary to the necessary prolonged after-treatment. The surgeon may perform the surgical operation successfully and well, but too often the after-treatment, which is quite as essential, if not more so, to the attainment of the best results, is entrusted to a nurse or the patient's relatives, who are in no manner fitted for attending to it intelligently or skilfully. Especially is this true when that treatment involves the use of electric currents. Here the ridiculous attempt is often made by one who but imperfectly understands the nature and capacities of the agent he is employing, to apply it for a definite purpose to a living structure whose mechanism is to him still more of a mystery.

93. Promotion of Healing Processes.—The help that electricity affords the surgeon in promoting the healing processes in certain states of defective local nutrition or feeble capacity for repair is quite remarkable and readily demonstrated. Perhaps in no cases is this action more easily shown than in certain chronic joint diseases and in ulcers such as bed-sores, manifesting feeble reparative activity. (Plate XVII.)

These local areas of sluggish or inadequate reparative activity are in many instances apparently dependent on a want of

vitality in the tissues of the part aside from the cause that has depleted this vitality. The cause may have been primarily an injury or a bacterial infection or an inflammation of other origin, leaving obstruction from organized or unorganized exudates. Whatever the process that has led to the weakened state of the tissues, a want of vital energy in the tissues involved is clearly an important, if not the chief factor, retarding or preventing recovery. To the state of local tissue-weakness, electricity in several of its forms of modality can bring substantial aid. The electric energy is transformed into physiological energy and the reparative process is strengthened.

94. Benefits of Negative Electrode. — If inflammatory exudates or excess of connective tissue growth is the retarding cause aside from the devitalized state of the living cells, the action of the negative electrode of the direct current will not only quicken the protoplasmic combinations necessary to nutrition, but will aid in bringing to the neighborhood of the electrode a more abundant supply of nutritive material (cataphoresis) and assist in the disintegration of the overgrowth of connective tissue-elements (cathodal electrolysis). It is a daily clinical demonstration that bed-sores and chronic ulcers with horny-like margins are soon changed to healthy granulating surfaces and aroused to quick repair by means of the daily applications of the negative electrode of the constant current about their margins with a strength of current of but 1 milliampere to a square centimeter of electrode surface.

95. Electric Repulsion of Bacteria.—In all pathological invasions of bacteria into the animal organism, one essential factor is the want of resisting strength on the part of the tissues to repel the invader. Nature has her own resources for defence, and when the organism is in a healthful and vigorous state in all its parts, disease-germs are promptly destroyed or cast out, and find no foothold or soil for their development.

96. The nidus for the growth of pathogenic bacteria is some defenseless or weakened area, some breach in the wall,

caused by damaged tissue, waste-products that should have been eliminated, or tissue devitalized or enfeebled from some cause. Electric energy applied to this locality, in proper form and with judgment as to the amount, helps to repair the breach both by assisting the normal cellular activity and converting the waste-products into substances that can be absorbed and eliminated. Thus, the invading bacteria, if they have already found a favorable soil in this damaged tissue, are opposed and ultimately destroyed by the electric action. Tubercular joints, and joints that are the seat of chronic inflammation not tubercular, are found to improve when treated by 15- or 20-minute applications daily of induced or direct currents.

97. Stimulating Action of Body Batteries.—Even the local application of body batteries, which in the hands of the charlatan and conscienceless advertisers have been the source of large revenues to the venders and of equally great disappointment to the duped purchasers, is capable, under the direction of the intelligent surgeon, of doing good in the way of stimulating local nutrition. The majority of these body batteries, if they are so constructed as to furnish any current whatever, give a direct current of only a few volts pressure; and acting through the resistance of the skin, which is always considerable, the current is small, in most instances but a fraction of a milliampere. Yet a current of this nature is freighted with great capacity for harm as well as good. In order to utilize the good and avoid the harm, he that employs such an appliance as a therapeutic resource must, in the first place, have a clear conception of the disease to be combatted, which the layman has not; a correct knowledge of the physics of the electric generators, which few to whom they are indiscriminately sold possess; and a therapeutic skill in adapting the physical capacities of the appliance to the pathological state so as to bring about a curative result, which skill few have been able to acquire except the well-trained physician or surgeon.

In these body batteries, polarity action must be remembered and taken account of, and also the strength of current and the time it would be safe to allow them to be used. Their

legitimate use is of course limited, but in chronic joint-inflammation and torpid ulcers, they have been known to be of much service. On the contrary, there have been most deplorable effects from the misuse of such appliances.

ELECTRICITY AS A MOTIVE POWER.

98. Power for Drills, Saws, Burrs, Etc.—The surgeon has need of drills, saws, and burrs for operating upon bone in the many defective states in which he finds it. Electricity is coming more and more into demand as the motive power by which these tools are made most effective. While it is perhaps true that the most essential knowledge demanded of the surgeon is that which will insure a correct use of the tool he is using and not of the motive power that moves it, yet the most efficient surgeon, as a rule, like the most efficient mechanic, is the man that knows the nature of his tools from start to finish; and a clear understanding on the part of the surgeon of the electric modality that furnishes his power will enable him to handle his tools with better judgment and skill. (Plate XVIII.)

99. Power for Fan.—Electric fans, recently a luxury, are already almost a necessity in the hospital and in the physician's office. It is true there is little need of the surgeon becoming an electric engineer in order that he may manage one of these little aids to his own or his patient's comfort. Yet this is but another instance of the manner in which electric energy is becoming a necessity as a handmaid to medicine and surgery, and he that wishes to avail himself of that service in the most effective way must know in other than a haphazard and superficial way the measure of its capacities for service.

100. Taking Account of Causes of Injury.—Both the physician and his patients are being carried about by means of electric conveyances of every sort, trolley cars, storage-battery cars, and electric automobiles. Direct and alternating dynamo currents are in use to propel many of these vehicles, as well as to aid in much of the industrial work of modern times. Accidents in travel or about the streets are frequent. Electric

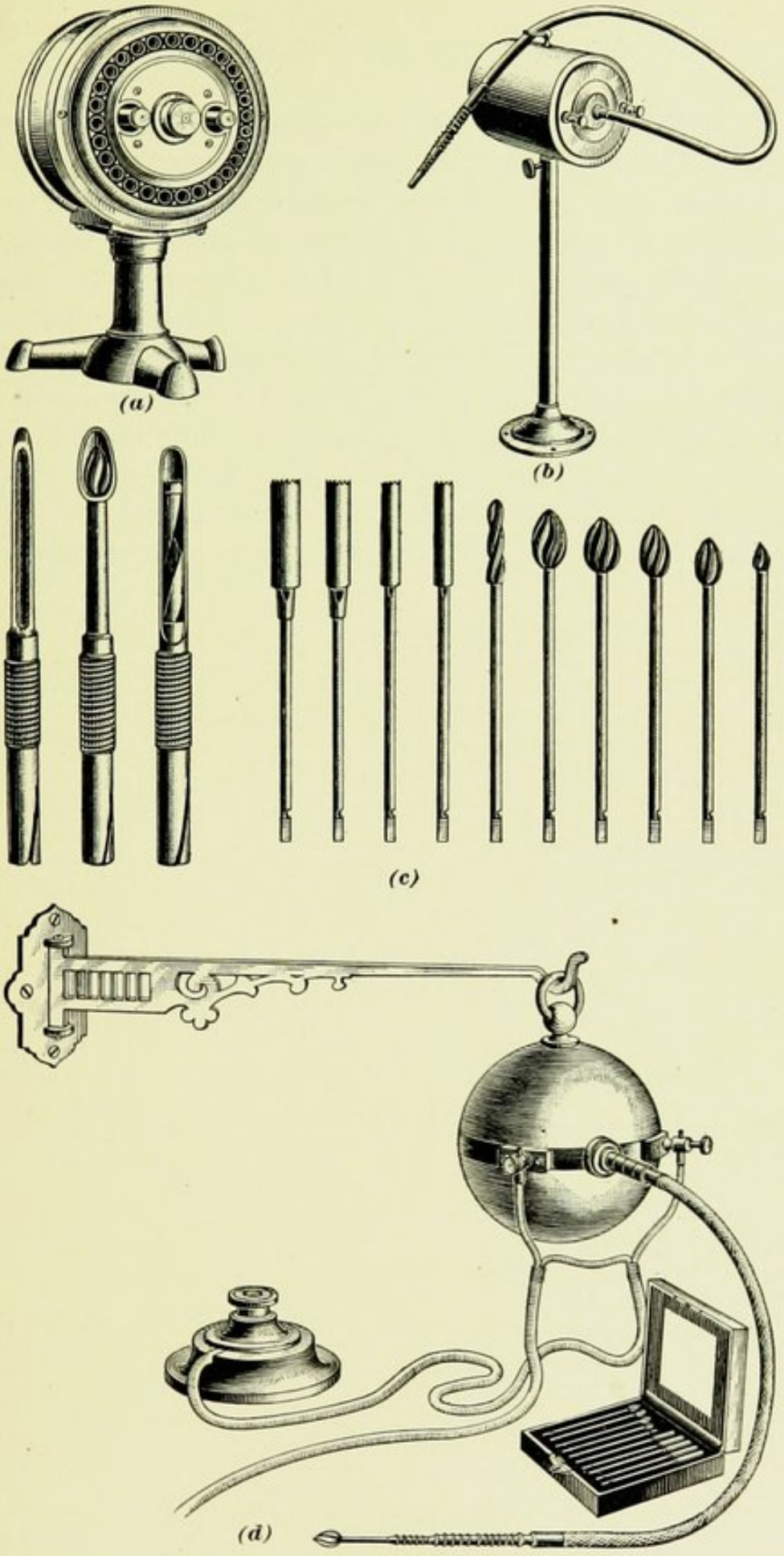


PLATE XVIII.

Electric Motors, Drills, and Burrs for Operating on Bone.

energy is becoming an important factor to deal with in the production of accidents. It is no longer only the scalding by steam or the coals of the furnace of his engine that adds to the severity of the fractures or contusions when an engineer is injured at his post of duty. The part played by the electric energy in causing the injury must now be taken into account. Both in dealing with the body of the injured man in order to promote the healing of his wounds and in the attempt to give an intelligent explanation of the nature of those injuries on the witness-stand, when the accident has a medico-legal chapter, the surgeon has need of the facts of electrophysics and physiology and of the relation they bear to the human organism.

ELECTRICITY IN DISEASES

OF THE

NERVOUS SYSTEM.

Electricity in Diseases of the Nervous System.

(1) Generally speaking, what are the effects on nerve and muscle of (*a*) the lower frequencies and potentials? (*b*) the higher frequencies and potentials?

(2) How does the manner in which the potential increases and decreases influence sensation and motion, irrespective of the degree of potential or the rapidity of alternations?

(3) Describe the effects of high-tension, high-frequency currents on (*a*) motor nerves; (*b*) sensory nerves; (*c*) muscular tissue; (*d*) vasomotor nerves; (*e*) tissue metabolism; (*f*) pathogenic bacteria.

(4) State briefly the electrical application most serviceable in the treatment of spinal irritation.

(5) What electrode of the direct current would you apply to the spine in treating a case of (*a*) spinal anemia? (*b*) spinal hyperemia? (*c*) State reasons.

(6) When is the faradic brush or static spark indicated in the treatment of spinal hyperemia?

(7) Of what service is electrotherapeutics in the treatment of spinal hemorrhage?

(8) Describe the use in the later stages of leptomeningitis of (*a*) the direct current; (*b*) the induction-coil current.

(9) State briefly the electrotherapeutic treatment of (*a*) acute myelitis, (*b*) chronic myelitis.

(10) What can you say of the use of electricity in the treatment of anterior poliomyelitis?

(11) When should electrotherapeutic treatment be instituted in a case of infantile paralysis?

(12) Give a detailed description of the electrotherapeutic treatment of anterior poliomyelitis.

(13) What would be the effect if the normal muscles of a limb received the same electrotherapeutic treatment as the paralyzed muscles in a case of anterior poliomyelitis?

(14) In the electrotherapeutic treatment of primary lateral sclerosis, state (*a*) the current used; (*b*) the active electrode; (*c*) current-strength; (*d*) duration of each treatment and how often repeated.

(15) What treatment does Strumpel advise for locomotor ataxia?

(16) (*a*) State the effects of alternating magnetic fields in the various degenerative disorders of spinal-cord structures. (*b*) How often should the treatment be repeated, and what should be the duration of each séance?

(17) Describe the electrotherapeutic treatment of ataxic p raplegia.

(18) On what does the electrotherapeutic treatment of spinal trauma depend?

(19) Describe (*a*) the electrotherapeutic treatment of neuralgia; (*b*) the use of the direct current; (*c*) induction-coil current; (*d*) static currents; (*e*) alternating magnetic stress.

(20) State (*a*) the maximum strength of the direct current used in the treatment of torticollis, (*b*) how many times treatment may be repeated daily; (*c*) the position of the indifferent electrode; (*d*) the position of the active electrode.

(21) What governs the choice of current in the electrotherapeutic treatment of writers' cramp?

(22) State (*a*) current used in treatment of Raynaud's disease; (*b*) position of negative electrode; (*c*) position of positive electrode; (*d*) maximum current-strength; (*e*) duration of each application; (*f*) number of times repeated.

(23) What can be said in a general way of the electrotherapeutic treatment of neuritis?

(24) Give a description of the electrotherapeutic treatment of simple and multiple neuritis.

(25) Describe the electrolytic treatment of tumors of peripheral nerves.

(26) State (*a*) the electrotherapeutic treatment of nerve trauma; (*b*) the current used; (*c*) the position of electrodes; (*d*) the current-strength; (*e*) how often treatment is repeated; (*f*) duration of each treatment.

(27) After nerve trauma, when function has been somewhat restored, state (*a*) the current used; and (*b*) the method of using.

(28) In making an electrical test of nerve and muscle, what should the aim of the physician be?

(29) Describe the apparatus devised by Doctor Herdman for using direct currents.

(30) In singling out separate nerves or "motor points" for diagnosis or treatment, what electrodes should be used, and why?

(31) What can you say of the physical and physiological actions of induction-coil currents in their range of influence on animal tissues as compared with the direct currents?

(32) In what do the therapeutic capabilities of the physician's induction-coil consist?

(33) In order to arouse better nutritive action in weakened and impoverished muscles, what rate of interruptions is used?

(34) What are the special uses of very rapid interruptions?

(35) What should be the position of a muscle when an electric stimulus is applied to it?

(36) If a muscle or nerve is found to respond to an induction-coil current, is that evidence that the muscle is not yet undergoing degeneration?

(37) Is it advisable to anesthetize children to determine electrically the exact condition of motor nerves and muscles?

(38) Of what service is electrotherapeutics in defective development of the brain?

(39) What can be said of the value of the various electric currents in the treatment of neurasthenia?

(40) Describe the electrotherapeutic treatment of megrim.

(41) What special advantages have alternating magnetic fields in the treatment of chorea?

(42) What electrical applications are most serviceable in the treatment of tetany?

(43) What are the indications for the use of electric currents in the treatment of plumbism?

(44) What is the indication for electrotherapeutic treatment in (*a*) alcoholism? (*b*) morphinism? (*c*) cocainism?

(45) When are electrical applications indicated in cases of cerebral hemorrhage?

(46) In the electrotherapeutic treatment of traumatic neurasthenia, what are the indications for (*a*) static sparks and the faradic brush? (*b*) general applications of anode of direct current?

ELECTRICITY IN SURGERY.

Electricity in Surgery.

EXAMINATION QUESTIONS.

(1) State the means of obtaining Roentgen rays.

(2) What is the weak point in the ordinary Ruhmkorff coil when it is used for generating Roentgen rays?

(3) What type of Crookes tubes is used with the Tesla coil?

(4) Has the Tesla coil or Ruhmkorff coil any other use in electrotherapeutics except for the production of X-rays?

(5) State the uses of the static machine in the surgeon's office other than for the production of X-rays.

(6) Describe the electrotherm.

(7) State the advantage of the storage battery as a means of heating the electrocautery.

(8) What do you consider the most satisfactory source of current for the electrocautery?

(9) State the chief advantages of the electrocautery over all other forms of cautery.

(10) What are the advantages of electrohemostasis?

(11) What do you consider the most serviceable application of the electrocautery at the present time?

(12) Describe Bottini's incisor.

(13) Describe the technique of the Bottini operation.

(14) How does the resistance of the carbon filament of the lamp compare with that of the cautery blade?

(15) What is the advantage of the storage-battery as a source of electric light?

(16) State the directions to be observed in illuminating the stomach.

(17) What are some of the beneficial effects of electric-light therapy?

(18) Describe the Finsen method of treating lupus.

(19) What takes place about the positive electrode when a direct current of sufficient strength is passed through living tissues?

(20) State the changes that take place around the negative electrode when a direct current of sufficient strength is passed through living tissues.

(21) State some pathological conditions that are amenable to (*a*) anodal electrolysis; (*b*) cathodal electrolysis.

(22) What are some of the advantages of using electrolysis for removing abnormal growths?

(23) On what does the success of electrolysis as an aid to surgery depend?

(24) What is the main advantage of the electrolytic method in surgery when employed skilfully?

(25) In electrolyzing an abnormal growth, how would you protect the overlying skin or mucous membrane?

(26) Why was the active electrode made positive in the operation on G. P., of Howell, Michigan?

(27) Describe, in your own words, the operation performed on this patient.

(28) On what does the amount of electrolytic action depend in operating on any morbid growth?

(29) State the advantages of anodal electrolysis in rectal neoplasms.

(30) Describe, in your own words, the operation performed on Miss J. D., for epithelioma of the rectum.

(31) How would you treat moles?

(32) When a mole is vascular, how would you treat it?

(33) Describe the technique of electrolysis for aneurisms.

(34) How many methods of electrolysis are there for treating stricture of the urethra?

(35) What can you say of the rapid method?

(36) Describe the Newman method of treating urethral stricture.

(37) What is the extreme limit of a séance in electrolyzing an urethral stricture?

(38) What precaution should be taken both before and after passing the urethral electrode?

(39) What can you say about the construction of urethral electrodes?

(40) How many methods are there by means of which cathodal electrolysis may be brought to bear on mammary fibroids, or fibrous increase in the thyroid or lymphatic glands?

(41) Describe the technique for removing superfluous hairs.

(42) What can you say about electric stimulus both before and after operations?

(43) What caution should be observed in using electric stimulus?

(44) Describe the effects of electric applications in cases of bed-sores and in chronic joint affections.

(45) Can a body battery be of any service when its use is directed by a capable surgeon?

(46) State some of the surgical uses of electricity as a source of power.

(47) How can a knowledge of electrophysics and electrophysiology be of service to the surgeon from a medico-legal point of view?

(48) Is it necessary that the surgeon possess a practical knowledge of electric currents that he may intelligently treat injuries caused by these currents?

(49) Summarize the uses of electricity in the practice of surgery.

INDEX.

INDEX.

A.	Sec.	Page.
Abnormal growths, Removal of	12	34
" " Treatment of	12	37
Abscess	11	58
Accurate application of electrode	11	208
Aconitin	11	29
" and veratrin as sedatives	11	29
Action of current on tissue	12	34
" " electricity	11	33
" " nitroglycerin	11	23
Active electrode	11	197
" electrodes for electrolysis	11	198
Acute encephalitis	11	163
" transverse myelitis	11	57
Advantages of dynomo current	12	10
" " electrocautery	12	12
" " electrohemostasis	12	16
" " electrolysis in rectal neoplasms	12	41
" " electrolytic method	12	38
After-treatment in Bottini's method	12	21
Alcoholic neuritis	11	100
Alcoholism	11	135
" Electrotherapeutics for	11	136
" Pathology of	11	135
" Symptoms of	11	135
" Treatment of	11	136
Alternating magnetic stress, Magnetic fields and	11	39
Ammonium acetate and pilocarpin	11	27
Anemia, Cerebral	11	140
" " Electrotherapeutics of	11	141
" " Pathology of	11	140
" " Symptoms of	11	141
" " Treatment of	11	141
" Spinal	11	49
" " Symptoms of	11	49
" " Treatment of	11	50
Anencephalus	11	113
Aneurism	11	142
Aneurism, aortic, Electrolysis of	12	49
" Electrolysis of	12	49
" of blood-vessels	12	49
" Pathology of	11	142
" Symptoms of	11	142
" Treatment of	11	142
Angioneurotic edema	11	92
" " Electrotherapeutics for	11	92
" " Pathology of	11	92
" " Symptoms of	11	92
" " Treatment of	11	92
Animal-extract therapy	11	21
Anterior poliomyelitis	11	60
" " Electrotherapeutics for	11	62
" " Pathology of	11	60
" " Symptoms of	11	61
" " Treatment of	11	61
Antiseptics, disinfectants, and antitoxins	11	24
Antitoxins, disinfectants, and antiseptics	11	24
Aortic aneurism, Electrolysis of	12	49
Arresting hemorrhage	12	16
Arsenic neuritis	11	104
" preparations	11	22
Artificial heat, Forms of	12	9
" " Value of	12	8
Ataxia, Locomotor	11	71
Ataxic paraplegia	11	73
" " Pathology of	11	73
" " Symptoms of	11	73
" " Treatment of	11	74
Atrophy and degeneration	11	9
" " "	11	63
" " "	11	107
" " "	11	167
" Progressive muscular	11	63
Atropin	11	30
" and hyoscin as sedatives	11	30

B.	Sec.	Page.
Bacteria, Electric repulsion of	12	66
Bath, Electric-light	12	31
Baths as a curative agent	11	16
Benefits of direct current in fibroid growths	12	57
" " negative electrode	12	66
Beriberi neuritis	11	104
Blood-vessels, Aneurism of	12	49
" " Derangement of	12	34
Body batteries, Stimulating action of	12	67
Bottini's method	12	18
" " Results achieved by	12	21
Brain	11	112
" Diseases of the	11	112
" Injuries to the	11	178
" Tumor of the	11	175
" " " " Pathology of	11	175
" " " " Symptoms of	11	176
" " " " Treatment of	11	177
Break-circuit handle	11	204
Bulbar paralysis, Chronic	11	170
" " " Pathology of	11	170
" " " Symptoms of	11	170
" " " Treatment of	11	171
Burns, X-ray, Prevention of	12	8

C.	Sec.	Page.
Cactus, Use of	11	23
Caisson disease	11	52
" " Pathology of	11	52
" " Symptoms of	11	52
" " Treatment of	11	52
Catalepsy	11	192
" Pathology of	11	192
" Symptoms of	11	192
" Treatment of	11	193
Cathodal electrolysis in fibroid growths	12	59
Cathodal electrolysis in stricture of the urethra	12	51
Cathodal electrolysis, Method of application of	12	62
Cathodal electrolysis of exostoses, warts, moles, superfluous hairs	12	61
Cathodal electrolyses, Results of	12	51
Causes of disorders of circulation	11	7
" " injury, Taking account of	12	68
" " trauma	11	12
Cautery, Form of	12	18
Cautery, Technique of method	12	20
Caution in using electric stimulus	12	65
Cerebral anemia	11	140
" " Electrotherapeutics for	11	141
Cerebral anemia, Pathology of	11	140
" " Symptoms of	11	141
" " Treatment of	11	141
Cerebral hemorrhage	11	147
" " Electrotherapeutics for	11	150
" " Pathology of	11	147
" " Symptoms of	11	148
" " Treatment of	11	149
Cerebrospinal meningitis, Epidemic, Pathology of	11	159
Cerebrospinal meningitis, Epidemic, Symptoms of	11	159
Chloroform	11	29
" and ether as sedatives	11	29
Choice of polarity	12	36
Chorea	11	125
" Hereditary, or Huntingdon's	11	126
" Electrotherapeutics for	11	128
" Pathology of	11	125
" Sydenham's	11	125
" Symptoms of	11	126
" Treatment of	11	128
Chronic encephalitis	11	164
" leptomeningitis	11	157
" myelitis	11	58
" pachymeningitis	11	152
" " Externa	11	152
" " Pathology of	11	152
" " Symptoms of	11	152
" " Treatment of	11	152
" bulbar paralysis	11	170
" " " Pathology of	11	170
" " " Symptoms of	11	170
" " " Treatment of	11	171
" progressive softening	11	168
" progressive softening, Pathology of	11	168
" progressive softening, Symptoms of	11	168
" progressive softening, Treatment of	11	168
" transverse myelitis	11	58
Cicatricial tissue	12	50
Circulation, Disorders of	11	7
" " "	11	49
" " "	11	90
Circulatory disorders	11	139
" system in traumatic neurasthenia	11	180
Classification of inflammations	11	53
" " nervous derangements	11	4
" " sedatives	11	28
" " diseases of spinal cord	11	41

	Sec.	Page.
Climate	11	16
Clothing	11	15
" improper, effects of	11	15
Cocain	11	29
" as a sedative	11	29
Cocainism	11	138
" Pathology of	11	138
" Symptoms of	11	138
" Treatment of	11	138
Conducting-cords and connections	11	194
Conium	11	30
" and gelsemium as sedatives	11	30
Construction of electrode	12	56
" " nervous system	11	41
Cord, spinal, Syphilis of	11	75
Corrosion of electrodes	11	198
Cramp, Writer's	11	87
Curare	11	30
" as a sedative	11	30
Current, Maintenance of	12	24
" Source of	12	26
" Strength of	12	25
" " Modification of	11	206
" Strength, Modification of by means of high resistance	11	206
Currents, High-tension, high-frequency	11	37
Cyclocephalus	11	113
Cystoscope, The	12	30

D.

Defects of development	11	42
" " " in nervous system	11	5
Deformities and malformations	11	80
" " " of brain	11	113
Degeneration and atrophy	11	9
" " "	11	63
" " "	11	107
" " "	11	167
" Reaction of	11	200
" " " Tests	11	201
Derangements of blood-vessels	12	34
Development, Defects of	11	42
" Enumeration of defects of	11	42
Diabetic neuritis	11	103
Diagnosis by induction-coil currents	11	209
" Electricity as an aid in	12	1
" Use of light in	12	22
Diet in nervous diseases	11	14
Difference between positive and negative polarity	11	198
Digestive system in traumatic neurasthenia	11	180
Diphtheria and tetanus, Use of antitoxins in	11	25
Diphtheritic neuritis	11	101
Direct current, Applying the	11	194
" " Defective connections in	11	194
" " Technique of the	11	193
" " The	11	34
" currents, Universal method of using	11	202
Disease, Caisson	11	52
Diseases, nervous, Diet in	11	14
" of the brain	11	112
" " " peripheral nerves	11	80
" " " spinal cord	11	41
" " " " Classification of	11	41
Disinfectants, antiseptics, and antitoxins	11	24
Disorders, Functional	11	13
" "	11	80
" Neutritive	11	5
" "	11	46
" of circulation	11	7
" " "	11	49
" " "	11	90
" " " Causes of	11	7
" " " Classification of	11	90
" " nutrition	11	117
Dispersing electrode	11	196
Disseminated and central myelitis	11	58
Disseminated and central myelitis, Electrotherapeutics for	11	59
Disseminated and central myelitis, Treatment of	11	59
Disseminated neuritis	11	96
" sclerosis	11	168
" " Pathology of	11	168
" " Symptoms of	11	169
" " Treatment of	11	169
Distinction between tonics and nutrients	11	22
Drills, saws, burrs, etc., Power for	12	68
Drugs, Excessive use of	11	19
" for writers' cramp	11	89
Dry cells, Using	12	10
Duration of treatments	11	210
Dynamo current, Advantages of	12	10
Dystrophies, Muscular	11	65

E.

Edema, Angioneurotic	11	92
Effect of frequency and potential	11	37
Effects of general galvanism and faradism	12	63

	Sec.	Page.
Effects of improper clothing	11	15
" " toxic substances on the nerves	11	8
Electric diffusion of potassium iodid in fibroid growths	12	61
" light bath	12	31
" " Internal uses of	12	24
" " in therapeutics	12	30
" " quickens growth	12	30
" repulsion of bacteria	12	66
" stimulus after operation	12	64
" " Caution in using	12	65
Electrical forceps, Direction for using	12	16
Electricity, Action of	11	33
" as a motive power	12	68
" " an aid in diagnosis	12	1
" " a source of heat	12	8
" " " " " light	12	22
" " " " " Roentgen rays	12	2
" " " stimulant to nutrition	12	63
" Modalities of	11	33
" Surgical uses of	12	1
" Uses of	11	3
Electrocautery	12	10
" Advantages of	12	12
Electrode, Accurate application of	11	208
" Active	11	197
" " for electrolysis	11	197
" Construction of	12	56
" Dispersing	11	196
" negative, Benefits of	12	66
" Position of	11	197
" Positive, for electrolysis	11	197
Electrodes	11	195
" Anodal	11	196
" Corrosion of	11	198
" Graduated dimensions for	11	204
" Graduated dimensions for Standard sizes of	11	204
" Pliable	11	199
" Uniformity of connections in	11	195
Electrohemostasis	12	12
" Advantages of	12	16
Electrolysis, Gradual method of	12	54
" in fibroid growths, Cathodal	12	58
" " surgery	12	34
" Metallic	11	200
" of aneurism	12	49
" " aortic aneurism	12	49
" " rectal neoplasms	12	41
Electrolysis, Rapid method of	12	52
" Use of cathodal	12	34
Electrolytic method, Advantages of	12	38
" treatment of fibroid growths	12	57
Electrotherapeutic technique, general	11	193
Electrotherapeutics of Cerebral Anemia	11	141
" " Cerebral hemorrhage	11	150
" " embolism	11	145
" " epilepsy	11	191
" " hyperemia	11	140
" " hysteria	11	188
" " paralysis agitans	11	173
" " traumatic neurasthenia	11	184
" " tumor of the brain	11	177
Electrotherms	12	9
Elements of nervous system	11	2
Eliminants	11	26
" Names of	11	26
Elimination through intestinal tract	11	27
Embolism	11	143
" and thrombosis	11	52
" Electrotherapeutics for	11	145
" Pathology of	11	52
" " "	11	143
" Symptoms of	11	144
" Treatment of	11	52
" " "	11	144
Encephalitis	11	162
" Acute	11	163
" Chronic	11	164
" Inflammations	11	151
" Pathology of	11	162
" Suppurative	11	165
Encephalocele	11	115
Enforced rest	11	18
Enumeration of defects of development	11	42
Epidemic cerebrospinal meningitis	11	159
Epilepsy	11	188
" Electrotherapeutics for	11	191
" Grand mal	11	188
" Jacksonian	11	190
" Pathology of	11	188
" Petit mal	11	190
" Treatment of	11	190
Epithelioma of the rectum	12	43
" Squamous	12	40

	Sec.	Page.
Erythromelalgia	11	94
" Electrotherapeutics for	11	94
" Pathology of	11	94
" Symptoms of	11	94
" Treatment of	11	94
Ether	11	29
" and chloroform as sedatives	11	29
Ethyl chlorid	11	29
" " as sedative	11	29
Examination of rectal and vaginal cavities	12	24
Excessive use of drugs	11	19
Exostoses, warts moles, superfluous hair, Cathodal electrolysis of	12	61
External pachymeningitis	11	53
" "	11	152

F.

Facial spasm	11	84
" " Electrotherapeutics for	11	85
" " Pathology of	11	84
" " Symptoms of	11	84
" " Treatment of	11	84
Fan, Power for	12	68
Faulty metabolism	11	7
" nutrition	11	6
" "	11	46
Fibroid goiter	12	57
" growths	12	57
" " Benefits of direct current in	12	57
" " Cathodal electrolysis in	12	58
" " Electrolytic treatment of	12	57
" " in the mammary gland	12	57
" hyperthrophy of the prostate gland	12	57
" tumor of the uterus	12	57
Finsen method of treating lupus	12	32
Fluoroscope, Position of	12	7
Forceps, Applying the	12	18
" Sterilizing the	12	16
Form of cautery	12	18
Forms of artificial heat	12	9
Frequency and potential, Effect of	11	37
Functional and nutritive disorders	11	81
" disorders	11	13
" "	11	80

G.

Gelsemium	11	30
" and conium as sedatives	11	30
General electrotherapeutics	11	33
" " technique	11	193
General galvanism and faradism, effects of	12	63
" pathology of nervous system	11	4
" sensations in traumatic neurasthenia	11	182
" therapeutics	11	13
Genito-urinary functions in traumatic neurasthenia	11	181
Gold chlorid, Sodium and	11	23
Gradual variation of current	11	200
Graduated dimensions for electrodes	11	204
Grand mal epilepsy	11	188

H.

Headache, Sick	11	122
Healing processes, Promotion of	12	65
Heat as a therapeutic agent	12	8
" Electricity as a source of	12	8
Heating by means of storage-battery	12	10
Hemorrhage, Arresting	12	16
" Cerebral	11	147
" " Electrotherapeutics of	11	150
" " Pathology of	11	147
" " Symptoms of	11	148
" " Treatment of	11	149
" Meningeal	11	146
" " Pathology of	11	146
" " Symptoms of	11	147
" spinal, Symptoms of	11	51
" " Treatment of	11	51
Hemostatic instruments	12	13
Hemostasis in modern surgery	12	12
Hereditary ataxia, Electrotherapeutics for	11	45
" " (Friedreich's Ataxia)	11	45
" " Pathology of	11	45
" " Symptoms of	11	45
" " Treatment of	11	45
" " or Huntingdon's chorea	11	126
High-tension, high-frequency currents	11	37
" high-frequency currents, Nature of	11	37
" high-frequency currents, Physical effects of	11	38
Hydrocephalus interna	11	115
Hydrocephalus interna, Electrotherapeutics for	11	117

	Sec.	Page.
Hydrocephalus interna, Treatment of	11	116
Hydrophobia	11	131
" Electrotherapeutics for	11	133
" Pathology of	11	131
" Symptoms of	11	132
" Treatment of	11	133
Hydrotherapeutics	11	16
Hygiene	11	13
Hyoscin	11	30
" and atropin as sedatives	11	30
Hyperemia	11	139
" Electrotherapeutics for	11	140
" Pathology of	11	139
" Symptoms of	11	139
" Treatment of	11	140
" of nerves	11	93
" " " Electrotherapeutics for	11	94
" " " Symptoms of	11	93
" " " Treatment of	11	93
" spinal	11	50
" " Symptoms of	11	50
" " Treatment of	11	50
Hypertrophy or hyperplasia	11	114
Hypnotics	11	32
Hysteria	11	185
" Electrotherapeutics for	11	188
" Pathology of	11	185
" Symptoms of	11	185
" Treatment of	11	187
Hysteroepilepsy	11	191
" Symptoms of	11	191
" Treatment of	11	192

I.

Improper clothing, Effects of	11	15
Induced current, Nature of the	11	35
" " The	11	35
Induction-coil currents, Diagnosis by	11	209
" " in Roentgen rays	12	3
" " Technique of	11	205
" coils, Modification of current-strength in	11	206
" " Variety of	11	205
Inflammations	11	9
"	11	53
"	11	151
" Classification of	11	53
" Encephalitis	11	151
" Leptomeningitis	11	151
" Pachymeningitis	11	151
Injuries to the brain	11	178
Injury to normal tissue	12	50
Insomnia, Use of drugs for	11	32
Instruments, Hemostatic	12	13
Interna pachymeningitis	11	153
" " Pathology of	11	153
" " Symptoms of	11	153
" " Treatment of	11	154
Internal illumination, Origin of	12	26
" uses of electric light	12	24
Interruptions, Variation of	11	207
Intestinal tract, Elimination through	11	27
Iodin and mercury, Use of	11	26
Irritation, Spinal	11	46

J.

Jacksonian Epilepsy	11	190

L.

Landry's paralysis	11	48
" " Electrotherapeutics for	11	48
" " Pathology of	11	48
" " Symptoms of	11	48
" " Treatment of	11	48
Lateral sclerosis, Primary	11	69
Laymen, Treatment of patients by	11	211
Leprous neuritis	11	97
Leptomeningitis	11	54
" Chronic	11	157
" Electrotherapeutics for	11	56
" inflammations	11	151
" Pathology of	11	54
" " "	11	155
" Symptoms of	11	55
" " "	11	156
" Treatment of	11	56
" " "	11	157
" " "	11	161
" Tubercular	11	157
" " Pathology of	11	157
" " Symptoms of	11	158
Light, Electricity as a source of	12	22
Living tissue, Reaction of	11	36
Lockjaw	11	129
Locomotor ataxia	11	71
Lupus, Finsen method of treating	12	32

M.

Magnetic fields and alternating magnetic stress	11	39
" " Varying the strength of	11	206

	Sec.	Page.
Maintenance of current	12	24
Malarial neuritis	11	102
Malformations	11	42
" and deformities	11	80
" " " of the brain	11	113
" Causes of	11	42
Maxillary bone, superior, myeloma of	12	38
Medication	11	19
Megrim	11	122
" Electrotherapeutics for	11	125
" Pathology of	11	122
" Symptoms of	11	123
" Treatment of	11	124
Meningeal hemorrhage	11	146
" " Pathology of	11	146
" " Symptoms of	11	147
Meningitis, Epidemic cerebrospinal	11	159
" Epidemic cerebrospinal Pathology of	11	159
" Epidemic cerebrospinal Symptoms of	11	159
" Syphilitic	11	158
" " Pathology of	11	158
" " Symptoms of	11	159
Meningocele	11	115
Meningocephalocele	11	115
Mental characteristics of traumatic neurasthenia	11	183
Mercury and iodin, Use of	11	26
Metabolism, Faulty	11	7
Metallic electrolysis	11	200
Microcephalus	11	114
Modalities of electricity	11	33
Modern surgery, Hemostasis in	12	12
Moles	12	46
" Removal of	12	46
" superfluous hairs, exostoses, warts, Cathodal electrolysis of	12	61
" Treatment of	12	47
Morphinism	11	137
" Pathology of	11	137
" Symptoms of	11	137
" Treatment of	11	137
Morvan's disease	11	44
" " Pathology of	11	44
" " Symptoms of	11	44
Motive power, Electricity as a	12	68
Multiple neuritis	11	98
Muscular atrophy, Progressive	11	63
" dystrophies	11	65
" " Electrotherapeutics for	11	68
" " Pathology of	11	65
Muscular dystrophies, Symptoms of	11	67
" " Treatment of	11	67
" exercise	11	17
" " Forms of	11	17
" " Necessity of	11	17
Muscle stimulation	11	208
Myelitis	11	56
" Acute transverse	11	57
" " " Symptoms of	11	57
" Chronic transverse	11	58
Myeloma of the superior maxillary bone	12	38

N.

	Sec.	Page.
Nature of aneurism	11	142
" " catalepsy	11	192
" " cerebral anemia	11	140
" " " hemorrhage	11	147
" " chronic pachymeningitis	11	152
" " embolism	11	143
" " encephalitis	11	162
" " epidemic cerebrospinal meningitis	11	159
" " hyperemia	11	139
" " hysteria	11	185
" " interna pachymeningitis	11	153
" " leptomeningitis	11	155
" " meningeal hemorrhage	11	146
" " syphilitic meningitis	11	158
" " trauma of the spinal cord	11	78
" " thrombosis	11	145
" " tubercular leptomeningitis	11	157
Negative electrode, Benefits of	12	66
Nerve-foods	11	21
Nerves, Hyperemia of	11	93
Nervous derangements, Classification of	11	4
" diseases, Diet in	11	14
" system, Construction of	11	41
" " Defects of development in	11	5
" " Elements of	11	2
" " General pathology of	11	4
" " Nutrition of	11	6
Neuralgia	11	81
" Electrotherapeutics for	11	83
" Pathology of	11	81
" Symptoms of	11	81
" Treatment of	11	82
" Use of sedatives for	11	83
Neurasthenia	11	118
" Electrotherapeutics for	11	121

		Sec.	Page.
Neurasthenia,	Mental symptoms of	11	119
"	Motor symptoms of	11	119
"	Pathology of	11	118
"	Symptoms of	11	118
"	Treatment of	11	120
"	Traumatic	11	179
"	Traumatic, Circulatory system in	11	180
"	Traumatic, Digestive system in	11	180
"	Traumatic, Electrotherapeutics for	11	184
"	Traumatic, General sensations of	11	182
"	Traumatic, Genito-urinary functions in	11	181
"	Traumatic, Mental characteristics of	11	183
"	Traumatic, Motor systems of	11	182
"	Traumatic, Pathology of	11	179
"	Traumatic, Respiratory system in	11	181
"	Traumatic, Sensory conditions in	11	182
"	Traumatic, Symptoms of	11	179
"	Traumatic, Temperature in	11	181
"	Traumatic, Treatment of	11	183
Neuritic trauma		11	109
Neuritic tumors		11	108
Neuritis		11	95
"	Alcoholic	11	100
"	" Symptoms of	11	100
"	Arsenic	11	104
"	Beriberi	11	104
"	" Symptoms of	11	105
"	" Treatment of	11	105
"	" Electrotherapeutics for	11	106
"	Diabetic	11	103
"	Diphtheritic	11	101
"	" Symptoms of	11	101
"	from carbonic oxid	11	103
"	" lead	11	103
"	Leprous	11	97
"	" Symptoms of	11	97
"	Malarial	11	102
"	" Symptoms of	11	102
"	Multiple	11	98
"	" Symptoms of	11	99
"	Pathology of	11	95
Neuritis, Rheumatic		11	98
"	Simple	11	95
"	" Disseminated	11	96
"	" Symptoms of	11	96
"	Typhoid	11	102
"	" Symptoms of	11	102
Neuroses		11	184
Normal tissue, Injury to		12	50
Nutrient remedies		11	20
Nutrients		11	20
Nutrition, Disorders of		11	117
"	Electricity as a stimulant to	12	63
"	Faulty	11	6
"	Faulty	11	46
"	of nervous system	11	6
Nutritive and functional disorders		11	81
"	disorders	11	5
"	"	11	46
Nitroglycerin, Action of		11	23

O.

Operation, Electric stimulus after		12	64
Opium		11	30
Origin of internal illumination		12	26
Other therapeutic uses of electricity		11	40

P.

Paralysis agitans		11	171
"	" Electrotherapeutics for	11	173
"	" Pathology of	11	171
"	" Symptoms of	11	171
"	" Treatment of	11	173
"	Chronic bulbar	11	170
"	" " Pathology of	11	170
"	" " Symptoms of	11	170
"	" " Treatment of	11	171
"	Landry's	11	48
Paraplegia, Ataxic		11	73
"	" Symptoms of	11	73
"	" Treatment of	11	74
Pachymeningitis		11	53
"	Chronic	11	152
"	External	11	53
"	Externa	11	152
"	inflammations	11	151
"	Symptoms of	11	53
"	Treatment of	11	53
"	Interna	11	153
"	" Pathology of	11	153
"	" Symptoms of	11	153
"	" Treatment of	11	154
"	Internal or hypertrophic	11	54

	Sec.	Page.
Pachymeningitis, Internal or hypertrophic, Symptoms of	11	54
" Internal or hypertrophic, Treatment of	11	54
Palsy, shaking	11	171
Pathology of alcoholism	11	135
" " angioneurotic edema	11	92
" " Caisson disease	11	52
" " chorea	11	125
" " chronic bulbar paralysis	11	170
" " cocainism	11	138
" " disseminated sclerosis	11	168
" " epilepsy	11	188
" " erythromelalgia	11	94
" " facial spasm	11	84
" " hydrophobia	11	131
" " leptomeningitis	11	54
" " megrim	11	122
" " morphinism	11	137
neuralgia	11	81
" " neurasthenia	11	118
" " paralysis agitans	11	171
" " plumbism	11	133
" " posterior spinal sclerosis	11	71
" " progressive softening	11	168
" " Raynaud's disease	11	90
" " simple neuritis	11	95
" " syphilis and tuberculosis	11	174
" " tetanus	11	129
" " tetany	11	130
" " torticollis	11	85
" " traumatic neurasthenia	11	179
" " tumor of the brain	11	175
" " writers' cramp	11	87
Penis, Epithelioma of the	12	44
Peripheral nerves, Diseases of the	11	80
Petit mal epilepsy	11	190
Physical effects of high-tension, high-frequency currents	11	38
Pilocarpin, Ammonium acetate and	11	27
Pliable electrodes	11	199
Plumbism	11	133
" Electrotherapeutics for	11	134
" Pathology of	11	133
" Symptoms of	11	134
" Treatment of	11	134
Polarity, Choice of	12	36
" of the current	11	195
" " " " Determination of	11	195
Position of electrode	11	197
Positive and negative polarity, Difference between	11	198
" electrode for electrolysis	11	199
Posterior spinal sclerosis	11	71
" " " Electrotherapeutics for	11	73
" " " Pathology of	11	71
" " " Symptoms of	11	71
" " " Treatment of	11	72
Power for drills, saws, burrs, etc	12	68
" " fan	12	68
Primary lateral sclerosis	11	69
" " " Electrotherapeutics for	11	70
" " " Pathology of	11	69
" " " Symptoms of	11	70
" " " Treatment of	11	70
Progressive muscular atrophy	11	63
" " " Pathology of	11	63
" " " Spastic form of	11	64
" " " Symptoms of	11	64
Promotion of healing processes	12	65
Pseudencephalus	11	113
Psychical influence	11	18
Psychotherapeutics	11	18

R.

Rapid method of electrolysis	12	52
Raynaud's disease	11	90
" " Electrotherapeutics for	11	91
" " Pathology of	11	90
" " Symptoms of	11	90
" " Treatment of	11	91
Reaction of degeneration	11	201
" " Living tissue	11	36
Rectal and vaginal cavities, Examination of	12	24
" neoplasms, Electrolysis of	12	41
Rectum, Epithelioma of the	12	43
Removal of abnormal growths	12	34
" " moles	12	46
Respiratory system in traumatic neurasthenia	11	181
Rest, Enforced	11	18
" Weir Mitchell method of	11	18
Results of cathodal electrolysis	12	51
Rheumatic neuritis	11	98
Roentgen rays, Electricity as a source of	12	2
" " Induction-coil in	12	3

	Sec.	Page.
Roentgen Rays in surgical practice	12	2
" " Static machine in	12	5
" " Tesla coil in	12	4

S.

Sclerosis, Disseminated	11	168
" " Symptoms of	11	169
" " Pathology of	11	168
" " Treatment of	11	169
" Primary lateral	11	69
" Posterior spinal	11	71
Sedatives, Cocain as a	11	29
" Curare as a	11	30
" Ethyl chlorid as a	11	29
	11	28
" Aconitin and veratrin as	11	29
" Atropin and hyoscin as	11	30
" Classification of	11	28
" Conium and gelsemium as	11	30
" Ether and chloroform as	11	29
" for neuralgia	11	83
Sensory, Conditions in traumatic neurasthenia	11	182
" stimulation	11	208
" symptoms of disseminated sclerosis	11	169
Shaking Palsy	11	171
Sick headache	11	122
Silver	11	23
Sodium and gold chlorid	11	23
Softening, Chronic progressive	11	168
" Chronic progressive, Pathology of	11	168
" Chronic progressive, Symptoms of	11	168
" Chronic progressive, Treatment of	11	168
Source of current	12	26
Spasm, Facial	11	84
Spina bifida	11	43
Spinal anemia	11	49
" " Electrotherapeutics for	11	50
" " Pathology of	11	49
" " Symptoms of	11	49
" " Treatment of	11	50
" canal, Tuberculosis in	11	74
" cord, Diseases of	11	41
" " Syphilis of	11	75
" " The	11	49
" " tissues, Tumors of	11	76
" " Trauma of the	11	78
" " Tuberculosis of	11	74
" hemorrhage	11	51
Spinal hemorrhage, Electrotherapeutics for	11	51
" " Pathology of	11	51
" " Symptoms of	11	51
" " Treatment of	11	51
" hyperemia	11	50
" " Electrotherapeutics for	11	50
" " Pathology of	11	50
" " Symptoms of	11	50
" " Treatment of	11	50
" irritation	11	46
" " Electrotherapeutics for	11	47
" " Pathology of	11	46
" " Symptoms of	11	47
" " Treatment of	11	47
" sclerosis, Posterior	11	71
Squamous epithelioma	12	40
Static charge and currents	11	39
" machine in Roentgen rays	12	5
" " Use of	12	6
Sterilizing the forceps	12	16
Stimulating action of body-batteries	12	67
Stimulation, Muscle	11	208
" Sensory	11	208
Stomach, Transillumination of the	12	26
Storage battery, Heating by means of	12	10
Stricture, Cathodal electrolysis for	12	51
" of the urethra	12	51
Strychnin, Use of	11	24
Superfluous hairs, exostoses, warts, moles, Cathodal electrolysis of	12	61
Superior maxillary bone, Myeloma of	12	38
Suppurative encephalitis	11	165
Surgery, Electrolysis in	12	34
Surgical measures	11	19
" uses of electricity	12	1
Sydenham's chorea	11	125
Symptoms of alcoholic neuritis	11	100
" " alcoholism	11	135
" " aneurism	11	142
" " angioneurotic edema	11	92
" " anterior poliomyelitis	11	60
" " ataxic paraplegia	11	73
" " beriberi neuritis	11	105
" " brain deformities and malformations	11	116
" " brain disorders	11	116
" " Caisson disease	11	52
" " catalepsy	11	192
" " cerebral anemia	11	141
" " cerebral hemorrhage	11	148
" " chorea	11	126

	Sec.	Page.
Symptoms of chronic bulbar paralysis	11	170
" " chronic pachymeningitis	11	152
" " cocainism	11	138
" " diphtheritic neuritis	11	101
" " embolism	11	144
" " embolism and thrombosis	11	52
" " epidemic cerebrospinal meningitis	11	159
" " erythromelalgia	11	94
" " facial spasm	11	84
" " hereditary ataxia	11	45
" " hydrophobia	11	132
" " hyperemia	11	139
" " " of nerves	11	93
" " hysteria	11	185
" " hysteroepilepsy	11	191
" " interna pachymeningitis	11	153
" " Landry's paralysis	11	48
" " leprous neuritis	11	97
" " leptomeningitis	11	55
" " leptomeningitis	11	156
" " malarial neuritis	11	102
" " megrim	11	123
" " meningeal hemorrhage	11	147
" " morphinism	11	137
" " muscular dystrophies	11	67
" " multiple neuritis	11	98
" " myelitis	11	57
" " neuralgia	11	81
" " neurasthenia	11	118
" " neuritic trauma	11	110
" " " tumors	11	109
" " pachymeningitis	11	53
" " paralysis agitans	11	171
" " plumbism	11	134
" " posterior spinal sclerosis	11	71
" " primary lateral sclerosis	11	70
" " progressive softening	11	168
" " " muscular atrophy	11	64
" " Raynaud's disease	11	90
" " rheumatic neuritis	11	99
" " simple neuritis	11	96
" " spinal anemia	11	49
" " " hemorrhage	11	51
" " " hyperemia	11	50
" " " irritation	11	47
" " syphilis and tuberculosis	11	174
Symptoms of syphilitic meningitis	11	159
" " tetanus	11	129
" " tetany	11	130
" " thrombosis	11	146
" " torticollis	11	86
" " trauma of the spinal cord	11	78
" " traumatic neurasthenia	11	179
" " tubercular leptomeningitis	11	158
" " tumors of spinal-cord tissues	11	76
" " tumor of the brain	11	176
" " writers' cramp	11	88
Syphilis and tuberculosis	11	10
" " "	11	74
" " "	11	174
" " " Neuritic	11	108
" " " Pathology of	11	174
" " " Symptoms of	11	175
" " " Treatment of	11	175
" of spinal cord	11	75
" Tumors due to	11	11
Syphilitic meningitis	11	158
" " Pathology of	11	158
" " Symptoms of	11	159
Syringomyelia	11	43
" Pathology of	11	43
" Symptoms of	11	44

T.

Taking account of causes of injury	12	68
Technique of the direct current	11	193
" " " induction coil	11	205
Temperature in traumatic neurasthenia	11	181
Tesla coil in Roentgen rays	12	4
Tetanus	11	129
" Electrotherapeutics for	11	129
" Pathology of	11	129
" Symptoms of	11	129
" Treatment of	11	129
Tetany (*Intermittent tetanus*)	11	130
" Electrotherapeutics for	11	131
" Pathology of	11	130
" Symptoms of	11	130
" Treatment of	11	131
Therapeutics, Electric light in	12	30
" General	11	13
Thrombosis	11	145
" and embolism	11	52
" Pathology of	11	145
" Symptoms of	11	52
" " "	11	146

	Sec.	Page.
Thrombosis, Treatment of	11	52
" " "	11	146
Tissue, Action of current on	12	34
" Cicatricial	12	50
Tissues, spinal-cord, Treatment of tumors of	11	77
" " Tumors of	11	75
Tonics	11	22
" and neutrients, Distinction between	11	22
Torticollis	11	85
" Electrotherapeutics for	11	87
" Pathology of	11	85
" Symptoms of	11	86
" Treatment of	11	86
Toxic substances, Effects of, on the nerves	11	8
Transillumination of the stomach	12	26
Trauma, Causes of	11	12
" neuritic	11	109
" " Electrotherapeutics for	11	111
" " Symptoms of	11	110
" " Treatment of	11	111
of the spinal cord	11	78
" " " " " Class I	11	78
" " " " " Class II	11	78
" " " " " Class III	11	79
" " " " Treatment of	11	79
Traumatic neurasthenia	11	179
" neurasthenia, Circulatory system in	11	180
" neurasthenia, Digestive system in	11	180
" neurasthenia, Electrotherapeutics for	11	184
" neurasthenia, General sensations of	11	182
" neurasthenia, Genito-urinary functions	11	181
" neurasthenia, Mental characteristics of	11	183
" neurasthenia, Motor symptoms of	11	182
" neurasthenia, Pathology of	11	179
" neurasthenia, Respiratory system in	11	181
" neurasthenia, Sensory conditions of	11	182
" neurasthenia, Symptoms of	11	179
" neurasthenia, Temperature in	11	181
" neurasthenia, Treatment of	11	183
Treatment, Appropriate, of abnormal growths	12	37
" Duration of	11	210
" of alcoholism	11	136
" " aneurism	11	142
" " angioneurotic edema	11	92
" " anterior poliomyelitis	11	61
" " ataxic paraplegia	11	74
" " beriberi neuritis	11	105
" " caisson disease	11	52
" " catalepsy	11	193
" " central myelitis	11	59
" " cerebral anemia	11	141
" " " hemorrhage	11	149
" " chorea	11	128
" " chronic bulbar paralysis	11	171
" " chronic pachymeningitis	11	152
" " disseminated sclerosis	11	169
" " embolism	11	144
" " " and thrombosis	11	52
" " erythromelalgia	11	94
" " epilepsy	11	190
" " facial spasm	11	84
" " hereditary ataxia	11	45
" " hydrophobia	11	133
" " hyperemia	11	140
" " hyperemia of nerves	11	93
" " hysteria	11	187
" " hysteroepilepsy	11	192
" " interna pachymeningitis	11	154
" " Landry's paralysis	11	48
" " leptomeningitis	11	56
" " "	11	157
" " "	11	161
" " megrim	11	124
" " mole	12	47
" " morphinism	11	137
" " muscular dystrophies	11	67
" " neuralgia	11	82
" " neurasthenia	11	120
" " neuritic trauma	11	111
" " tumors	11	109
" " pachymeningitis	11	53
" " paralysis agitans	11	173
" ' patients by laymen	11	211
" " plumbism	11	134
" " posterior spinal sclerosis	11	72
" " primary lateral sclerosis	11	70

	Sec.	Page.
Treatment of progressive softening	11	168
" " Raynaud's disease	11	91
" " spinal anemia	11	50
" " " hemorrhage	11	51
" " " hyperemia	11	50
" " " irritation	11	47
" " syphilis and tuberculosis	11	175
" " tetanus	11	129
" " tetany	11	131
" " thrombosis	11	146
" " torticollis	11	86
" " trauma of the spinal cord	11	79
" " traumatic neurasthenia	11	183
" " tuberculosis of spinal cord	11	74
" " tumor of the brain	11	177
" " tumors of spinal-cord tissues	11	77
" " writers' cramp	11	88
Tubercular leptomeningitis	11	157
" " Pathology of	11	157
" " Symptoms of	11	158
Tuberculosis and syphilis	11	10
" " "	11	74
" " "	11	108
" " " Neuritic	11	174
" " " Pathology of	11	174
" " " Symptoms of	11	175
" " " Treatment of	11	175
" of spinal canal	11	74
" " spinal canal, Electrotherapeutics for	11	75
" " spinal canal, Treatment of	11	74
" " " cord	11	74
" Tumors due to	11	11
Tumor of the brain	11	175
" " " " Electrotherapeutics for	11	177
" " " " Pathology of	11	175
" " " " Symptoms of	11	176
" " " " Treatment of	11	177
" due to tuberculosis and syphilis	11	11
" neuritic	11	108
" " Electrotherapeutics for	11	109
Tumor neuritic, Symptoms of	11	109
" " Treatment of	11	109
" of spinal-cord tissues	11	75
" " spinal-cord tissues, Electrotherapeutics for	11	77
" " spinal-cord tissues, Pathology of	11	75
" " spinal-cord tissues, Symptoms of	11	76
" " spinal-cord tissues, Treatment of	11	77
Typhoid neuritis	11	102

U.

Urethra, Stricture of the	12	51
Urethroscope and cystoscope	12	28
" The	12	28
Use of antitoxins in diphtheria and tetanus	11	25
" " cactus	11	23
" " cathodal electrolysis	12	34
" " drugs for insomnia	11	32
" " light in diagnosis	12	22
" " mercury and iodin	11	26
" " strychnin	11	24
Uses of electricity	11	3
Using dry cells	12	10
Universal method for using direct current	11	202

V.

Value of artificial heat	12	8
Variation of current, Gradual	11	200
" " " Precautions in	11	200
" " interruptions	11	207
Varying the strength of magnetic fields	11	206
Vegetable tonics	11	23
Veratrin	11	29

W.

Warts, moles, superfluous hairs, exostoses, Cathodal electrolysis of	12	61
Weir Mitchell method of rest	11	18
Writers' cramp	11	87
" " Electrotherapeutics for	11	89
" " Pathology of	11	87
" " Symptoms of	11	88
" " Treatment of	11	88
" " Use of drugs for	11	89

X.

X-Ray Burns, Prevention of	12	

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