Studies in Photo-Therapy

"To-day scarcely any one doubts the energetic therapeutic action of blue electric light."—(Minin.)

CHAPTER XLIV

LOCAL PHOTO-THERAPY

A Rudimentary Explanation. Finsen's Work. Photo-Chemical Therapy. Experimental Data. Technic of Finsen's Lupus Method. Details of Treatment in Full. New Lupus Lamp. Method of Treatment with the Lortet-Genoud Lupus Lamp. The Foveau-Trouvé Lamp. Progress in Photo-Therapy Lamps. Sun Cases.

The scientific and advancing photo-therapy of the twentieth century has begun with two sharply distinctive lines of research and development, one seeking strictly local and photo-chemical actions and the other mixing the chemical with the luminous and red rays and dosing their proportions to meet local and general indications of an entirely different character. Three general terms have arisen to express the three branches of work now done with electric-light apparatus of different kinds; Finsen's therapy, Light treatment, and Radiant Heat Baths. The photo-therapy allied to Finsen's work deals mainly with very small local applications of *cold chemical rays* of light to lupus and similar small lesions which are adapted to its minute contact-device. "Light treatment" is the larger and more general application of the chemical or mixed rays, or even whole-light from certain lamps, for tonic and nutritional purposes as an intensified sun-bath, especially in the treatment of pulmonary tuberculosis, and general skin diseases amenable to "light" action. Radiant Heat employs whole light with special reference to the production of "warm sunshine," and occupies the therapeutic field of super-heated dry air with important advantages which will appear in our course of study.

Photo-therapy is dependent on mechanical variations in the construction of sources of light which will permit the selection of such rays out of the spectrum as will have the needed physiological actions, and as great advances are promising in this way we commend the study of this section with confidence that before this book is old

we shall see practical apparatus conforming to the private practitioner's needs in very general use in the profession.

A Rudimentary Explanation.—Common familiarity with electric-light for illuminating purposes has *un*-prepared the physician to consider it a *therapeutic* agent. If *light* really possesses the properties that are claimed for it how is it that millions of people work for hours daily near arc and incandescent lamps without any of the effects now brought to our attention? Perhaps many readers have made this fact an argument to reject as a surprising and incomprehensible *fad* the whole romance of photo-therapy, but the explanation is very simple.

Lamps for *illuminating* uses are made with but moderate candle-power and with glass globes which let the luminous rays pass more or less freely through them, but which screen off part of the heat radiation and all of the higher chemical rays. Commercial lights therefore are made to yield *luminous* effects for illuminating purposes, with special economy directed to this one end. The practical purpose of the *Therapeutic Light* is radically different. It is to furnish the physician with an artificial sun which can be commanded at will, and focused, filtered, modified, and directed to set up certain physiologic actions upon a definite local area, or to otherwise influence the general system. Between the neutral actions of luminiferous rays from the commercial electric-light, in the general illumination of which a person may pass hours at a time with no more than the imperceptible tonic influence of light *vs.* the dark, and the scientific therapeutics of concentrated rays filtered out of the spectrum for specific chemical or radiant-heat action, and focussed upon a definite area of prepared tissue with a *definitely dosed intensity* of from a single thousand to 60,000 candle-power, there is a difference similar to that between washing the hands in a basin of neutral water and the full resources of modern hydro-therapy. Every physician can understand what this means.

No doubt the developed apparatus must be seen at work to be appreciated, for practitioners glancing through current journal articles often fail to grasp the merits of what does not come before their own eyes for personal examination and test; but the Instruction Plates in this section will lessen the difficulties of recognizing the basis of photo-therapy. Neither one kind of light, nor one form of apparatus, nor one dosage, nor one technic, is the whole of photo-therapy. Far from it. To secure the many grades of effects we need several mechanical devices to alter the latent energy of light into an agent of the materia medica. It must be prescribed to meet

indications. These may call for a local or general dose, a dose at close contact or at distances up to four feet, a dose restricted to either chemical rays or radiant-heat rays, or both in modified combination; or whole-light with all its complex mixture of properties may be needed for the case. From a single sixteen candle-power lamp to a group of fifty; from special Lortet, Bangs, Nernst, or Dowsing and other lamps, and from small arcs up to great craters with carbons an inch and a quarter in diameter and giving the light of 60,000 candles, we have a range of dosage and action that compares in extent with the scope of other physical therapeutics. The material of an incandescent filament can greatly alter the composition of the light-rays proceeding from it, and this fact is utilized in the construction of therapeutic lamps.

Some may ask why the *arc*-light is required for intense local photochemical effects. Has the incandescent light no chemical rays? Yes, but the ordinary incandescent lamp has a very low candle-power and is inclosed also in glass, which is a great barrier to ultra-violet rays and to most of the visible chemical rays. A sixteen candle-power lamp might give a dosage of actinic rays comparable with one-tenth of a milliampere in galvanic dosage and too small for work. A thirty-two candle-power incandescent lamp generates considerable heat. A fifty candle-power lamp gets very hot. A 100 candle-power incandescent lamp is seldom seen. The generation of heat makes a large incandescent lamps impracticable. But for chemical effects on lupus a light of 100 candle-power would be like a drink of a drop of water to a man craving a pint. To get enough chemical rays for active therapeutic effects of certain kinds a total light of 30,000 to 40,000 candle-power has been required, and the only mechanical device that can as yet furnish this without dangerous heat is the arc.

In the crater of a great arc-light the heat is estimated at over 6,000 degrees F., but it does not radiate far out into the air. It can be screened from the patient and cooled, and high intensities are thus possible. For some other needs in phototherapy the incandescent light is more valuable than the arc, but each has its field and meets different indications. The fact that the incandescent light cannot be used without a glass globe while an arc can, is another reason why the *chemical* rays of the latter have been more accessible to the physician.

Beginning then with the understanding that photo-therapy selects and applies the three main energies of composite light under a variety of conditions which are regulated by medical and surgical judgment, and that the results are only secured through the aid of the directing devices of photo-mechanics, we may intelligently take up the study

of details. Beginning in our next paragraph with the pioneer apparatus first in the field and employing fifty to seventy amperes of current, the reader will note as we proceed through this section the gradual simplification of lamps and the rapid lessening of the quantity of current required. It is along these lines of practical development that photo-therapy will find its way into common use.

Finsen's Institute Work.—To American practitioners, who have but little heeded the development of photo-therapy or suspect its growth, the facts of Finsen's work will come like a revelation. Both to instruct the reader and to record its status in an historic year we shall cite from Stelwagon's visit to the Copenhagen Institute about July, 1900:

"The Institute consists of several one-story buildings; laboratory, reception-room, room for treatment of mucous membranes, two for the light treatment itself, and tables and stands for sunlight treatment outdoors. The sun is used in summer and in clear weather. The electric equipment is five large arc-lights of sixty to eighty amperes, each having four condenser-tubes dividing the light to treat four patients at once. About each arc-light are four tables with a patient on each, the face outside the lesion covered from the rays, a nurse with dark glasses pressing the 'compressor' on the spot marked by the physician for treatment—and sets of twenty patients rotating every hour and a quarter through the day. An hour is allowed for the exposure and fifteen minutes for changing the patients, adjusting the rays, etc. Nurses, assistants, and patients agree that the arc-light is better than the sun. It is stronger in action, and, therefore, the immediate reaction is sharper than by the sunlight treatment. (Plates 189, 190, 191, 192, and 193.)

"The number of lupus cases here for treatment seems legion. The tables are occupied *from half-past seven in the morning till nine in the evening*, except the noon rest of two hours allowed attendants. In 1897 there were seven patients. Now, the clientele has grown beyond management, and *more than 100 are on the waiting list!* They come from all parts of the world. Professor Finsen, Drs. Bie, Bangs, Larsen, Balee, Sunding-Smith, and Forcheimer, and all associated with the Institute, are even more enthusiastic to-day than in the first year of the work. Their earnestness must impress every visitor, as it did me, and very positively indicates that it is not novelty that is attracting patients but actual work. The patients themselves seem enthusiastic and come daily with unvarying regularity. The interest of the nation and city has been aroused. The government has contributed 225,000 kronen. The treatment seems successful. Recurrences seem rare and easily managed. In slight cases a few months' treatment will suffice, but in extensive cases more than a year is needed. I saw and conversed with a few patients who had

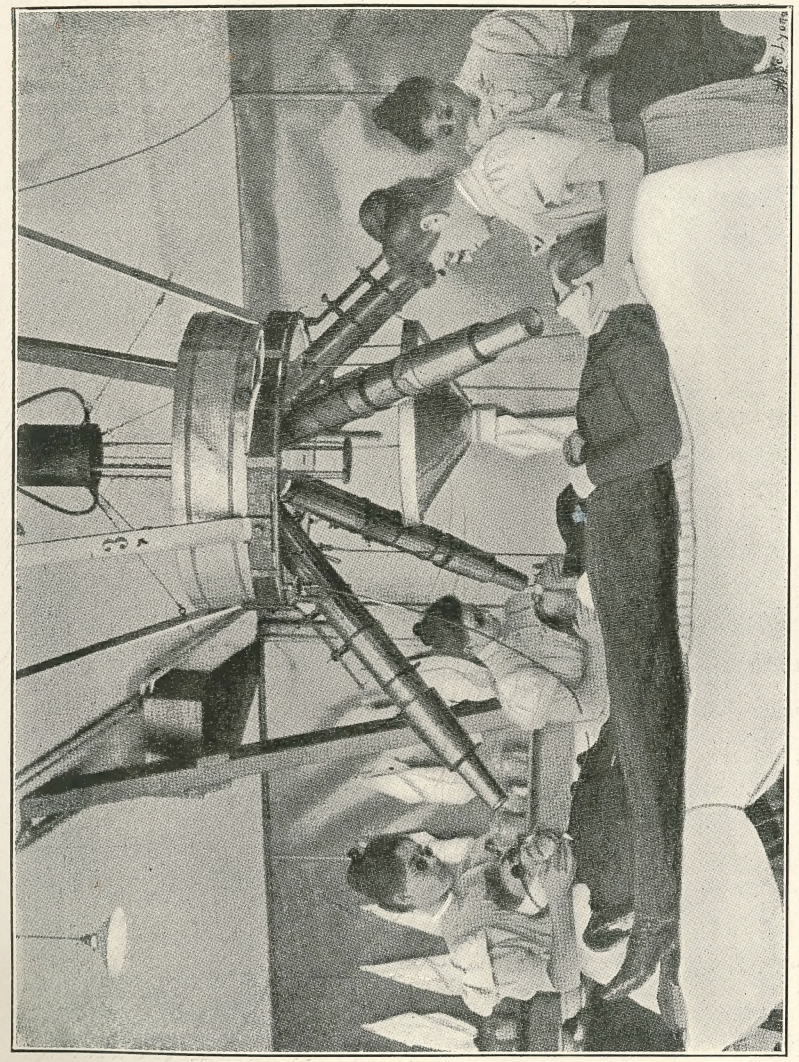


PLATE 189.—Finsen's pioneer arc-light "tube" apparatus treating four patients an hour. Its interest here is chiefly historical. These pictures were sent author by Dr. Finsen.

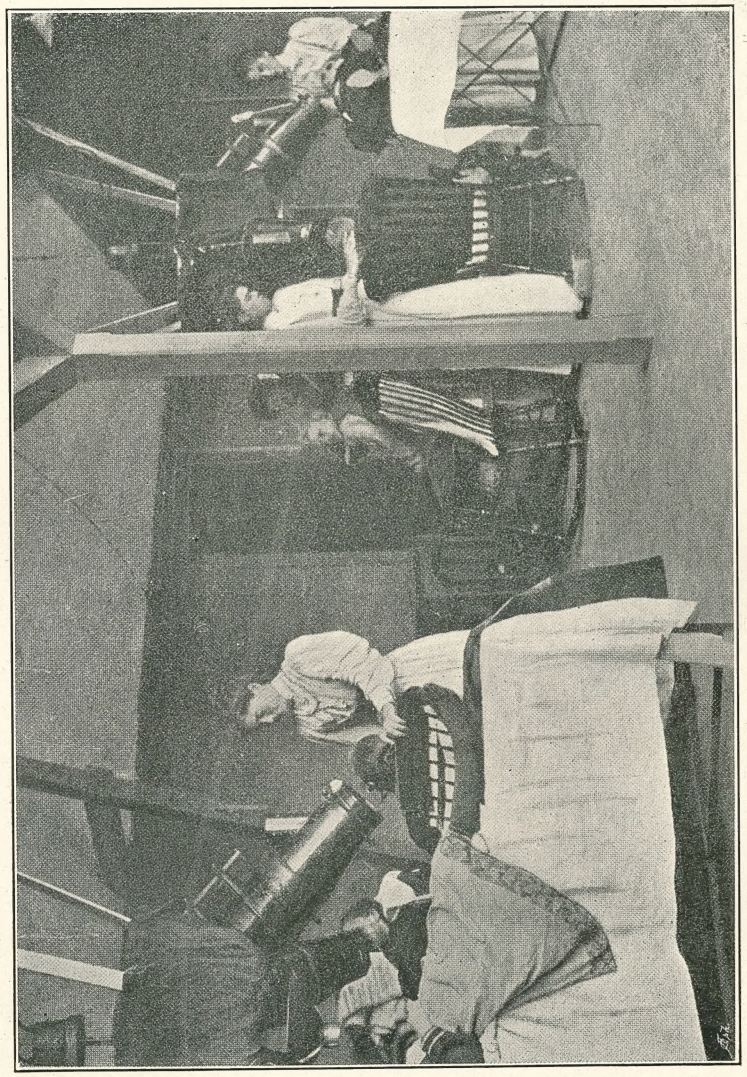


PLATE 190.—Scene in one of Finsen's treatment rooms.

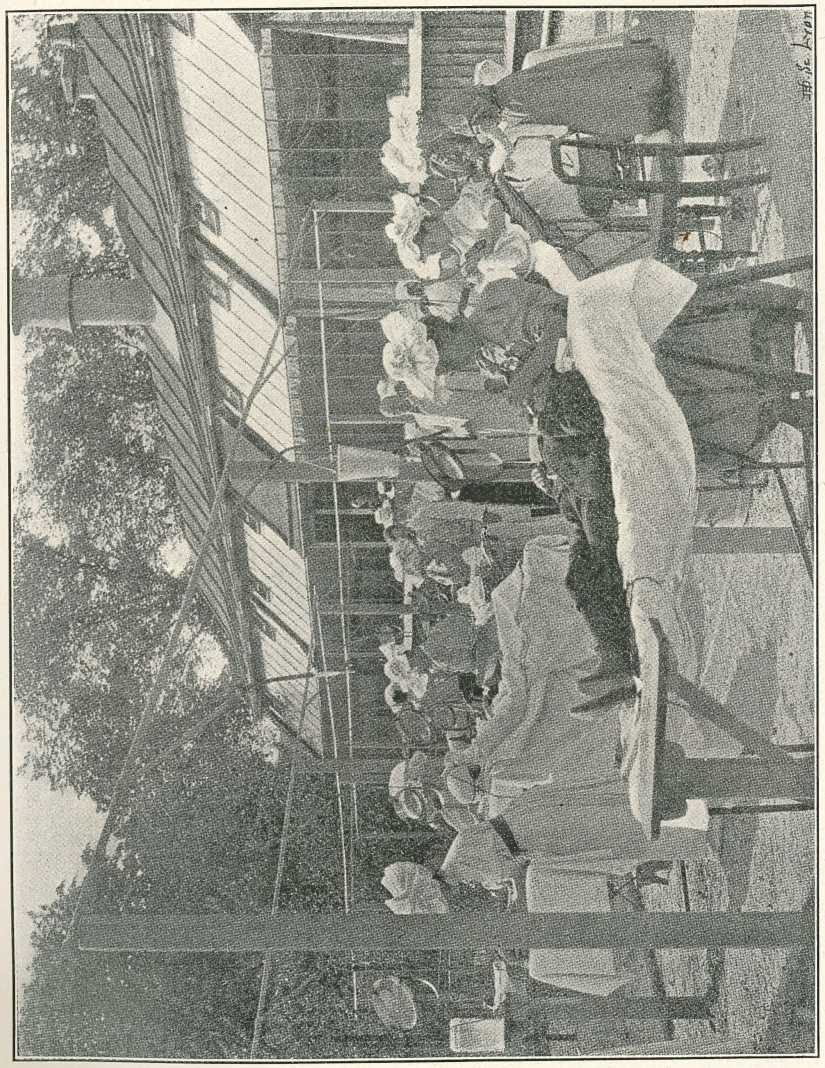


PLATE 191.—Sunlight treatment in Finsen's Institute. A scene out-doors in summer.

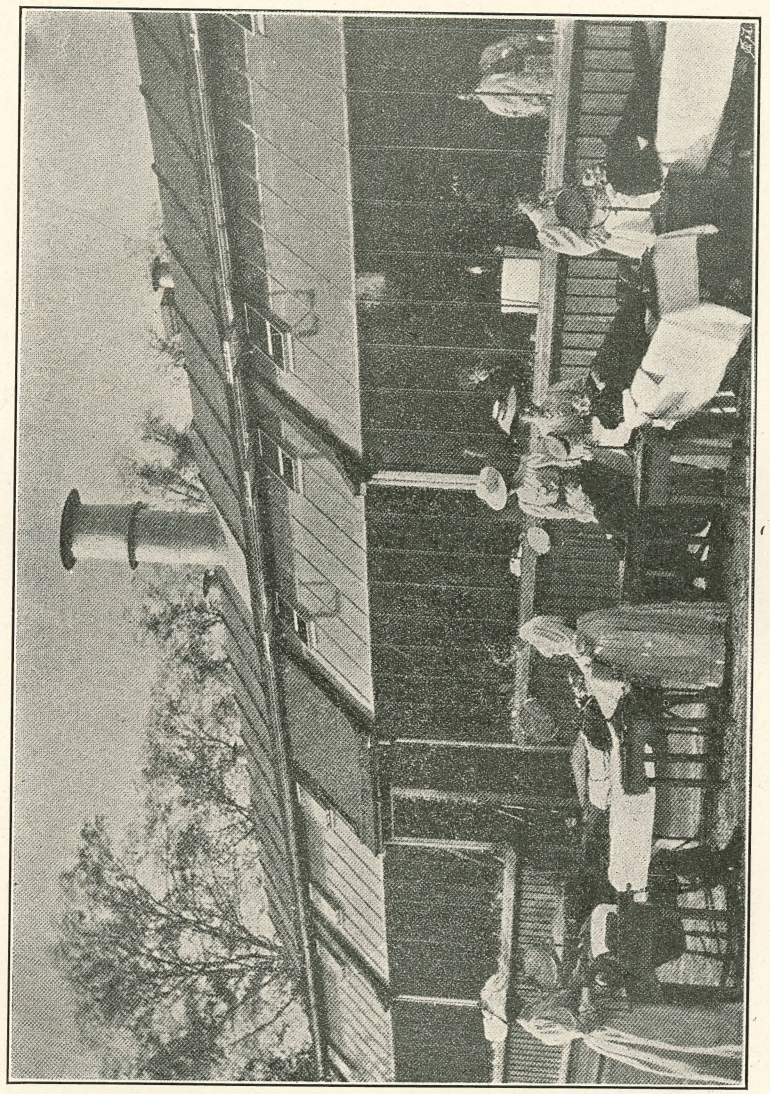


PLATE 192.—Another scene showing sunlight treatment of lupus cases.

had a daily sitting for more than a year, but even these were satisfied with their progress."

A considerable number of physicians from all civilized countries have visited and reported on the work of the Finsen Light Institute at Copenhagen. Dr. Stephen Mackensie in England noted as follows:

"During the four years the treatment has been carried on the apparatus has undergone great development and improvement, with correspondingly increased results. I was greatly impressed with the equipment, organization, and management. The impression I formed of the light treatment of lupus was very favorable. In the cured cases the scars were supple and smooth, without contraction, and less unsightly than by other methods of treatment. Where the lupus nodules were superficial, the results were uniformly good. Where the nodules were deeply situated, they were less satisfactory, owing to the difficulty to the penetration of the light, and the treatment had to extend over a greater length of time. Many of the cases were of extreme severity, chronicity and extent, affording a very unfavorable prospect of success by any treatment. Some would not have been undertaken had they not been sent by medical men. In most of the very severe cases the mucous membranes of the lips, gums, inside of cheeks, tongue, and nostrils were implicated, and in not a few the palate and larynx were affected. It appeared to me that the mucous membranes were distinctly more frequently involved in the Scandinavian cases than in those seen in this country, and quite a large proportion had perforations of the septum nasi. I gathered from the physician in charge of the clinical department that the mucous membranes are affected in about seventy-five per cent. of the cases. The general run of cases seen at Copenhagen was altogether more severe than that with which I am familiar, but it is difficult to be sure that the type of disease is more severe, as the reputation of Finsen's Lysinstitut is so great that all the old and uncured cases find their way there.

"The light treatment up to the present has only been applied to, beside the skin, the lips, gums, hard palate, tongue, septum of the nose, and guardedly to the eyelids. The results of the application of light to lupus of the mucous membranes have been favorable. Other local remedies to these parts are also applied, especially the electric cautery: strong solution of iodine, and lactic acid are used to the gums, and tampons of mercuric chloride to the nostrils. I was much convinced of the great importance of very frequent local measures being employed to the affected mucous membranes.

The application of light excites a degree of inflammation of the tissues treated, varying very much with the susceptibility of the patient. Whether this inflammation is a specific reaction is open to discussion. I think probably not, but that it depends more on the

idiosyncrasy of the individual, as the reaction varies much in cases equally typically Lupus vulgaris, and as Erythema solare is excited by the chemical rays in the healthy skin. In most cases the inflammation is slight and no pain is caused, but in some vesicles and bullæ are produced. The inflammation is much less when sunlight is employed than when the arc-light is used, as it has to be during the greater part of the year. When severe the treatment has to be suspended for a time if the patch is small, or applied to another part if the disease is extensive, so that the inflammation may subside. Erysipelas occurs in some cases under the light treatment, as it does under other methods, and also in lupus not under treatment. This was the case more frequently at a former period, but *since each patient has had applied a boric-acid ointment, and the part protected by a bandage after each application of the light before leaving the Lysinstitut, its occurrence is much less frequent.*

"Patients report themselves periodically after their discharge for inspection, to ascertain if the arrest of the disease is complete. It often happens that lupus nodules that had been overlooked from being deeply situated, or masked by the inflammation excited by the treatment, are detected, and these cases are again treated for a short time. As to recurrences, it is difficult to speak; but I saw cases where there had been no recurrence after one year's and two years' discontinuance of treatment. Of course, reinfection is as possible as primary infection. Like all other methods of treatment, the light treatment is not equally suitable for all cases of lupus. Some would be more rapidly, if not more effectually, treated by surgical measures as perfected by Lang, and which are becoming more generally employed than a few years ago. But the ordeal of an operation, and the risk of an anæsthetic, infinitesimal as it is, have to be weighed against this. I have no experience of the treatment by Roentgen rays, or the hot-air treatment. But as compared with the treatment by erasion, and the application of escharotics, the light treatment yields far better results, in my opinion, and for this reason that it is selective in its action, killing the bacillary exciters of the granulation-tissue, without destroying any tissue, diseased or healthy. It is applicable to all cases, and better than most other methods of treatment for the majority of cases."

A writer in *American Medicine*, November, 1901, remarks that in the London hospital to which a Finsen apparatus was presented by the Queen, *the number of cases awaiting treatment was so great that two years must elapse before they could receive attention.* Lupus is estimated to constitute about only two per cent. of all skin diseases in England, and is even less common in this country.

On December 9, 1901, a paper by Dr. Bangs stated that "over six hundred cases of lupus have been treated in Copenhagen, with positive results in ninety-eight per cent. of the number." Late reports

are not at hand, but for reference and comparison we present a few cases described by Dr. Bie in earlier publications. New lamps now give better results in one quarter of the time with a quarter of the current.

Lupus Vulgaris.—"No. 192 (Fig. 8), thirty years old. Lupus vulgaris faciei et cavitatis nasi. The patient has been suffering from lupus vulgaris fifteen years. Previous treatment: (1) cauterization of the lupus; (2) homœopathic treatment; (3) scraping out and thermo-cauterization during three years. The disease was progressing very slowly just before the beginning of the treatment. The extent of the disease is seen in Fig. 8. The affected places were swollen and red. Everywhere numerous nodules, partly confluent, with crusts and small ulcerations, no large ulcers. A number of disseminated nodules in the healthy skin. There was an extensive but almost quiescent lupus cavitatis nasi.

"June 1, 1898. Treatment by light with a quartz apparatus and a lamp of fifty amperes one hour a day. For the mucous membrane of the nose: Compresses saturated with a solution of perchloride of mercury and touching with a solution of iodine and iodide of potassium (1:2:2) once a week.

"September 30th. Steady improvement. No ulcers at present. The skin of the nose seems to be healthy. Everywhere good scar-tissue; hardly any nodules visible.

"October 29th. No distinct nodules. Treatment discontinued.

"November 15th (Fig. 9). Everywhere the scar-tissue is smooth and but little visible. No distinct nodules.

"January 19, 1899. Letter from the patient's doctor. No relapse.

"No. 84 (Fig. 10), twenty-three years old. Lupus vulgaris faciei, cavitatis nasi et manus dextræ, phthisis bulbi dextri; spina ventosa digiti iii sinistri. The patient has been suffering from lupus for seven years. Previous treatment: (1) ointment; (2) scraping, several times repeated; (3) touching with iodine. There was lupus on both sides of the face and of the right hand. The extent of the disease on the left part of the face was about the same as on the right half of the face, as shown in Fig. 10. The dorsum of the right hand was affected to the half of its extent, and still a part of the right fourth finger and the fifth one. The lupus consists of ulcers, covered with crusts, and of disseminated non-ulcerated nodules. The right ala nasi was almost quite destroyed.

"October 18, 1897. Light-treatment of the face, alternating every two days with lamps of thirty-five amperes and glass apparatus during two hours, and lamps of fifty amperes and quartz apparatus during one hour.

"February 19, 1898. Hardly any improvement.

"March 8th. A slight improvement only.

"April 13th. Good improvement. The apex nasi is not ulcer-

ated. The ulcers of the cheeks are less numerous, small, and superficial.

"May 17th. The affection of the face is constantly improving, no ulcers, a few disseminated nodules.

"June 15th. Light-treatment one hour every day with a lamp of fifty amperes and a quartz apparatus.

"August 18th. The affection of the face apparently cured. No distinct nodules.

"October 25th. A fine scar-tissue everywhere in the face. Still a few doubtful patches. Treatment discontinued.

"November 11th. The scars on the face are sound, only two small solitary nodules on both cheeks. Light-treatment a few times.

"May 24, 1899 (Fig. 11). Everywhere a smooth and pale scar-tissue; the small scars are but very little marked. On the right cheek three small, fresh, and doubtful nodules; otherwise no nodules.

"The right hand is treated by light (a lamp of fifty amperes and a quartz apparatus) from October 25, 1898, till January 16, 1899; in addition a pyrogallic-acid ointment is applied five times, three days.

"May 24, 1899. The hands were covered with a smooth scar-tissues still a little red, but without any nodules.

"No. 143 (Fig. 12), aged twenty-two. Lupus vulgaris faciei et laryngis. The patient has been suffering from lupus about six years. Previous treatment: (1) ointments; (2) cauterization; (3) excision with transplantation three times; (4) scraping. The disease had been spreading quickly shortly before the treatment. The affected part was much infiltrated, of a deep livid color. There were many irregular partly confluent ulcers, flat, with prominent granulations. The skin between the patches was thin, smooth, and shining. On the nose only a few nodules; they were somewhat more numerous on the margin, on the cheeks and the lips. The greater part of the cartilaginous structure of the nose was destroyed. The upper lip was much infiltrated, the prolabium somewhat crusty, but it semed to be free from lupus. The gums at the incisor teeth were swollen.

"February 19, 1898. Light-treatment, alternating every two days with a lamp of fifty amperes and a quartz apparatus during one hour, and a lamp of thirty-five amperes and a glass apparatus during two hours. Tampons with a solution of perchloride of mercury in the nose.

"April 6th. Considerable improvement, less redness and infiltration, only a few ulcers. The upper lip not swollen any longer.

"May 25th. Steady improvement, hardly any ulcers; the swelling and redness are disappearing; only a few nodules.

"June 15th. Light-treatment every day during one hour by a lamp of fifty amperes and a quartz apparatus.

"August 18th. No ulcers; only on the alæ nasi a few brownish patches; no distinct nodules. Treatment discontinued.

"Next time the patient was examined, on November 15, 1898, the skin was smooth everywhere, the scar-tissue fine. There was only

one nodule on the right side of the nose and one on the right cheek; these were treated a few times. Since treatment was left off in August an ulcer has developed on the right side of the prolabium of the upper lip; it is seen on Fig. 13; the photograph was taken on November 15, 1898. The whole right part of the upper lip was swollen. This ulceration was very obstinate; it was treated during a certain time by light in December, 1898; and since then by galvano-cauterization twice; it was also scraped once. It has now diminished to about the size of a pea.

"February 2, 1899. A little brown nodule was observed on the left ala nasi; it disappeared by galvano-cauterization.

"May 3d. The scar-tissue of the skin is fine; there are no nodules.

"No. 177 (Fig. 14), aged sixty-five. Lupus vulgaris faciei et cavitatis nasi. The patient had been suffering from lupus for ten years. Previous treatment: scraping three times during the first year of the disease; later at irregular intervals. There was a very considerable infiltration and hypertrophied granulations. Everywhere irregular, nodular ulcers were visible, forming large, confluent surfaces, between which nodules of the size of a pea. In the neighborhood numerous nodules and small ulcers.

"April 18, 1898. Light-treatment, alternating every two days with a quartz apparatus, and a lamp of fifty amperes during one hour, and with a glass apparatus and a lamp of thirty-five amperes during two hours.

"From June 15th. Light-treatment with a quartz apparatus and a lamp of fifty amperes every day during one hour. The treatment was continued till October 17th. In addition pyrogallic acid ointment was used in some of the periods, when the affected parts were not treated by light, altogether six times on the right cheek, four times on the left, and once on the nose. The treatment by ointment lasted every time about three to four days.

"October 17th. Treatment discontinued. There was everywhere a smooth, soft scar-tissue; no distinct nodules.

"December 3d. Letter from the patient's doctor: 'On the margin of the left ala nasi a tiny ulceration, covered with crusts, with doubtful nodules. The remaining part of the affected area, the nose as well as the cheeks, is covered with a smooth scar-tissue.'

"January 13, 1899 (Fig. 15). Note made in the clinic of the Institute. There is a smooth, rather bright scar-tissue everywhere; the left cheek is the best, with only a few nodules; on the right cheek also but a few nodules; but, besides, some suspicious spots of pigmentation. On the root of the nose a couple of superficial small nodules; the soft part of the nose is a little swollen and red; there are some deep spots of pigmentation; on the margin of the left nostril a few small ulcerations. In the interior of the nose lupus still exists. Light-treatment with a quartz apparatus, and a lamp of seventy amperes one hour every day.

"February 11th. Treatment discontinued.

"March 10th. Letter from the patient's doctor: 'Quite well at present; no sign of relapse.'

"The principal advantages of the method are, besides its reliability, its excellent cosmetic results, the infrequency of relapses and their slight extent, and the fact that the treatment is painless. The good cosmetic result is due to the fact that there is no destruction of tissue, healthy or diseased. It is for the same reason that the results in respect to relapse are so favorable. One may, without harm, treat both the diseased tissue and the apparently healthy surrounding skin until one is fairly sure of having destroyed all the disease germs. When the patient has been treated till there are no distinct nodules of lupus to be seen at the moment, the treatment is discontinued, till the swelling and redness of the skin have disappeared, so that it is easier to determine whether anything is left of the disease or not. If there is nothing visible, the patient is still kept under observation. Many have, however, to be submitted to a second course of treatment. Whether the nodules which develop are the result of recurrence, or whether they could not earlier be recognized as lupus nodules, is a matter of little consequence in itself. The principal thing is that there have always till now been a few scattered nodules, which disappear after a short further course of treatment.

"If the treatment is carried on for some time after the last nodule of lupus seems to have disappeared, recurrence would be more surely guarded against. The fact that the treatment is discontinued as soon as we think it justifiable to do so is due solely to the desire to save the time and the money of the patients as far as possible. Inasmuch as the efficacy of the treatment is absolutely certain, and the patients, on account of its painlessness, are very willing to submit themselves to a second course, a recurrence is not nearly so serious a matter as it is after the older methods of treatment.

Lupus Erythematosus.—"The treatment of this disease has in many cases given excellent results—permanent recovery and firm scars. Nevertheless, the effect of the treatment is not nearly so sure as it is in the case of lupus vulgaris. A few cases have improved very slowly and with a constant tendency to recurrence. What the cause of this great individual difference may be it is still impossible to determine, if for no other reason because we have not a sufficiently large material (altogether only twenty-eight patients).

Alopecia Areata.—"As the indication for the treatment by concentrated chemical rays of light is that the disease must be superficial, local, and bacterial, and as it is at least possible that alopecia areata is due to an infection, we have tried to treat this disease. In January, 1899, when the first experiments were published in Danish, seven cases altogether had been cured. The following are the notes of one of the cases:

"No. 65, aged fifteen. In the beginning of June, 1897, the patient noticed a bald spot about one centimetre in diameter, which

was steadily increasing. When the treatment began on September 3, 1897, there was a large completely bald spot of six by four centimetres. After shaving the areas immediately surrounding, the patient was treated eight times for about half an hour from September 3d till September 24th.

"October 4th. Lanugo hair on the patch.

"November 5th. A normal growth of hair.

"January 12, 1898. A bald spot of two and one-half by two centimetres is seen.

"Treatment five times one hour from January 12th to 16th.

"January 22d. Fine small hairs.

"March 29th. The growth of hair is as vigorous as on the rest of the scalp.

"October 22d. Unchanged."

In October, 1900, another visiting physician from this country wrote that at the Finsen Institute he had seen a case of "a large fungating cancer of the neck at least five inches in diameter, first removed by the knife and the base then treated with photo-therapy." The patient obtained a "healthy" cicatricial tissue, and examination indicated that a "cure" had been accomplished in this case.

It is the opinion of Morris and Dore, in England, after extensive experience with the Finsen light treatment of lupus and rodent ulcer "that this treatment may fairly claim to rank as second to none in importance and utility," and the same authors are "confident in hoping that light used in this way will not only give better results in lupus and other intractable diseases of the skin, but more permanent benefit than any form of treatment hitherto employed." These views were expressed a year ago before newer lupus lamps had demonstrated very much quicker results than the early lamps of Finsen. Of the new lamp, using only about one-fifth the current of Finsen's large arc-light a skilled dermatologist in Europe, with experience in both X-ray and Finsen treatment of lupus and rodent ulcers, writes me under date of October 28, 1901: "The introduction of the new lamp will certainly take the place of the X-rays in the treatment of all cases of lupus where it is possible to apply pressure; but for cancerous affections of the skin the X-rays are superior, as my results have proved." This verdict must also apply to lupus, etc., affecting mucous membranes, and areas which size or situation puts beyond the Finsen method.

Finsen's Photo-chemical Therapy.—Finsen's modern Photo-therapy exactly reverses his practice of 1895, which used light *deprived* of its chemical rays in the treatment of exanthemata; rejecting the actinic rays because of "their power to cause inflammation of the

skin." This once rejected property is now used as the more important curative agent in composite light, both of the sun and electricity; and with means of rational dosage a great therapeusis is developing effective methods. Unless otherwise stated we will consider that the term "Finsen's therapy" in this section signifies only the treatment of local superficial parasitic skin diseases by focussed and filtered luminous-and-chemical rays, and not luminous-and-heat rays, which constitute an entirely different therapy for us to discuss in turn. The terms actinic, chemical, blue, violet, and ultra-violet, as applied to rays of light refer practically to the same thing—to the same general group of rays—in the medical literature of this subject. Exact science differentiates closer, but the physician need not. Finsen's Therapy and the developments from his pioneer work rest on three *proven facts:*

1. Chemical rays of light will destroy bacteria.

2. It is the chemical rays that produce sunburn, and they will cause inflammation.

3. The chemical rays will penetrate the skin, even photographing a landscape through the entire body.

From these general facts to the concrete application of them in the cure of disease is a matter of *dosage*. The deodorizing and antiseptic properties of light, and wholesomeness of its action on sick people was not questioned; but there were two matters for clinical study, and they have been studied by great investigators:

1. Did the germicidal power of light reside in whole white light or in *a special part* of the spectrum?

2. Could the antiseptic action of light, ordinarily slow, be made to destroy bacteria *quickly?*

The first question has been decided by the elimination of green, yellow, and red rays, and what are now known as the chemical rays are accepted as the main therapeutic agency in this treatment. The second question opened many difficulties which have been partly solved by electricity, lenses, and mechanical devices, but the future of photo-therapy in private practice will rest on the further development of facile, simple, and effective apparatus, of which the recent nascent stage of construction was the promise rather than the substance. Light-rays are certainly *therapeutic*, but the use of them will appeal to average therapeutists only when they present a ready, simple, inexpensive, and effective means of securing results that are beyond methods already installed in common use. The value of results so far demonstrated has been somewhat impaired in the estimation of the general profession because of the difficulty of the treat-

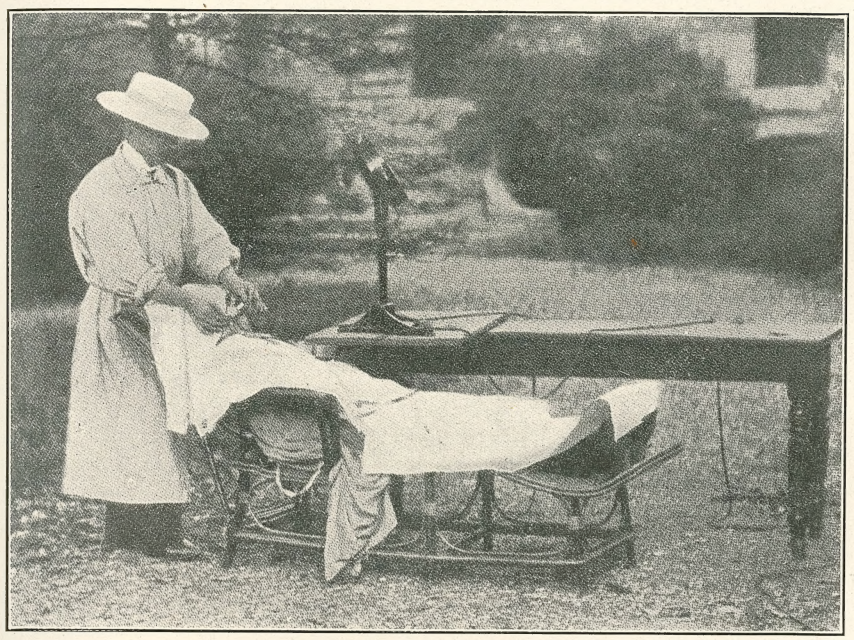


PLATE 193.—This plate shows the sun-lens on the table, and the attendant holding the "compressor" on the lesion. A scene in Finsen's Institute. It is more than probable that, cheap as sunlight is, when it can be had, yet new strides in vacuum-tube light at low cost will displace all other mechanism in photo-therapy. Such a picture as this will become historical and reminiscent.

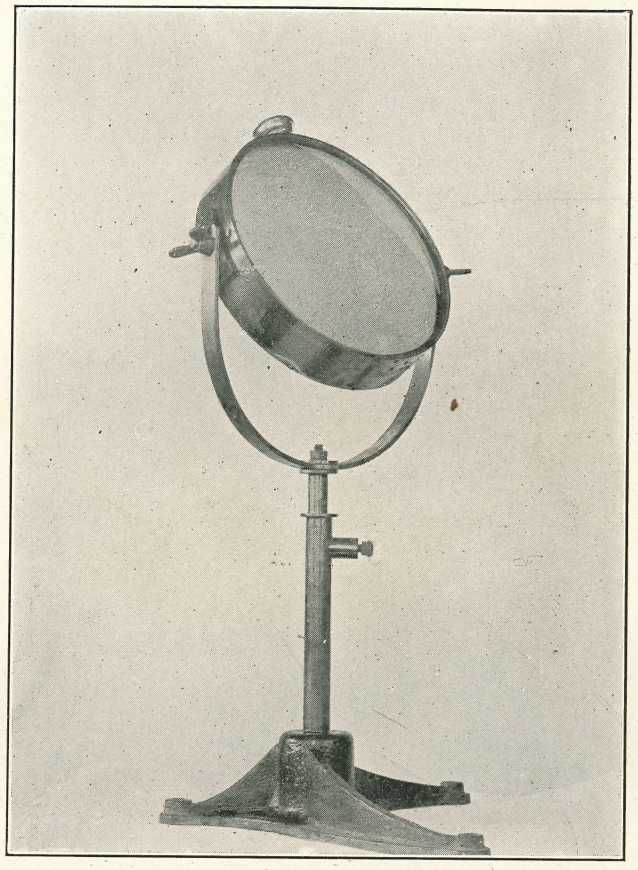


PLATE 194.—Finsen's Lens for Sun's Rays. It is only when light is concentrated in such a way that it contains as many blue, violet, and ultra-violet rays as possible that its bactericidal property becomes so powerful that it can be used therapeutically with advantage. To avoid burning the skin it is also necessary to cool the light, and this filtering lens serves the double purpose. It consists of a lens of about twenty to forty centimetres in diameter. The lens is composed of a plain glass and a curved one, which are framed in a brass ring, and between them there is a bright blue, weak, ammoniacal solution of copper sulphate. As one surface of the liquid is plain, the other one being curved, its optical function is that of an ordinary plain convex glass lens. By making the lens of a blue liquid instead of solid glass a considerable cooling of the light will be obtained, because water absorbs the ultra-red rays, and because the blue color excludes a considerable amount of the red and yellow rays. These three kinds of rays have particularly strong heating effect, while their bactericidal power is insignificant. On the other hand, the blue, violet, and ultra-violet rays, which it is important to procure in as great a number as possible, are but very slightly impaired by passing through the blue liquid. The lens hangs on a foot, made in such a way that the lens can be raised and lowered as well as turned on a vertical and horizontal axis; therefore it is easy to place the lens perpendicularly on the sun rays, and at such a distance as to make the light strike the area of the skin which it is intended to treat. All the pictures in this series were sent to the author by Dr. Finsen personally, and their reproduction authorized.

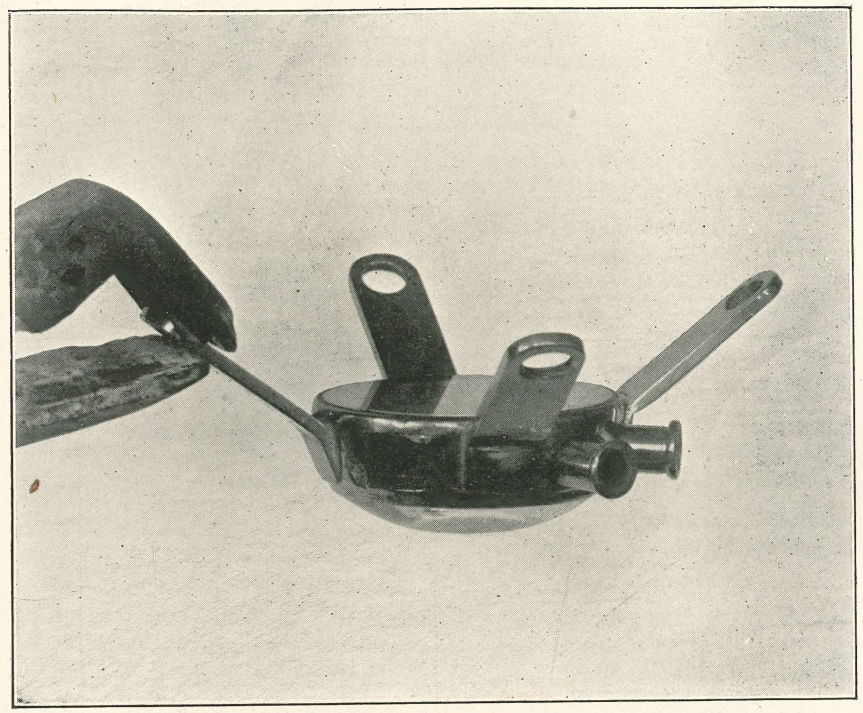


PLATE 195.—Finsen's Compressor of Rock Crystal. Rays from either the large electric arc or the sun, even after passing through the filtering lens, are still too warm for use on the skin. Blood in the surface vessels also hinders penetration of the rays, hence this device is employed to cool and compress the tissues. It consists of an upper plate of quartz and a lower plain convex lens of quartz, both framed in a conical brass rim which carries two tube-holes for the circulation of running cold water between the upper and lower quartz, and four short arms for elastic bands by means of which the compressor is held in close contact on the part. Rubber tubing is attached from a water bag or faucet to the compressor, and during treatment the flow is kept continuous to cool the skin so that it can stand the strongest light. By pressure of the convex quartz on the skin the surface vessels are made anæmic, and this promotes the penetration of the chemical rays, as taught. In this manner an area of skin of about one and one-half centimetre in diameter is treated for an hour every day except Sunday. Large lenses of crystal are desired, but the cost is prohibitory. Newer lamps giving "cold" light will remove this feature.

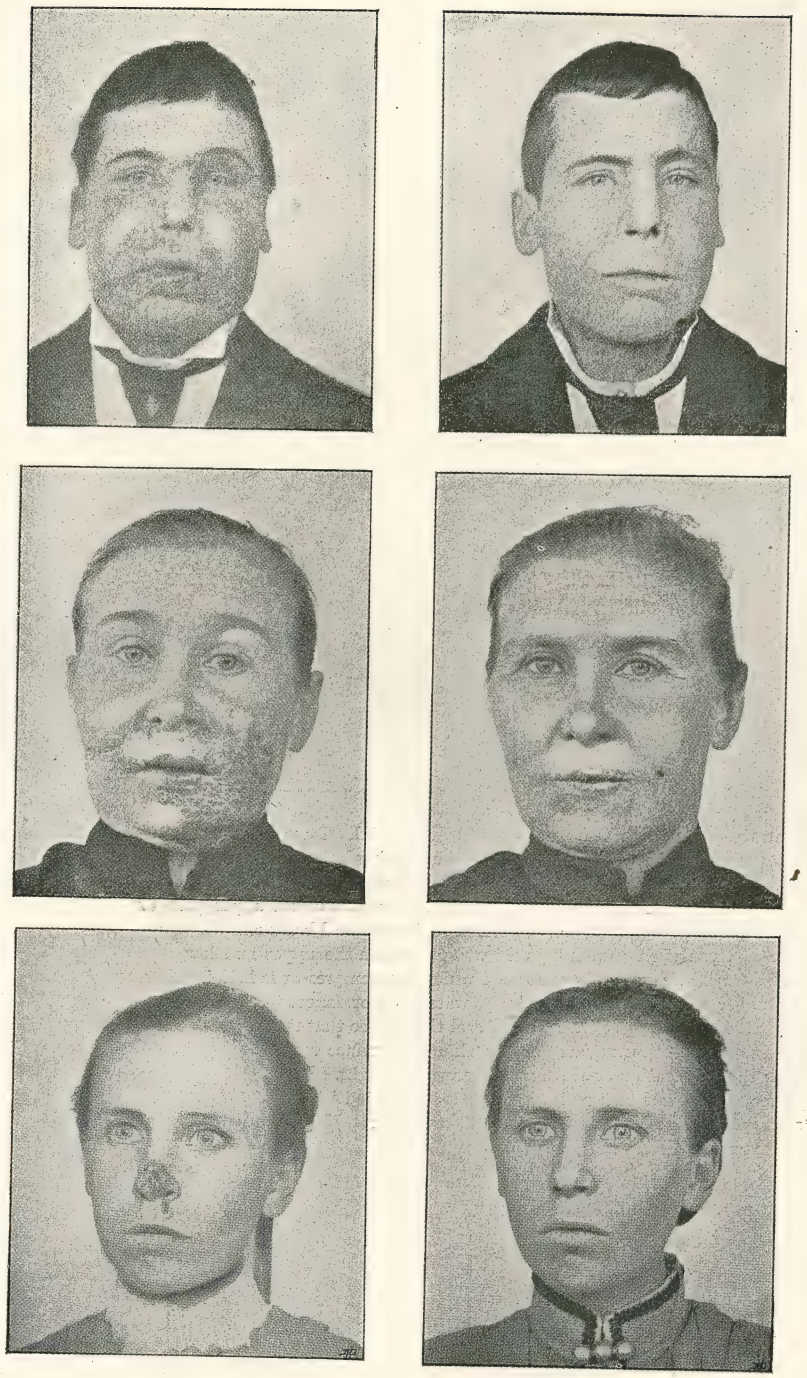


PLATE 196.—Examples of Finsen's cases before and after treatment.

ment, the time required, and the first cost (and cost of operating), the apparatus in regions where sunlight must give way to electricity. But if the prospect of overcoming these primary drawbacks is good the subject will interest us all and photo-therapy will find uses in nearly every office. Were it not apparently certain that this event will come about, this section would not now be written, but so much has been done and so much is undergoing a promising evolution in the essential mechanism of dosage that we may well study here the basic principles in brief, and when the apparatus comes we shall be ready to use it. Some of it is here now in quite a satisfactory state, and each year is a year of advance in electricity.

The basic principles relate similarly to the use of the sun's rays and electric-light rays, and, if the sun shone always in every office we would need no other source of light. But in electric-lights there is an immense difference in the proportion of chemical rays per candle-power, or in the totality of the lamp, and on this account the given lamp must be made for the purpose of its therapeutics.

1. The light must be rich in chemical rays and concentrated to have therapeutic energy.

2. It must be cooled to avoid burning.

3. The cooled and concentrated rays must be brought close to the part and focussed on the lesion, and to be most effective the field under treatment should be made anæmic by pressure on the skin to empty the superficial capillaries. The little device for doing this is called a "compressor." Much blood makes the tissues less transparent.

Concentrating and focussing light-rays is familiar to every schoolboy who has ever played with a reading-glass, and needs no mention beyond stating that such lenses are a part of Finsen's apparatus. Few physicians, however, who know how a lens will set wood on fire know how the focus is reduced to merely comfortable warmth for safe application to the skin in a long séance. Let us make this plain to the reader. Make a brass mounted convex glass lens as follows: in the face of a brass rim fix a curved glass pane, and in the back of the rim fix a flat pane; drill a hole through the rim and fill the space between the two panes of glass with a weak ammoniacal solution of copper sulphate, just strong enough to color it a bright blue, and stop the hole with a cork. This makes a convex lens. Hold it over the skin so that the sun's rays will pass through it and be concentrated to a focus. The water between the two panes of glass absorbs most of the ultra-red rays, and the blue in the water excludes most of the red and yellow rays, and *heat* is almost all produced by these

three kinds of rays. By keeping them from the tissues the rest of the light is cool. The blue liquid does not very much reduce the blue, violet, and ultra-violet rays, and they pass to the tissues in nearly their full dosage. (Plate No. 194.)

With electric-light rays the method is a little different, because all the sun's rays reaching us are long enough to pass through the glass and blue solution, while a similar obstacle would stop many of the shorter rays of electric-light. Therefore, only plain distilled water is put betwen the two panes which filter the rays (or, alum may be put in the water) and, instead of glass which stops many of the ultra-violet electric rays, quartz is used when possible, as it lets these important rays pass more freely. As the water thus in the path of the rays heats up when a powerful lamp is used it is kept below boiling-point by allowing it to flow to and from a pair of suspended water bags, or is kept circulating by some other device. A filter made of *glass* panes and filled with a blue solution will greatly lower the efficiency of a very high candle-power electric lamp, and the greatest efficiency is obtained by colorless water and rock-crystal filters. Additional cooling of the skin is produced by the "compression" which, in the Finsen technic, assists to make the part anæmic. See description accompanying illustration. (Plate No. 195.)

With the Finsen apparatus in its early period, or prior to recent improvements, an area of skin about six-tenths of an inch in diameter could be treated at a time, and was usually given a séance of one hour every day. The limited field of application, the tedious time required, the long duration of attendance needed, and the fact that a costly apparatus feeding on fifty to eighty amperes of current was the only substitute for the sun, tempered the imitative furore of those who were gratified by the results. The *quality* of the results was such that, despite the length of time consumed and the fact that only small and accessible lesions were treated, the method held the attention of Europe for three years. The X-ray and direct static sprays, high-frequency discharges, etc., then showed about the same results in far less time and with much greater facility, till in the summer of 1901 a new "lupus lamp" took precedence over earlier models and reduced the exposure-time to less than a fourth of Finsen's. (See Plate 201.)

Experimental Data.—On the evening of May 11, 1897, Finsen exposed the normal white skin on the inner side of his own left forearm to the whole rays of an eighty-ampere arc-light placed vertically over the part. The exposure was ten minutes at twenty inches distance, when it got too hot for tolerance. The arm was then removed to thirty inches and ten minutes further exposure was made—a total

of twenty minutes. The arm was specially prepared for the study of effects and Finsen estimated the intensity at over 40,000 candle-power. In 1901 he made the following report: *

"The point was to expose the skin so that certain parts would be acted on by *all* the rays, while other parts would be under the influence of certain special parts of the spectrum only. I placed on the arm a plate of quartz, a series of different colored glasses, stripes painted in india ink, and an ointment the protective action of which I wished to ascertain. These were placed on the arm in such a way that the skin around them was freely exposed to the whole light and thus a comparison of the different actions could be made. The quartz was one and one-half millimetres thick. The pieces of glass were two millimetres thick and were red, yellow, green, blue, and plain. The arm was covered as usual by the clothing except during the exposure to the arc-light. The skin showed at once some uniform reddening even on the parts which had been covered. Two hours later the color was a little paler but still red all over. At the end of three hours the reddening had increased, but only on the places which had *not* been covered. The difference was, however, very slight.

"Next morning the tracings on the skin were plain. The skin was now quite dark red and hot, and somewhat tender to touch, but where it had been covered by india ink it was white and normal, in marked contrast to the surrounding red. Under the ointment and five strips of glass there were equally white normal stripes, but where the *quartz had been the skin was as hot and tender and red as where no covering at all had been.*

"The reddening remained well-marked for some days and then gradually receded. When the redness had nearly disappeared the skin began to peel off like bran. This lasted six days. The skin was then pigmented so that the stripes made a strong contrast of white on a brown ground. This faded for several months, and by October was scarcely perceptible. My experiment shows the different action on the skin of *heat* rays and the *chemical* rays. Heat immediately reddens, attains its maximum at once, and then abates to the normal color of the skin. The chemical rays produce no color at first. This appears only after several hours and takes twelve to twenty-four hours to reach its maximum. In my test the heat was very strong during the first ten minutes, whereby the skin was immediately reddened but became much paler after two hours. This initial redness therefore depended on the heat rays.

"The redness that developed three hours after the treatment (an hour after the heat reddening had abated) was due to the action of the chemical rays on the skin. The test of the letters showed how absolutely *local* and sharply defined is the inflammation caused by these chemical rays. The brown ointment and the india ink protected

* Condensed from the Journal of Physical Therapeutics.

the skin by their color, but the skin was equally uninfluenced under all the layers of glass, regardless of colors used.

"The results under the various glasses strikingly proved that *the redness of the skin depended exclusively upon the action of the invisible rays beyond the violet of the spectrum, and that the visible chemical rays had not produced any effect whatever.* But the conclusion to be drawn from this is not that visible chemical rays *cannot* produce any photo-chemical inflammation. Simply, the dosage was insufficient. It is a daily experience in the treatment of skin diseases with concentrated light that the visible chemical rays, even after filtering through thick glass lenses, can and do produce the inflammatory reaction, with the arc-light as well as sunlight. Even when the light has to pass not only through the four thick glass lenses of the concentrator, but through a solution of methylene blue or an ammoniacal solution of copper sulphate (which absorb the greater part of the ultra-violet rays) there frequently appears an evident and sometimes pronounced photo-chemical inflammation followed by pigmentation. To test this point I made further experiments on my own arm. . . . The results showed that the skin reacted with the usual inflammation, as follows:

"1. Through a *quartz* cooler, most strongly.

"2. Through a pane of clear *glass*, less strongly.

"3. Through a pane of blue *glass*, least strongly.

"4. Through *glass* filters of other colors there was no action whatever.*

"In these tests the red marks on the skin were raised above the surface like flat hyperæmic spots with the border raised sharply over the normal skin. There were no blisters, and the elevation was not due to loosening of the epidermis. These experiments not only confirm but extend Widmarks's observations. Widmarks's splendid series of experiments, which I have repeatedly referred to and which for the first time afforded scientific proof that it is the ultra-violet rays that produce light-erythema, show the great difference in light action through glass and through quartz. A glass pane absorbs, as is well known, the greater part of the ultra-violet rays from the electric arc-light, while white quartz (rock crystal) panes allow such rays to pass.

"The powerful influence of heat and cold upon the expansion and contraction of blood-vessels and capillaries is not likely to be underestimated, but the effects of *light* are not so fully appreciated. Resulting from the single twenty-minute exposure on my arm I observed that the capillary dilatation could be shown by rubbing the skin even five or six months after the pigmentation had disappeared. That the chemical rays produce dilatation of the capillaries I had previously demonstrated by microscopic observation on the tail of tadpoles, and that this action with modified exposures has a certain advantageous

* If the student will fix these facts in mind it will make clear some of the needs of a good apparatus. The media used as a filter may rob an otherwise fine apparatus of half its dose-efficiency. Do not forget this.

influence scarcely admits of doubt. It may be presumed that there will flow, or at least that there *can* flow, more blood to the skin when the capillaries are distended, and that this improves the nutrition of the skin and makes it more able to perform its functions. If this be the case, as it no doubt is, that a more frequent but less intense illumination than was made on my arm has the same effect on the skin capillaries, we must expect to find more blood (or more capacity for blood-supply) in those parts of the skin that are exposed. These facts are demonstrated."

"Let us now further consider the cutaneous redness produced by *heat.* There are two kinds: direct and indirect. The direct action is the heat erythema which appears on the local application of strong heat, and depends on a paralysis of the muscular coats of the cutaneous vessels. It differs from the erythema of chemical rays in occurring immediately during or after the exposure, and in disappearing in a short time proportionate to the intensity of the dose. The indirect redness is that which occurs from an increase of the body-heat and the consequent determination of blood to the skin. Repeated action of this kind does not increase the permanent redness of the skin. From an elaborate study of the effects of cold under many conditions we find that cold *per se* has no lasting effects on the vascularity of the skin. But experience shows that *light* in conjunction with both heat and cold modifies the effects and is a decisive factor in actions generally attributed to heat and cold alone. In conclusion, the following points have been established by this series of investigations:

"1. I have confirmed the results of Widmark's researches on the action of light upon the skin, and further proved that the visible chemical rays as well as the ultra-violet have the power to produce specific photo-chemical inflammation of the skin.

"2. I have shown that in the electric-light the strongest bactericidal power resides in the ultra-violet rays, and, as a practical conclusion of this, it follows that *quartz lenses only and exclusively should be used in electric-light concentrating apparatus.* The substitution of quartz lenses for the now obsolete glass lenses has immensely advanced the treatment with concentrated light.

"3. I have shown that the capillary dilatation caused by ultra-violet rays is long lasting, being detectable even half a year after my own test exposure.

"4. Comparison of the different factors acting on the skin has shown that the normal reddish hue which the uncovered skin acquires is wholly or in great part produced by the chemical rays of light.

"These third and fourth observations mean a great advance in the study of the physiological action of light upon the skin. We have taken a long step forward, and it only remains to know the exact signification and importance of an abundant blood-supply to the skin. We are entitled to presume that the skin is better nourished and more able to perform its functions, and when we arrive at a definite knowledge of these we will then, without doubt, arrive at the conviction

that we have in the chemical rays of light a resource—perhaps the most powerful known to us—whereby (in the form of light baths) we can enhance the functions of the skin."

When high-intensity arc lamps are used for the local photo-chemical reactions of Finsen's therapy (as distinguished from the general actions of photo-therapy), the physician must use a proper filtering medium or he will lose most of the power of his lamp. The ascertained facts as to absorptive power of different media are, according to Larsen, as follows:

1. Clear glass allows about ninety per cent. of the visible chemical rays to pass through it.

2. A thin pane of red glass lets through about eighty per cent.

3. Red glass lets through twenty-eight per cent. of the outer red rays, twenty-three per cent. of the middle rays, four per cent. of those next the yellow, and absorbs all others.

4. Yellow-red glass lets through thirteen per cent. of red rays, two per cent. of yellow rays, two per cent. of green rays.

5. Green glass allows a trace of yellow rays to pass, fourteen per cent. of green rays, and a small amount of blue rays.

6. Blue glass lets through thirty-three per cent. of the upper red rays, three per cent. of the remaining red, and about seven per cent. of the yellow.

But this relates only to the visible part of the chemical rays of the spectrum. Not only do media of colored glass shut off so much of the desired rays from the tissues as above stated, but colored glass and *blue solutions* cut out practically all the more important invisible chemical rays of the arc-light. This means in practice that when a patient is treated with ever so large a lamp but through a glass cooler filled with blue water the exposure will be reduced to a very feeble dosage. More efficient dosage will be obtained with a filter of thin clear glass filled with clear uncolored water kept flowing to cool it. But the most efficient dosage of the electric-light, the only one which really secures the ultra-violet and full energy of all the chemical rays, is the clear crystal filter of polished quartz. Next to having a lamp of high-intensity rich in chemical rays, and using it at close proximity to the lesion, the crucial feature of a lupus lamp must be considered the filter. In the study of photo-therapeutic apparatus look well to this point. In Bie's classical paper on Finsen's photo-therapy, published in September, 1899, he takes occasion to remark: "It must further be taken into account that until a year ago apparatus was used (in the Finsen Institute), the bactericidal effect of which was

quite insignificant compared with that now employed, *because the lenses were of glass instead of quartz.*"

The following involuntary contribution to the physiological study of high intensity chemical and heat rays of light was reported from Niagara Falls, December 29, 1901. Compare the intensity of action of Finsen's seventy-ampere arc, giving 40,000 candle-power, with this arc of 350 amperes at 220 volts giving 308,000 candle-power, the highest on record.

In the Furnace Company's works a method of burning holes in masses of "salamander" with an electric arc was substituted for the usual and slower drill. The carbon was six feet long and two inches in diameter; the rheostat was immersed in a barrel of running water to keep it cool; when the current of 350 amperes at 220 volts was turned on an arc was made that could be extended to six inches, and the light equalled about 308,000 candle-power. It was equal to 160 street arc-lamps. Every one who looked at the arc for even a very few minutes had a severe inflammation of the eyes with the exception of two men who wore plain white-glass spectacles, and they suffered no inconvenience whatever, although one of them looked at the light a great deal. Says the engineer in charge: "I was affected worse than any of the others, because I stood within ten feet of the arc and looked at it more than any one else. After the first exposure to the arc I rode home on my wheel, and, before reaching home, was nearly blind and in terrible agony, and consulted a physician immediately. My eyes were bloodshot, and the lids so inflamed that the eyes were completely closed. My eyes were kept bandaged and treated with an eye-wash alternated with witch-hazel lotion, but suffered a great deal for four days. The skin of my face all peeled off except where protected by hair. Under the shade of the hat the skin peeled less, but still quite severely.

"The next morning ten or twelve of the foremen and employees complained of similar trouble. In fact, every one who looked at the arc, except the two who wore glasses, were more or less severely affected. Some were laid up totally blind for a day or two. Others were laid up only half a day, while several who came to work the next morning worked with great difficulty on account of the pain and inflammation in their eyes. We then wore a mask with white glass, 'stone-cutter's goggles,' and, though there was still a little inflammation in our eyes from close and continuous work, yet we did not suffer as before."

Technic of Finsen Lupus Method.—Whatever modifications in technic may come about through improved apparatus, and especially

through the desirable substitution of small currents for the large amperage of Finsen's lamps, it seems certain that the principles of administration as worked out by him will remain with us for some time. The most instructive description we have so far seen is that of Morris, which is herewith given: *

"*Care of the Filter.*—The lenses, especially the bottom one, must be clean and bright. The water in the filter must be changed daily and must be clear. Ordinary clear water gives as good results as distilled water.

"*The Focus.*—The area treated is usually kept well within the focus of the light, but if a smaller focus can be borne it has a greater effect.

"*Screens.*—The rays should fall *perpendicularly on the compressing device.* By fixing a metal screen to the end of the tube (of the Finsen apparatus) the least deviation of the compressor from square with the axis of the rays will throw light on the screen, and the position can be rectified.

"*Pressure.*—Elastic bands are used to hold the compressors on the part when possible. They are somewhat more painful to the patient than hand pressure, but insure even and firm pressure during the whole of the sitting; a thing difficult to maintain with the fingers. Elastics also obviate the need of a nurse to hold each instrument when many cases are treated at the same time.

"*Preparation of the Patient.*—The crusts are removed with forceps, then the area to be treated is bathed with boracic lotion, and if there is any grease on the part, with ether. The skin is then marked with a blue pencil so as to ensure the light being applied to the same spot. After treatment the compressors are cleaned with alcohol and carbolic acid. The diseased surface treated is dressed, if necessary, with a simple zinc-lanoline ointment, or a paste with zinc-vaseline and a little boric acid.

"*The Reaction.*—This largely depends on the intensity of light at the time of the exposure, and this in turn depends on many factors, such as the exactness and size of the focus, the clearness of the lenses and water of the filter, the quality and even burning of the carbons of the arc, etc. The reaction will further depend on the depth of the disease, the amount of scarring, pigmentation, and vascularity.

"*Time of Onset of Reaction.*—This varies from five to twenty-four hours. It is generally noticed the morning following treatment. It is usually slight for the first few days and then becomes more marked. It does not appear to diminish in intensity after continual treatment, but if anything to increase. After a preliminary hyperæmia with slight redness a bleb forms, bursts, and dries, to form a yellow crust at the end of about a week, and in ten days or two weeks

* The current exciting the arc lamp used by Morris was seventy-five amperes of sixty volts, but as newer lamps gave better results with less current and shorter exposures we omit his references to current strength.

the sore has completely healed. When situated over loose tissues (for example, over the eye) there is often great swelling of neighboring parts.

"Experience shows that the beneficial effect produced varies directly with the intensity of the reaction. The same principle seems to apply in the case of ulcer as in lupus. When the epidermis is absent there is no blistering and crusting as when the skin is intact, and many more consecutive applications can be borne on a single spot. The reaction then shows itself by redness and soreness, with perhaps some swelling of the surrounding parts and great tenderness on pressure. This supervenes about the fourth or fifth day, and if the treatment be continued the skin around the ulcer becomes inflamed. Of all the diseases amenable to light treatment, lupus vulgaris is most benefited, but the treatment cannot be regarded as a specific, and we cannot go so far as Dr. Bie, who regards as doubtful the diagnosis of cases which do not respond to it. That it has a marked effect upon rodent ulcer and other diseases does not disprove the bactericidal theory of its mode of action, although it negatives the supposition that it is specific for the tubercle bacillus alone; apparently there is some chemical or nutritional effect upon the tissues also to be taken into account. In all the cases we have treated, the improvement has been marked and uniform, though in some cases very slow.

"*Effect in Lupus Vulgaris.*—In several cases a small isolated superficial nodule had disappeared after one application. As a general rule, and speaking broadly, it may be said that in an extensive case a single spot is treated daily, and the parts first treated are sufficiently healed in a few days to permit of treatment being renewed. If the area to be treated is only a small one the applications are continued as 'long as possible until the soreness of the parts and the crusts formed necessitate cessation of treatment for a few days. In an extensive case a year with intervals of rest may be given as a rough indication of the duration of the treatment.'

"In cases where there is much thickening of the skin the use of pyrogallic ointment will considerably lessen the duration of the treatment. We have used a five-per-cent. ointment in a few cases for about a week, and then after allowing the part to heal the light applications have begun.

"*Effect in Rodent Ulcer.*—In a case of extensive disease, where the typical hard edge was in places absent, the effect of a single application was apparently to stimulate healing of the part. In cases where there was no ulceration, reddening and perhaps slight excoriation of the skin resulted from a few applications, and the growth gradually becoming softer gradually disappeared. In small ulcers entirely surrounded by an indurated rolled edge there was no visible effect at first, but after several continuous applications the discharge increased and an inflammatory reaction occurred; at the same time the induration gradually disappeared until a simple 'punched out' ulcer with soft edges remained. On cessation of the treatment healing took place

with great rapidity. The stimulating effect upon the tissues is marked in the ulcerations both of rodent ulcer and lupus vulgaris.

"*Effects in Lupus Erythematosus.*—The effect has been marked, but not so certain as in lupus vulgaris. In the more chronic cases, with much scarring, it is difficult to get a good reaction.

"*Constitutional Effects of the Treatment.*—Practically *nil.* (The application is strictly local.)

"*Effect on the Eyes.*—The eyes are carefully covered with protecting wool or paper, but the light can still be seen by the patient. There have been no deleterious effects upon the eye itself, but slight 'running of the eyes' has been experienced.

"*Effect on Mucous Membrane of Nose by Penetration.*—In one case in which the skin of the nose was treated, improvement took place in the mucous membrane, and the sensation of smell was said to have improved.

"*Unfavorable Conditions.*—Certain conditions make a case unfavorable for obtaining the best results by this treatment. These are:

"1. Those which *hinder the penetration of the chemical rays* and so prevent a good reaction. This cause covers scarring, pigmentation, great vascularity, great depth below the surface, thickness and induration of nodules, surrounding inflammation and induration, and confluence of the nodules.

"If the lesion has been previously scraped the cicatricial tissue is often dense, and a thick scar is nearly opaque to the rays. Brown ointment and india-ink made the skin under them immune from the rays in Finsen's test, and any pigmentation which intercepts the ultra-violet rays will lessen or annul the dose. Blood, arterial and red, is a red screen to the chemical rays to a certain extent, and, therefore, 'great vascularity' opposes treatment, and the area of the lesion must be rendered anæmic to secure an effective dosage. The reasons why depth and indurations reduce the therapeutic activity of a given amount of rays are obvious from the above.

"2. *Difficulties of Position.*—A lupus patch or other lesion may be suited to treatment, but be so situated that the conditions of photo-therapy cannot be well met. On the skin, for example, when the lesion is near the eye, special compressors may be necessary; or, if on the eyelid it may not be possible to apply adequate pressure at all. If on a mucous membrane, the interior of the mouth and nose are inaccessible to Finsen technic, but the gums and lips can be treated, the latter by everting them. In these cases the combination of X-rays with photo-therapy has been successful. Practically any surface and any mucous membrane affected with lupus can be reached by the X-rays, and pressures are ignored, though useful when convenient.

"3. *Extent of the Disease.*—As only small areas can be treated at a single exposure with the focus of a lupus lamp it is obvious that very extensive cases are unfavorable in practice. X-rays reach large cases without this drawback.

"*Disadvantages.*—To both patient and physician the disadvantages of Finsen's treatment have been the long time required, the small area treated at a time, and the expense. (Already these are lessened by newer apparatus and the technic is now on a much better basis.)

"*Favorable Conditions.*—Cases favorable to the method are those in which the area of the lesion is limited, is superficial, is not spreading, and has not had previous treatment, especially of an operative nature to thicken and scar the tissues.

"*Advantages of the Method.*—These are its reliability, painlessness, excellent cosmetic effects, the softness and non-contractility of the final scar, the lessened liability to relapse, and the avoidance of surgical measures."

The Lortet-Genoud Lupus Lamp.—In the summer of 1901 a great advance was made in the mechanics of the particular form of local photo-therapy which Finsen had previously made his own. By those who claimed that Finsen's method was the best means of treating lupus it was admitted that two grave drawbacks had been evident from the first: the length of time required for curative results, and the need of a current of seventy to eighty amperes—sufficient to light 160 incandescent sixteen candle-power reading lamps. Moreover, the device of a condenser to secure the needed maximum amount of light and of a filter to eliminate the heat rays led in practice to a serious loss of the chemical rays and reduced the dosage they were employed to increase. With the costly Finsen tube apparatus the field of treatment was an area less than the size of a silver quarter of a dollar, or an English shilling. Efforts were therefore made to dispense with the device which required a seven-fold increase of current to overcome its interference with the active dosage, but to do this it was necessary to protect the patient from the heat, as before, and to use the chemical rays so near their origin that dispersion was not allowed to take place. The first lupus lamp to attain these ends deserves specific mention here, though others soon followed and surpassed it. Certainly it was no small achievement to reduce at one step the Finsen current from eighty to twelve amperes; to reduce the exposure-time from an hour to fifteen or even only ten minutes; and to bring down the total duration of treatment from many months to a few months. With the above was also a much less primary cost and a very much lessened cost of operation, the results in their entirety being that a method impossible outside a wealthy institution having financial support was made feasible for any hospital, or practice in a private office. The first apparatus which thus simplified the technic was the lupus lamp of Lortet and Genoud, made by Souel of Lyons. It is shown in the accompanying illustrations in this chapter. (Plates 201, 202, 203.)

The direct current arc takes twelve to fifteen amperes at from

fifty-five to sixty-five volts, regulated by a rheostat. The carbons are adjusted at an acute angle, the positive carbon being eight millimetres in diameter and the negative twelve millimetres. They last four or five sittings and are easily replaced. The arc is regulated by a system of screws. The essential novelty is a metallic besin, double-walled, with sides seven millimetres apart and a round hole in the centre of both bottoms twenty-five millimetres across, these holes being stopped with obturators which contain in their centre a plane lens of quartz. Through this rather remarkable device flows a current of cold water so that the double basin with the quartz "eye" screens the heat from the patient, lets all the chemical rays pass through, acts as a compressor, and by its close application makes the concentrating lens unnecessary. The whole apparatus is mounted on a heavy base which permits movements and adjustments in all directions. As will be seen in the illustration this apparatus brings the tissues close up to the crater of light instead of carrying the rays two feet to reach the patient, and this clinical revolution in method was the decisive advance over previous lamps.

Technic with the Lortet-Genoud Lupus Lamp.—Commence treatment at an outer margin of the diseased surface to prevent further extension. If there is suppuration employ other treatment to stop it before commencing the light. Also first remove crusts by a tepid boric solution, or other suitable means. If scaliness is present to hinder the passage of light-rays apply a little essence of cloves, which makes the epidermis transparent. When these obstacles of suppuration, crusts, and scales have been removed and the part is ready for the application of photo-therapy sterilize it carefully. If it is near the eyes protect them by a bandage. If it is upon the nose stuff a tampon of cotton into the nostril, and if the lips or cheek are involved also use an internal pad of cotton to diminish the pain of external pressure during treatment.

After making these preparations place the patient in a sitting or recumbent position in proper relation to the apparatus. Pose the patient so as to secure convenience and avoid discomfort. The compressors are made in three sizes—one and one-half, two, and three centimetres in diameter. A choice is important in treatment. The whole surface of the lens of the compressor must be in actual contact with the tissues to protect them from the heat rays and the circulation of water through the basin, which constitutes at once the heat-screen and the means of pressing the capillaries empty of blood for the penetration of the chemical rays into the lesion must be free from air bubbles and unimpeded. If air bubbles appear on the lens expel them

PLATE 197.—One of Finsen's cases before and after treatment.

PLATE 198.—One of Finsen's cases before and after treatment.

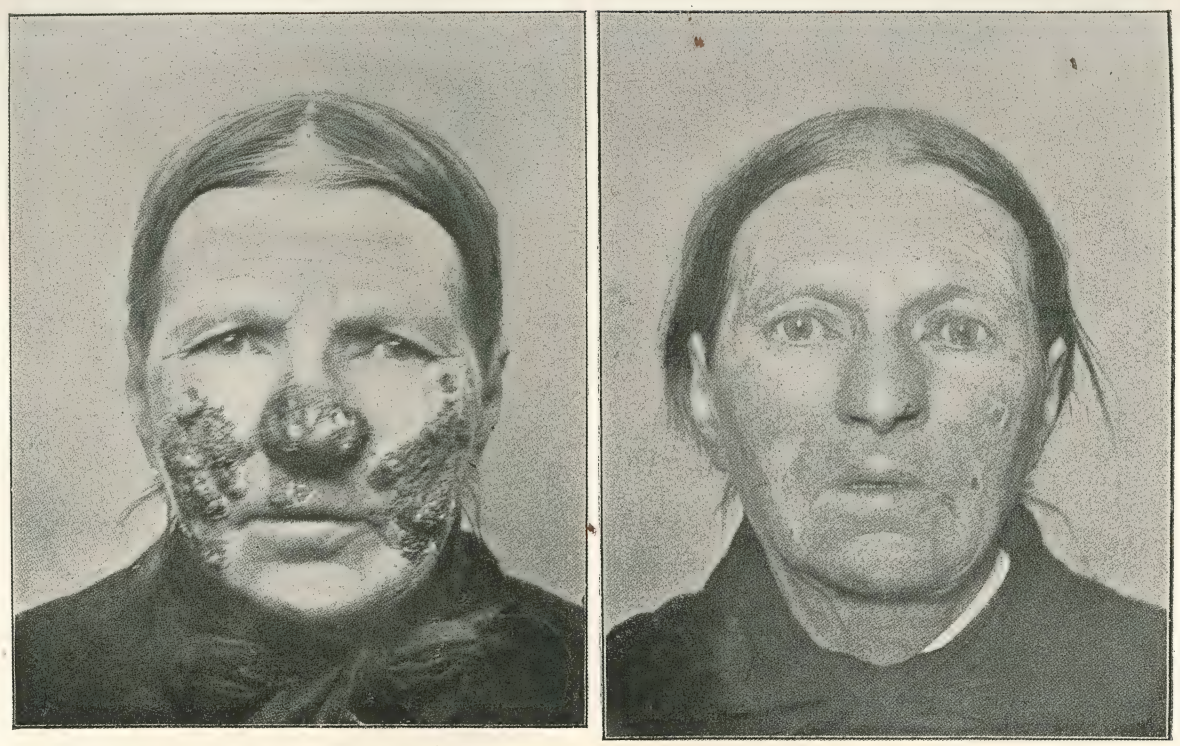


PLATE 199.—One of Finsen's cases before and after treatment.

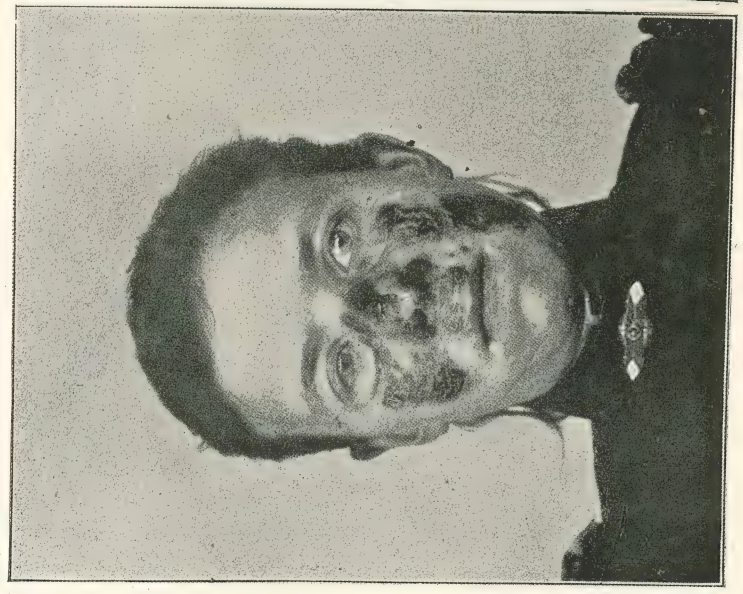


PLATE 200.—One of Finsen's cases before and after treatment. The preceding series of Finsen plates are here inserted for the valuable purposes of comparison. When improved apparatus makes photo-therapy the ready resource of every physician with high efficiency at low cost, and a technic with as little trouble as the expert now finds the X-rays, it will be of great interest to turn to the work of pioneers and compare their apparatus and results. These pictured records are taken from transient copies of medical journals and collected here in permanent form to encourage and instruct those who have read of Finsen's work without realizing what it was like. These plates show what it was like in 1901, after the development of the two prolific years of experience—1899-1900. At the date of this writing, early in 1902, a revolution is taking place in the mechanics of photo-therapy, and what is pictured to-day will soon be historical and obsolete.

by freeing the outflow before beginning the application. Also sterilize the compressor for each treatment.

For plane large surfaces, such as the cheek, select the largest lens. For irregular or small surfaces, such as the chin, ear, nose, and near the eye, select the medium or small lens, which will give the best contact. For parts of such shape that complete contact with any compressor is impossible then cover the lesion with a layer of tin-foil cut to fit and with a hole in its centre corresponding to the portion of the area that can be properly compressed by such part of the lens as will make close contact. Then apply the compressor over this window in the foil so that the rays will pass at right-angles with the centre of the lens.

Next fix the carbons in their carriers so that their ends nearly meet. Attach the upper carbon to the positive pole and the negative to the lower. Draw back the mirror far enough to prevent contact with the arc. Now turn on the current with all the rheostat resistance in circuit, and adjust the carbons and rheostat so as to give an even light of maximum intensity. Then cut off the current, adjust the apparatus to the level and position suited to the patient, place the lesion in relation to the screen, and apply the compressor to the part in firm, absolute contact so that the axis of the rays will be perpendicular to the plane of the surface treated. Maintain steady and sufficient pressure on the tissues during the application to render them anæmic as desired. (See Plates 201, 202, 203.)

All is now ready for the therapeutic exposure. Move forward the luminous point of the arc till it is two centimetres from the compressor, with the crater of the positive carbon slightly above and the centre of light exactly in the path of the axis passing through the lens to the tissues. The rays now fall on the tissues only about four centimetres from their source and fulfil the conditions required for the greatest therapeutic energy. Make the first exposures eight or ten minutes only. If more intense reaction is needed after testing the patient's susceptibility, increase the séance to fifteen minutes, using care and judgment as to the duration. During the séance watch the patient and the arc; keep the carbons adjusted as they consume, and keep the compressor firmly applied. At the end of exposure-time cut out the current, release the patient, cover the lesion with boric vaseline on a small square of boric lint, and during the following days maintain an aseptic condition to avoid suppuration.

In certain cases the reaction is very intense; therefore limit the length of the sittings, and separate them at sufficiently long intervals to avoid excessive action. In experiments made to compare the energy

of this *closely applied* light with the more remotely applied light of Finsen's tube apparatus it was found that "the newer method reduced sensitized paper in two or three seconds while the older method required six seconds; an exposure to the forearm of three minutes produced an intense erythema followed by desquamation, and ten to fifteen minutes suffices to produce the reaction necessary for cure." The fact that the older method of getting the light-rays to the tissues took daily exposures of a full hour was due to the far greater distance of the lesion from the source of light more than to any other feature of the technic. Light diminishes according to the law of inverse squares and an arc two feet removed is quite a different thing from an arc at four centimetres.

The Foveau-Trouvé Lamp.—Leaving the original Finsen-tube apparatus, which required State aid or great fees to pay the cost of treatment, still further in the rear is a little lamp which claims priority over the Lortet-Genoud device and superiority in operating features. All we can here say of it is stated in a communication from the designer:

"Priority in the matter of simplifying the arc-light for lupus therapy belongs to me. My apparatus was shown in action at the Institute of France on December 24, 1900; that is to say before the lupus lamp of MM. Lortet and Genoud, which was described at the Académie des Sciences de Paris on March 4, 1901. The Lortet-Genoud apparatus is patented, while besides this drawback it is also more costly, more complicated, and less effective, than the radiator of chemical rays devised by M. Trouvé and myself. This has not been patented and is therefore at the service of all instrument-makers.

"I beg attention to one further point, viz.: that the usefulness of our invention extends also to tuberculous lung disease, a fact that I was the first to point out. In proof of the claim of priority I refer to my communications to the Institute de France, December 24, 1900; to the Académie Royale de Médecine de Belgique, December 29, 1900, and March 30, 1901; to the Académie de Médecine de Paris, April 16, 1901; and to the Société de Dermatologie et de la Syphilis de Paris, May, 1901. Instead of an arc-lamp requiring eighty or even sixty amperes of current, a special installation of lenses, a large circulation of cold water, a cupro-ammoniacal solution, costly sittings of long duration for the treatment of an area of one or two centimetres, our apparatus consists of an incandescent lamp with special carbons, requiring from five to eight amperes, placed in the focus of a parabolic reflector with a conical concentration, a small circulation of water and two plates of quartz forming a compressor; or, an arc-lamp answers even better." (See Plates 204.)

It will thus be seen that the cost of photo-therapeutic apparatus for Finsen methods has already been reduced from the early sum of

nearly $1,000 for installation, and which was still half that sum till these later lamps arrived, is now in a fair way to attain the moderate price and operating simplicity for which the majority wait. Without much question the early expensive forms of apparatus are obsolete; the therapeutic principles survive.

Progress in Photo-therapy Lamps.—We will now consider for a moment the wide departures from the common commercial incandescent lamp which promise shortly to provide new intensities of therapeutic rays with convenient dosability, simple apparatus, and small cost. To at all appreciate the future of photo-therapy the medical mind must entirely ignore the reading light or commercial illumination and consider what can be done with selected rays. The following from electrical journals illustrate:

"The subject of electric lighting has not been exhausted by any means. A new beginning has been made by the recent introduction of a modification of the old kaolin light, whereby the mixture of oxides as a light-emitting element has served to produce a glow which is more brilliant than an incandescent light, yet not so dazzling as an arc. Meanwhile the Nernst lamp looms up on the horizon. Intermediary in intensity between incandescent and arc-lamps the new light promises to be a most important factor as soon as it is put commercially on the market. The quality of the light and its complete steadiness recommend it, while its high efficiency, approaching that of an arc-lamp, make it especially valuable for many uses."

We can now contrast a new type of arc lamp with the "Actinolite" and Finsen's tube apparatus, which consume heavy currents of sixty to eighty amperes each, and which are therefore not suited to office practice. It possesses the other great advantage of low heat-rays with intense chemical-rays so that no cooling device is required on the skin of the patient, a fact which simplifies the technic.

"Dr. Bang, the well-known Danish physician, has constructed a new electric lamp which is likely to prove of great importance, even outside the field for which he has intended it. In the ordinary arc lamp the carbons are heated to some 3,000 degrees, but Dr. Bang has succeeded in avoiding this high temperature by making the carbons hollow and letting a strong current of water run through them. The effect is very singular. Almost the whole of the energy of the electric current is removed to the light arc between the two electrodes, while the latter themselves *remain so cool that one can touch them with one's fingers while the lamp is burning.* In addition to this the carbons are consumed so slowly that the usual automatic adjustment can be dispensed with. In science the new lamp will no doubt be invaluable, says *Engineering; its cold light is able to kill bacteria in one-eighteenth of the time required with the light of the ordinary*

arc-lamps. The electrodes can be made from different substances, according to the use for which the lamp is intended. For medicinal purposes, carbon, silver, and certain kinds of iron appear preferable. Metallic electrodes have been used for several years by doctors, but they have had many drawbacks; they gave a great heat, the metal melted, etc., and it was necessary to place the patient at a comparatively great distance from the lamp. All these objections have been overcome—or, rather, entirely removed—in Dr. Bang's lamp, which is very small and handy, and in *which consumption of electricity is exceedingly small.*" (Electrical Review, January 4, 1902.)

The manager of the Laboratory in Finsen's Light Institute (Dr. Bang) writes the following notice of his new lamp:

"No former lamp has been so constructed as to produce the coldest light with the richest generation of ultra-violet rays, but the writer has now succeeded in making such a lamp by using metals of suitable spectral properties, as, for instance, iron, the spectrum of which is well known to be very rich in the desired rays. The use of these metals as electrodes without melting them has been made possible by cooling them with water, either by making them hollow and letting a current flow through, or by placing larger lamps in water in a specially constructed vessel. In this simple way a light of unexpected properties is obtained. While with carbons the greatest quantity of light comes from the points of the incandescent carbons, especially from the crater of the positive carbon, the arrangement in question gives a real arc-light, as it is almost exclusively the arc between the electrodes that emits radiation. The effect of the cooling is therefore not only prevention of the fusing of the electrodes, but also that the formation of the crater is much reduced; the energy developed thus passes to the arc, and the arc-rays are produced rather than the electrode rays.

"The bactericidal power of these rays is such as has not hitherto been realized. While the usual arc-lamp of twenty-five amperes and fifty-five volts at sixty-six centimetres distance and under the most favorable conditions kills Staphylococcus pyogenes aureus in four and one-half minutes, the latter is killed by the lamp described, with iron electrodes and equal current power and other conditions, in somewhat less than four seconds, which shows a bactericidal power of sixty times that of the usual arc-light. Similar results are shown regarding the irritant effects on the skin of these cold rays. Five minutes' radiation at one metre distance from the lamp is sufficient to produce a well-marked light erythema of the whole face, which lasts for several days.

"For local treatment the writer has constructed quite a small lamp, which, including various adjuncts, is not much bigger than a tablespoon. This lamp is placed upon the skin *in toto*, as the light arc is so cool that it can be placed at one to one and one-half centimetres from the skin. More than 150 trials, upon sound as well as upon lupus skin, have shown that a lamp of five amperes and forty volts gives in five minutes (generally in three minutes) over a sur-

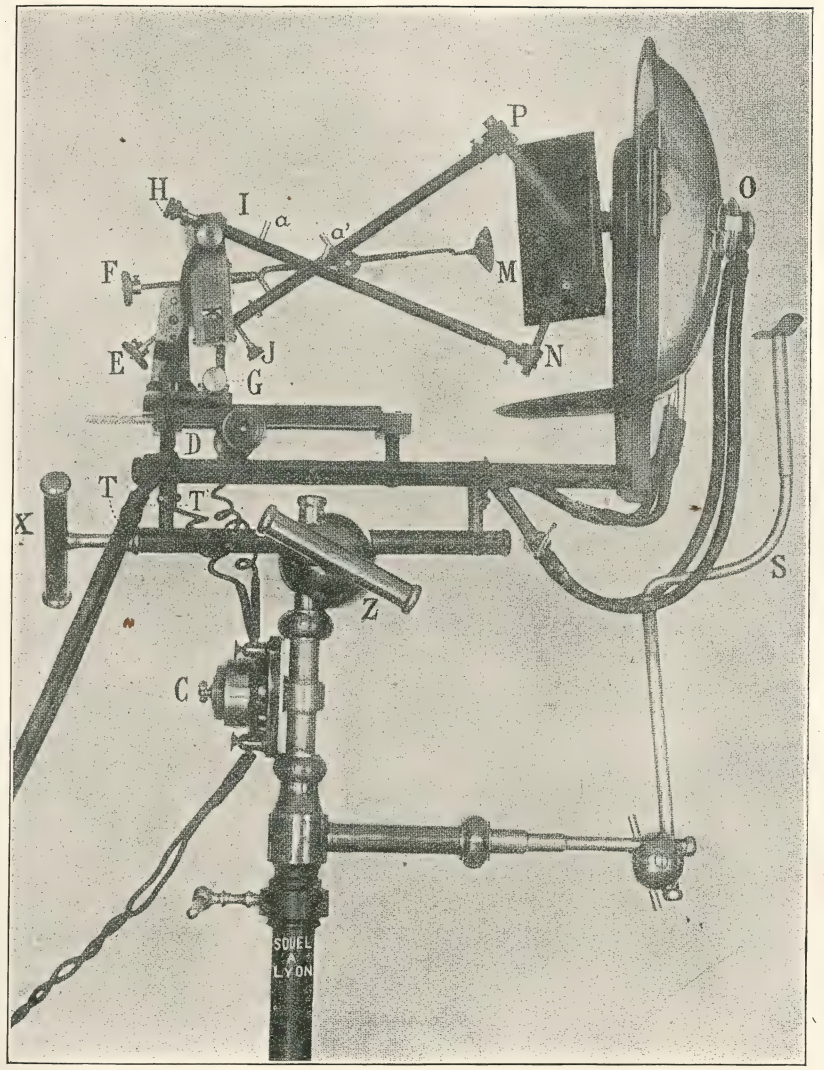


Plate 201.—The Lupus Lamp of Lortet and Genoud. Explanation of lettered figure. a a are two small levers. By pressure on them the operator removes old carbons and replaces new; D advances or draws back the arc; E is a screw which raises or lowers the arc; F is a screw which regulates the separation of the carbons of the arc; G gives a lateral movement to the arc; H advances or draws back the negative carbon; J gives lateral movement to the positive carbon; M is a small mirror behind the arc; T T are two tubes to connect with the water-pipe; X is the handle which turns the lamp as desired when the set-screw Z has been loosened.

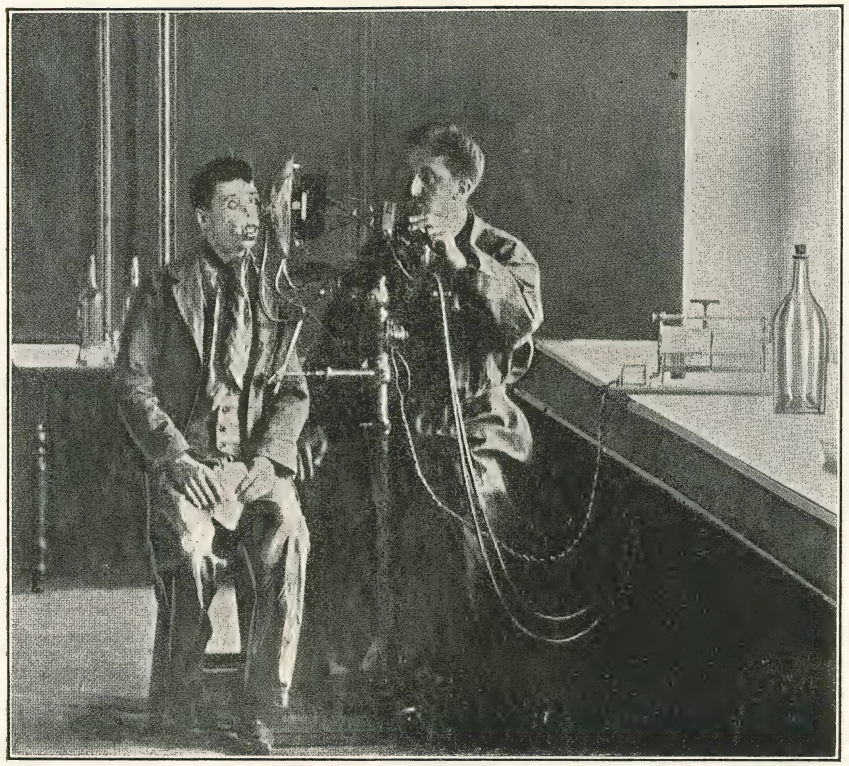


PLATE 202.—This copy of a French Plate shows the clinical method of employing the L.-G. lupus lamp, with the patient in position, and close contact made by the compressor on the diseased area.

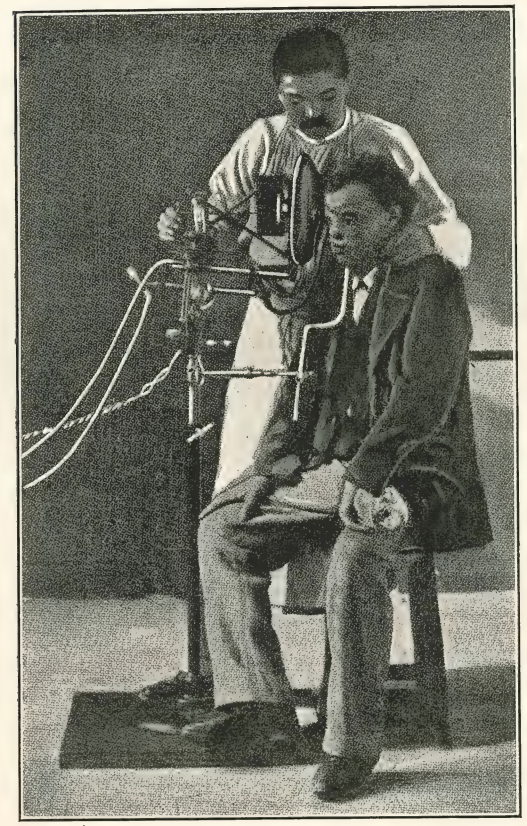
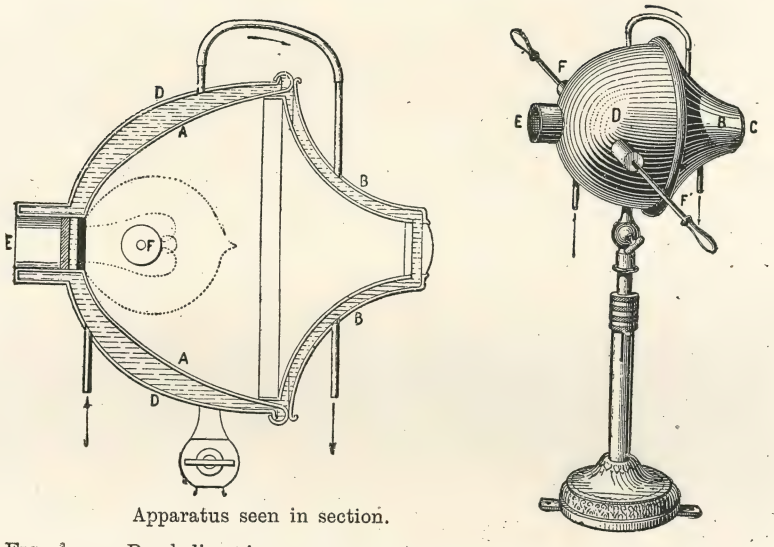


PLATE 203.—This copy also shows how the patient is placed in position for treatment with the L.-G. lupus lamp. While these plates are copies of inferior prints, yet they illustrate the method better than nothing. Fine original photographs to represent this apparatus were expected, but though ordered some months ago, the lamp was so long delayed in shipment, transit, and custom-house, that we go to press without as yet seeing the first apparatus of this kind brought to this country.



Apparatus seen in section.

FIG. 1.—A, Parabolic mirror; B, prolongation of cone of concentration; C, quartz chamber (compressor) for the utilisation of the entire chemical radiator; D, inner cooling covering; E, opening for the utilisation of both direct and other rays, for inspection and regulation of the arc; FF, carbons which can be regulated at will; G, adjustable support for the apparatus.

PLATE 204.—The Foveau-Trouve Lamp.

face of ten square centimetres light reaction of the same strength as from the usual apparatus of sixty amperes and fifty volts in five and a quarter hours. In other words, to obtain this effect with the old apparatus 33,500 kilowatt seconds were necessary, which treated four patients, therefore 3,375 kilowatt seconds per patient; whereas with the new lamp only sixty kilowatt seconds, or one fifty-sixth of the energy formerly consumed. As is quite natural, the effect is higher if a stronger current is used, but as the effect of the usual lamps are in practice nearly proportional to the amperes, it would appear that the bactericidal power of the new lamp is proportional to the whole quantity of energy, or to the number of watts (five to ten amperes and thirty to fifty volts). The most suitable current seems to me to be eight amperes and forty volts. *As the light of this lamp is very powerful no concentration is necessary. In consequence of this, and as no automatic regulation is necessary, the lamp is very cheap to construct, and it can be used on any ordinary installation for incandescent lamps.*

"As I have found that unauthorized makers have distributed low quality products under the name of 'Finsen's apparatus,' and quacks have made 'improvements' upon them, I have applied for patents for this lamp in its different forms, as technical uses may be found for it. The applications are dated from July 29th to August 17, 1901."

In most marked contrast with this cold light is the special filament invented by the English electrical engineer, Dowsing, which can be made so rich in red (heat) rays that it is put on the market as a substitute for gas-radiators in the heating of small rooms. With the adjuncts of reflectors and couch a series of Dowsing lamps, or rather, radiant-heat tubes, form a therapeutic apparatus which we will describe in a later chapter of this section. Still another remarkable variation of special ray effects was described by Mr. Cooper Hewitt before the American Society of Mechanical Engineers, in New York, January 4, 1902. His light in vacuum tubes with mercury gas instead of filament has no heat (red) rays, and with chemical action requires no cooling device for the patient. We, therefore, see that invention tends to a direct production of selected rays for therapeutic uses instead of filtering out with great difficulty selected rays from a common source. This is a marked advance.

"Mr. Hewitt's lamp consists simply of a glass tube, with a bulb at one end, into which he introduces the gas generated from mercury. The tubes, when filled, are connected with the ordinary electric power in any building and the current turned on. The gas acts as the conductor and as soon as the switch is turned, the tube is flooded with light. Four of these tubes were placed at regular intervals around the gallery of the auditorium last night and one was hung from the

ceiling. The incandescent lights were also turned on, and the light from these looked like jets of uncertain yellow flame, as compared with the light in Mr. Hewitt's lamps. The lamps attached to the gallery gave a light equal to that of about 200 candles, while the one which hung from the ceiling and the one over the entrance to the house seemed to have about twice as much power. Mr. Hewitt says that he can produce his light at about one-eighth the cost of the incandescent lamps and about one-third the cost of arc-lamps and of gas-lamps. The lamps were used last night chiefly to illustrate Mr. Hewitt's paper and to show to the members of the institute what progress he had made in his experiments. In the course of his paper he said:

"'The mercury gas lamps exhibited to-night are operated on the standard Edison 118-volt direct-current circuit installed in this building; lamps of this class consume amounts of current varying from one to six amperes, and the efficiency is approximately one-half watt per spherical candle-power. Under better conditions as high an efficiency as one-fourth watt per spherical candle-power has been obtained, determined by careful and accurate measurements. I have made lamps with diameter of bore less than one-eighth of an inch and as large as three inches, and from less than three inches in length up to over ten feet, giving from less than ten candles up to fully 3,000. Lamps of very small bores give more trouble in manufacture and operation than those of moderate size. Lamps of innumerable shapes and dimensions have been constructed and great variation of candle-power for various diameters obtained. There appears no reason why lamps may not be made of any size required and of any desired candle-power per inch within wide limits, the only limitation appearing being that imposed by softening of the glass when too many candle-power per inch are produced. *It is possible to predetermine with almost absolute exactness the voltage, current consumption, and candle-power of a lamp when the manufacture is perfect.*

"'The light produced by pure mercury gas comprises orange-yellow, lemon-yellow, green, blue, blue-violet, and violet. For some purposes the lack of red in the spectrum is objectionable, but for many uses it is a positive advantage.

"'*It should be noticed that this light has very great penetrating power, and seems to be effective through greater distances than an equivalent amount of measured candle-power from the ordinary incandescent lamp.* This may be due to the fact that the waves of the red light are less penetrating than those waves which are present in the mercury light, and hence the least valuable portion of the spectrum having such illuminating effects is omitted, and the energy is practically expended in the more useful portions of the spectrum. When it is considered that this light, when obtained with mercury gas, has an efficiency at least *eight times as great* as that obtained by the ordinary incandescent lamp, it will be appreciated that it has its use in places where lack of the red is not important, for the economy of

operation will much more than compensate for the somewhat unnatural color given to illuminated objects.'"

Through the courtesy of the inventor the author has been able to see this blue-light tube and to observe its spectrum. The spectrum certainly presents the appearance of great richness in the field beyond the blue. There is little heat on touching the tube when a moderate current is used, and there is apparently almost no radiation of heat beyond the tube. For a number of years laboratory work has been directed to completing this lamp in commercial form, and its entire range of action is being subjected to scientific investigation. It is in competent hands. It is known that its rays are exceedingly strong in bactericidal power, that it is simple, practical, and cheap, and the chief delay in offering it to physicians appears to be the business detail of the formation of a company to manufacture and sell it. It requires practically no installation; is almost as simple as screwing a lamp in a socket and switching in the current. The cost will be so reasonable that it may be fairly compared with that of this book. What this means to the general medical profession, if all expectations are realized, can hardly be estimated. On the other side—non-medical illumination—there still remains some modification to perfect the light, but it is hoped that by the beginning of 1903 it will be ready for public sale and use.

Sun Cases.—Here, in New York, a colleague recently told the author that one of his patients had quickly cured himself of an eczema on the hands by using a reading glass and the sun. In our section on X-ray lupus therapy a similar case is cited. There are probably many that do not come to our attention; but in the shining land of Southern California the method has free scope. To show what can be done with simple apparatus a physician writes in May, 1901, of his personal experience with "home-made" photo-therapy:

"For his sun method Finsen uses a lens eight inches in diameter, fitted into a band of metal about three inches wide and closed on the opposite side by a piece of plain glass. The chamber between these glasses is filled with blue water. This cools the fierce heat of the focussed light and lets only the chemical rays through. His patients take 100, or 200, or more treatments. I must claim some advantages for my own treatment and that of our fellow practitioners here, for we secure the same results, viz.: a cure with a minimum scar-tissue, and do it in a month with five or ten treatments instead of requiring over a year of almost daily sittings an hour long. The apparatus we employ costs as follows:

"A good sun-glass four and one-half inches in diameter. $2 00
"Smoked glasses 50

" Chloroform q. s..... $0 25
" A metal punch..... 1 00
" Piece of leather for shield..... 05

" A total of $3.80. My own cases have been but twenty, yet my results have been entirely satisfactory to myself and patients, except one in which I used the Finsen method for some months and exhausted my patience and that of my patient, so that we both decided to call a halt, and, under my ordinary method, matters were brought to a favorable issue at once. The sun-glass is efficient in removing small moles and warts, in increasing the growth of the hair, in hastening the cure of eczema. Under either local (or, if necessary, general) anæsthesia it is efficient in the total destruction of lupus, epithelial cancer, and other growths of the skin. It is not to be compared with the knife, yet is at times superior to it.

" For the reason that the chemical action of the sun's rays penetrates deeper than caustic action is does work that the cautery and caustics cannot do. Its use should be acquired by every physician. It is exceedingly simple, yet requires some experience and care when dealing with facial blemishes where scar-tissue is dreaded.

" In the application protect the surrounding healthy skin by a leather shield in which cut a hole with the punch or a knife to exactly fit the margins of the diseased part—as in the lead " masks " used in X-ray treatment. In operating near the eye or nerve tracts additional precautions should be taken. Wear a pair of smoked glasses during this treatment of a patient to protect your own eyes from the intense brilliancy of the focus point, but wear them well down on the nose so that you can glance over the top from time to time and thus judge of the effect produced. Do not strive to do too much at one séance. Proceed cautiously, letting the patient return several times rather than burn so deeply as to leave an unfortunate scar."

CHAPTER XLV

PHOTO-THERAPY: PROJECTION ARC-LIGHTS AND ARC-LAMP CABINETS

Treatment of Tuberculosis. The Profound Action of Chemical Rays upon Tuberculosis. Ichthyosis Hystrix. Local Anæsthesia by Blue Electric Light Rays. The Arc-Light Cabinet. Notes on Actions and Effects.

In contrast with the high-intensity local applications of exclusive chemical rays we find the large arc-light used for more general purposes and in two distinct forms of apparatus. One of these projects the rays in the manner of a " search light " but with medical modifications, and the other puts two or four lesser arcs in a cabinet. Both forms of apparatus are shown in our Instruction Plates. To best understand the physiology and therapeutics of any one *light* apparatus this section on photo-therapy must be studied as a whole, for we cannot repeat every detail in each chapter. Physicians have met many such references as the following, which appeared in the *Medical News*, January 4, 1902. Few have the slightest idea how such treatment is carried out:

" **Artificial Light in the Treatment of Tuberculosis.**—During the past few years considerable attention has been devoted in some quarters to the treatment of pulmonary tuberculosis and various other tuberculous lesions by the means of intense artificial light. A serious drawback to this treatment has been the expense of the apparatus necessary for its fulfilment and the great difficulty in regulating the dosage necessary for individual cases. F. de Cournielles (Comptes Société de Biologie, November 22, 1901) employs the voltaic arc for this purpose. The source of light is placed very near the patient, the heat-rays being removed by a special apparatus designed for this purpose. In this manner one obtains with a voltaic arc of five to twelve amperes effects equal to those obtained by the employment of eighty amperes in other apparatus. A convex mirror concentrates the rays upon the desired region. This method gives a minimum amount of light and a maximum effect therefrom. Many cases of various tuberculous

lesions have been successfully treated by this method, and its employment in all tuberculous conditions as a routine procedure is strongly urged."

The technic of such treatment with a projection arc-lamp is clearly indicated in the series of our Instruction Plates which shows the apparatus and patients under treatment. Referring readers to the Plates for illustration we will now present a report of clinical results. The first citation, it will be noted, refers to cases treated with a heavy current (fifty amperes), and is a sample of several reports which lack of space compels us to omit. The second is an example of cases treated with a much newer lamp taking but a quarter of the current and therefore more practical for ordinary medical use.

Among special mentions of the treatment of pulmonary tuberculosis by concentrated light-rays we find the following in the *Philadelphia Medical Journal*, September 21, 1901:

"That I might test the light-treatment, I purchased a fifty-ampere electric lamp with a twenty-inch condensing lens and had this arranged with an adjuster so that at a distance of fifteen feet the light could be concentrated on a surface an inch in diameter if it should be desired. With this concentration the heat is so great that it fractured a strip of one-fourth-inch plate-glass two inches in width at two feet distance and a strip of one-eighth-inch blue-glass of the same width at six feet distance. In using this powerful lamp a screen made of strips of blue glass is interposed between the patient and the lamp to cut out some of the heat-rays. The chest of the patient is bared and the light concentrated to a circle from fifteen to twenty inches in diameter according to the tolerance of the patient. The exposures vary from half an hour to an hour and are given daily.

"The first effect of the light is a diminution of cough and temperature within forty-eight hours. In most cases the temperature is down nearly to normal within the first week of treatment. I am accustomed to judge somewhat of the improvement by the gain in weight; this is taken the day of the first exposure, and subsequently every two weeks. In every case the amount of expectoration is perceptibly diminished and the number of bacteria to the field very much diminished within the first week of treatment. This indicates a reduced tax on the system, as the reduction of the number of bacilli to the field and the smaller quantity of expectoration makes a smaller army of microbes to be fed at the expense of the patient's system. Several patients who on beginning treatment walked a block with difficulty at the end of two weeks could walk a mile. The beneficial effect on appetite was always marked from the very first treatment. The cessation of the cough necessarily permitted better rest at night. It is remarkable with what rapidity symptoms are ameliorated under the influence of the concentrated rays of light.

"No. 1. H. B. B., aged thirty-three years, born in Connecticut. Trained Nurse. Came to me November 17, 1900. Menstruation regular, urine normal. In her mother's family, grandfather, two brothers and four sisters have died of pulmonary tuberculosis. Her mother is a picture of health and has always been well. No member of father's family has had any tubercular disease. In July, 1900, while on duty at the Seaside Home, she found herself growing weak, and her duties fatigued her greatly. She had noticed a morning cough for a year past, but it did not alarm her. By August the cough became annoying and there was increased expectoration. This alarmed her and she consulted a relative who is a physician and he diagnosed tubercular infection. Sputum was first examined October 5th, and found to contain bacilli in 'considerable numbers.' She was then taking creosote ♏ xxxx t. d. in capsules. Tr. Ferri Chloridi ♏ x t. d. Liq. Potas. Arsen. ♏ viii every other day, and Russell's Emulsion ʒ ii t. d.

"November 20th, light-treatment was instituted. Medication was continued with the exception of the iron and Russell's emulsion, Turk's emulsion of cod-liver oil in half-ounce doses was substituted at the suggestion of Dr. Reynolds. She was examined by Dr. Reynolds and myself. A cavity was detected in the apex of the right lung, but very small in size. Her pulse was rapid and weak. Skin soft and flabby. Eyes dull and heavy. Whole bearing indicated debility and malaise. November 21st sputum was examined by Dr. Craig and found to contain bacilli of tuberculosis. December 20th he found little if any change. January, February, March, and April, 1901, found them in gradually decreasing numbers. His May examination showed a few bacilli. April 23d, May 1st, May 18th, June 9th, and July 16th examined by Dr. Willis S. Cummings, my assistant, and 'no bacilli' found. On June 12th and 19th Professor Van Cott made careful examinations and could not find any tubercle bacilli and congratulated the patient on the result.

"The patient's normal weight previous to August, 1900, was 120 pounds. Then she found that she had lost six pounds. On November 20th she weighed 114 pounds. She continued to gain until February, 1901, when her weight was 119½ pounds, one-half pound less than normal. Her temperature had never gone above 100°, but after the institution of treatment it began to fall and by March 1, 1901, became normal. The cough was promptly mitigated, and expectoration decreased to such an extent that it was often difficult to get a specimen for examination. Physical examination from time to time by Drs. Reynolds, Cummings, and myself indicated a gradual but steady improvement in the condition of the lung. In April Dr. Reynolds, after examining the lung, pronounced it practically healed. May 12th Professor A. Jacobi, who was visiting me, kindly consented to examine Miss B. and stated that 'while there was evidence of degeneration having taken place, the process had evidently stopped.'

"The light-treatment began with half-hour exposures daily (except Sunday) on November 20, 1900, and continued until June 15,

1901. Light treatment and creosote were discontinued at that date. July 16th her weight was 119 pounds, cough had ceased, no bacilli in sputum, cavity apparently healed. The affection in this case has been stamped out and the patient cured of the results of this invasion of microbes. (See Plates 205 to 209.)

"No. 3. G. G. C., aged thirty-seven years. Express Clerk. Nativity, New York. Married. Contracted cold in December, 1899. Health continued to decline and tuberculosis was diagnosed. He had his sputum examined in May, 1900, but no bacilli were found. On June 1st he had another examination made and the bacilli were present. In spite of treatment, which seems to have been intelligent and skilful, he continued to decline in health. A cavity developed first in one lung and then in the other. In the fall it was thought best for him to go South and he went to Texas. The climate did not benefit him. On the contrary he lost ground steadily till the middle of December, 1900, when he came home to die. His physician referred him to me on his return home. It was with great effort apparently that he came to my office on January 1, 1901. He was greatly emaciated; there were good-sized cavities in both lungs. His pulse was feeble and rapid. Temperature running to 103½° every evening. Cough distressing, expectoration free. Sputum contained large quantities of bacilli. In fact his condition was such that I was not anxious to place him under treatment. But at the urgent solicitation of Dr. B. I took him under treatment.

"His first visit to my laboratory was accomplished with difficulty, although he had only one block to walk from the cars, which passed within three or four doors of his house, and it was only a ride of twelve blocks. His medication was Turk's emulsion of cod-liver oil, liquid peptonoids with creosote, and Fowler's solution. His light-treatment was daily exposures of one hour each from January 2, 1901, to June 1st. His improvement was rapid and remarkable. At the end of the first week he walked from his house to my office without fatigue, the cough was greatly mitigated; sputum decreased in quantity; temperature not above 101°; appetite greatly improved; night sweats decreasing. January 1st his weight was 131 pounds; January 14th his weight was 134½ pounds, showing a gain of three and one-half pounds in two weeks; 30th, his weight was 137 pounds, a gain of two and one-half pounds in the second two weeks, or six pounds in a month. April 3d his weight was 138 pounds, and has remained about that figure. By June 1st he was walking five or six miles a day. The sputum showed no bacilli. His lungs were cicatrizing, and he felt perfectly well. He procured an out-door position about the race-tracks, and treatment was suspended.

"This case is remarkable for the great and rapid improvement from the very start. I have treated ten cases in all. In every case cough, expectoration, temperature, and sudorosis have been relieved within the first few days. The appetite also has rapidly improved. While the period of experiment has been less than a year, the success

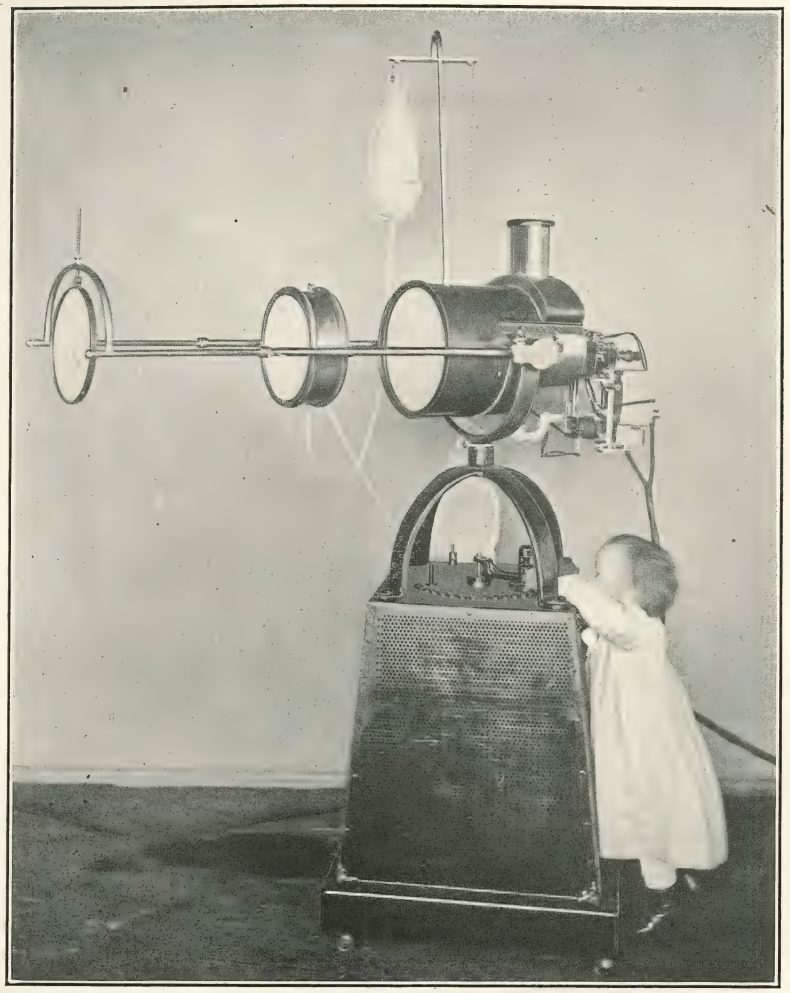


PLATE 205.—The series of ten Instruction Plates next following illustrate some of the uses of the new projection arc-lamp called the "Actinolite." It is made in three sizes, and uses currents from 25 up to 100 amperes. The child who ran to the rheostat to play with the switch just as the photographer snapped his camera gives a fair idea of the proportions of the medium 60 ampere apparatus.

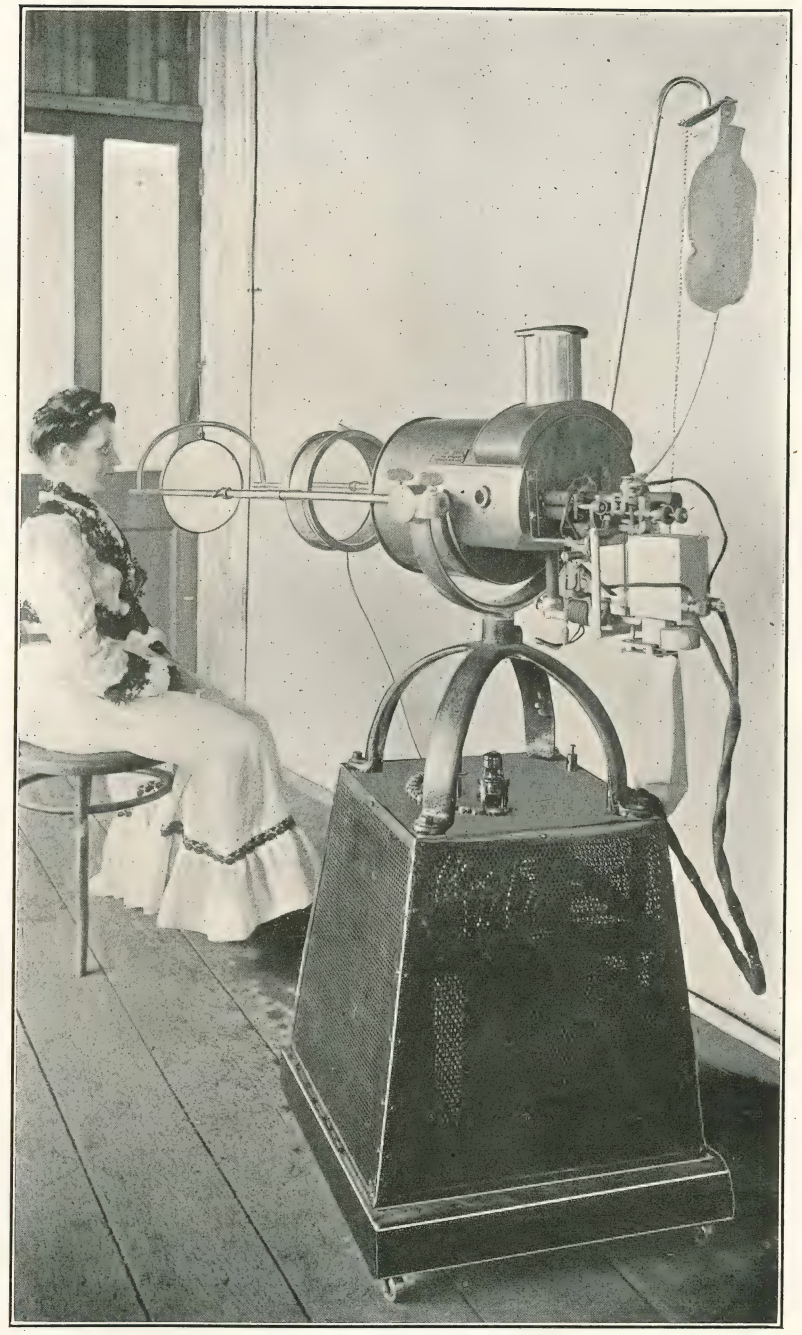


PLATE 206.—Showing adjustment to focus chemical rays on small area of cheek. Patient wears spectacles to protect eyes from glare. The water-bags keep a continuous flow of cold water through the filter seen just in front of the lamp-hood. The concentration lens near patient's face adjusts on sliding arms to the required distance.

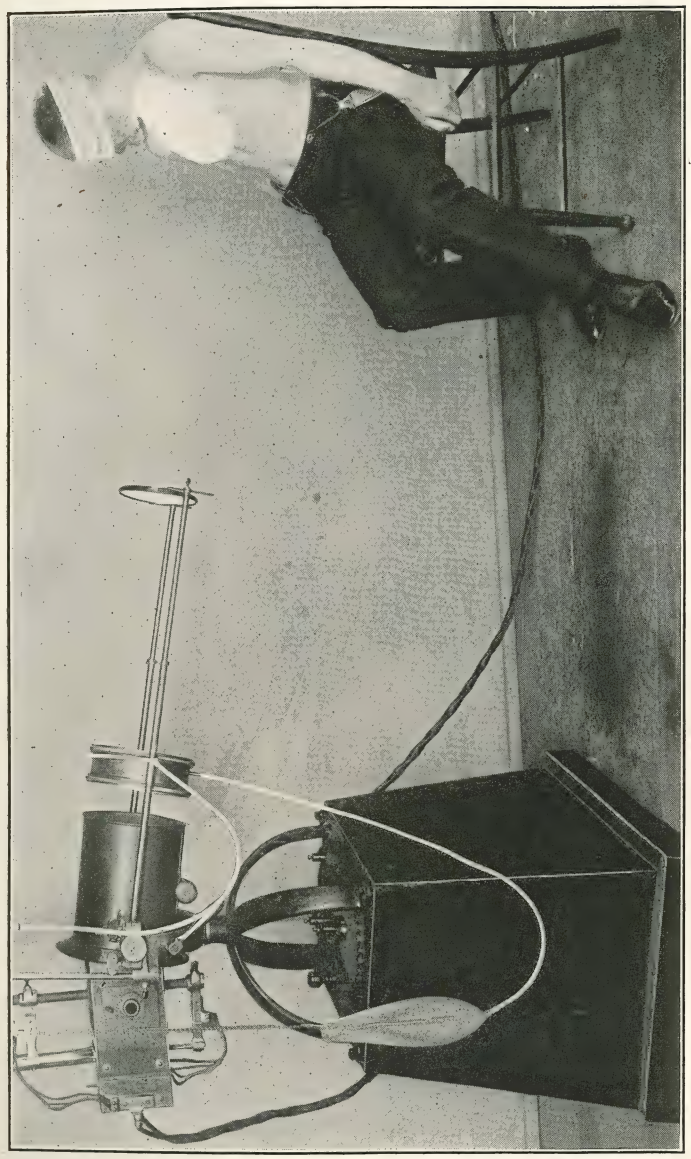


PLATE 207.—At this distance the lens is directing light rays over the area seen on the patient's chest. This represents an application to affected portion of the chest in tuberculosis.

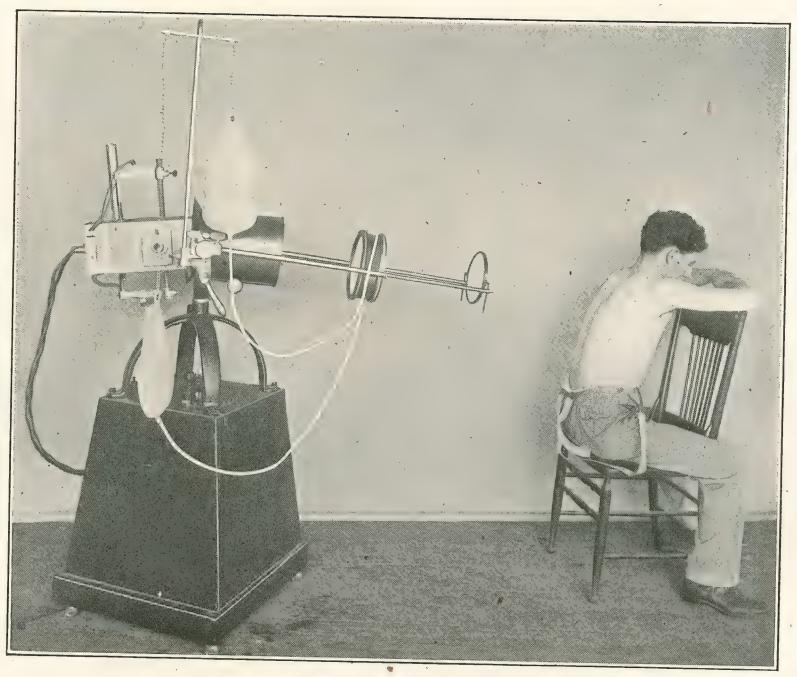


PLATE 208.—Showing a tuberculous patient seated with rays directed to back. By sitting patient nearer the lens the radiation is made more intense.

has been sufficient to warrant a continuance of the treatment. It seems to me that we are pursuing a plan of treatment that promises much in the future. I would add a word of caution. The patients should not be exposed to cold without very careful protection for some hours after taking treatment, as the pores are open. The sudden cooling of the skin after prolonged exposure to heat will overtax the kidneys and possibly produce congestion in them.

"I would advise careful examination of urine in every case where treatment is being given. The treatment could be better carried on in a sanatorium. It is hoped that this paper may induce a number of the profession to try this method that its place may be determined as a therapeutic measure." (HOPKINS.)

Under the caption, "The Profound Action of Chemical Rays upon Tuberculosis," we find the following summary of de Courmelles's experience:

"The violet and ultra-violet rays act, in common with static electricity, high-frequency, and X-rays, to produce certain favorable effects in both external and internal manifestations of tuberculosis. In separating the chemical-rays from the arc-light by means of a current of cold water and a quartz lens there may be produced with a low current (twelve amperes at eighty volts) sufficient rays to be effective in lupus vulgaris, lupus erythematosis, various dermatoses, and (what is a new fact) in pulmonary tuberculosis. External reaction inflammation is not necessary to demonstrate the penetration. A case of lupus with cutaneous and osseous lesions of twelve years' duration, with cough and a slight souffle at the left apex, was submitted in the Hospital of Saint Louis to the influence of the rays, and after five sittings of ten minutes each the souffle disappeared. (September, 1901.) Since then various patients have been treated, and, notwithstanding the absence of heat, have all experienced an immediate sense of well-being followed by diminution of the cough and improvement in the stethoscopic signs. These facts deserve to be pointed out with a view to their being confirmed or disproved, or at least made generally known." (See also page 486.)

Lest the new reader in these fields of physical therapeutics should think that fancy played a large part in the claims of men who report much greater benefits to tuberculous patients than routine medical training leads the practitioner to expect, it is well to say here that neither novelty nor extravagance exists in these claims. On pages 482-5 of my Manual of Static Electricity in X-Ray and Therapeutic Uses, we find that both cancers and consumption were benefited proportionately as much in 1790 by the feeble electric currents then used as they are being benefited in 1902 by the more powerful currents now used. All along the century scores of physicians have been treat-

ing and benefiting these cases; some more than others because of greater skill and better apparatus, *but all demonstrating the fact that in high-potential electric discharges the medical world has long had the most effective weapon known against the diseases for which X-rays and light-rays have now seemed to be new remedies.* In Chapter XXX of my Static book, written in February, 1897, may be read methods of treatment and results in thoracic conditions, including consumption, that surpass anything done with the newer rays and technics. Yet most of the medical world calmly ignores the great boon of electricity in tuberculosis and goes on its way seeking serums and specifics or exploiting some flash-in-the-pan new "cure," while practitioners have only to take the resources always offered them by electricity and benefit these patients beyond any claims yet made. Personally the author can vouch for the fact that with larger currents and the better teachings of experience he can far surpass the results he described in 1897. As X-rays, light-rays, high-frequency effects, and static currents are all very closely related electrical discharges their actions can be easily studied without mystery or clinical doubts.

Ichthyosis Hystrix Treated by the Electric Arc-Light.—Dr. G. W. Goler writes upon the case of a boy whose arms presented dirty brown scales, thicker on the anterior surface and thickly beset with protuberances one-eighth of an inch in height, which looked like cracked flat warts of dirty-brown color and gave to the touch the sensation of a horseradish grater. After anointing with lanolin, the light from a twenty-ampere lamp was projected for twenty minutes daily upon the parts through two eight-inch plano-convex lenses mounted in pairs. By the third day the skin had lost its warty appearance, and at the end of seven days the skin was soft and normal. Subsequent application of the light was made to the legs, and after twenty exposures of about thirty minutes each there was complete recovery, which has persisted for three months.

Local Anæsthesia by Blue Light-Rays.—The following communication will interest a great many who can put it to test and prove the facts for themselves. The reliability of the statement is vouched for by the circumstance that the writer is the Senior Medical Officer of the Imperial Bodyguard Cavalry Regiment of Russia:

"To-day scarcely any one doubts the energetic therapeutic action of blue electric-light. The undoubted superiority which belongs to blue electric-light depends upon its action on the vasomotor nerves. Cold blue light is more active at a certain distance than in close proximity. Certain effects of blue light are the reverse of those of white

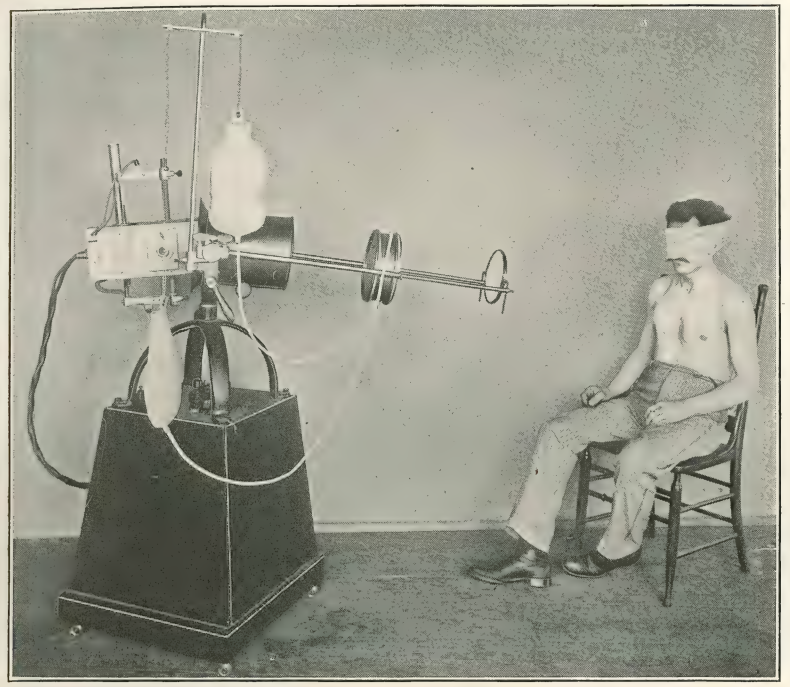


PLATE 209.—The same patient turned to direct rays on anterior surface in tuberculosis.

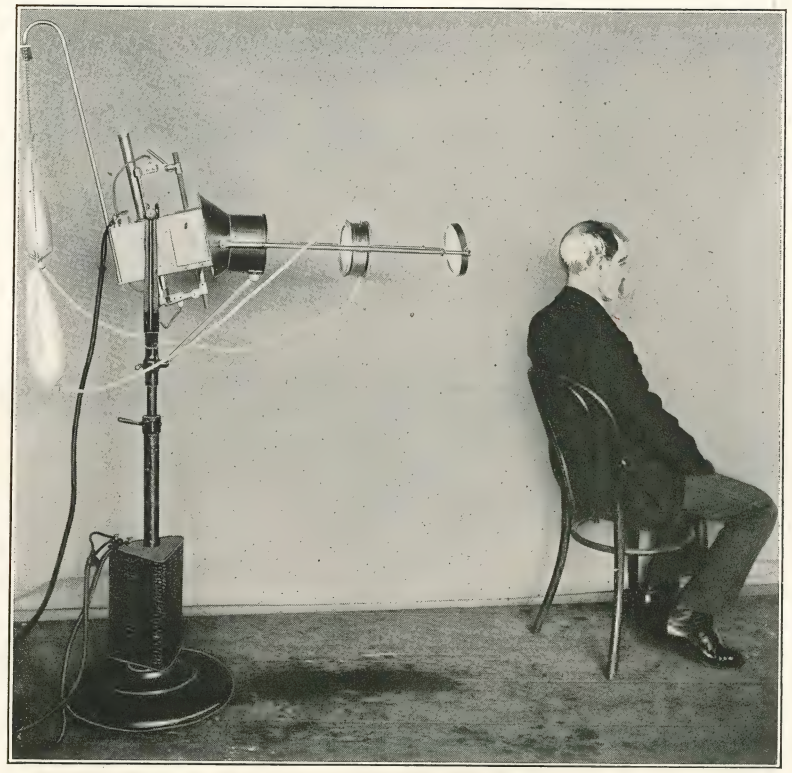


PLATE 210.—Showing the light-rays focussed upon a half of the scalp in parasitic disease. The current is on and the effect shown in the plate is exactly that of the light during the exposure without any retouching.

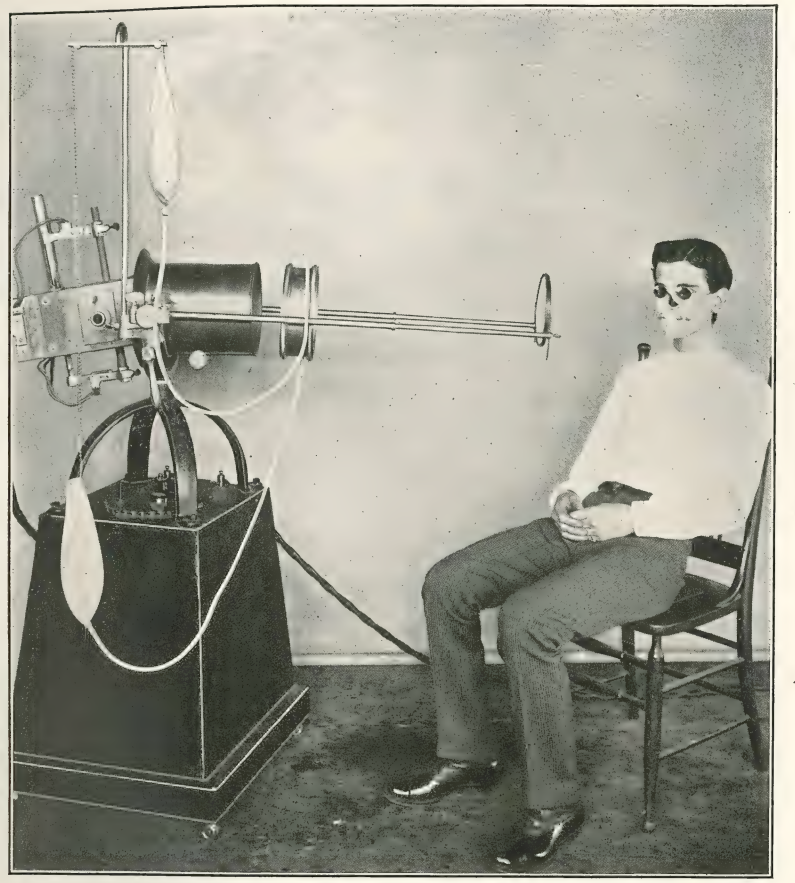


PLATE 211.—Showing rays focussed on end of nose and upper lip in lupus case. Patient is wearing dark glasses to protect eyes. No attempt at compression is made. For local applications this lamp is less efficient than the L. and G. lupus lamp for the reason that it acts on the tissues only at a very long distance from the source of light. It also uses four times the current.

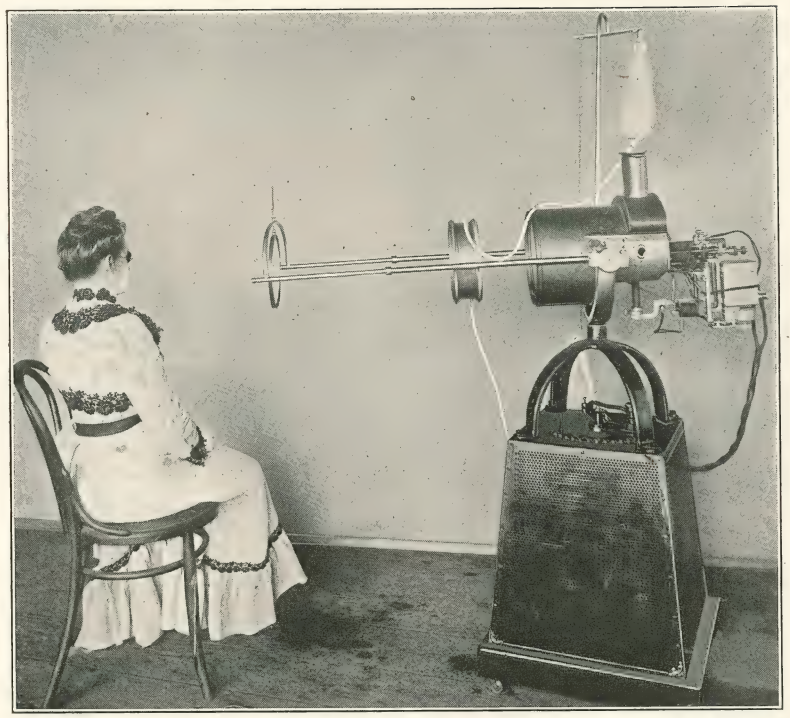


PLATE 212.—Showing a side view of lamp focussed on small area of face. As an experiment in attaining high candle-power with heavy currents this lamp was designed more for general treatment than for small lesions. It is probable that it will be improved in many ways.

light. For instance, a granulating surface will become anæmic under blue light and hyperæmic under white light.

"*The degree of pain-relieving power possessed by blue electric-light is far greater than I had hitherto supposed.* Although I had often been astonished at the alleviation brought about so quickly by the blue electric-light in acute pleurisies, still I had only used it for making a tender spot tolerant to investigation, but now my experience has shown that far stronger claims may be made for its action in this respect. *We now resort to the application of these rays instead of cocainization to render painless incisions and stitching of wounds, and the blue electric-rays not only cause a more complete anæsthesia, but powerfully promote healing from the beginning.* As examples I may relate two cases:

"1. Mr. X., Secretary of a foreign embassy, cut his finger with a piece of glass. The cut was on the outer side of the third finger and about three centimetres (more than an inch) long. After a ten-minutes' radiation with blue light from a small lamp of fifty candle-power, two stitches were made without pain. Healing commenced at once and was complete in four days.

"2. A soldier of the Bodyguard Cavalry Regiment cut the dorsal surface of his left thumb, the wound being three centimetres in length. After cleansing and a ten-minute radiation with blue light three stitches were introduced and the patient felt no pain. He chatted the whole time with those present and described the sensation as if 'a soft cotton ball was pressed on to the wound.' Healing by first intention was complete by the third day. These two cases place beyond doubt the fact that stitches may be introduced and removed without pain under the influence of blue electric-light." (DR. MININ.)

The Arc-Light Cabinet.—The arc-light bath cabinet is an entirely different apparatus from the incandescent lamp bath cabinet and has a materially different therapeutic range. It provides a general exposure of the nude surface of the entire body to the nutritional or alterative action of either whole or filtered light associated with *moderate* heat. By connecting brush electrodes within the cabinet to a high potential coil or Static machine an ozone spray can be discharged during any portion or all of a bath séance in the treatment of pulmonary cases. I have seen two cabinets equipped for ozone sprays, and it is a very simple matter to add the feature to any cabinet when desired.

The particular arc-light cabinet shown in this section is new. It is made in sections so that it can be set up or taken apart with little trouble, and when in use rolls easily on castors and can be moved to any part of a room. The "bed" has a mattress covered with a germ-proof and fire-proof material, and the walls are white enamel. The entire inside can be washed with antiseptic solutions. The exterior

is oak. The door is in panels so that any desired section can be opened or closed at will. Convenient to the head of the couch is a glass cuspidor to receive expectoration. It can be removed and cleansed at will. The light is furnished by two arc-lamps of either ten or fifteen amperes, as may be selected by the operator. The adjustment of the carbons is automatic, and "protectors" keep sparks from flying during treatment. A rheostat controls the regulation of the light and a *ventilating* device affords regulation of the degree of heat, which is registered outside the cabinet by a thermometer placed in view of the operator. A sliding panel fitted with blue glass enables the operator to inspect the interior when desired, and to communicate with the patient. The lamps are four feet above the recumbent patient and the light may be used as white, whole light, or it may be filtered through blue media for the more exclusive action of the chemical rays. The main objects of the cabinet are the treatment of tuberculosis, diseases of the respiratory tract, and general skin diseases—conditions which it is assumed that combined light, heat, and ozone can favorably affect. In these cases adjunct treatment must not be neglected, as no one agent can meet all indications.

The Instruction Plates 215 to 219 will make clear the uses of what is essentially an isolated compartment of the Light-Room of Finsen, described in another place. We need not dwell on its physiological possibilities or therapeutic advantages, as these are part of the whole subject of this section. It will be sufficient to cite the most recent remarks of an American physician who claims a clinical experience of now eight years with the treatment of many patients in an arc-light cabinet: *

"It is only necessary to keep in mind the condition of patients for whom *a general arc-light bath* is indicated to appreciate how essential it is that the *entire body* be exposed to the action of the light, and this, with a minimum of discomfort and without danger of chill. No better reason need exist than the well-being of the patient to lead us to select the cabinet as a means of exposing the entire body to the radiant energy of light, for it is self-warming and superior to an open room in all cool seasons of the year. That arc-light therapy produces some physiologic effect by reason of its heat-rays cannot be gainsaid in view of the well-established action of heat upon nutrition, and in the class of cases for which the cabinet treatment is indicated the moderate warmth is extremely grateful as well as beneficial. Nor should the value of the ozone generated be lost sight of. Its physiologic action is to increase the number of red blood-corpuscles, the hæmoglobin, the urea, and to establish nutritive changes, and, therefore, in the arc-light bath the benefit is not the result of actinic rays alone.

* Condensed from the Journal of Physical Therapeutics.

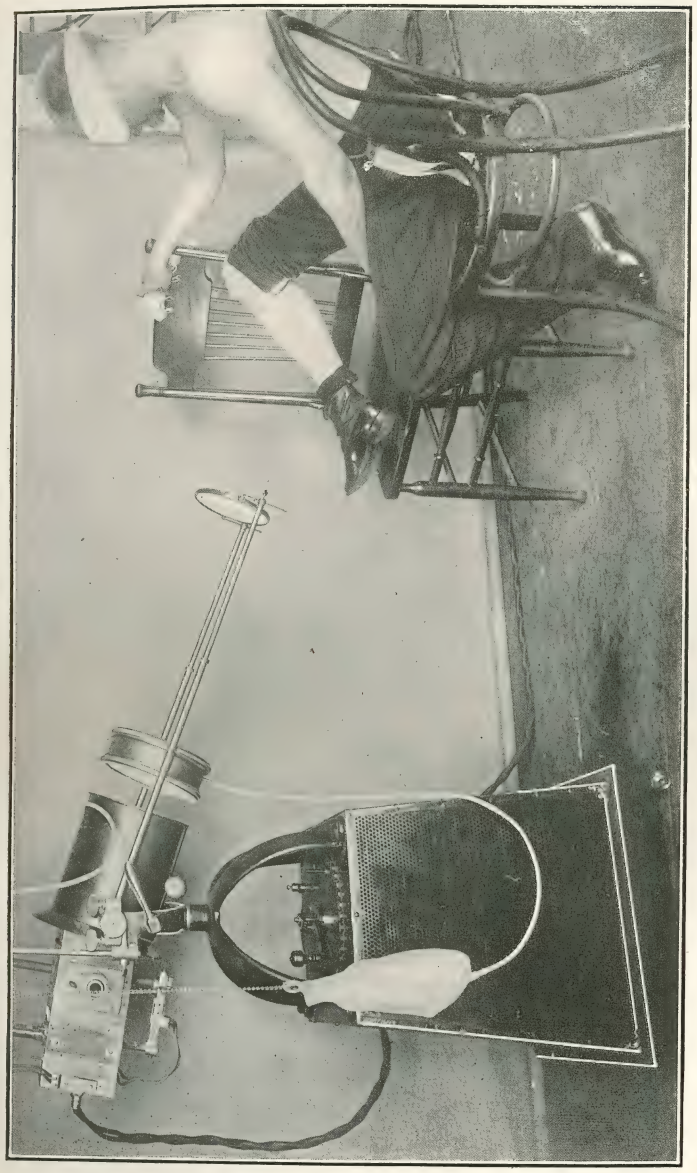


PLATE 213.—Showing lamp adjusted to direct rays on lesion of the leg. Patient sitting.

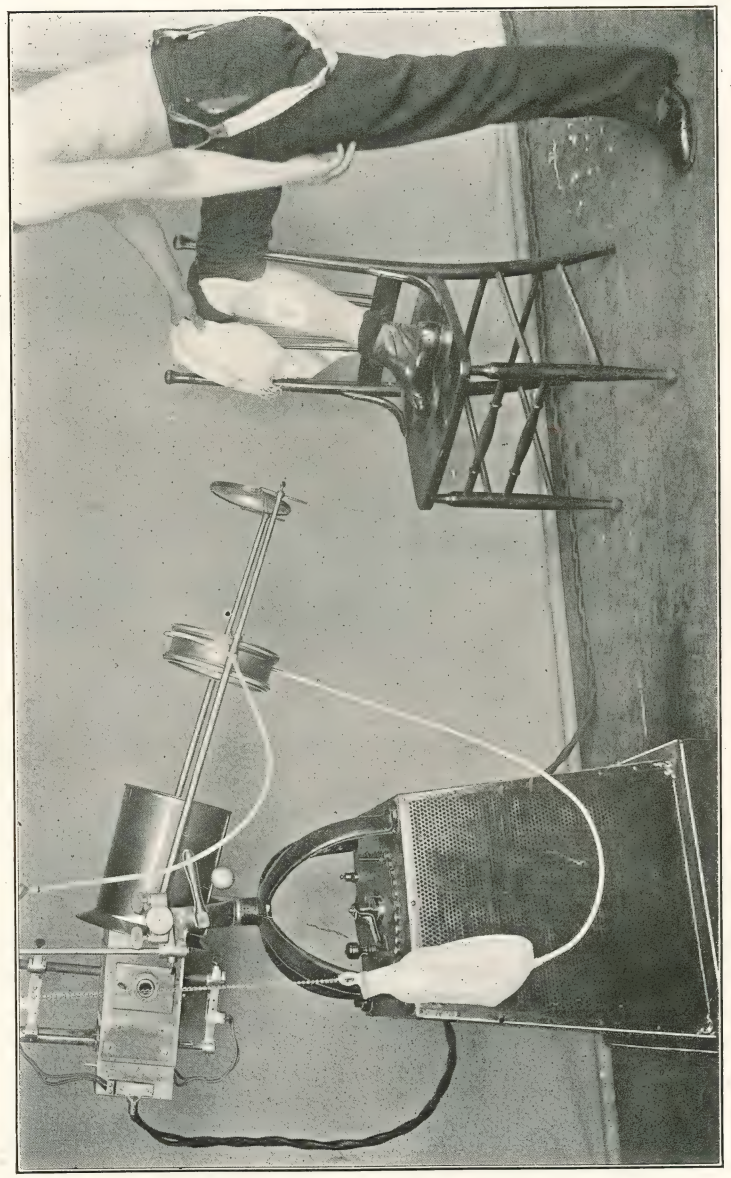


PLATE 214.—Treatment of ulcer on leg with patient standing. By the use of high currents this lamp aimed at reducing exposure time to a few minutes, but in its present form requires further improvement. It is here shown chiefly to illustrate the early phases of the development of photo-therapy as fully as possible in this work. It affords excellent comparison for study.

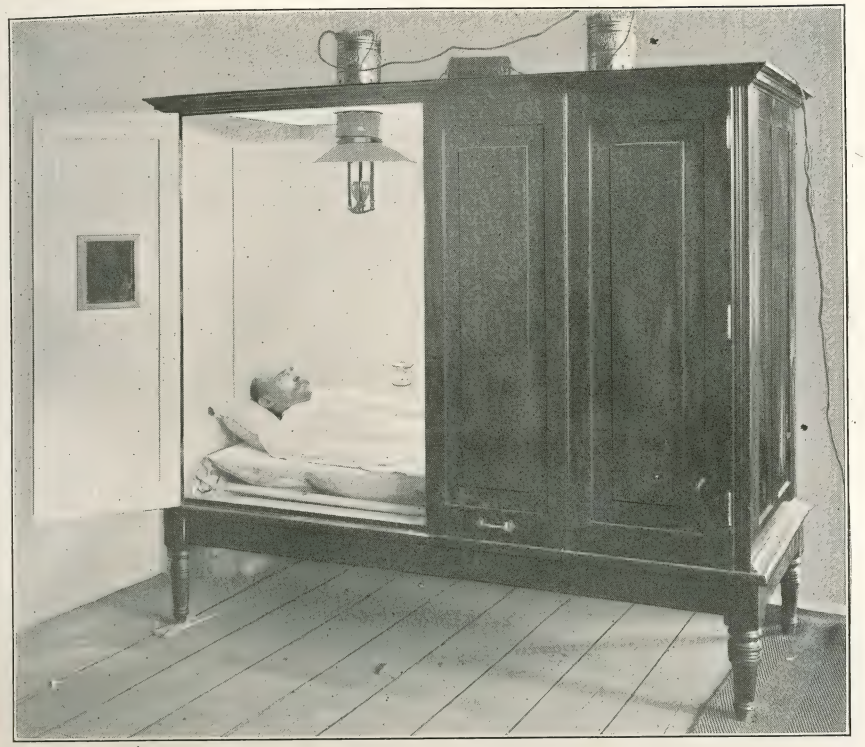


PLATE 215.—The five Instruction Plates immediately following illustrate a new Arc-Light Cabinet having two 15 Ampere lamps, with special reference to the general administration of the chief chemical rays with only a small amount of the heat rays. Especially designed to treat pulmonary tuberculosis and general skin diseases. Also for general tonic alterative effects. See text for full description and clinical information. This plate shows the patient on the asbestos couch covered with sheet, and last doors of cabinet ready to be closed. The blue glass observation-window seen in the open door gives the operator a view of patient during treatment. When the cabinet is closed direct patient to remove sheet to allow rays to reach entire body without hindrance. The cabinet only attains a comfortable warmth. It is not a "radiant heat" apparatus.

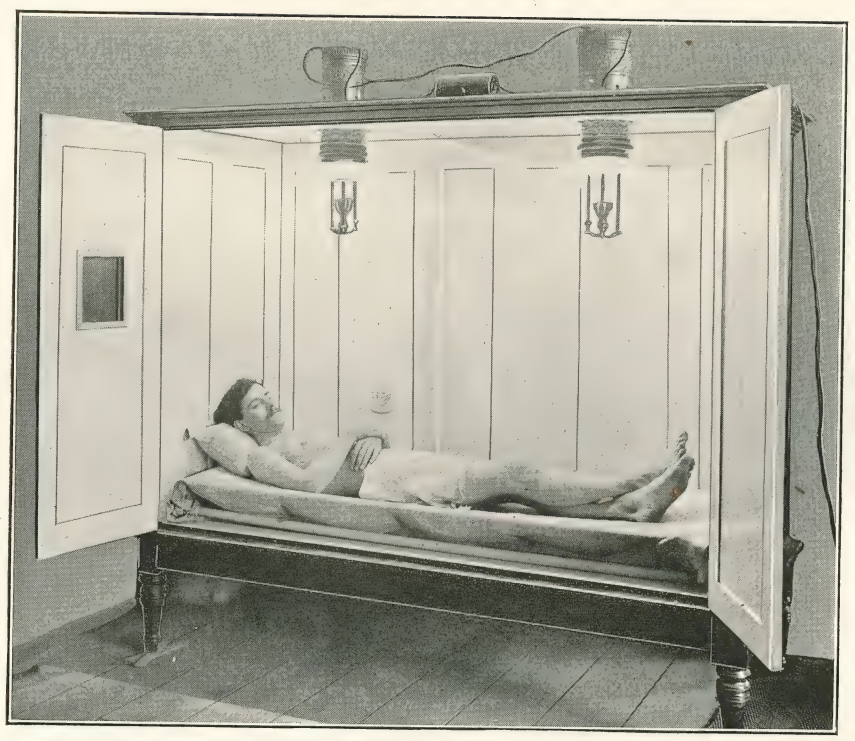


PLATE 216.—This Plate shows the Cabinet with front open and both lamps in view. The small glass cuspidor near patient's head is for expectoration during treatment. Instruct patient to breathe deeply while in the cabinet.

Some action from the visible spectrum as well as from ozone must be considered.

"The effects noted from the clinical administration of electric arc-light baths in such a cabinet as is here described have included the establishment of circulatory changes with a uniform regulation of the heart's action—as shown by improved volume and slower rate of pulse—a temporary and slight rise of temperature, increased activity of the skin, improved respiration, fuller and slower and gradually increasing respiratory capacity, and diminished irritability of the mucous membranes and lessened discharge in tubercular, bronchial, and asthmatic patients and in catarrhal conditions of the nasal passages.

"There is an increased excretion of urea and CO_2, accompanied by an improvement in nutrition and function. Patients treated in the cabinet have uniformly presented an appearance of being rested and refreshed, and not infrequently they fall asleep during the administration. In diseases of the respiratory system a soothing effect upon the mucous membranes is always experienced, while, from the first bath the cough and expectoration diminish. This has been regularly noted in every case of pulmonary tuberculosis, but in advanced cases the relief has not been maintained. Every case of bronchitis has also had prompt relief from the cough and expectoration. In persons convalescing from acute bronchitis, broncho-pneumonia, and grippe, with constant harassing cough, inability to sleep, great physical weakness, lowered nerve-tone, etc., relief has been obtained from the first treatment, characterized after a few moments in the bath by fuller and freer respiration, lessening of the irritability of both nasal and bronchial mucous membrane with diminished cough and expectoration.

"Upon the conclusion of the treatment they have invariably presented an appearance of increased vitality which has been evidenced by improved respiration and pulse as well as by a sense of well-being which without exception they have themselves remarked upon. These improved conditions seem to point to something which acts directly upon the mucous membrane as a powerful oxidizing agent. Even in cases where the cough was incessant there has been complete relief during the twenty to forty minutes spent in the cabinet bath.

"From the well-known physiologic action of ozone it is felt that it is a vital factor in *general* applications of the electric arc-light for diseases of the respiratory passages. In profound anæmias, in the various manifestations of disturbed nutrition, in neuritis, rheumatism, and in such skin affections as acne, eczema, and psoriasis, the results are due to the chemical rays mainly. Their influence upon the capillary circulation initiates the circulatory and resultant nutritive changes, followed by the disappearance of the special manifestations of disease characterizing the individual case. That the same physiologic action takes place when the condition is one in which the respiratory passages are involved goes without saying, but the speedy relief obtained from difficult respiration and harassing cough would seem to point to an agent acting directly upon the mucous membrane rather than indi-

rectly through its influence upon the peripheral circulation. It is unnecessary to recapitulate here the various pathologic conditions in which the arc-light bath is valuable. The therapeutic indications are as broad as those for sunlight and pure air."

Notes on Actions and Effect.—In writing of his photo-therapy Finsen contributed the following note on arc-light baths in October, 1900:

"For five years or more I have had a general form of light bath in mind to give an exposure of the whole body to the chemical rays of light. This idea I have carried out in practice, but have not published anything about it. . . . These chemical light-baths, such as I have suggested and carried out, are quite different from the electric light 'radiant heat' baths in their effects. They are cold as to temperature, they produce a very strong action of light on the skin of the highest value, and have an excitant action which needs further study. The dilatation of the capillaries and blood-vessels of the skin produced by light is not altogether an acute or rapid process, but is in reality of long duration. *The light treatment of the skin will result in dilatation of cutaneous vessels and determine a more active blood-supply thereto, which in its turn must be assumed to favorably influence nutrition and enable the skin the better to perform its functions.*

"For my *light baths* I sometimes employ the sun and sometimes the arc-light. In the sun-baths the patients promenade naked in a sunlit yard where everything is done to keep down the temperature in order to avoid sweating—by frequent sprinkling of the ground or by shower-baths on the skin to reduce its temperature. The effects are widely different from those of sun *sweat*-baths.

"My 'electric-light baths' consist of a circular room about forty feet across, with two immense arc-lamps of 100 amperes each placed in the centre about six feet from the floor. Radiating partitions from the centre of the room divide it into several compartments with beds placed in an inclined position. On these beds entirely naked the patients rest. The temperature factor of the light is so low that the room must be artificially warmed for the comfort of the patients, yet the chemical action on the skin is as strong as powerful sunlight. It produces a pleasant sensation of slight prickling and warming on the skin. In some persons an exposure as short as ten minutes will produce a pronounced erythema, while others will have only a slight reddening after an hour's exposure. There is, therefore, a great difference in individual susceptibility to the action of chemical rays on the skin, and some care must be exercised in regulating the exposure-time."

The different degrees of effect of the three light baths (white incandescent, blue incandescent, and blue arc) upon the pulse and temperature of the same persons have been carefully studied by Dr. Bokemeyer. The tests were made at the same hour of each day under exactly similar conditions with all precautions to ensure scientific accu-

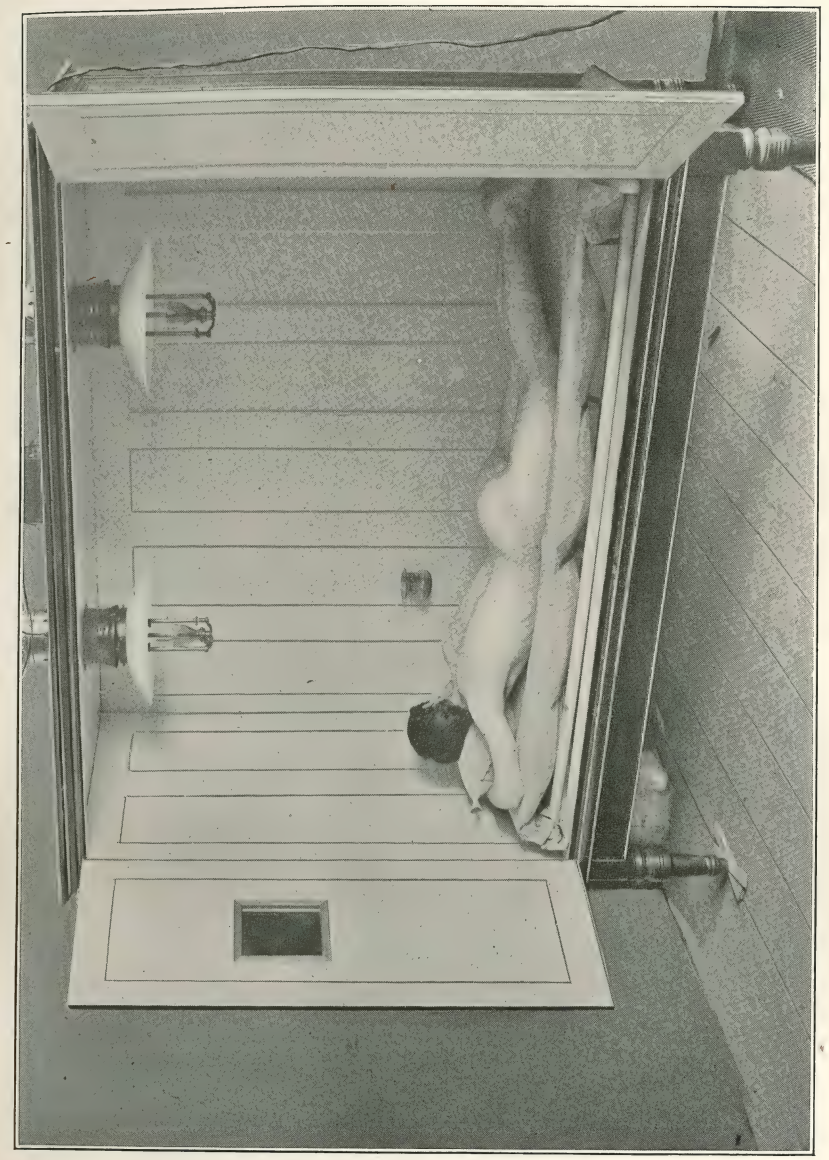


PLATE 217.—Another view of the Arc-Light Cabinet showing patient exposed for general application of the rays to entire spine and back of body. He can turn to either front or dorsal position at any time the physician directs during treatment.

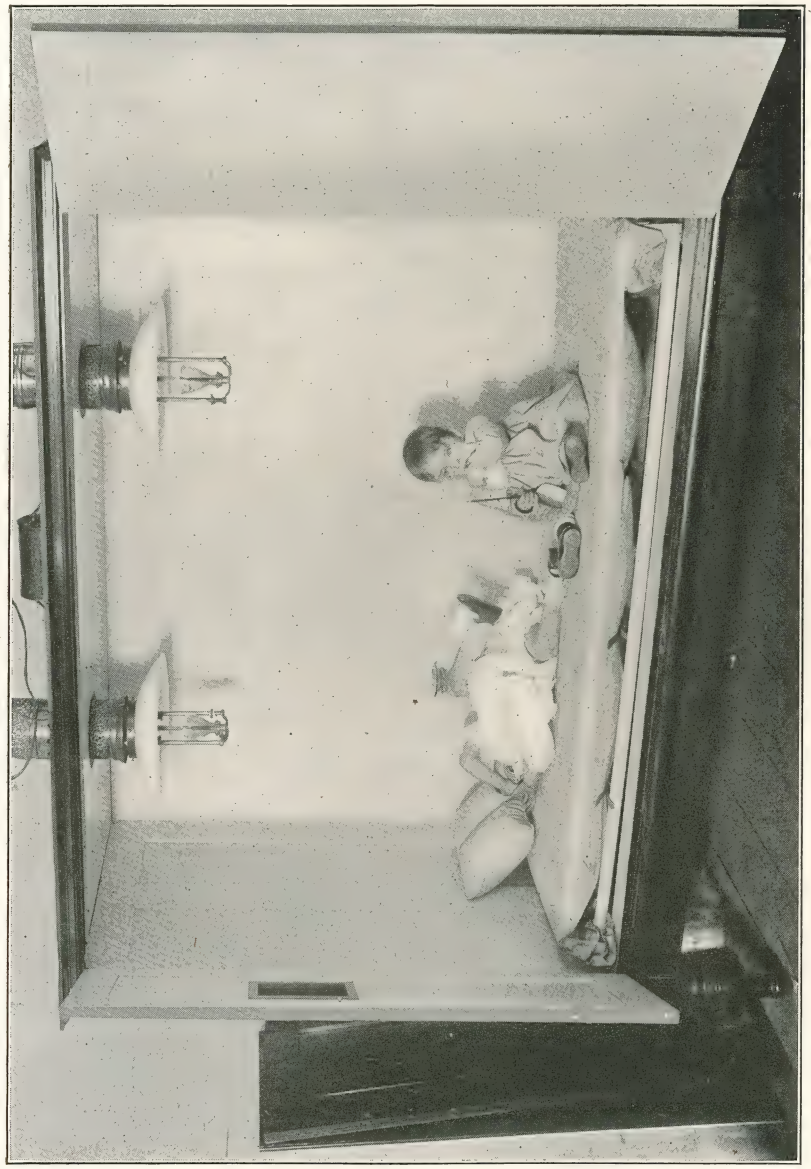


PLATE 218.—Showing how two or more little children can be treated in the Cabinet at once. Remove the clothing and let them romp and play in the bath for fifteen minutes. There is no sensation save that of the comfortable warmth. No dark glasses are needed to shield the eyes, as a screen below the arc protects the patient from the glare.

PLATE 219.—This Plate shows the Arc-Light Bath Cabinet as it appears when closed with patient inside. The thermometer near the observation window records the temperature during treatment, and this usually reaches 95 to 100 degrees F. Each section of the front is removable, and on casters the apparatus can easily be rolled to any part of a room.

racy. Exposures were limited to the time required to raise the bath from an initial temperature of 77° F. to 144½° F.; and this was eighteen, twelve, and twenty minutes in the white, blue, and blue-arc tests. Omitting the extensive details and tables of these observations we find that the results show:

1. The White I. light raises both pulse and temperature to a much higher degree than either kind of light filtered through blue media. The increases were not proportional and varied in different individuals; ranging from twenty-five increased beats per minute and 3.30° F. to fifty-nine beats extra pulse rate with only 1.90° F. added to the temperature of the body. The whole white light excels in radiant-heat effects. The red-rays in whole light are the strongest exciters of the whole nervous system. Removing the red-rays by a blue filter we next note:

2. Under Blue I. light, pulse and temperature were influenced within a narrower range, and, though the bath heated to 144° F. in a third less time, the action was milder despite the rapid heating. Pulses were increased only from four to thirty-nine and body temperatures from 36° F. to 1.26° F. The blue filter therefore gives, at the same heat, a very different effect upon the pulse and temperature. Its use will be indicated when it is desired to produce quick perspiration without great excitement of the nerves.

3. The Blue Arc-light causes only small fluctuations to pulse and temperature. In some cases the pulse remained nearly normal. The highest increase was thirty-two. In some cases the temperature by the mouth remained normal while the greatest rise during an exposure was 72° F. This form of light is used for the chemical actions of blue-rays in larger quantities than the small candle-power of incandescent lamps yield, and when the sudorific effects are of the least importance.

With whole white light a strong irritation of the skin is often felt by the patient, while in the blue arc-bath the sensations are extremely mild. Yet in these tests the arc-light exposure was twenty minutes.

Perspiration generally commenced when the heat of the bath reached 3.60° to 5.40° F. above the body, but with *whole* light often began before blood-heat was reached. In one case it commenced at 83.75° F. This occurs from the fact that radiant-heat radiations act direct upon the sudorific nerves. When the red rays are filtered out by blue globes the sudorific effect becomes less for the same incandescent lamp and still less for the arc-light.

In studying the effect of the appearance of perspiration upon the heart and temperature it was found that it had a decided influence

in preserving the equilibrium, and that the subjective well-being of the patient was never disturbed. Anguish, oppression, palpitation of the heart, and difficulty of breathing do not occur in connection with light baths under therapeutic regulation.

Bokemeyer also noted the difference in weight after each form of light bath. It varied from a half to a full pound only in the above tests, though the difference is generally one to one and one-half pounds when the white or blue incandescent baths are given their usual time, and temperature of 155° to 167° F. In the reported tests they were kept down to the average of the arc-light baths, which are seldom carried beyond 144.50° F. We will next take up the subject of light-rays from glowers which are enclosed in low-vacuum bulbs, and shall see that great variety is already entering into this form of therapeutic apparatus—as yet scarcely known by name to thousands in the medical profession.

CHAPTER XLVI

PHOTO-THERAPY: INCANDESCENT ELECTRIC-LIGHT CABINET BATHS

Distinctions in Character of Light-Baths. Flotsom. Physiological Actions of Mixed and Whole-Light Rays. Dr. Kellogg's Cabinet Apparatus. Technics of Treatment. Studies in Facts and Faults.

In the consideration of incandescent electric-light baths it must not be forgotten that these lamps are of small candle-power (the usual reading lamp is but sixteen candle-power), while therapeutic arc-lights have run from 20,000 up to more than 60,000 candle-power. Obviously the lesser *total* of rays must be proportionately less in chemical-rays and the ability of light to kill bacteria, to cause inflammation, to produce pigmentation of the skin, and, finally, its exciting action, are all bound up with the chemical rays; and to be therapeutically energetic they must not only be present, but must be richly abundant, concentrated, and brought close to the specially prepared part. Note that the conditions in the incandescent-light bath are the antithesis of this. The candle-power is small, the chemical rays are few and not concentrated, they are not brought very close to the tissues, and the general field of treatment is not rendered anæmic. Neither is the field of treatment a mere spot, as in the Finsen method, but is any region or all of the body save the head. It is not only important to keep this distinction clear in our study of this therapy, but we must also note that there are several classes of incandescent-light baths of quite different degrees of action.

1. The Kellogg (and German) bath cabinet, now very widely used in foreign sanitariums, and well known in this country but less used than abroad, which is a luminous "radiant-heat" bath, producing sweat and alterative actions without much raising the patient's temperature or that of the cabinet. Perspiration takes place with the patient in an atmosphere of about eighty-five to ninety-five degrees.

2. The newer "Radiant-heat" bath of Dowsing, which employs specially constructed electric lamps of the incandescent type, and which

raises the temperature of the cabinet and of the patient as much or more than the " Dry hot-air apparatus."

Therefore, do not let the terms " electric-light treatment," " electric-light bath," " radiant-heat bath," etc., confuse themselves in your mind. It is important to apply each to its proper use and to no other. Distinguishing terms would be:

1. Radiant-heat baths. (High temperature luminous-rays.)

2. Sudatory Light baths. (Inducing sweat at low temperatures; 85° to 95° F.)

3. Chemical Light baths. (Arc-lights with main heat-rays excluded.)

Before passing to the more scientific study of these rays it will be of interest to note a few of the ephemeral and waif-like mentions in current medical literature which do so little to inform the practitioner of what he needs to know, but which may here point the way to fuller knowledge in connection with the text. Floating through current medical literature we find considerable variety in scattered references to observed effects of red, blue, and white light. For the benefit of combined therapeutic suggestions we may note a sample of each:

" The *Lancet* in a recent number remarks that in our conscious superiority to our forefathers we have been used to look with contempt on their ways of treating cases of small-pox by means of red light in the form of red blinds, curtains and coverlets, but with our present knowledge of the chemical and physical action of the different rays of the spectrum and the influence of light and darkness on life's highest and lowest manifestations, we may have felt a suspicion that whatever the theory of the mediæval physician, their freaks may have had a scientific basis.

" In a late number of the *Zeitschrift für Krankepflige*, we find that it has been tried, and apparently with remarkable results, in the treatment of measles. A child eight years old was stricken with measles. On the second day he was brought under the influence of red light. In three hours the rash disappeared, the fever subsided, and the child was apparently well, wanting daylight to play in. The red blinds were removed and daylight admitted to the room, but in three hours thereafter the medical man was again summoned and found the rash and fever had returned and the child was weak and prostrate. The red light was again resumed, the rash again disappeared in a little over two hours as did the fever, this time permanently. In two more days the child was well in every respect.

" Strebel gives a somewhat lengthy account of his experience with light-baths, having apparently found them useful in any form of disease in which they were tried. He mentioned especially that they

were valuable in kidney and heart-disease, in diabetes, and obesity. It had particularly good effects in arteriosclerosis and fatty heart."

" Minin achieved remarkable results by the use of electric light in the treatment of superficial wounds, burns, and a few cases of skin eruptions. The effect of electricity in these cases depends on the light and not the heat, inasmuch as the best results are obtained with the light at a considerable distance from the body. Blue light constricts the blood-vessels and produces marked anæsthesia, while white light has the opposite effect. The anæsthesia caused by blue light is as marked as that produced by cocain, and the author employed it successfully in minor surgery. Two cases are cited in which superficial wounds were sewed up under the influence of blue light of fifty candle-power, without the patient experiencing the least pain. Contusions due to falls were promptly cured by blue light. In one case, a burn of the first degree yielded to two applications of the blue light from a lamp of fifty candle-power, each sitting lasting ten minutes. In another case of injury to the mouth, throat, and œsophagus caused by the accidental ingestions of ammonia, several applications of the blue light accomplished a complete cure. The light was directed to the mucous membrane of the mouth and in front of the neck and chest. A case of rheumatic purpura was cured by the application of white light from a fifty candle-power lamp followed for a few minutes by blue light from a lamp of twenty-five candle-power. In another case of simple purpura five applications of the electric-light resulted in a cure, after other remedial agents failed. The treatment also exerted a beneficial effect on the general nutrition of the patient."

" Gerault of Paris recently had as a patient an employe of an electric machine factory, who had a severe case of chronic rheumatism. Upon being assigned to some special work in a room where the rays from a fifty candle-power incandescent lamp fell horizontally on him at close range he soon noticed a marked diminution of the pain and reported it to his physician, who had similar lamps placed in his office. Rheumatic and other cases so far treated have given excellent results."

Says Dr. Robinson: " In the field of dermatology the use of light as a therapeutic agent gives promise of great value. I have known a long-standing case of eczema universalis permanently cured by the sufferer exposing himself, nude, to an hour's sun-bath under a large window on all sunny days during July and August. All other conditions remained the same. All previous treatment had totally failed."

We will now begin the study of psysiological actions as a guide to therapeutics. Dr. Sibley of the N. W. London hospital gives us the following suggestive study in connection with radiant heat:

" I now propose to mention some facts relating to the addition of luminous rays to non-luminous heat. I am especially interested in experiments to determine which of the light-rays have the most pene-

trating therapeutic effects. A great many observations on this subject have been made on plants and the hæmoglobin of the animal cell has been compared to, and has many functional similarities with, the chlorophyll of the vegetable cell. There are therapeutic principles in these observations:

"A.—*General.*

"1. *Action of Rays of Different Refrangibility.*—The rays of different refrangibility which together constitute sunlight, and appear as variously colored bands in the spectrum, vary in their physiological action on the processes of plant life. Chemical changes, so far as they are in the main dependent on light, are produced chiefly or solely by rays of medium or low refrangibility (namely the red, orange, yellow, or green). This is the case, for instance, with the production of the green color of chlorophyll, the decomposition of carbon dioxide, and the formation of chlorophyll, starch, or sugar. On the other hand, the rays of high refrangibility (the blue or violet as well as the invisible ultra-violet rays) are the principal or the only ones which produce mechanical changes, so far as these are dependent on light. It is these rays which influence the rapidity of growth, alter the movements of the protoplasm, compel swarm spores to adopt a definite direction of their motion, and change the tension of the tissues of the mobile organs of many leaves, hence causing movements.

"2. *Action of Light of Different Intensities.*—That the action of light on plants varies with its intensity, as does temperature with its elevation, admits of no doubt, and is obvious in all physiological observations.

"3. *Penetration of the Rays of Light into the Plant.*—The rays of greatest refrangibility are in general almost entirely absorbed by the superficial layers of tissue, while the red light penetrates most deeply.

"B.—*Special.*—(1) *Chemical Action of Light on Plants.*

"(*a*) *Formation of Chlorophyll.*—All the visible parts of the solar spectrum have the power of turning the etiolated chlorophyll granules green, but the yellow rays and those nearest them on each side are the most powerful, and this is also the case with the exhalation of oxygen from cells containing chlorophyll.

"(*b*) *The Decomposition of Carbon Dioxide.*—The influence of light upon the evolution of oxygen is greater the more carbonic acid is contained in the air; only those rays which are visible have the power of decomposing carbonic dioxide, and those which appear brightest to the eye (the yellow rays) are alone as efficacious in this process as all the others put together.

"(*c*) *The Formation of Starch in Chlorophyll Granules.*—The formation of starch is a function of chlorophyll granules exposed to light, its absorption a function of chlorophyll granules not exposed to light. The formation of starch in chlorophyll granules depends on conditions which favor assimilation; and the principal feature of the

PLATE 221.—The Upright Electric-Light Bath. The general indications for this apparatus are the same as for the horizontal cabinet, and the application is the same, but persons suffering from cardiac lesions, and especially obese patients, are often more favorably treated in vertical positions.

PLATE 223.—The Horizontal Electric-Light Bath. This form of cabinet is most convenient for general purposes when sufficient floor-space can be commanded. From sixty to one hundred sixteen-candle power incandescent lamps are required for the various degrees of dosage. The cabinet is freely ventilated, and the temperature of the air within it may not be greater than that of the room in which it is placed.

process, the evolution of oxygen, proceeds vigorously in light consisting of red, orange, yellow, and to a certain extent of green rays; while the more strongly refrangible half of the spectrum, consisting of green, blue, violet, and ultra-violet rays, has only a very slight effect.

"(2) *Mechanical Action of Light on Plants.*

"(*d*) Without discussing the question, it may be briefly said that the influence of light on the movements of protoplasm varies according to the nature of the motion.

"(*e*) *Cell Division and Growth.*—Light retards growth; but it is only the rays of high refrangibility, the blue, violet, and ultra-violet, which act in this way.

"(*f*) *Action of Light on the Tension of the Tissue of the Organs of Leaves endowed with Motion.*—It is only the more refrangible rays that produce a paratonic effect, while the red rays are inert.

"These few remarks on the actions of the various light rays upon plant life would seem to open up a wide field for experiment and observation with regard to the treatment of diseases by different light-rays in addition to heat-rays. It is probable that as we learn more of the pathology of those conditions we are accustomed to treat we shall be able to decide beforehand what particular colored rays would be most serviceable to the treatment of any given disease. Apart from some general principle, if we desire a treatment which shall not tend to produce burning of the skin, but one which will penetrate into the tissues, we shall use the red-rays, and *vice versa*. As a matter of experience, I have found the heat produced by red-rays far more soothing and less irritating in its effect than using the whole of the rays of the visible spectrum together.

"With regard to the general effect of the luminous rays there is no doubt that the addition of luminous rays to ordinary non-luminous radiant heat produces an increased diaphoresis. Patients who do not sweat with non-luminous heat very quickly do so when some light rays are added, and this is often noticeable even at a lower temperature than had been previously tried."

From plants to human beings may seem a long stride to many, and some may think the above a mere laboratory study with no practical application, but in Cornell University and other experiment stations it has been demonstrated that the electric-light is a physiological alternate for darkness. One of the most complete and important researches ever made into the actions of general light-rays on human beings may be read in the classical paper of Dr. J. H. Kellogg, who has kindly furnished us the substance of his work for our instruction here. It is as follows:

"Siemens found that the plants exposed to ordinary daylight and six hours of electric-light in addition 'far surpassed the others in darkness of green and vigorous appearance generally.' Strawberries and

other fruits were fully equal to those raised under ordinary conditions, and grapes were of stronger flavor than usual. Melons were remarkably large and aromatic, and bananas were pronounced by excellent judges to be 'unsurpassed in flavor.' Many of these experiments have been repeated in this country and with similar results. The most important experiments were those conducted at the Cornell University Agricultural Station in 1889-90. These results showed clearly—

"1. That the electric-light may be used under such conditions as to make it fairly comparable to sunlight in its power to promote protoplasmic activity.

"2. That the electric-light acts as a tonic to plants so that they are able to endure adverse conditions which otherwise would cause them to collapse.

"3. That the electric-light is a true vital stimulus, since the effect of its use at night, upon plants, is essentially the same as that of the longer day of the Arctics upon plants growing in that region.

"Although not fully acquainted with the facts above referred to when I first began the use of the electric-light bath, I had seen brief notices of these experiments, and thereby became interested in the subject from a therapeutic stand-point. For more than twenty years I have made use of the sun-bath as a therapeutic means, and twelve or thirteen years ago experimented with large convex lenses for the purpose of concentrating the sunlight, and thus intensifying its effects in the treatment of neuralgia, and spinal and other hyperæsthesias.

"Something more than four years ago I began experiments with single lights provided with reflectors, and soon after had constructed two cabinets, or small rooms, large enough to contain one person, with fifty to sixty incandescent lamps arranged in regular rows on the inside. Since that time I have made constant use of the electric-light emitted by the incandescent lamp, as a therapeutic means. Together with my colleagues I have employed the bath by this means nearly 10,000 times, and in a great variety of ailments, at the Battle Creek Sanitarium, and have largely used it as a substitute for the Turkish, Russian, vapor, and hot-air baths, all of which I had previously employed for many years. Finding it free from any of the objections to which the baths named are open, for numerous reasons, some of which I will point out subsequently in this paper, and also finding its effects extremely agreeable to patients, and remarkably efficacious in many stubborn cases which did not readily yield to other therapeutic agents, I have employed it much more frequently than I had previously made use of analogous means, and in a much wider range of cases.

"My earliest experiments in the use of the electric-light bath showed me that it was capable of producing very characteristic effects. This led me to undertake a series of physiologic experiments for the purpose of placing its therapeutic use upon a rational basis, and for the purpose of comparing the effects of the electric-light, Turkish, and Russian baths. Some of these experiments were made three years

ago; others have been made more recently. The objects of the experiments were to determine the effects of the electric-light bath as compared with those of the Turkish and the Russian baths upon—

"1. CO_2 elimination.
"2. Urinary secretion.
"3. Perspiration.
"4. Surface and internal temperature.
"5. The number of blood corpuscles and the amount of hæmoglobin. The results of these experiments and the methods employed may be summarized as follows:

"1. *CO_2 Elimination.*—Three healthy young men were subjected to the influence of the incandescent electric-light or radiant-heat bath for five, ten, twenty, and thirty minutes respectively, the time being the same for each, and all other conditions being made as nearly alike as possible. The same young men were likewise subjected to the influence of the Turkish and the Russian baths for the same lengths of time, but on different days, care being taken to maintain a uniform dietary during the entire series of experiments, at the same hours of the day. The average per cent. of CO_2 obtained before the experiment, was 3.60. For the electric-light bath the average per cents obtained were as follows:

5 minutes	4.10	20 minutes	4.20
10 "	4.10	30 "	5.10 and 5.13

"In a repetition of the thirty-minute bath, the higher percentage of 5.13 was obtained. For the Turkish bath the average per cents obtained were:

5 minutes	4.03	10 minutes	4.07
		30 minutes	4.01

"For the Russian bath the per cent. was 3.96 for a bath of thirty minutes. The highest amount of CO_2 elimination was 4.29 litres, which was in the incandescent electric-light bath for thirty minutes. The temperature of the air in the baths was as follows:

"Electric-light bath, 28 to 36 degrees C. (85 to 97 degrees F.), or constantly below the temperature of the body; Russian bath, 38 degrees C. (100 degrees F.); Turkish bath, 55 degrees C. (131-155 degrees F.).

"2. *Urinary Secretion.*—The following table shows the average figures obtained for the three young men who were the subjects of experiment. The facts determined in relation to the urine were: the amount, the specific gravity, the acidity, the amount of urea, the amount of uric acid, the total chlorides expressed in terms of HCl, the phosphoric acid, and the total solids. The figures given were determined by accurate quantitative analysis of the whole amount secreted in twenty-four hours. The figures obtained in relation to the most important of these quantities were as follows:

Electric-light bath: urea	26.32	gms.
Total chlorides	5.25	"
Total solids	49.30	"
Turkish bath: urea	27.39	"
Total chlorides	6.91	"
Total solids	52.70	"
Russian bath: urea	29.56	"
Total chlorides	7.60	"
Total solids	55.14	"

" The figures obtained for the urine were the exact reverse of those obtained for the CO elimination. The diminished amount of urea, total chlorides, and total solids present in the urine during the twenty-four hours in which the subject was subjected to the electric-light bath, was evidently the result of increased elimination by the skin, showing that the electric-light bath is much more powerful than either the Turkish or the Russian bath as a means of stimulating vicarious eliminative work upon the part of the skin. The amount of perspiration induced by the incandescent electric-light bath was fully double that induced by the Turkish bath in the same length of time. The amount of perspiration induced by the Russian bath was less than that induced by the electric-light and the Turkish bath.

" 3. *Perspiration.*—Two points were determined in reference to perspiration:

" (1.) The time required to induce perspiration.
" (2.) The temperature at which perspiration began.

" The averages were as follows:

" *Incandescent electric-light bath:* time required to induce perspiration, three minutes, thirty-two seconds. The average temperature at which perspiration appeared was 27.2 degrees C. (eighty-one degrees F.).

" *Turkish bath:* the time required to induce perspiration, five minutes, thirty-five seconds. Temperature of the bath, 53.6 degrees C. (128.5 degrees F.).

" *Russian bath:* the time required for perspiration, six minutes, forty-five seconds. Temperature, 101.8 degrees F.

" The above figures show very clearly the superior value of the electric-light bath as a means of stimulating cutaneous activity.

" 4. *Surface and Internal Temperature.*—The influence of the bath upon surface and internal temperature is a matter of importance, since Bouchard has shown that the heat-regulating apparatus of the body is called into operation by a rise in the temperature of the blood equal to .40 degrees C. (.72 degrees F.). In experiments made in December, 1891, for the purpose of determining the effect of the bath upon surface and internal temperature, I obtained the following results in a comparative study of the effects of the electric bath and the Turkish bath upon surface and internal temperature:

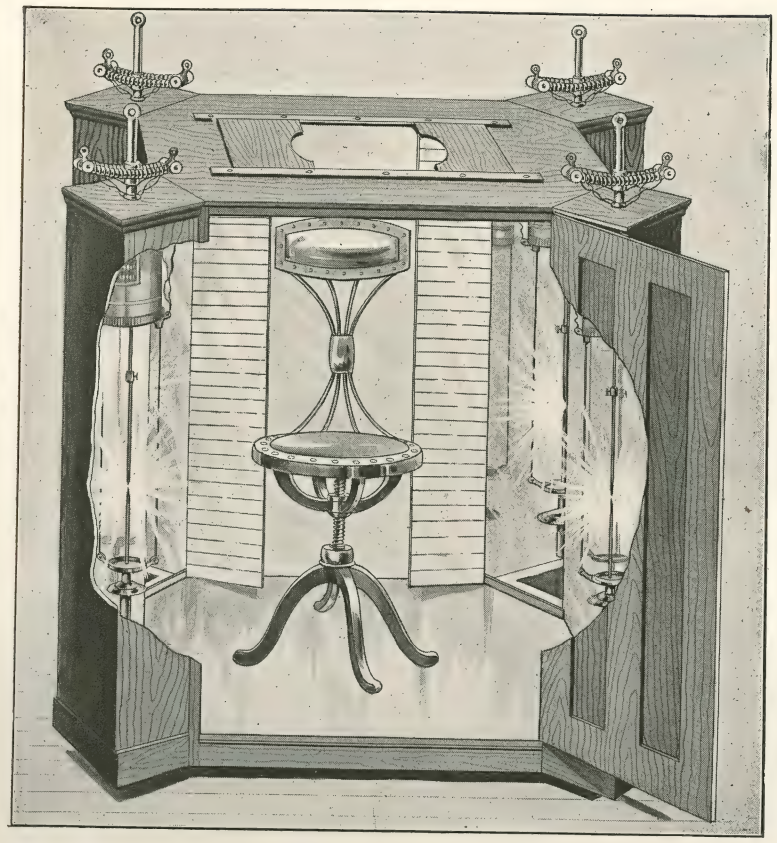


PLATE 225.—The Arc-Light Bath. This bath is rather imperfectly shown in this plate. It may be used either for the heating purposes of the calorific and luminous combined rays, or for the special effects of the chemical rays which influence the nervous system chiefly. When the latter are employed screens of cobalt glass are placed around each of the four arc-lights, situated one at each angle of the cabinet. When heating effects are desired, the mixed rays are employed without screens. The general indications for after-treatment with the arc-light bath do not differ essentially from those described for the incandescent electric-light bath.

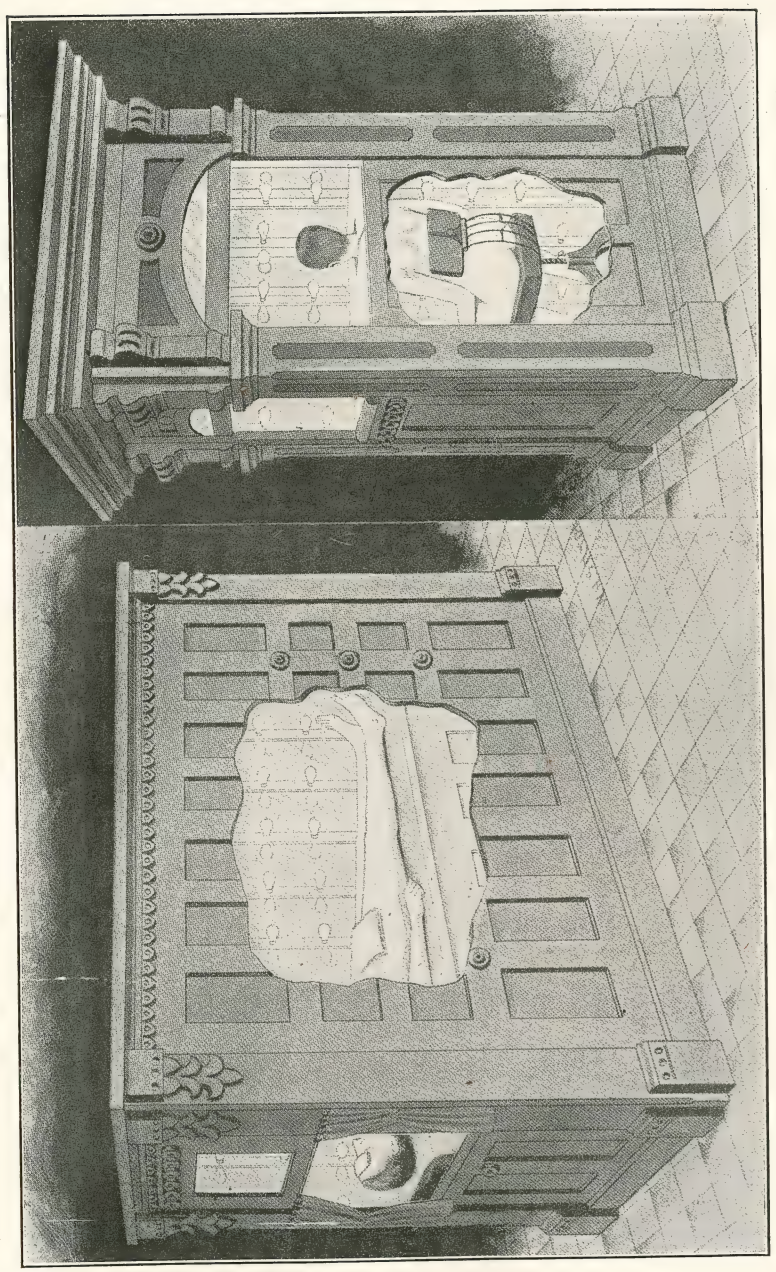


PLATE 226.—Showing positions of patient in horizontal and upright cabinets during treatment.

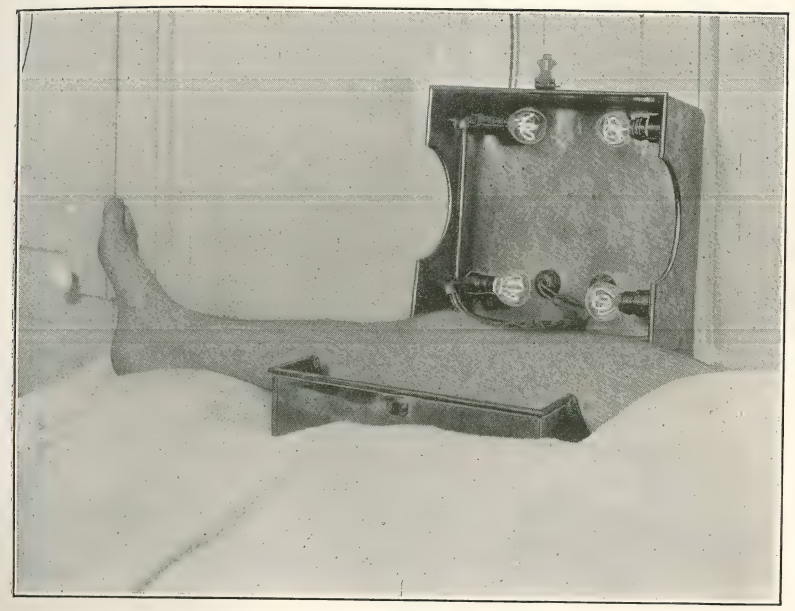


PLATE 227.—Electric-light box for local application to any part of the lower extremity. Place the affected part in the field of light rays, close down the cover of the box and turn on the current.

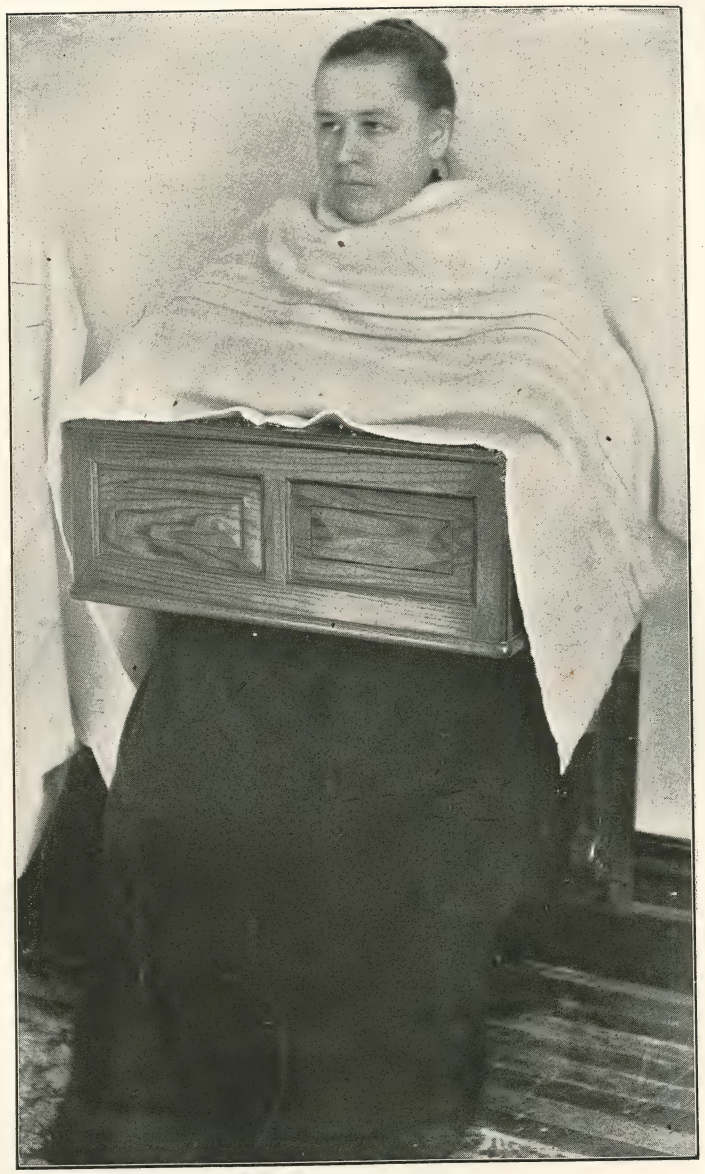


PLATE 228.—Local Electric-Light Bath to Trunk of Body. Remove clothing from the abdomen, sit patient with the exposed part against the open side of the box containing the lamps, throw a blanket over the chest and shoulders, and turn on the current.

"*Electric-light bath:* temperature of bath, 34.5 degrees C. (94 degrees F.). Internal temperature of subject before the bath, 36.6 degrees C. (98 degrees F.). Surface temperature, 35 degrees C. (95.44 degrees F.). Patient began to perspire after one minute. At the end of five and a half minutes he was removed from the bath. The temperature was taken at once and the internal temperature was found to be 37.5 degrees C. (99.6 degrees F.); the surface temperature, 37.9 degrees C. (100.2 degrees F.). Ten minutes after the bath the mouth temperature was 37 degrees C. (98.5 degrees F.); and the axillary temperature was 36.6 degrees C. (98 degrees F.).

"*Turkish bath:* temperature of bath, 70.5 degrees C. (159 degrees F.). Temperature of the subject before the bath, 36.4 degrees C. (97.4 degrees F.); axillary temperature, 96 degrees F. Perspiration began in five and a half minutes. Immediately after the bath, the mouth temperature was found to be 37 degrees C. (98.7 degrees F.); axillary temperature, 37.2 degrees C. (99 degrees F.). Ten minutes later the mouth temperature was 37 degrees C. (98.8 degrees F.); axillary temperature, 36.6 degrees C. (98 degrees F.). From these statements it appears that the incandescent electric-light bath is far more effective than the Turkish bath in raising both surface and internal temperature, which clearly indicates the penetrative power of the intense heat-rays of the electric-light.

"5. *The Blood.*—The effects of the incandescent electric-light bath upon the blood were determined by a careful count of the corpuscles by Gower's instrument and a determination of the hæmoglobin by the hæmatoscope of Henocque. The figures obtained showed no very marked increase in either blood-corpuscles or hæmoglobin, although in one case the number of corpuscles was increased nearly 200,000 per cubic millimetre.

"The physiological effects of the electric-light bath* are chiefly those of heat, and do not differ very essentially from the effects obtained from other sources of heat, except that the electric-light bath is a much more efficient and convenient method of administering heat than any other which has been devised, with the exception of water, which doubtless has a wider range of use. The purposes for which heat is applied are usually two:

"(1.) The induction of perspiration.

"(2.) The stimulation of protoplasmic activity, and thus increase of tissue metamorphosis.

"In the incandescent electric-light bath the heat enters the body directly as a radiant force, instead of by the slow method of convection and conduction, thus more rapidly raising the temperature of the blood, and hence quickly inducing perspiration. That heat stimulates vital activity is a fact which every one who has ever studied the amœba, or white blood-corpuscle, upon the warming stage is well acquainted.

*Using whole mixed light from the ordinary sixteen candle-power commercial lamp. Special therapeutic lamps have widened the range of action as is noted elsewhere in this section.

The effect of poultices and fomentations in producing pigmentation of the skin, as well as the effects of intense heat, either from the sun or other incandescent sources upon the complexion, afford further evidences of the important physiological effects of heat. Entering the body directly, instead of slowly working its way through the poor conductors which are found in the successive layers of tissue which compose the covering of the body, the radiant heat of the incandescent electric-light stimulates and vitalizes the tissues to a high degree.

"*Therapeutic Uses.*—I have found the electric-light bath of far greater value in the treatment of a great variety of maladies than any other means of applying heat, except water, and find that it may be much more generally employed than the ordinary Turkish, Russian, vapor, or hot-air baths. One reason of this is the convenience and rapidity with which the degree of heat employed may be graduated by turning on or off one or more groups of lamps, by which means the amount of heat is rendered absolutely and instantly controllable. The source of heat relied upon is the incandescent filaments of the lamps rather than a heated atmosphere, and hence is easily and instantly controllable. The instant the lamp is turned off, the heat which it has previously emitted is withdrawn from operation. If additional heat is required, the desired number of lamps may be turned on and become instantly operative.

"Another reason for the more universal application of the incandescent electric-light bath is the fact that when properly applied, its effects are *highly tonic in character*. A short application of the bath at full force for a time *just sufficient to induce powerful stimulation of the skin without provoking perspiration*, is one of the most effective means of peripheral stimulation with which I am acquainted. The tonic effects of such an application may be still further intensified by instantly following the bath with a cold spray or other cold application, thus producing a revulsive effect of the most agreeable and effective character. The excessive heating of the skin prepares the way for the cold application, without at the same time so overheating and relaxing the blood-vessels as to render recovery of the tone of the cutaneous tissues so tardy as to involve the risk of exhausting the patient too greatly or exposing him to the liability of taking cold.

"Still another special advantage of the incandescent electric-light bath over other sources of heat is the facility with which it can be localized. In this respect it is far superior to fomentations or any other local application of heat. By means of suitable appliances, the heat can be focussed upon a small point if desired, and affects not only the surface, but the deeper tissues. I am sure that the radiant energy of the electric-light penetrates the tissues to a depth of several inches. This I proved by actual observation, as before intimated. For deep-seated pain, as well as for the relief of hyperæsthesias of the skin, I know of no remedy more valuable. Many applications of this sort

have been made by myself and my colleagues, several thousand in all, and I have constant reason to be grateful for the acquisition of this therapeutic measure, as it has afforded relief to many cases which have stubbornly resisted all other therapeutic means which I have been able to employ.

"*Rationale of the Effects of the Incandescent Electric-Light Bath.*—The peculiar value of the electric-light bath I consider due to its efficiency as a *source* of radiant energy. The heat is derived from the electric-light by radiation, and not by conduction. The skin, as well as the air, is to a large extent transparent to radiant heat, and the same is true of all the living tissues. This is evidenced by the phenomenon of transillumination. By a speculum placed in the vagina or rectum and a suitably arranged electric-light of sixteen or thirty-two c. p. placed over the abdomen, I have seen the whole interior of the trunk illuminated and made to glow with a bright red light, the red color being due to the reflection from the red corpuscles of the blood. Even the bones are transparent to light when in a living state. This is clearly shown by placing the hand between an electric-light and the eye, with the fingers in close contact; the hand being placed near enough to the light, the whole fingers will be seen to be illuminated by the light, and not simply the soft parts.*

"One of the great advantages of the radiant heat or incandescent electric-light bath over the Turkish, Russian, vapor, or similar forms of bath, is the fact that the body can be subjected to the most intense heat desired without confining the patient, and without overheating the atmosphere surrounding him. This is due to the well-known fact that rays of heat pass through such transparent media as the air without heating them.

"So far as I know, an empiric in Cincinnati was the first to make use of the arc-light for therapeutic purposes. His use of the bath, however, was in connection with the 'blue glass' fanaticism which spread so extensively over the country a few years ago, the electric-light being substituted for sunlight, a very uncertain quantity at some seasons of the year. In 1890 one of my colleagues, Dr. Kate Lindsay, called my attention to the personal benefit derived from the use of the heat of the electric-light obtained by the application of a lamp in contact with the body and covered in such a way as to collect and retain the heat derived from it. I learned from several other persons of similar effects obtained in the same way, and at once had constructed a variety of devices for applying heat to the different parts of the body, and also for general application.

"The first bath for general application consisted of a bank of lights, between thirty and forty in number, arranged upon a frame which was hinged upon the wall in such a way that it could be raised and folded back against the wall while the patient was placed upon a suitable couch beneath it. The patient being in readiness, the frame

* Since this was written photographic tests have demonstrated the penetration of the chemical effects of light rays through the trunk of the body, as elsewhere cited in this section.

was lowered to a position about six inches above the body of the patient, and the space about the patient inclosed by means of curtains which dropped from the edge of the frame carrying the lights.

"The second form of bath which I had constructed soon after, consisted of a cabinet about eight feet in height upon the inside of which were placed between fifty and sixty incandescent lights arranged in rows, the spaces between the rows of lights being filled with silvered glass so as to multiply the number of lights to an infinite number by reflection. The cabinet is so arranged that the whole body of the patient, including the head, can be exposed to the influence of the light, or the head can be excluded, as in the ordinary vapor-bath. The cabinet is freely ventilated, and by means of switches and a proper grouping of the lamps in wiring, the number of lights in use can be instantly and perfectly controlled. A description of this bath was published in a German medical journal by Dr. Gebhardt, who visited the Sanitarium and personally tested the bath in 1892.

"The third form of bath for general application of the incandescent light, which I have had constructed more recently, consists of a cabinet lined with mirrors and containing some sixty incandescent lights, so arranged that the patient lies in a horizontal position, the lights being placed on three sides. The patient lies upon a suitable couch with rollers, which is pushed entirely within the cabinet, or only so far as to expose such portions of the body as it is desired to bring under the influence of radiant light and heat. By this plan the influence of the light can be confined to the feet and legs, or any other portion of the body up to the neck. It is only necessary to protect, by a sheet and a piece of mackintosh, any portion of the body which it is desired to exclude from the action of the bath. I have also had constructed and have in use special appliances by means of which applications may be conveniently made to the spine, the trunk, the feet, and other parts of the body. After ten years' use of the electric-light bath in a great variety of ailments, I esteem it as of greater utility than any other means of applying heat to the body, with the exception of water, the universal applicability of which gives it paramount value over all other therapeutic agents which can be employed for this purpose." (Kellogg.) (Plates 221 to 229.)

Methods of Treatment.—The following directions and Instruction Plates were prepared especially for this work by Dr. J. H. Kellogg, whose cordial assistance is here gratefully acknowledged by the author.

"The Instruction Plates in this section show the following forms of our Electric-Light-Bath Apparatus:

The Horizontal Cabinet for treatment of the entire body with composite light-rays from incandescent lamps.

The Upright Electric-Light-Bath Cabinet for similar treatment in erect positions.

Local Applications to feet, spine, and trunk of body.

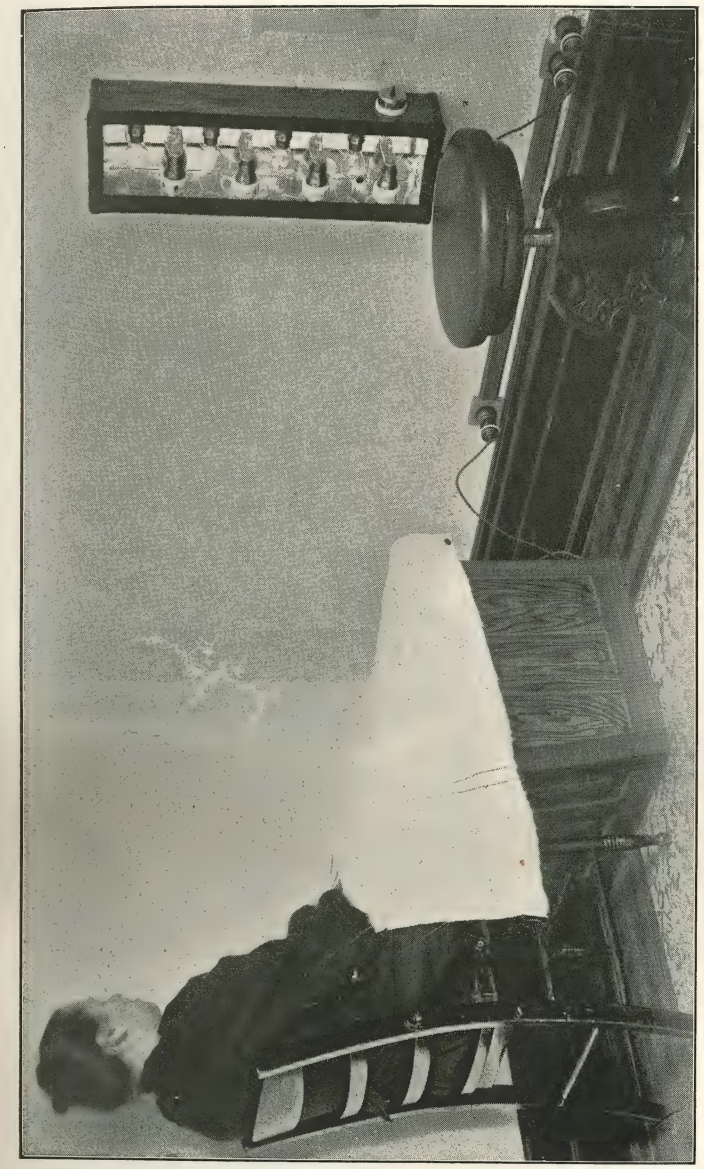


Plate 229.—This plate shows the feet of the patient undergoing light treatment in a foot cabinet, while at the right on the wall is shown a vertical box containing lamps for treatment of the spine. In each case expose the part, apply it in the field of light-rays, cover the adjoining tissues, and turn on the current.

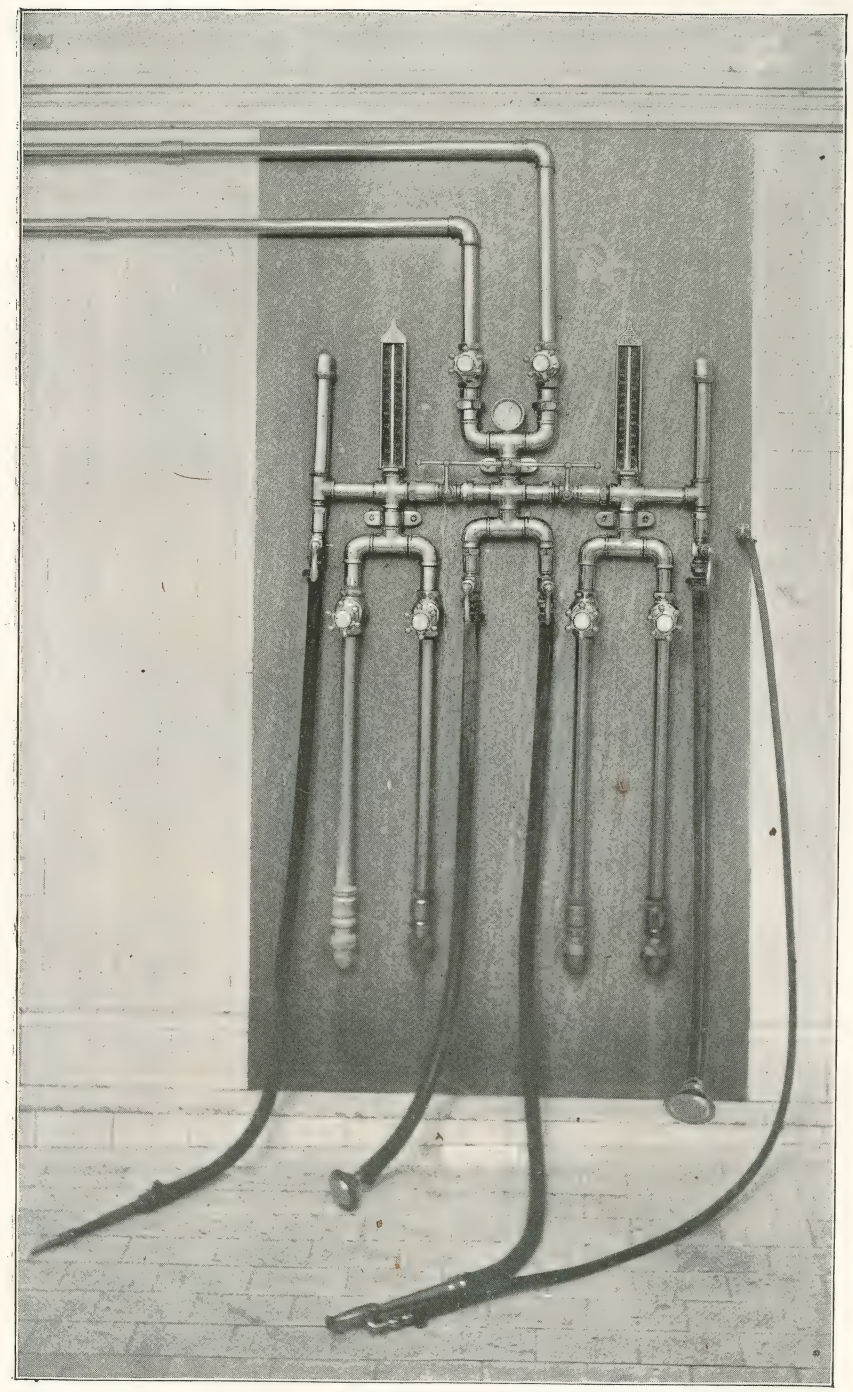


PLATE 230.—Dr. Kellogg's Douche Apparatus for "After-treatment" of cases coming from the electric-light cabinet.

PLATE 231.—The series of six Instruction Plates immediately following illustrate the hydro-therapeutic applications which suitably complete the administration of Radiant-Heat Baths. Each step of the procedure is taught in the text. This plate shows a patient receiving a "Cold-Mitten Friction."

PLATE 232.—A "Cold-Towel Rub" to chest after treatment in a Radiant-Heat Bath.

Leg and Arm Apparatus.

Arc-Light Cabinet.

For the treatment of patients in these various luminous and radiant-heat baths, both local and general, the technic is divided into two important parts which must closely supplement each other in order to secure satisfying results. Referring to other portions of this section for the actions ascribed to therapeutic luminous rays we will here state the direct treatment in the bath and the important after-treatment which concludes the séance properly.

Preparation of the Patient for General Bath.—Remove the entire clothing. Lave the face and neck in water of 60° F. and apply a moderately thick compress of cheese-cloth dampened in water of the same temperature to the scalp and frontal region, as shown in the Plate. If there is a decided tendency to cerebral congestion a cold towel, or compress, or ice-collar, should also be applied to the neck. Before the patient enters the bath care should be taken to have the feet warm. If cold, they may be warmed by a hot foot-bath for five minutes, or by the application of electric-light to the feet.

When all is ready for the treatment draw the rolling couch out of the cabinet and have the patient recline upon it so that the feet will enter the cabinet foremost. Support the head comfortably with suitable hair pillows. Then push in the couch, turn on the desired number of lamps, and adjust the dose.

The *duration* of the luminous-heat bath or tonic electric-light bath will depend upon the effect desired. For simple tonic effects, or as a preparation for the application of cold, the duration should not be more than three or five minutes—or just long enough to secure a reddening and slight moistening of the skin. If it is desired to produce vigorous perspiration the patient may remain in the bath fifteen or twenty minutes, or even longer. If, however, the duration of the bath is greatly prolonged the intensity of the dose should be reduced by lessening the number of lights, or by diminishing the luminous power by a rheostat. The temperature of this form of bath is taken with a thermometer (the bulb of which is covered with lamp-black), placed upon the fully exposed abdomen of the patient. Temperatures ranging from 160 F. to 350 F. or even higher may be employed. After removing the patient from the bath a cold application of some sort should be made in all cases in which there is not some special contra-indication prohibiting the use of cold; as, for example, cases in which it is desired to prolong perspiration after the bath by means of a dry pack, or acute, inflammatory cases in which the patient is wrapped in blankets and allowed to cool gradually.

Hydriatic Applications to Follow the Electric-Light Bath.—*The electric-light bath enormously dilates the surface vessels and excites cutaneous activity to the highest degree.* The normal tone of the surface circulation may be best restored by the application of cold water. Cooling by evaporation through exposure to the air is detrimental, and even dangerous, unless the patient actively exercises continuously during the cooling process, for the reason that the slow evaporation which takes place causes prolonged chilling of the surface, and spasm of the vessels, which results in visceral congestion and the total loss of the *tonic effect* which it is, in most cases, desirable to secure by this bath.

Perhaps the most efficient of all hydriatic applications for cooling a patient after an electric-light bath, is the *douche*. Either the rain douche, or shower bath, or some form of the horizontal douche (broken douche, fan douche, or spray), or the multiple douche may be employed. A thoroughly equipped electric-light treatment-room should certainly be also provided with a suitable douche apparatus. The author's douche apparatus is shown in the Instruction Plate 230. This device provides for exact dosage by means of pressure-gauges and thermometers, and it is so arranged that water of all practical temperatures may be applied; hot and cold water may be employed alternately or simultaneously. When a douche apparatus is not available, a wet-hand rub, a cold-mitten friction, towel rub, or wet-sheet rub, may be employed. The method of the application of these several procedures is indicated in the Instruction Plates. For fuller instruction in the administrations of water the reader is referred to the author's work on Hydrotherapy,* but the essentials of technic are as follows: (See Plates 230 to 236.)

A Cold-Mitten Friction.—This is a cold application and is applied by means of a cold mitt or sack made of haircloth or moreen. This is dipped in cold water at a temperature of 60° F. and applied with vigorous friction to different parts of the body in succession. Each part is rubbed until red, and thoroughly dried before proceeding to the next part. Usually water at a temperature of 60° F. is employed first. The temperature is lowered one or more degrees daily, until a temperature of 40° F. is reached. The patient's face should be moistened by the hands dipped in cold water before beginning the application. This procedure is best adapted for feeble patients, or those who cannot react to the general cold application, or to the more vigorous tonic measures. (Plate 231.)

The Cold-Towel Rub.—In this application the towel is rung out of

* "Rational Hydrotherapy," by J. H. Kellogg, M.D.

cold water and quickly spread out over the bare skin, and then rubbed by the hands of the attendant, while the patient holds the towel in place. The movements of the hands are made from above downward and in one direction only. The rubbing is alternated with percussion and is continued until the towel is warm. A dry towel is applied and the dry parts rubbed until warm, and the application is then extended to other parts of the body—the arms and legs—one at a time; and then to the back and sides of the legs. The cerebral circulation is protected by cooling the patient's neck with a napkin dipped in cold water. This is a most excellent hydriatic procedure and is adapted to patients who have a fair degree of reaction. The cold-towel rub follows in natural succession after the cold-mitten friction. The temperatures employed in the cold-towel rub are the same as in the cold-mitten friction. Great care should be taken to secure a good reaction of each part before proceeding to another part. Plates 232 and 233 illustrate this application.

Wet-Sheet Rubbing.—In this procedure the patient stands enveloped in a wet sheet while the attendant alternately rubs and spats the outside of the sheet. The sheet is wrung out of cold water at a temperature of 65° F. to 50° F. The rubbing should be continued until the sheet is warm. As the patient acquires the power to react the temperature of the water is lowered, and the sheet, by less wringing, is allowed to contain a larger amount of water. The application is best made by two attendants, one rubbing the upper part and the other rubbing the lower part. Care should be taken to bring the sheet in contact with the skin everywhere, as thoroughly as possible. There are three steps in this procedure, as shown in Plates 234 to 236.

Application to the Feet and Spine.—In applying the electric-light bath to the feet the patient's limbs are uncovered to the knees; the legs are placed in a small lidless box, each side of which is furnished with electric lights. The bath is continued until the skin is thoroughly reddened and local perspiration induced. In some cases general perspiration occurs. This procedure should be followed by a cold application to the feet and legs, or to all the surface *which has been reddened by exposure to the luminous rays.* The ordinary duration of the bath is from ten to twenty minutes. Its chief utility is in cases of rheumatism, or gout of the feet and ankles (the gout being acute or chronic), tuberculous diseases of the bones or joints, chronic inflammation of the structures of the joints resulting from sprain, bruises, or other traumatisms. A higher temperature may be secured in this form of bath than *by any other known means.* Some French physicians reported observations of a temperature as high as 500° F. It

is impossible to safely reach so high a temperature, or so powerful a stimulation of the tissues by hot air, steam, hot water, or any other known means.

Local Applications to the Spine are exceedingly useful in many cases of chronic spinal neuralgia; also of spinal diseases accompanied by congestion or irritability. The patient sits on a stool in front of the apparatus, which is attached to the wall. The duration of the application should be from ten to twenty minutes, or until the skin of the back is thoroughly reddened. The application to the spine should be of sufficient duration to secure a change of the dusky red color induced by heat to the brighter red color resulting from the reaction of cold. Not infrequently general perspiration is induced, which requires the cold application to the general surface, and the cold-towel rub and the wet-sheet rub to tone up the general surface and prevent taking cold. A reaction following the general cold application greatly assists the effect of the local application to the back. The cooling may be effected by means of the cold-mitten friction and cold-towel rub, or by pouring cold water upon the parts, or, best of all, a cold spray. The temperature of the water may be 60° F. to 50° F., or even lower. A short cold application is more effective than a prolonged cold application, especially when the measure is applied for derivative effect, as in cases of insomnia, in which it is desirable to fix as much blood in the lower extremities as possible by relaxing the cutaneous vessels, which are often found in a state of chronic spasm. This bath renders great service in cases of this sort; it is more rapidly and efficiently active than the hot foot-bath, or any other similar procedure.

The Electric Light for Joints.—The electric light affords the most efficient of all means of combating morbid processes in the joints; it may be applied to the knee, ankle, elbow, wrist, finger, and to other joints. Various special devices admit of the application of the light to the hip-joint and the cerebral articulations. The instrument may be closed so as to superheat the air about the joint; but this is not always necessary. The highest temperatures are attainable only when there is a free circulation of air, so that the air in contact with the skin is always dry. By this means it is easily possible to obtain a temperature of 400° F. or more. A temperature, much lower than this, however, is not tolerable when the air is saturated with moisture.

The *after-treatment* following the application of the electric light to a diseased joint must be determined by the pathological conditions present and the effect desired. In *acute* cases it is important to maintain the highest possible degree of activity of the circulation so that

PLATE 233.—"Cold-Towel Rub" to arm. With this plate and the text the process may be carried out by any nurse.

PLATE 234.—The next plates illustrate the three steps of accomplishing the "Wet-Sheet Rub" as a finish to the Radiant-Heat Bath. We here witness the first step; patient standing in tub with dripping sheet being thrown around him.

PLATE 235.—Showing the second step of the "Wet-Sheet Rub."

PLATE 236.—Third step of the "Wet-Sheet Rub" as an "after treatment" to the Radiant-Heat Bath.

the blood may be diverted from the internal structures. This is best accomplished by wrapping the parts in a thin linen towel wrung out of cold water at 60° F., covered first with a mackintosh, and then with several layers of flannel. The mackintosh should be made to fit the skin closely above and below, so as to avoid evaporation and chilling. In *chronic* cases accompanied by exudate without pain, a light-bath may be followed by the spray or douche with cold water, lasting from thirty to sixty seconds. In the absence of a douche apparatus the water may be poured upon the knee from a basin held as high as possible while the limb is supported over a tub. Alternate compresses may be applied, instead—that is, immediately following the application of the light bath, a towel wrung out of cold water at a temperature of 60° F. may be placed about the joint for twenty to thirty seconds. This may be followed by a *hot* fomentation, and a return of the light-bath for four or five minutes, or until the part is well heated, when the cold compress may be reapplied. The procedure should finish with an application of the cold compress for thirty seconds followed by rubbing (the whole surface receiving thorough massage), and the application of dry woolen bandage extending well above and below the knee, and of sufficient thickness to maintain the activity of the surface circulation."

Studies in Facts and Faults.—Dr. Wilhelm, of the Bertheldorfs Sanatorium, Germany, strongly champions the incandescent electric-light bath. He instructively reminds us that a photographer must not examine a sensitized plate by the light of a candle unless he has, by a red screen, deprived the candle of the actinic (chemical) rays; and if a single candle has so much chemical energy that it will fog a plate, how much more then has an electric-light bath cabinet grouping 800 candle-power of light-rays round a patient's body! As so few medical readers are fully informed of the A B C's of this subject it will not be without interest to dwell a moment on the facts set forth in Wilhelm's paper.

"Blue light that cures lupus, proceeding from the extreme actinic end of the spectrum, and red light that favorably influences the exarthemata (small-pox, measles, scarlet-fever, and various skin diseases), from the opposite end of the spectrum, meet—*extremes meet*—in skin therapeutics and act specifically as distinct kinds of light, each in its own way. If we consider a photo-electric cabinet lighted by a cluster of fifty incandescent lamps of sixteen candle-power each, the extraordinary similarity of the effects with those of the sun must strike any one, and if we imagine these lamps—sufficient to light an entire villa—collected for therapeutic purposes around a single patient in a space not three feet in diameter and not much more in height, we

think that this concentrated energy of 800 candles justly deserves the name of 'light bath,' and cannot be put in the ordinary category of a mere 'sweat bath.' Moreover, we can now fix the lamps invented by Professor Nernst* in Edison's sockets, and they give us double the amount of light.

"We not only thus obtain a light twice as intense, but a light derived rather more from the actinic side of the spectrum and furnishing what is now considered the preferable source of mixed light for therapeutic purposes. Looking over the lists of those who have already installed this incandescent, or Nernst lamp cabinet bath, we find the name of many a colleague of very critical turn of mind, and it is scarcely necessary to point out that a physician, before making so important an order, obtains all the information available. Every German physician who uses X-ray therapy will appreciate the great value of the actinic rays, and will also recognize the merits of the Finsen therapy, but will desire in many cases expressly to avoid the inflammatory reaction, the pigmentation of the skin, etc., without giving up the other therapeutical uses of light. And nothing will better accomplish this object than the incandescent mixed-light bath, with its relatively small total of chemical-rays. With the usual incandescent one-half ampere (sixteen candle-power) lamp the proportion of luminous rays to electrical energy consumed is about thirty per cent. The Nernst one-half-ampere lamp raises this to sixty per cent., while the arc-light gives about eighty-five per cent. By means of the red blood our body absorbs the actinic blue and violet rays immediately below the surface according to the *law of color absorption*, while as *brilliant light* the other rays penetrate even through bones to the innermost parts. Why should these red rays not act favorably on the inside of the body as they do on the outside? Considering light-rays as divided into three classes for therapeutic uses—heat, luminous, and chemical—and comparing their range in terms of the musical scale, we may say that whole light extends over about four octaves.

"1. Luminous rays occupy about one-sixth of the total.

"2. Heat-rays occupy the lower two octaves and contain the red and ultra-red.

"3. Chemical-rays extend chiefly from the blue to the invisible end of the scale.

"To avoid confusion between common speech and technical expression it is very necessary to distinguish invisible heat radiations which are strictly *rays of heat*, and hot luminous rays from the red end of the spectrum. It is because all normal-sighted men first perceive red rays as light and not as heat that red lights are so universally used as signals. Moreover, it is not only general theoretical considerations which lead us to distinguish heat from red light, but therapeutics compel us so to do. In all other hot baths the heat reaches the interior of the body by *conduction* after slowly penetrating through

* Nernst lamps have been used somewhat in this country since 1900 and are familiar to all who read Electrical periodicals, even if they have not yet seen the beautiful light itself.

the superficial layers which oppose great resistance to the passage of ordinary heat rays, but which allow light rays readily to pass. Therefore, the average duration of a hot-air bath is and must be two or three times as great as that of an incandescent-light bath of mixed luminous, chemical, and heat radiations. It is very properly the qualities of light as *light*, which have gained for the latter its claim to preference. We agree perfectly with the view that a portion of the light rays are transformed in the body into heat, and on this account incandescent mixed-light baths can render excellent service as sudation baths, but we are not obliged to let them act so powerfully or so long. *We can regulate the dosage.* In every well-arranged cabinet any or all of the lamps can be inserted or removed at will. They can be turned on or off at will. The duration of the bath can be prolonged with a few lamps if desired. Beginning with the full light till the patient is comfortably warmed we can then reduce the number one-half, or one-third, and control the heat without making him lose the beneficial action of light *per se*.

"Per contra; light rays enable a higher temperature to be more easily borne. 'Under the influence of electric-light,' says M. Siemens, 'plants can bear a powerful stove heat without losing their vigor.' From my personal experience I can affirm that in an incandescent-light bath I can easily support a temperature of 75° C., while in ordinary heat baths malaise appears at 45° C. But, not to protest against the excellent practice of employing incandescent-light baths as sudation baths, but to maintain their importance as true *light* baths and preserve the name they justly deserve as such, let us keep clear the two facts:

"1. The thermometer rises in the ultra-violet end of the spectrum as well as in the red.

"2. *All* the luminous rays, including the red, possess a chemical action.

"On account of a lively reaction on the skin in whole-light baths, transpiration occurs at comparatively low external temperatures, but this does not imply that they are sweat baths alone. The common term 'electric-light bath' is scientifically inexact at this stage of the development of photo-therapy. All observers should now state in their publications whether they speak of whole incandescent light, Nernst light, arc-light, or any form of light filtered through red, blue, or other special decomposing media. The subject has outgrown the empirical term and calls for scientific terminology."

When a patient has derived benefit from skilled *light* treatment with special incandescent lamps, Nernst lamps, or the large arc-light a distant practitioner cannot expect to give him the same results with a primitive incandescent cabinet fitted only with commercial sixteen-candle-power lamps. The effects of active alkaloids cannot be duplicated by domestic herbs, and the same principle applies to photo-

therapy. The question between inferior apparatus and scientific instruments has long been in the fore of electro-therapeutics, and, young as is photo-therapy, it already suffers from the same cause. It is eminently desirable that treatment should be successful and failure in equipment or technic will spell failure in effects on the patient. Recently a Berlin physician devoted a few words to this feature of practice, and what he says can instruct any who desire to learn.

"The early and disastrous confounding of incandescent-light baths with blue arc-light baths rested upon the primitive opinion of *hydropaths*, who first regarded all light as equal and all light-baths as merely sweating baths. This mistake was soon corrected, but the uninformed still propagate the error. The experimental proofs of the different action of the rays of the spectrum have been given by Finsen, and clinical proofs we have brought forward in a report of observations which now include 4,000 cases, with notes on pulse, temperature, respiration, etc. It is still too frequent that physicians fail to distinguish between the fundamental factors of photo-therapy. It has happened that patients with old knee-joint effusions, which had been benefited under our care, have relapsed after some time or excessive exertion, and have taken a series of light-baths elsewhere. They have, perhaps, been disappointed at not seeing the 'brown mottling' (the reddish-brown string-like discolorations), which they have been accustomed to observe on the spot, especially under local radiation, and which is the first sign of lymph-cell activity and commencing absorption. On inquiry it has been found that these patients have really had only a general exposure in a commercial incandescent-lamp cabinet with neither arc-light, reflectors, nor regulated dosage; or, perhaps the arc-light was there but no *reflector* concentrated the filtered rays on the special spot, and suitable combined treatment was not carried out. These patients then had simply had a sweat, with little or no local effect. This is not true photo-therapy.

"Also, proper treatment after the *whole* or *filtered*-light baths with reference to hygiene, massage, gymnastics, rest, diet, and hydrotherapeutic measures must be employed on intelligent medical principles to make up a complete treatment of scientific character, according to the indications. No branch of photo-therapy should be left to a non-medical assistant. The physician should give the treatment his personal supervision and direct the dosage.

"There should be no light bath without subsequent douching of a special kind, and of a proper temperature. No light bath should be given (nor any hot-air bath) without due regard to the time since the last meal, the condition of the stomach and intestinal tract before the bath, and the regulation of the diet after treatment. The principle here is the same as in practically all forms of treatment by heat, water, or actions which disturb the temperature and circulation. An hour after a small meal, or two hours after a hearty meal, is a safe rule for patients to wait before treatment.

"No *light* bath should be given without careful discrimination between the indications for the arc or incandescent, or whole, or filtered, light; and only the newer and most improved modifications of apparatus should be employed. Reflecting mirrors in cabinets should be tin-foil and never mercury-coated glass. And after the bath the physician should utilize to the best advantage the appetite, thirst, and inclination for exercise, that must follow the excretion of a kilo. of sweat, secreted in a quarter of an hour."

CHAPTER XLVII

PHOTO-THERAPY: LIGHT RAYS WITH PREDOMINATING RADIANT HEAT

THE DOWSING RADIANT HEAT AND LIGHT TREATMENT. CLINICAL REPORTS. COMPLETE STUDIES OF PHYSIOLOGICAL ACTIONS. THERAPEUTICS.

IN the preceding chapter we have considered *whole* light in general treatment without regard to special filaments and construction of the incandescent type of lamp. But we need not limit ourselves to the regular commercial light, for we find that the proportions of certain rays in whole light can be varied at the source by altering the quality of the material which forms the glower and by operating the glow in special media. This simple discovery puts a new phase on the subject of Light-treatment. Foremost among the newer modifications, which aim to supply an increased dosage of the rays which contribute to the production of tonic and nutritional warmth for physiological effects, has been the combination of about ten electric glowers mounted in polished reflectors which constitutes the apparatus we shall next describe.

The Dowsing Radiant-Heat and Light Treatment.—This new form of light apparatus had its origin in attempts to solve the problem of cooking and of heating rooms by electricity. At the suggestion of a London physician the electric stove of Mr. H. J. Dowsing was modified into a therapeutic instrument of the first class, and points the way to a still greater development in the future of luminous rays with selected medical properties. The lamps of the apparatus, which radiates "warm sunshine," are sections of white opaque glass tubing closed at the ends and possessing a glow-filament of special composition in which lies the secret of the great generation of heat-rays. The vacuum tubes are made of any required form, for both direct and alternating currents of any voltage in street-circuit use. In the smaller local apparatus, one or two tubes are mounted with *reflectors* which direct the rays on the part. The "body" apparatus is built up out of a series of "units" connected so as to treat the entire body. The

patient is undressed and laid on the mattress and covered with a large sheet and quilt. The reflectors are adjusted to each side of the bed and across the feet. The quilt is raised from contact with the patient by supporting rods and is closed snugly around the neck, thus leaving the head out in the cool air while the radiant heat is retained and applied to the patient. The patient enjoys the bath with the head cooled in the usual way. Of this apparatus a Berlin physician writes:

"Those of you who have seen and examined this apparatus must confess that it produces a very splendid radiation of dry luminous heat with advantages which no other heat-producers possess. It develops a heat of 250° F. to 300° F. in a few minutes. This heat I have myself witnessed from both the large and local lamps. The 'heating radiator' with these lamps is a very useful *stove* which you can place anywhere in your consulting-room and make it a very agreeable as well as the most practical medium for warming not only the room in which you treat your patients, but for warming bodily the patient himself so that the undressing for a physical examination is pleasant. *I always make use of this radiator for warming the extremities of patients when beginning to massage them,* otherwise it often takes a long time to increase the circulation of the feet and toes. In winter and on cold days patients long to get under the rays of this radiator, which spreads its pleasant warmth immediately when the current is turned on. No discomfort is felt even when the heat is raised, as it can be, from 200° F. to 500° F., the heat being absolutely dry. *There are no deleterious products of combustion.* As soon as the current is turned off the lamps become dark and cool, and no trace remains of their having been in action. They are very little trouble. The heat, as heat, does not burn in the ordinary way. You feel it as warmth, but it does not sting and burn. I have carefully taken the temperature of patients before a full body bath and just before I turned off the current, and have found a rise of from 2° to 7° F. within thirty-five to forty-five minutes' treatment.

"Since introducing this apparatus in my house I have treated, and am now treating, patients with all kinds of ailments, from incipient colds to complicated and very obstinate sufferings. Neuralgias and rheumatic pains, when local only, often begin to disappear during the first séance, and these patients are charmed. If colds in the head, throat, and chest, if internal congestions in all organs have been cured by inducing perspiration and setting up a profuse action of the capillaries of the skin, then surely these radiators of luminous heat fulfil all requirements, while they have advantages which must be kept in mind. You may riddle your naked patient with luminous rays and without any cover over him, and he will tell you he enjoys it like basking in the sun.

"In this bath you do not breathe vitiated air as in Turkish baths nor the exhalations and expectorations of other patients sharing the same bath-room. You do not want to use water after the perspira-

tion, but are briskly rubbed down and dried over the whole body with dry towels, so that even kidney cases remain entirely free from the external use of water, which is in this and many other cases a precaution to be highly appreciated. To those suffering from weak heart and circulation, or from heart disease, this treatment appears not to produce the slightest cardiac depression even in the very feeble and debilitated. It is indicated even in some cases of chronic heart mischief, as well as in chronic pericardial and pleuritic adhesions, chronic bronchitis, and complaints that lead to superficial decarbonization of the blood in the lungs. Among the most favorable cases published are acute as well as chronic gout and rheumatism, chronic articular swellings, pains and stiffness, adhesions, uric-acid deposits, callus after fractures, exudations after dislocations, sprains, contusion, and other traumatisms, besides a host of other complaints of a peculiarly distressing nature. A surgeon has applied dry heat of 300° F. to an inflamed joint with benefit to the inflammation, soothing the pain and easing the patient in a remarkable manner; and further experience has proved that more can be done in one hour in this way than by a week of the old fashioned poultices and fomentations." (V. J., M.D., M.R.C.P., Lond.)

To still further acquaint the reader with medical experience with this apparatus we shall cite two or three other expressions upon its clinical use. They are both recent and authoritative.

"I have treated a lawyer, whom Dr. Bennett sent me on April 12th this year, for very obstinate lumbago of five weeks' standing, with massage and with these luminous heat radiation full baths, which brought him first within ten minutes (later on within five minutes) into perspiration. His temperature before the bath was 98.8°, his pulse 88, his respiration 22, and the specific gravity of urine 1026; uric-acid deposit. After thirty-five minutes' most profuse perspiration in the covered bath his bodily temperature showed under the tongue 102° F., his pulse 108, his respiration 16. On April 21st he had been able to walk long distances and he had improved very greatly. He had then but one bath a week, and his temperature went usually up, from before the bath to the end of his perspiration, between four and five degrees. At last I pronounced him cured, and in the next bath, on May 19th, he, being naked, was riddled with luminous-rays, and he enjoyed this bath immensely, his temperature increasing after thirty-five minutes in the bath to 99.5° F. and not more. The window of the room remained open all the time, and after twenty minutes' rest he got up with his temperature normal, pulse 72, his urine then being clear and of 1018 specific gravity, and he walked out in laughing mood, jolly spirits, and whistling.

"I always observed that after the bath patients feel more vigor, vitality, and enjoy better spirits. In applying the heat in this manner, *i.e.*, in the nude state of our body and without any cover, the

air cannot be charged with moisture at all, as the heat-rays disperse and absorb it; then, of course, you do not see the perspiration so profusely on the body except on those parts which the rays do not project upon, such as the head and face, where drops of sweat are easily seen rolling down. The 'heat regulator,' or rheostat, is indeed a very important factor, because it enables you to check the heat immediately should a patient feel it more in one part of the body than the other. We therefore constantly watch the patient, and on his giving warning we can still more quickly remove any sensation of burning or stinging than with the rheostat; we merely remove the plug of the conducting wire which leads to the lamp opposite the spot where he complains of caloric hyperæsthesia, which may be on the leg, the thigh, the forearm or upper arm, the soles of the feet, and so on, and on the corresponding, *i.e.*, the right or left, side of the body. This is surely an advantage over all other methods of heat application, and it insures perfect safety in working the apparatus and directing the body with the caloric according to the doctor's and patient's wishes, and with the best results.

"I mentioned also, in a previous part of my paper, that the heat-rays may be partially screened in their course, and I frequently make use of a glass screen of a certain color if the natural color of the luminous light proves too exciting for the patient. Dr. Bowles has told us that the violet end of the spectrum are the rays which produce sunburn, and I have found, as a matter of experience, that the heat produced by red rays is far more soothing and less irritating to many patients than other colors; blue, again, better suits the lymphatic and anæmic constitutions; but those form a specialty of studies, and the more we learn of the pathology of those conditions we are about to treat the more likely we shall be able to decide beforehand which color will be the more suitable for the treatment of any given patient.

"On the whole, I have obtained very good results with our ordinary light-rays for this radiation treatment in cases of neuralgia, headaches, rheumatic pains, and in colds of the head, in dry and cold skin with greatly impaired and difficult diaphoresis accompanied by cold extremities, sometimes pains and stitches in abdomen, flatulence, etc. In cases where the finger or fingers sometimes up to half the hand got cold, bluish, white, numbed, dead, or cribbling, in which treatment with remedies, bath, hot poultices, have not shown the slightest improvement, this luminous electric-heat treatment has produced a very satisfactory change. The same I can say of falling asleep or numbed feeling with formication all over one extremity when lying in bed without compressing the part; this happens mostly in uric-acid diathesis. In such cases massage, open-air exercise, and profuse perspiration by Dowsing's rays abolish the tendency. In old, enfeebled people, in whom the bodily temperature was below the normal before the bath, I have obtained a return to normal temperature by degrees in the course of their baths, and the trouble of cold hands and feet greatly diminished. This, of course, follows the general im-

provement in the circulation of the blood and the increase of the heart energy.

"One of my patients, a lady nearly seventy-four years old, who came to me in November, 1898, had suffered for eight years great pains in the stomach, having great difficulty in her digestion, combined with nausea and frequently sickness after meals, swelling all around the stomach so that she was obliged to loosen her dresses; the pains are accompanied with great coldness in the stomach and abdomen, extending to the spine between the shoulder-blades, where three dorsal vertebræ, fifth, sixth, and seventh, are very painful on even a slight pressure with the fleshy ends of the fingers. Her whole epigastric region is also very tender on the slightest touch with the hand. The action of the bowels always costive, never diarrhœa or looseness, but sometimes dreadful pains like colic across the whole internal abdomen, returning with great violence every few minutes, and producing cold sweats all over her. Her skin is rather dry and very slow to perspire, even when she tries most persistently to do so during rheumatic pains, which affect both her shoulders down to the elbows, and extend upward through the neck into the occiput. She is not subject to attacks of influenza, but catches violent colds frequently, particularly when travelling; she suffers also greatly from headaches, neuralgia, and during the last two years from great giddiness, and since last year from deafness in the right ear; her strength has greatly diminished; she cannot walk upstairs without great efforts, and cannot walk any distance in the street without fatigue and fear of falling down; bending down is very painful to her in back and loins, and her arms are now very weak, she cannot lift them to the head from painfulness or rheumatism in the shoulder-joints; her legs are frequently taken with cramp, especially in the calves. Her eyes are very weak.

"When I became aware I could not improve her any further I decided to give her a Dowsing bath, which she at once told me has given her more energy and vitality than anything else, and when repeated produced a wonderful change in her, so that at the end of a dozen of these luminous radiant-heat baths, which she took on alternate days with my massage, the deafness and singing in the ear had disappeared, her eyesight improved also. I got a letter to the following effect from her mistress, with whom she was as lady companion for over twenty-five years, being considered rather as an old and intimate friend: 'It is (she wrote) such a comfort to see her (my patient) so well and so cheerful now. Her tale used to be one of constant suffering, and naturally it told on her spirits and nerves. The electric-light baths seem to have had a *great* effect on her, seeming to double the relief your other treatment gave her. The improvement is the more remarkable owing to her advanced age (over seventy-three, I believe) and the fact that her case is such a very chronic one, and, further, because all medical treatment has so utterly failed with her hitherto. All medicines and treatments have hitherto proved actually

injurious to her. I was really in *despair*. You will understand, then, how grateful I feel.'

"I have already stated that I find great usefulness in these luminous-heat radiations in combination with massage treatment. I may also say that I can, if necessary, easily use electric-battery currents with these electric sudatorial baths, and I fancy that the open-air treatment for consumption would be greatly benefited by occasionally warming the patient when he is unable to take open-air exercise, because you can charge your patient with as much heat as you find needful for his benefit as well as his comfort. So, if the patient lies on his couch on the open balcony or under the veranda, you merely switch on the current from the main, and he will feel warm without altering his position within five minutes. Let us hope that the authorities of our Hospital will establish a special and separate department for the treatment of disease by modern electricity in all its phases of old and novel usefulness—including constant and interrupted current (hot-water baths) from the main, d'Arsonval's high frequency and high potential currents, the X-rays and lupus treatment, electrolysis and luminous-heat radiation treatment." (Jagielski.)

"In these electric-light radiant-heat baths we have an agent which, while supplying all the advantages of other forms of heat baths, possesses something more; namely, luminous rays affording much of the benefit of sunshine. The principle underlying this form of treatment may be expressed in the fact that *heat facilitates function*. It increases the combustion in the body as evidenced by the increased elimination of carbonic acid from the lungs. The raising of the body temperature depends less upon the amount of heat applied to any small surface than upon the degree to which radiation from the rest of the body is prevented or counteracted; hence, in practice, where constitutional results are desired it is best to give a whole body bath even in the case of local lesions. The effects are very striking and wonderfully uniform. Dr. Chretian, of the Salpêtrière Hospital in Paris, thus states his extensive experience and observations of physiological actions:

"'More or less profuse perspiration not only of the part treated, but over the whole surface of the body.

"'Marked reddening of the skin on the part treated—a capillary dilatation.

"'Diminution and rapid disappearance (sometimes almost immediate) of the pain.

"'Restoration of movement when impaired by pain.

"'Some acceleration of the pulse and increase of the body temperature. The latter may be from one to three degrees, registered by the mouth. It is gradual throughout the treatment, subsides slowly when the heat is discontinued and falls to normal in from three to five hours, if not reduced by after-treatment.'" (Kerr.)

"Heat radiation is the propagation through ether of impulses

imparted to it from the molecular motion of a heated body. There is not a transference of heat, but a transference of *energy which becomes heat on encountering an obstacle in its path.* Heat and light are each forms of 'radiant energy.' There is no essential physical difference between them, and their laws of propagation are identical. The dark rays differ from the visible rays only in their longer wave-length. Tyndall's experiments show that as light rays are added to a band of the spectrum the heat-rays became more intense, acquire a greater amplitude, and, therefore, a greater energy of vibration, as the latter is proportional to the square of the amplitude. The obvious inference from these facts is that if we desire to penetrate the tissues of the body with warmth we should use luminous heat.

"Now, how does radiant heat effect its curative purpose? Let us present the answer by example. An ankle-joint has been violently twisted, ligaments have been wrenched and some fibres torn across, there has occurred extravasation of blood into the tissues, and perhaps into the joint cavity itself. Considerable swelling has quickly arisen and other symptoms of inflammatory reaction, in which the various structures of the joint are involved—synovial membrane, ligaments, sheaths of tendons, malleolar bursæ, etc. The pain is of a 'sickening' character, and it becomes agony on putting the foot to the ground. There is at first an active dilatation of the arteries and arterioles of the part, widening the capacity of the vessels so that more blood is driven by each heart-beat toward the affected part. The capillary dilatation is less and is chiefly the result of passive stretching by the influx of more blood than they can easily contain, but the result is that the normal difference of tension between the fluid within the capillaries and that in the lymph spaces around them is considerably increased, and hence diffusion of coagulable lymph will ensue. In situations where primary increased flow (impeded and at length arrested by adhering and cohering red and white corpuscles) has been succeeded by stasis the exudation will be still more active. As lymphatic absorption cannot keep pace with vascular exudation the surrounding and uninjured tissues will be highly œdematous and distended with liquor sanguinis which does not coagulate. Much of the pain is due to the pressure of exudates held in by unyielding ligaments. The lymphatic system aims to minimize this evil by increased activity of absorption, but can only in part compensate for the vascular flux. How is heat of service in such a condition? Let us see:

"1. The most obvious result of heat on the exposed part is first a reddening of the surface and next a profuse perspiration. The redness is the dilatation of cutaneous vessels, the result of hyperstimulation. The sweating is due to the dilatation of the network of vessels in intimate relation with the sebaceous and sudoriferous glands and hair follicles, to direct stimulation by the heat of the cellular elements of the glands, and to nerve influence. As the necessary fluid is probably derived from the capillaries by transudation through their walls the blood-pressure within the capillaries will be equalized with

the pressure in the adjacent lymphatics and lymph spaces, and this will tend to reduce the cutaneous œdema.

"2. As the result of the above changes in relaxation, pressure, and blood-supply there is a general movement of blood and lymph from the deeper to the more superficial structures of the part.

"3. The now accelerated blood-stream will unload congested parts and carry off morbid products. The lymphatic system, by increased absorptive activity, will lessen to some extent the exudation in and around the joint.

"4. As the penetrating effect of the radiant heat increases the arteries which divide and subdivide in the subcutaneous tissues to supply the cutaneous capillaries will themselves become dilated. The still deeper vessels (the arterioles derived from the nutrient vessels of the joint) will now, in comformity with the law of compensation, have a tendency to contract.

"5. The molecular activity of the part will probably be enhanced, and the metabolic and nutritive process will be for a time accelerated. There may also perhaps occur an alteration in the state of the part, owing to modifications in its molecular constitution, such as might occur from violent perturbation or vibration." (Hedly.)

"In the bath of radiant-heat rays of light the exposure is longer or shorter according as we wish the patient to perspire very freely, as indicated in gout, rheumatism, and all forms of fibrous-tissue adhesions affecting the joints, muscles, etc., or, whether an irritation of the skin with dilatation of its blood-vessels is all that is desired, as in hysteria, neurasthenia, anæmia, etc. The advantage of the electric-light sweat-bath is the fact that it never gives any shock to the patient's system, it does not burden the heart, the production of heat in the organism is regulated. From my own experience I should like to call attention to the favorable influence of the electric-light bath in chlorotic conditions, in neuralgic pains, on the appetite and sleep of neurasthenic patients. For these purposes the warming of the skin without producing great perspiration is all that is required. In all forms of fibrous-tissue adhesions affecting joints, muscle, etc., the slow, vibrating electric current and the introduction of iod. of pot. or cit. of lithium by cataphoresis, after the exposure to the light has proved very beneficial. In cases of gout, rheumatism, Raynaud's disease, scleroderma, psoriasis, the light has proved a most wonderful remedy." (Kreutzberger.)

Reports of the aid of radiant-heat baths in obesity have occasionally been astonishing. "Dr. Strebel gives two of these sweat-baths per week followed by a water-bath of 86° F. reduced for the last five minutes to 64° F., and completes the séance with massage and frictions." While the reduction of excessive local accumulations of fat find a routine prescription in some form of hot air or sweating application the author believes that by far the most energetic *supplementing*

therapy is to be found in the tissue-oscillator we describe. Test it but one minute on your own person and you will need no argument about its rationale. Many methods of working off local fat have come to the author's knowledge, but this neat device takes hold of the flabby mass and literally "shakes the life out of it," while the remainder of the system is at passive rest and the patient in a state of perfect comfort. The fact that this adjunct treatment is *delightful* and *short* appeals to most patients as well as to the office practitioner who is in a hurry. Three, five, or eight minutes is a full-length séance for a corpulent abdomen in the oscillator. The results are self-evident after a few séances.

From authentic data we may estimate that not less than 300 sanitariums have procured electric-light-cabinet bath apparatus prior to this date. We have before us a long list of names of high-class institutions using either the Kellogg or Dowsing radiant-heat baths which would impress readers with the spread of photo-therapy did space permit us to cite them. We also have in hand clinical records of cases which lack of space compels us to omit, as this work is mainly designed to teach the practitioner how to do the same work himself. The trend of articles on this subject may be inferred from a few lines taken from an extensive account of cases in a London hospital:

"Many more diseased conditions than might at first sight be imagined are benefited by local radiant heat. My rule at the hospital for some years has been when a patient suffering from any complaint does not improve after a course of routine drug treatment to order radiant heat, and I must say that in the majority of cases improvement very quickly shows itself, often to a marked degree. The following cases are notes from a large number of diseases treated by myself at the Northwest London Hospital."

The list of cases described covers rheumatoid arthritis, vasomotor disease, epilepsy, chronic rheumatism, chronic Brights, asthma, bronchitis, chorea, peripheral neuritis, spinal disease, post-fracture of shoulder, strumous ulcers of leg, etc., some of them having only three or five treatments. The writer proceeds: "In addition to the above, if space permitted, could be cited as having been successfully treated by radiant heat all forms of arthritis—rheumatic, gouty, neurotic, tubercular, traumatic—also synovitis, bursitis, periostitis, adhesions, hysterical joints, various forms of neuritis, paralyses, cases of general or local malnutrition, many skin diseases, etc." Evidence of the value of luminous heat needs as little further discussion as does the value of food and sunshine.

In an extensive review of "The Progress of Therapeutics," during

1900, Wilcox disposes of X-rays in nine lines, with mention of their use by one physician and in two diseases, but accords the following longer notice to the fellow product of electricity—the radiant-heat rays, which we may almost call dark X-rays. Many times a writer applauds one product of electricity while ignorantly rejecting its twin brother, and *in these days when similarity of action can be traced through many apparently variant therapeutics a broad study of the so-called physical agents will teach us that they group round very similar indications and work for good along very closely related lines. An expert can duplicate average effects of almost any one of them by skilful direction of a dozen others. The force of this fact has been impressed upon the author during his investigations for this book, although he was well aware of it before.* But to quote:

"Various authors—Paulson, Rand, Gomberg—have studied the electric-light bath. They find that it is the most satisfactory and efficient of all methods for inducing perspiration, inasmuch as it is a direct stimulant to the glands. Perspiration appears in from three to five minutes, even when the temperature of the air surrounding the patient is not above 85° F. That this bath is a powerful means of calorification is shown by the fact that the rectal temperature may rise to 103° F. or even higher in the bath. The peculiar value of the electric-light bath is due to its efficiency as a source of radiant energy which is not communicated to the skin by convection, for the skin as well as the air is to a large extent transparent to radiant heat, and the same is true of all the living tissues. Thus it is true that the heat from the electric-light penetrates the body just as it would penetrate any other transparent or semi-transparent medium.

"This bath has also the advantage that it encourages heat elimination by promoting free perspiration. There is also the excretion of effete matters which accompanies free perspiration, and with the elevated temperature of the blood there is a quickening of all the vital processes. It is claimed that this method is especially valuable in the treatment of cardiac disease and in diabetes where prolonged sweating measures cannot be employed without more or less risk. The penetrating nature of the heat of the electric-light bath stimulates oxidation of the residual tissues, and this hastens the disappearance of the redundant fat in obesity. In the dropsy associated with either cardiac or renal disease, in the toxæmias of chronic dyspepsia, in chronic malaria, syphilis, chronic rheumatic affections, anæmia, and in various other disorders excellent results have been achieved. A local application for fifteen or twenty minutes, followed by the application of an ice compress, is almost a panacea for the pain of sciatica. Since it is evidently a nerve tonic, the excellent results of its use in the treatment of the symptom-complex known as neurasthenia, particularly when due to toxæmia, rest on a solid foundation." (Wilcox.)

Educated medical men making inquiry as to the principles of photo-therapy may wisely distinguish between the findings of scientific research and the remarks of illiterate attendants employed to keep the apparatus in order and wait on patients. This is not always done. A nurse recently showed the author a radiant-heat apparatus and glibly stated: "Yes, we have baked a good many patients. All there is to it is the heat, you know. Some use gas and this uses electricity. That is all the difference." But between this sapience and science there is a gap that physicians should not fill in with credulity. Yet despite the fact that the physiology and therapeutics of light-rays are now demonstrated with greater fulness and accuracy than those of ninety out of a hundred drugs the facts still lack diffusion throughout the profession. This was illustrated in a most interesting letter from Carlsbad, published in 1901, in which Dr. James Tyson gave an account of his late visit:

"The electric-light bath is an interesting bath. It consists of a cabinet in which the patient is inclosed except his head. Numerous lights project from the sides of the cabinet toward the interior. The bath is a sweat-bath in which the heat is derived from the electric lights, and the chief feature is that the sweating takes place at a much lower temperature than that in a vapor- or hot-air bath. My recollection is that it is about 95 F. None of the physicians with whom I conversed at the Kaiserbad *were able to offer any explanation.*"

In a similar manner every department of therapeutics suffers from statements that "nothing is known" about action, rationale, etc., while *the fact is that we are here able to present definite instruction from many sources*, explaining the rationale of the electric-light bath in each of its varieties. The important difference between Hot-air Therapy as taught in our section on that subject and the action of luminous heat-rays is maintained by all writers on photo-therapy, and "radiant heat" is not "hot-air" by any means. We shall now study the scientific investigations of Dr. Guyénot of Aix-les-Bains respecting radiant heat in the years 1900-1901.

"Sunlight is the great type of luminous radiance which warms bodies on which its rays fall. The heat of the sun is not 'conducted to us through a warmed ether 95,000,000 miles thick, but is 'radiated' to us through cold space and generates warmth on the earth by the potential energy of its impinging rays. Furnace heat is different. Mechanical devices (lamps in vacua) can transform electrical energy into radiant-heat luminosity. Some bodies completely stop the passage of heat-rays and some stop light-rays. The first class are called 'Athermanous' and the second 'opaque.' Some transmit heat-rays and are called 'Diathermanous,' while bodies diaphanous to light-rays are

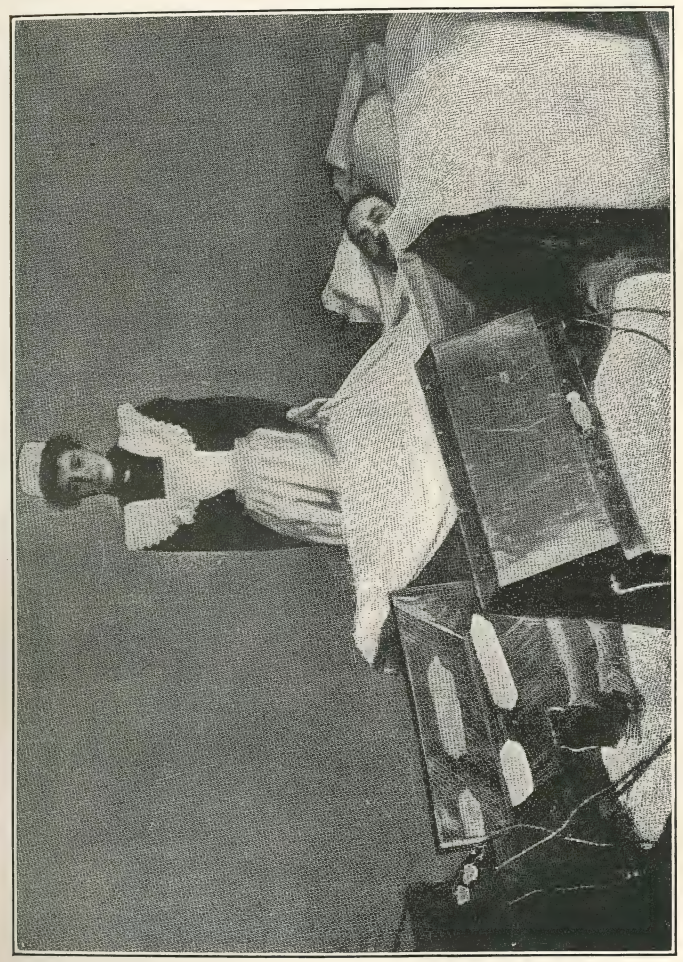


PLATE 237.—The Dowsing Electric-Light Radiant-Heat Apparatus. This illustration shows two reflectors on each side arranged on an ordinary bed with patient ready to be covered. The apparatus does not lend itself well to photographic display, and unless one has seen the original the cut gives a poor idea of the treatment. Such an apparatus is now in use in New York. The text aims to supply the essential instruction.

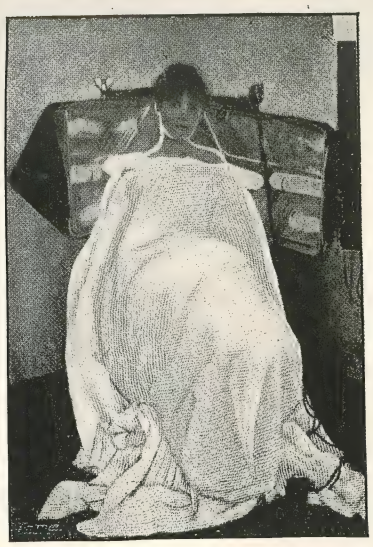


PLATE 238.—Local applications of single units of the Dowsing Radiant-Heat Light Rays. After a recent publication in Paris.

called 'transparent.' An alum solution will stop heat-rays while it passes light, and a piece of smoked rock salt will shut out all light, but will let heat-rays pass freely.

"The transmission of conducted (ordinary) heat depends on heating the surrounding air.* To raise the temperature of any substance fifty degrees by heat conducted through a separating layer of air it is absolutely necessary to raise the air fifty degrees. Radiant luminous heat will give the same result without heating the air. Luminous heat radiates across space; it can be diffused as light; it can equally be reflected, and directed by reflectors. A piece of tinder can be fired by reflected radiant heat twenty feet from the light, as if it had been in contact with the flame. Sunburn takes place on the Alps with the air freezing. Radiant luminous heat results from the blending together of heat-rays, luminous-rays, and chemical-rays, and it is possible to alter the proportions of these by mechanical devices, or to eliminate any one of them and have separately either heat, luminosity, or chemical action. Therefore, concentrating a hundred pages of scientific experimental research into a few words we may summarize the clinical facts thus:

"Radiant Luminous Heat is composed of rays of the spectrum which can be separated from each other for selected actions.

"It can be reflected by mirrors or polished metals, as can rays of light.

"It can pass through glass without losing its properties.

"Radiant heat can be directed on a body without heating the surrounding air.

"By special apparatus it can be diffused and caused to heat the air to very high temperatures, and can not only treat patients in this way, but can warm rooms as well as the familiar gas-heater but with the advantage that electric-light radiators do not vitiate the atmosphere we breathe in.

"The physiological action of radiating luminant heat is a composite study of three mingled groups of rays—the low-red spectrum, the visible spectrum, and the ultra-violet spectrum, each possessing important properties and supplementary effects. The first remarkable fact to notice is that the human body can comfortably support higher temperatures with radiant heat than with conducted heat. The general body application is practicable up to 400° F., while local applications may reach 500° F. with safety. Treatment employs a dosage below these maximums, but the patient can tolerate these for forty minutes without harm. Radiant heat has a much greater power of penetration than conducted heat. The pulse is excited less than in Turkish-baths, and in an hour returns to normal and becomes stronger than before. Profuse perspiration is induced, varying in amount in different persons, but always more abundant than in other baths.

"The sedative action of the radiant-heat bath is most marked.

* In this section all references to "common heat" will mean conducted heat as distinguished from radiant heat. Some authors call conducted heat "obscure heat," or "dark heat," in contrast with luminous heat. Keep the difference in mind.

In cases of gout and suitable painful affections a sense of relief is experienced almost from the first. Among other tests, a dog was treated with a bath of conducted heat at 150° C. At the close of the application the elevation of the body temperature was 1 degree and of the legs 3.6 degrees. In a radiant-heat bath several days later, at 122 degrees C., the active effects were about doubled, the body temperature rising 1.8 degrees and the hind legs 8.3 degrees centigrade.

"We will now consider a particular apparatus which is constructed to especially develop luminous heat in far greater quantities than the commercial reading incandescent lamp. It was sent to me from London with a request to investigate and report on its action. By means of special filaments and vacuum tubes the lamps of the apparatus emit very intense heat-rays with less chemical radiation than arc-light or the sun. After witnessing and demonstrating the results obtained I submit the following to the French medical body, being absolutely convinced that those who will study as I have done will soon share my opinion as to the therapeutical benefits of this apparatus. It is needless to expect impossibilities of it, but we have here a new and powerful ally which is without danger, and which leaves far behind all other bath systems of hot-air. The heat-rays are of such intensity that a thermometer placed between two lamps sixteen inches apart and provided with reflectors will almost immediately rise to 400° F. The dosage is regulated by a rheostat. The physiological actions of this form of radiant-heat bath consist in the following phenomena:

"Very marked redness of the skin. Very abundant perspiration and the elimination of increased quantities of carbonic acid by the lungs. Rise of pulse and temperature. Increased excretion of urea and solids in the urine and lessened uric acid. Increased activity of general nutrition and elimination. Much greater penetration than conducted heat. Excitation of the skin by the chemical rays. Increase in number of red blood-globules. In all cases the degree and extent of action varies according to the number of lamps and duration of treatment. On such diseases as gout, rheumatism, arthritis, and other kindred diseases the effects observed are: A short time after placing the part in the apparatus the skin becomes red and perspires freely. The redness is due to the dilatation of the superficial capillaries and the perspiration is the sequence of three factors:

"1. The dilatation of the vessels, particularly those in close relation to the sweat glands, sebaceous glands, and follicles.

"2. The direct stimulation of the cellular elements and of the glands by various radiations.

"3. The reflex excitation of the nerves.

"The dilatation of the cutaneous vessels and the necessity for the tissues to replace the moisture lost by perspiration leads to a general movement of the blood and produces an increased circulation. This lowers the blood pressure and removes the principle cause of painful symptoms, and at the same time carries away the morbid products in the circulation. At this moment, under the penetrating and prolonged action of the radiant heat, the arteries dilate and then contract according to the well-known laws of compensation. This takes place without danger to the patient, and the presence of luminous and chemical rays add complex factors of benefit which are of incontestable utility.

"All affections for which dry hot-air is useful, whether local or general, are treated with great advantage in the improved form of radiant-heat bath. Physiological data and clinical observations are now so numerously demonstrated that in certain affections we have established precise indications and obtain particularly good results. Among these are gout, rheumatism, rheumatoid arthritis, phlebitis, contusions, sprains and fractures, obesity, anæmia, exudates, coldness, recent 'colds,' and to a less extent, sciatica, neuralgias, nephritis, nervous diseases, diseases of the lungs, skin, and various unclassified conditions of both functions and organs.

"*Gout.*—One treatment in the apparatus employed by me often suffices to give relief. The sedative effect is felt at about 320° F. and is continued several hours after a bath of thirty to forty-five minutes duration, and if the pain returns it is always less severe than before. The duration of a severe attack can be reduced to a few days by giving a *general* bath in the morning and a *local* bath to the affected joints in the afternoon. In chronic gout the pain is slowly but surely lessened and beneficial results obtained. Adjunct treatment to meet special indications will hasten the results.

"*Rheumatism.*—In chronic cases, articular, muscular, gonorrhœal, and in senile arthritis, the sedative action of the baths is marked after a course of treatment. We have also treated a case of inflammatory polyarthritis in which salicylate and antipyrine failed to relieve. A complete bath at 320° F. for twenty minutes daily gave great satisfaction and benefit. The pain diminished, the swellings decreased, the temperature lowered, and the urine increased. Relief followed each application, and the attack was limited to twelve days with a good convalescence thereafter.

"In *Contusions*, *Sprains*, and *Fractures* radiant heat renders great service and in many institutions has become the routine remedy.

"In *Phlebitis* a single treatment produces a marked decrease in the size of the affected part, and by repeated applications a rapid return to normal is accomplished.

"*Rheumatoid Arthritis.*—In recent cases, even at the period of very sharp attacks, the joints are rapidly relieved and reduced in size by the treatment. In later stages with ankylosed and deformed joints with little pain the immediate effect of radiant-heat applications is not marked, but with perseverance an improved nutrition is established and final results become gratifying.

"The value of radiant heat in *nephritis* consists in the abundant diaphoresis which it causes and the relief to the kidneys and heart. In many general affections radiant heat is an excellent auxiliary to

other measures, and will often enable other measures to succeed when they have failed alone."

"It is the usual rule that the best effects are obtained by applications to *large* surfaces even in local lesions, and the general body apparatus is therefore mostly employed not only for general conditions, but for localized affections. In the latter case the full bath is applied to all except the head, and at the same time a special reflector is used to intensify the rays on the local tissues needing concentrated local action. The apparatus permits this to easily be done."

Studies in Hot-Air Therapy

"I originally approached the invention with the scepticism which becomes second nature to medical men. But having tested it on my own person I found that it did what it pretended to do." (SHADWELL.)

CHAPTER XLVIII

HOT-AIR THERAPY

STUDY OF ACTIONS AND EFFECTS. BY-EFFECTS. CARE OF THE PATIENT DURING HOT-AIR TREATMENT. ACCESSORIES TO APPARATUS. DIRECTIONS FOR USE. THE BODY MACHINE. FULL TECHNIC. LEG AND ARM MACHINE. STUDY OF MISTAKES AND FAILURES. CLINICAL EXPERIENCE. DIAGNOSIS OF PUS. HOT-AIR APPARATUS FOR USE IN BED.

Wightman's conclusions about hot air as a therapeutic agent were as follows:

Dry heat is a valuable pain-reliever without any of the depressant effects common to drugs.

In connection with constitutional and medicinal treatment we have in dry heat a positive curative agent.

It is a stimulant to rapid repair and absorption.

It is one of the most valuable eliminative agents we possess.

Where indicated, it possesses a sedative action on the nervous system obtained by no other means.

LET us now study the agent of which so many have made use. As the therapeutic effects of heat depend on definite dosage to meet indications and require a form of administration suited to the case, a special apparatus may enable us to secure effects which surpass those generally obtainable. When, therefore, we leave the consideration of common heat and study the therapeutics of heat of very high degrees kept *dry* by systematic precautions, we at once enter regions of technic across which his familiar knowledge of hot-water bottles, hot douches, hot-air cabinets, Turkish and Russian baths, hot fomentations, heated flannels and bricks, etc., will not carry the practitioner with success. A new study must be made of actions, indications, contra-indications, and technics. In this section of this work we shall cover the principles of modern scientific Thermæro-therapy. That it is an important medical subject is evident from the growth of the manufacture of varied and ingenious apparatus.

To cite cases, medical reports, and discussions of theory and prac-

tice relating to superheated dry air could interest us through many pages. With ease we could devote an entire treatise to the subject, but to keep this section to its main purpose of *Instruction in Technique* (which no regular treatise now supplies) we must omit routine text and study how best to create for ourselves the good results that others have described in recent literature. We venture just one preliminary word. Says Dr. Shadwell, in undertaking the supervision of "Authoritative Reports" on this therapy in gout, rheumatism, arthritis, sprains, sciatica, eczema, etc. (a notable English work published in 1898):

"When requested to supervise the preparation of this volume I readily consented for three reasons. In the first place experience has convinced me of the value of the treatment; in the second place, I think it ought to be better known than it is; and, in the third, I have no personal interest in it whatever. I originally approached the invention with the scepticism which becomes second nature to medical men, but having tested it on my own person I found that it did what it pretended to do. And then I saw a boy with a knee-joint full of fluid and wincing at every movement gradually charmed off within half an hour into a smiling and painless indifference which permitted the free handling and flexion of the limb without a murmur. Since then I have seen results produced in old and hopeless cases of rheumatic arthritis which I could not have believed on lesser evidence than my own eyesight. The facts related in this volume amply corroborate my experience and make it unnecessary for me to say more on that head. Attested as they are by many independent observers of high standing in the profession, they form a body of evidence which no one can affect to ignore or despise. They do not come from a few clinics, but from a large number of first-rate hospitals, not only in England, but in Paris, Canada, and the United States. It is impossible to deny the weight of so large a mass of concurrent testimony."

Leaving all other narrative to the reader's leisure in his library, let us at once begin our practical study of what dry hot air can do and how we can make it do it.

Studies of Actions and Effects.—What is now popularly known as hot-air treatment means the application of dry air heated to temperatures ranging from 200 to above 400 degrees Fahrenheit, with the tissues protected by ventilation and by absorbent coverings which remove the diaphoresis of the skin and maintain the essential factor of safety—dryness during the exposure. To be of active therapeutic value the temperature must be from 220° to 280° F. for the whole body (save the head, which is never placed in the apparatus), or 300° to 380° F. or upward for local applications. Cork, wood, asbestos, fibrous magnesia mattresses, stout canvas—poor conductors

of heat—line all parts of fine machines which the patient is liable to touch, and permit a dosage far higher than former means of thermal therapeutics. Moderate degrees of heat in any form do not parallel the actions of high intensities, and are not to be compared with the therapeutics of special hot-air apparatus. Let us now note the central facts which the physician needs to know.

When any part of the body is subjected to the action of *currents* of superheated dry air in the manner we are here considering, it speedily becomes hyperæmic. An initial contraction of the arterioles and capillaries is followed in a few moments by a dilatation which causes a deep flush to spread over the whole surface. The pulse becomes fuller and stronger, and increases from ten to twenty-five beats per minute. In favorable cases a sensation of agreeable anæsthesia is induced, and pains of types which are relieved by heat diminish or are entirely removed. Muscular spasms relax, a profuse acid perspiration with increased specific gravity ensues, and with the stimulation of the cutaneous nerves and lymphatic circulation the patient feels a sense of general comfort. If this state is not developed, but on the contrary pain or some symptomatic disturbance is aggravated, then alter the dosage as indicated or consider if the indications have been misunderstood. A patient on whom the effect *appears to be unfavorable* can be made a most useful source of clinical study, and by improving opportunities to question the causes of non-effects or ill-effects when these unexpectedly occur we can learn how to do better next time.

With the *body* apparatus the increase of temperature may be from one to five degrees by the mouth, the rectal reading being slightly less. This low rise in general temperature of a body subjected to nearly 200 degrees above the normal is maintained by the safeguarding evaporation of water from the skin, and if this is interfered with a blister or burn may result and severe effects may occasionally develop.

The alkalinity of the blood is increased, and there is a temporary increase in the number of corpuscles. Respiratory movements are increased from two to six per minute. The action of this intense heat tends to loosen small stiff joints, reduces œdematous swellings, creates marked acidity of the sputum in rheumatic and gouty cases, sets up a slight thirst and a varying loss in weight. The renal secretion is stimulated as to amount of water, chlorides, and urea, indicating a marked increase in metabolism. The urine passed immediately after treatment has a decreased specific gravity.

The primary action during exposure to the heat will be followed after several treatments by *physiological* effects, among which are:

increased tone and functional activity of the circulatory apparatus and excretory organs; increased excretion of uric acid in lithæmic cases; disappearance of acne in gouty cases; temporary increase of soreness and nervousness in gouty and rheumatic cases during the absorption of urates and other deposits from the tissues; the softening and absorption of deposits, callus, exudates, fibrous adhesions, etc. In cardiac and renal cases there is a reduction and sometimes permanent relief of albuminuria. Many chronic skin diseases witness a great improvement. The inflammatory reaction following a severe sprain or the breaking up of an ankylosed joint is limited (and sometimes aborted) by immediate treatment. There is generally a little reduction of weight in ordinary patients and a greater reduction in cases of obesity, and while this may be temporary, yet when the object of treatment is loss of weight the results can be fairly maintained as a rule by a suitable diet and an occasional hot-air séance after a course of fifteen to twenty primary treatments.

Congested mucous membranes and kidneys, and throbbing headaches are relieved by the revulsive action on the vascular surface, and Kessler cites a case of angina pectoris; a woman who would submit to 240 degrees for an hour in a body machine with entire relief to her attacks, though she would faint in an ordinary hot-air cabinet. Some remark a soothing influence of the heat with a tendency to sleep. Without doubt one of the most important therapeutic factors in hot-air treatment is *the increased flow of temporarily superheated blood through the tissues.*

By-effects.—When a chronic case is subjected to frequent treatment for a long period (an hour and a half) there may be a debilitating action on the system and the patient may complain of being weakened. Intermit the séances for a time or maintain a tonic state of the tissues in all such cases by the auxiliary aid of static electricity. The value of skilfully employed static electricity as an adjunct to both Thermæro-therapy and Hydro-therapy is very similar to that of drink as an adjunct to food.

When too long a treatment is given to susceptible patients they may complain of nervous restlessness and even muscular twitching, and these call for attention on the part of the operator. Do not exceed the time of benefit in any séance.

If a patient finds the routine drink of cold water to cause palpitation of the heart or distress of the stomach try a hot drink to aid the perspiration, or let the drink if desired be taken at the close of the séance. Individualize the matter of drink during hot-air treatment and consult idiosyncracies rather than a routine.

If a patient does not develop profuse sweat as the heat rises at the first treatment a *low* temperature will cause distress. A few people "never sweat" or sweat with difficulty, and these cases must be watched till the function is established under a gradual course of preparation. Soften the skin with manipulation and unguent, stimulate the glands by motor-massage if you have that useful adjunct, and lift the heat slowly to tolerance for four or five preparatory treatments, when perspiration will usually be all that is desired. Without the safety-valve of active sweat glands 160 degrees of heat will be more of an over-dose than would 300 under right conditions. Watch this point.

In some cases of rheumatic, gouty, or neurasthenic patients miliary rashes may be caused by very acid perspiration, but these disappear in a few days as the sweat becomes neutral and finally slightly alkaline in reaction. Slight epistaxis has been noted in a rare case. Local cyanosis and chromidrosis have (rarely) been noticed as incidents during first séances, but have disappeared speedily. In a case of a neurotic young woman with an irregular heart the pulse went below fifty after each séance, but this was temporary and no other symptom was noticed. A patient may feel a sense of lightness in the head or see flashes of light before the eyes at the beginning of a first treatment, but these speedily cease or will be avoided by a little caution in developing the dosage slowly. Operators have reported that they have treated advanced cases of general arterial sclerosis without any unpleasant effects from increased blood-pressure. In these cases caution is wise. Develop the dose gradually.

"Since my former article," says Blech, "I have treated over 200 patients with the hot-air apparatus, making a total of 3,621 treatments, without any ill-effects other than slight superficial burns of the epidermis which could have been avoided had both nurse and patient exercised the necessary care. I make this statement as an offset to a reported case of an old man in whom was said to have been observed acute parenchymatous nephritis and uræmic intoxication as the result of hot-air administrations. The case was one of subacute rheumatic synovitis. The urine was examined three months before the use of hot air began. The symptoms persisted for thirteen days after hot air was stopped, despite active rational treatment directed to the nephritis. If due to hot air the symptoms would have ceased in two or three days. The report by no means proves that the condition was caused by hot air. It may, however, have been caused by a sudden chilling after heating the extremity treated and indirectly thus heating the body. I have directed dry hot air at a temperature of 400 degrees for one hour daily against the lumbar region in two cases of acute parenchymatous nephritis, and in both instances with

immediate relief of the symptoms, particularly the pain caused by the inflammation of the uriniferous tubules.

"In the beginning of my experiments I was inclined to be afraid of intense heat and examined every patient's heart, arteries, and kidneys before prescribing hot-air treatment. In a certain class of heart disease an indiscriminate application of hot air might perhaps lead to disastrous results and I have myself observed a few persons faint, but immediate cessation of the treatment, a cold drink, and a cold wet towel around the head suffice to restore the patient. Patients with valvular insufficiency have taken these treatments for articular affections and have tolerated them well, beginning with short applications of lower temperatures and developing the dosage gradually."

This is sufficient to guide the physician in the matter of intrinsic actions, and we will next consider the particular attention to be given the patient. We shall see that this depends much on the part treated, and is most important when the whole body save the head is subjected to a high temperature for forty minutes.

Care of Patient During Hot-Air Treatment.—Undoubtedly proper care of the head is one of the most important functions of the attendant during any general hot-air séance which acts on the cerebral circulation. Test this yourself so that its necessity will be best appreciated. Even without any of the new apparatus go into an ordinary Turkish or Russian bath; let the head be dry; let it get hot; feel the general discomfort that will tend to develop—in some at lower temperature than in others, but finally in all. Even nausea, vertigo, and dyspnœa may appear, as well as congestion and headache. Then without lowering the body-heat at all or reducing the temperature of the room note how a cold wet towel to the vertex and around the head clears away the symptoms and produces comfort. Much more is there need of care of the head when the highest effects of modern Thermæro-therapy are sought.

Under extreme systemic dosage it is not enough to simply apply dry cold to the head. There should be a *radiation* of the heat; the application to the head must be moist to assist radiation and must not only be applied at the start, but must be continually renewed as needed throughout the séance. The dexterity with which the attendant cares for the head will have much to do with the future visits of the patient and the satisfaction of the treatment. The patient should not only be benefited, but he should be benefited with *comfort*. The best teacher on this point is the instruction of personal tests. Make them on yourself and give the benefit to your patients. They will appreciate it.

With the body apparatus the preparation of the patient and the

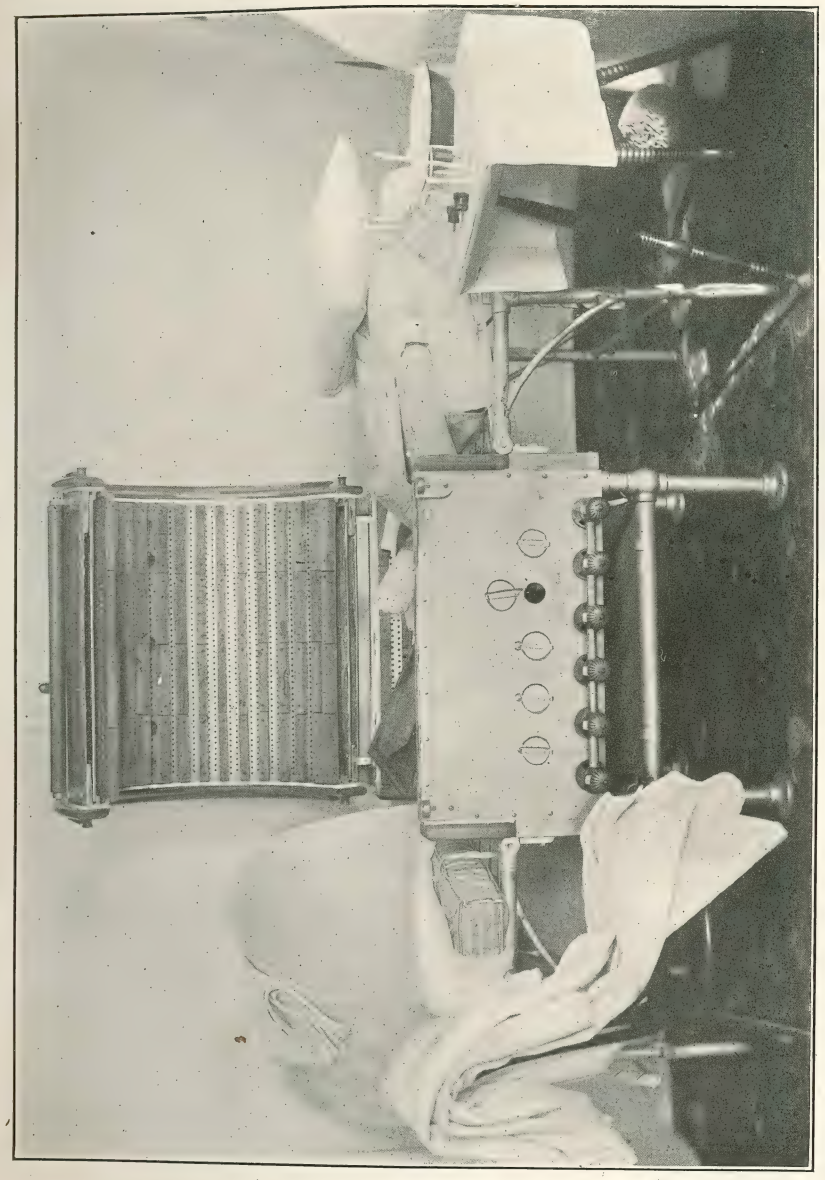


PLATE 239.—Sprague Body Apparatus (open) showing details of complete equipment.

The series of sixteen Instruction Plates on Hot-Air technics immediately following were photographed exclusively for this system of instruction, and represent the methods of the Sprague Hospital.

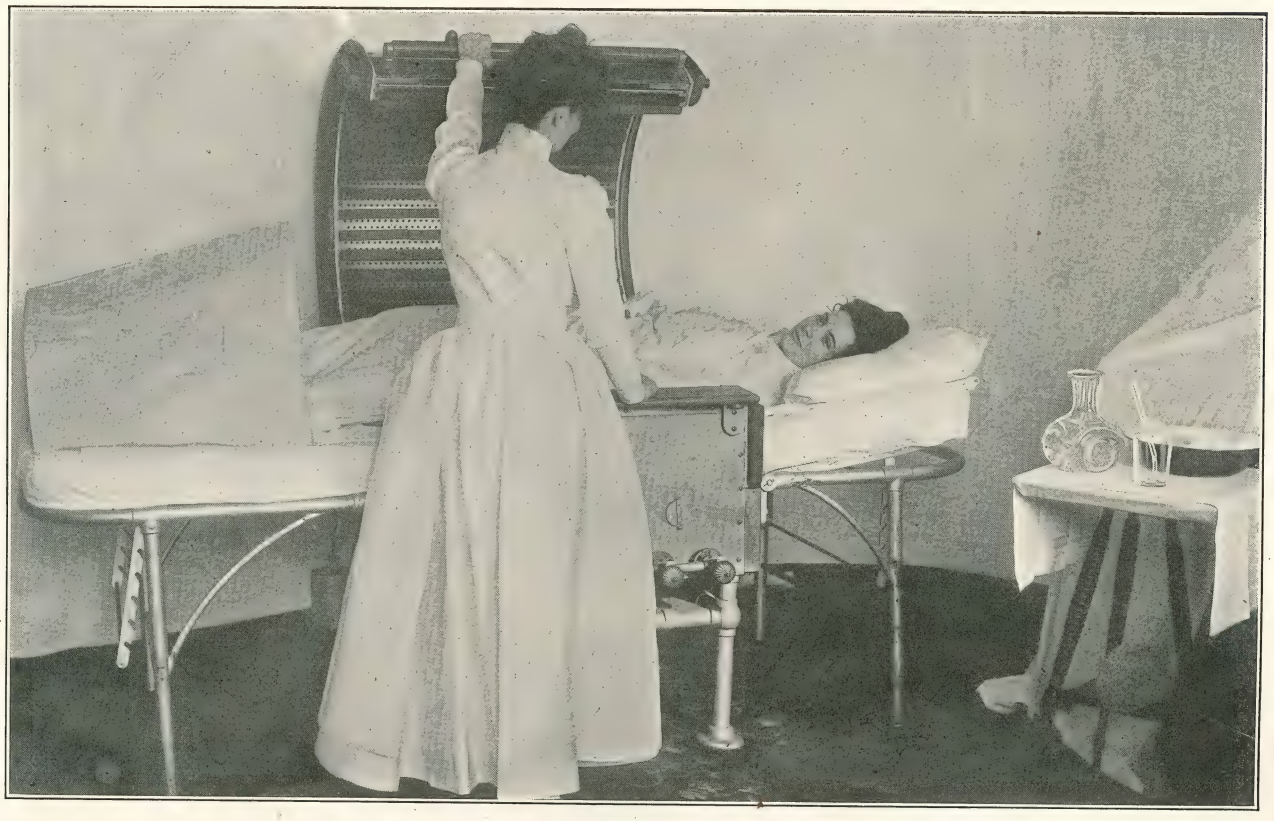


PLATE 240.—Patient in position for treatment and apparatus being closed by attendant.

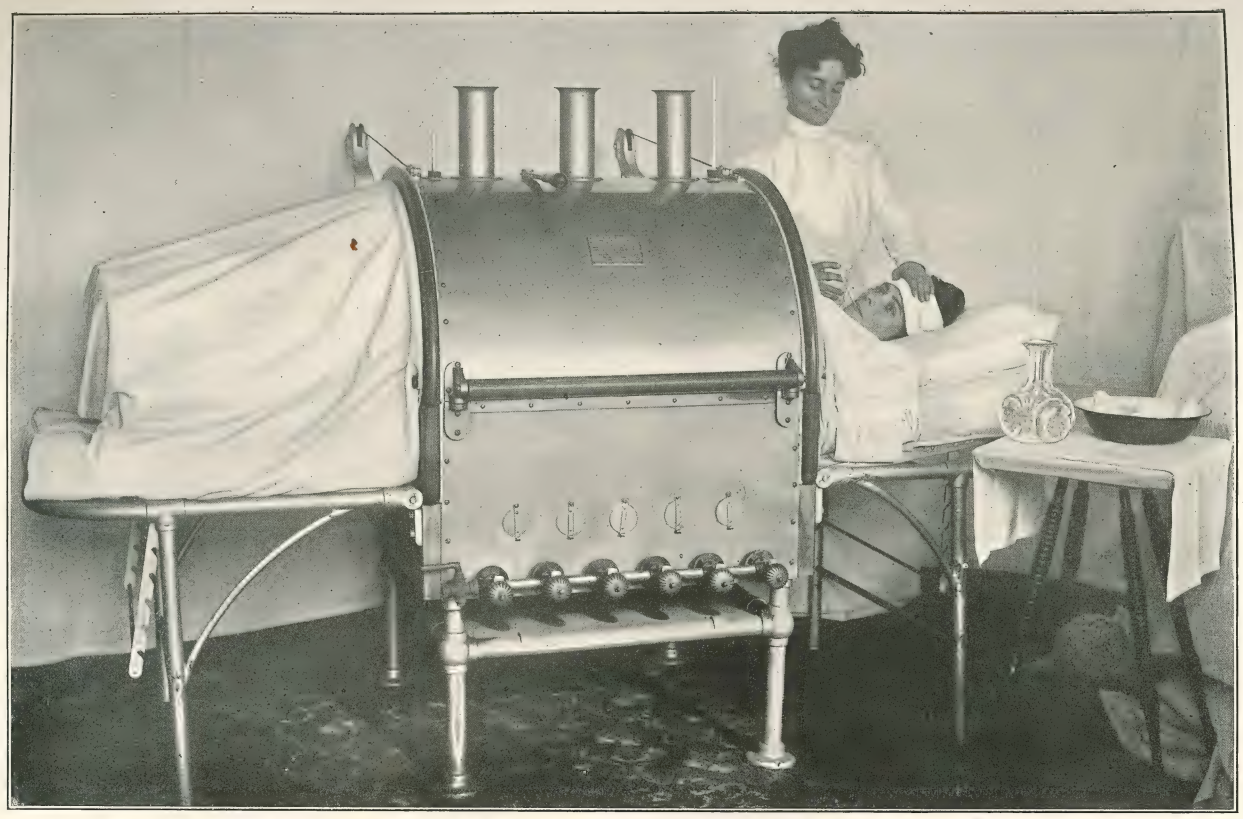


PLATE 241.—Sprague Body Apparatus closed and patient taking drink through tube.

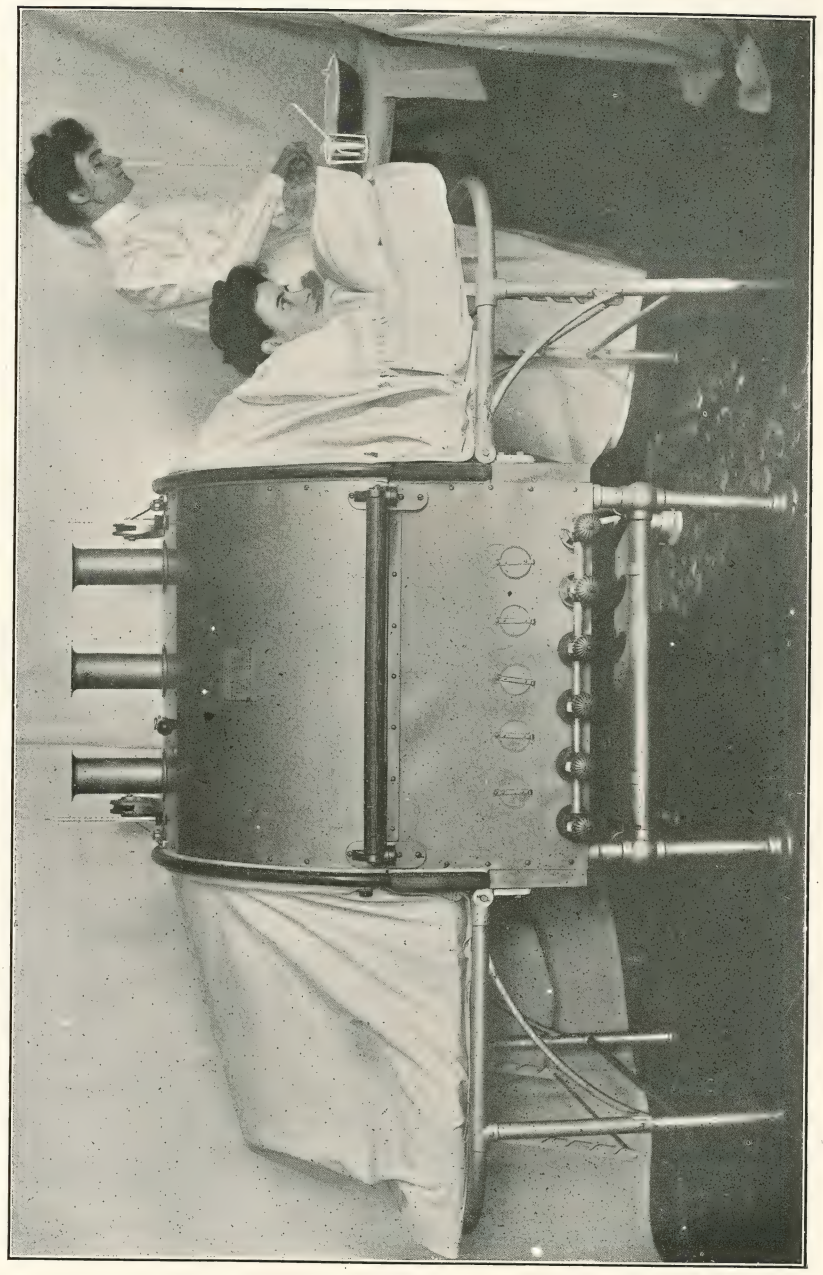


PLATE 242.—Showing patient turned in body apparatus and application to entire back.

precautions to observe are very important. Judgment in the matter of covering must be acquired by experience. What would be too light for some will be too heavy for others. If the covering is too thin the heat may "burn," and if too thick the object is defeated. New patients in the leg apparatus complain first and most of the feet. The extremities should be carefully watched. Too much covering may prevent rather than aid perspiration. With ordinary precautions there is no good excuse for burning a patient.

During the first treatment the patient should have constant attention. Watch the respiration and pulse as well as the thermometer on the apparatus. Always exercise care in a patient's first treatment to overcome timidity and the natural dread of an untried high temperature. Begin within comfort and increase the therapeutic dosage with care, and very slowly, till reactions are determined and benefit is established. Then the same patient may be treated confidently.

As the dosage of heat depends on the condition of the patient and the disease, as well as on the extent of tissues to be heated, the difference between small local applications and the general treatment in the body apparatus must be adjusted to the case. While intensity ranges from 120 to 400 degrees the extremes relate chiefly to local application to small parts. With the general surface of the body subjected to a heat which acts upon the heart, lungs, kidneys, great blood-vessels, and nerve centres, a temperature of more than 280 degrees is seldom used. Do not hastily get the idea that hot air always means 400° F. Probably the majority of treatments are under 350 degrees. Profuse perspiration is obtained usually at 180° F.

A séance in the body apparatus is quite a different thing from a limited local application to an extremity or small joint. Fifteen minutes of *general high-intensity heat* is often enough, and thirty minutes is a fair average limit. The time depends on the conditions. General treatments of an hour should be given only to meet definite indications in a special case. Local applications are more often higher in dosage and longer in time. Full hour séances are often beneficial here. Regulate dosage and time by the effects. Individualize according to results. Judge the indications and make a first cautious treatment to nearly meet them. Then modify the next treatment by the report of the effects of the first. Bear in mind that the entire time spent in the machine is not all *active* treatment, hence do not consider that the body has forty minutes of maximum dosage. With the slow and gradual rise of temperature which should be taking place from the beginning to nearly the end of each séance the period of *high-intensity* dosage is comparatively short.

In order to care for the patient certain accessories besides the main machines are needed, and after stating what these are we will be ready for the explicit clinical directions which form our main concern.

Hot-Air Accessories.—Besides the chief apparatus, hot-air treatment requires a few minor but very necessary adjuncts, and among these are:

1. Light-weight bath-robes for men and women patients. Have the robe laundried after use and serve each patient with a fresh robe folded so as to be unmistakably direct from the laundry.

2. Have a pair of bath slippers for the patient to slip on after taking off his own shoes and stockings. Washable ones are easily kept clean, and that is a recommendation with many patients. They are needed in walking to and from the place of undressing to the machine, but are not kept on during treatment in the hot air.

3. A liberal supply of light turkish towelling of assorted sizes is needed. Have some in sheets the full length of the patient. Have some in regular ordinary towel sizes. Also small squares like a "wash-rag." Also rolls of absorbent cotton.

4. A massage table of suitable height and equipped with sheet, blanket, and at least four medium-sized pillows is wanted. Take an ordinary hair or feather pillow and over it put a cover of white rubber sheeting to make it waterproof in its uses when damp cloths are placed under a patient's head. Outside this rubber covering use a clean muslin pillow-slip as on any other pillow. An abundant supply is important, as some patients want the head low and one or two will adjust it right. Others want the head higher, and by adding one or two more the patient can be easily suited. Also, during massage of the abdomen the head will be raised on extra pillows and the knees flexed to relax the muscles.

5. A supply of alcohol is needed. The alcohol-rub is a routine which many patients value highly. Get two of the narrow-necked bottles with special stoppers such as barbers use to dash shampoo solution on the hair. Keep the clear alcohol (for rubbing) in one bottle near the massage table. In the other put a cleansing mixture made by adding one part of saponis viridis to two parts of alcohol so as to form a liquid that looks like sherry wine.

For the sponging-off process have a neat *papier-maché* or enamelled pail holding about a gallon. For each patient put in this pail about two quarts of warm water and a dram of the above soap solution. Have a soft large sponge, and when beginning on a patient squeeze it out a few times in the fresh water and a fine cleansing lather will form. This removes the effects of perspiration from the skin in a most agreeable manner and leaves the skin velvety. Do not use plain warm water or ordinary soap. Make up a little stock of the above mixture and fill the shampoo bottle as needed.

6. A neat basin for the cold-water compress to the head while the patient is in the cylinder must be near the machine. Also the drinking glass and tube, or patent straw. A patient cannot well use his hands to drink directly from a tumbler when recumbent in the apparatus, and a tube to suck through is essential. A fresh patent straw for each patient will be appreciated by those who are not sure that a tube of glass is really aseptic and clean since the previous case. Ice for the drinking water will be needed, and in summer the water for the compresses will need ice to cool it sufficiently. Where good water exists use the regular supply, but in some localities the better class of patients will appreciate the attention of a special carafe of some fine table-water instead of the public storage. Lithia may be added when desired.

In winter extra blankets will be needed to cover over patients while resting, but in institutions with systematic facilities the temperature of the dressing- and treatment-rooms is kept at an even degree the year round, except as it rises higher in summer. In the treatment of women patients who want to avoid dampening any part of their hair a fine silk bathing-cap can be used while wet cloths are applied to the forehead and back of the neck. Do not use an ice-bag on the head as a means of keeping it cool. Continuous cold of this kind is not wanted in these treatments, and the reaction after the séance when ice-bags have been used has been unpleasant in some cases. The cool, damp cloths, used as here taught, are far better than an ice-cap, as a rule.

Large institutions will have several machines and rooms in use for a large clientele, but in smaller practice two medium-sized rooms will do. Have the machines in one room and move the patient to the other for the after-treatment and cooling, and a second case can be progressing in the machine while the first is cooling off. For local machines less space is required, and with duplicate apparatus several cases can be cared for in rapid succession.

Some will ask what assistance is needed. The chief demands arise from the use of the body apparatus. Male assistants for male patients and female assistants for female patients is the rule in institutions using this therapy. Were it not for the sponging and massage this would be less necessary, for during the hot-air séance there need be no real exposure of the patient. In most local hot-air applications one attendant could serve both sexes without difficulty. Our Instruction Plates show how little objection there need be to this.

Attendants are recruited from among graduates in massage. They need have no previous experience with thermæro-therapy, for you can speedily direct them in the mechanical details, all medical responsibility resting with the physician. Owing to the multitude of massage operators of both sexes it would appear that satisfactory attendants could be readily obtained anywhere in this country. When only a local apparatus is used for an occasional case in private practice it is perfectly feasible to get along without any assistance at all. Any new assistant or physician with the following directions in his hand may confidently master the technic we shall now study.

Directions for Use.*—In important respects the technic of the *body* apparatus differs from that of the more local application in the leg and arm apparatus; hence we shall here separate instruction covering details of managing the patient during both general and local séances.

The Body Apparatus.—It takes about ten minutes for the large machine to warm up. Therefore light it ten minutes before the patient is ready. The gas heater works exactly like a gas range. Use a match or wax taper; turn on the gas full, wait an instant till gas fills the tube and drives out the air, hold the lighted taper near enough to the burner to ignite, and observe the effect. If (as often happens to a beginner who has not yet acquired the knack) the gas blows back with a report and burns with a yellow flame at the ventilator, turn on the gas at once, as it has not properly lighted. This happens chiefly when the cold pipes are first used after standing over night. When once warmed by the flame the gas flows in and mixes properly with the air and burns with the familiar blue jet, which is correct. Relight the burner till the flame is blue. The blue jet is free from the poisonous vapors of the yellow luminous flame and gives out far more heat. A flame, the color of the gas-light we read by, would be all wrong for the burner in a hot-air machine. We want heat, not light, and the blue flame which suits the heater would be useless to read by. This preliminary item is important.

Light the body machine with its extensions off. Take out the thermometers. Close up the ends with the canvas curtains drawn over the thermometer-holes in the top and close the ventilating funnels. This shuts off escape of heat and enables the apparatus to warm up quickly for use. Meanwhile have the patient undress completely and

* The author desires it to be understood that owing to the many different designs of apparatus certain details in these instructions must be adapted by each operator to his own machine. Explicit directions based on a given instrument cannot include every detail of other designs, but the *principles* involved are essentially those here taught. Nothing in this work is intended to discriminate against any apparatus not illustrated in our Instruction Plates, which cannot picture every machine in the market.

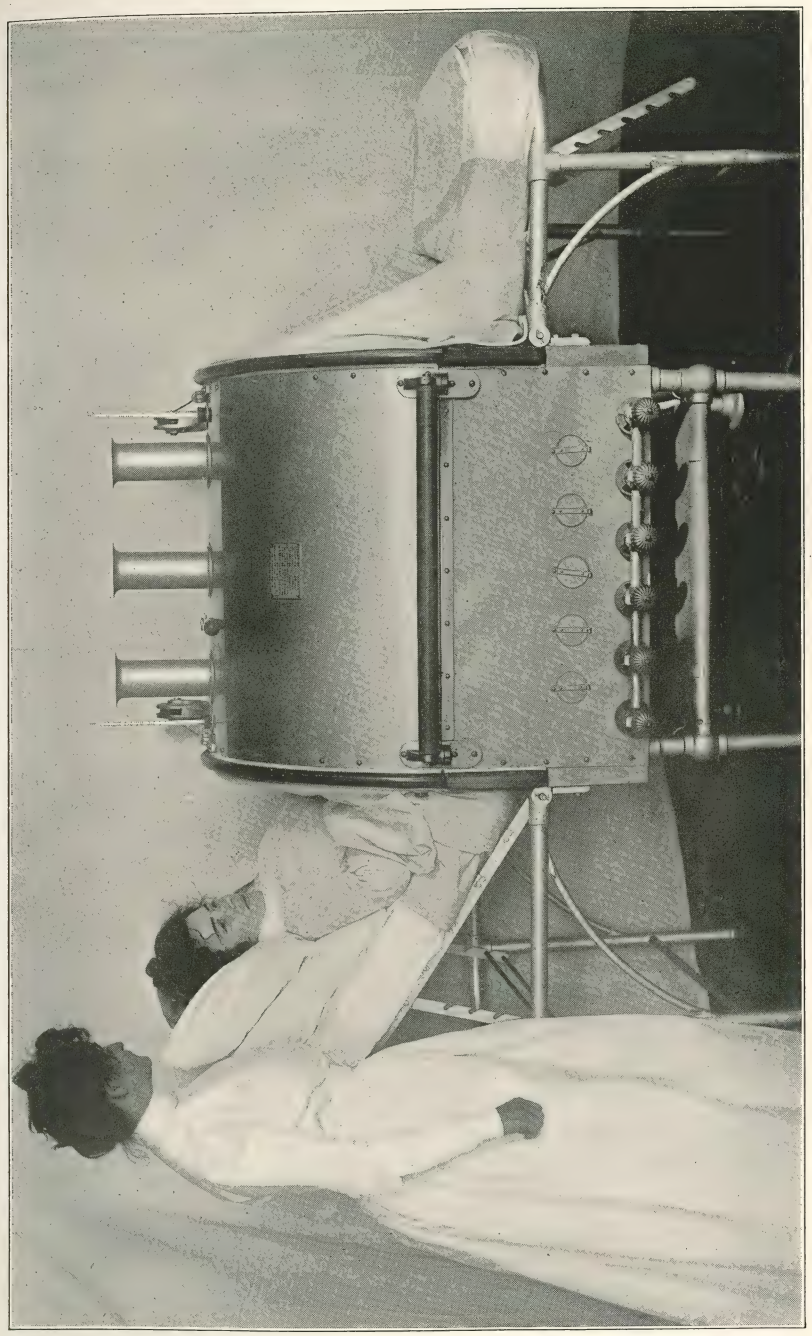


PLATE 243.—Showing patient receiving high degrees of heat to lower half of body.

PLATE 244.—Commencing the Alcohol Rub after treatment by Hot-Air Method.

PLATE 245.—Massage of Knee after Hot-Air Treatment.

PLATE 246.—Massage Process following Hot-Air Treatment in Body Apparatus.

put on the bath robe and slippers. When all is ready ask the patient to walk to the side of the machine, raise the top, place the wooden cover over the metallic side-arm to protect the patient from the hot contact and have him sit on it (or below it), and, with a side-swing of the body neatly achieve a full length dorsal decubitus on the couch which forms the bed of the apparatus. This non-conductor couch is at first cool and heats very slowly. Do not let a patient enter a machine in which the mattress has been allowed to remain hot. The body does not like a superheated *bed*. Always see that the mat is cool. Now remove the slippers and leave the feet bare.

Have the patient's head project out of the machine according to the needs of treatment. If you wish to treat the lower tissues mainly let the head come well out so as to clear the field of heat and keep cool easier. If you need to heat the upper thorax, or reach the shoulder, for instance, let the head be only just clear of the opening of the cylinder. With a little experience you can shift the patient up or down to secure the best results with the most comfort—and comfort during this treatment is a very important thing.

Now remove the wooden fender, close down the top of the cylinder, put the two thermometers in place, and prepare the patient. Tuck a folded small turkish towel under the chin and around the neck to cut off the hot air from the face. Adjust the canvas hood which finishes this end of the machine so that it is tucked closely under the chin and over the shoulders outside the towel, to act as a barrier to the escape of hot air beyond the parts it encloses. This takes but a few seconds.

Next go to the foot of the machine and place the canvas extension over the patient's feet, closing down also the canvas flap which completes this end of the apparatus so as to shut in the heat. Then open midway the ventilating draft of the funnels to secure *circulation* of the heated air, a most important feature of the treatment. These are the primary preparations and are to be quickly done so as to avoid loss of heat by keeping the machine open, and to get the patient started to warm up. *Details* of technic come next.

The patient now lies comfortably on his back with his hands at his side and the bath robe folded over him. Under him is a bed that feels cool in the warm cylinder. From above pours down a rain of fine streams of gradually increasing dry heat. It acts chiefly on the *uppermost* surface of the tissues, and if the patient raises the knee or lifts his hand nearer the roof of the cylinder he will feel the difference in temperature between the floor and the ceiling of his temporary prison. Instruct him not to touch the metallic parts or even

the cork lining, though he can touch the cork with impunity, but let him occupy the middle of the couch and simply rest in the most comfortable position and throw open the robe to expose all the body. Do nothing further till the patient reports commencing perspiration.

Note the thermometers at head and foot of the machine. There will often be a marked difference in their reading. One may be fifteen or twenty degrees higher than the other, and this is caused by the direction in which the current of outer air passes through the room and affects the machine. But till perspiration begins and the head feels the heat the patient needs no special attention. It may be ten or more minutes before he says he is ready for the next step.

As soon as he reports a marked sense of heat with well-established perspiration, wet a small square of the turkish towelling in cold water, wring it partly out and lay it across the eyes and over the forehead. With the hands press it to good contact and let it remain till it feels too warm. Then wet and cool it again, and repeat this cool application to the forehead at short intervals till the séance ends. If the head feels more effects of the heat than this simple application relieves, lay a similar cold wet towel *under the nape of the neck*. It is wonderfully refreshing to some whose cerebral circulation is easily disturbed by the heat. It will be noted that the entire hair of the head is not wet. The cold damp cloth is only applied to the frontal region or to the back of the neck, and the vertex rarely needs the cold. This fact is very important in the treatment of women, whose hair would deter many from taking the treatment if it had to be wet, dried, and toileted at each séance. Men do not care, but most women object to a treatment which wets the head.

Now comes the question of *drink*. Do not fill each patient with routine ice-water "to promote perspiration." Generally omit water in corpulent persons and hydræmic states. Generally let thin patients drink freely. These have no fluid to spare from their tissues, while the hydræmic class should lose watery constituents from the system without resupplying them by drink during the treatment. Get this distinction clear in the mind as a guide to practice, but also accept the patient's wishes within reason. When perspiration has started or the patient asks for a drink have a lump of cracked ice in a glass, pour in fresh water and place in the tumbler either a glass tube or a patent "straw." When gratefully cool but not fully ice-cold, hold it so that the patient can suck it through the tube, as he cannot well otherwise drink in the recumbent position with his hands closed in the machine. A half glass of water twice during a séance is usually sufficient, but if a patient is thirsty and craves more let him have it.

For the most part regulate the quantity by the law of supply and demand. If you wish to maintain a balance in a thin or medium patient let him drink about as much as he perspires. If you wish to flush out the system with increased perspiration supply drink more in excess. If you wish to extract watery constituents and reduce obesity, œdema or exudates reduce the drink accordingly, relieving only special thirst. Avoid the internal shock of extremely cold ice-water. Have it only gratefully cool; or, in some cases, a hot drink will be more beneficial. Experience will teach this.

If a patient needs to wipe his nose or rub his eye, or pay any other attention to his face during treatment, simply pull up the canvas at one side of the neck so that he can get one hand to his face without letting in much cold air and close the canvas down again when he returns the hand to the cylinder. There is no inconvenience to the patient on this point during treatment. He can use his hands freely whenever he wishes to do so. Some want to keep their arms out of the body apparatus altogether and a patient can be humored in this respect if necessary, but it is preferable to have the arms in the cylinder so that the entire circulation below the head is acted on evenly by the heat. In cases which require treatment only below the waist line the upper portion of the body can be out of the apparatus, and the patient need be only partly recumbent. The above directions will then be modified accordingly. The various positions are beautifully shown in our Instruction Plates, which are without doubt the finest and most complete series of photographs ever made to illustrate this subject.

Having started the head to keep cool and comfortable the next thing in order is attention to the body in general and to the special part which requires either special treatment or safeguarding. Ask the patient if any part of the skin is getting too hot. If we want the entire system to be directly heated and with the least loss of time, ask the patient with his own hands inside the cylinder to lay off the anterior folds of the bath-robe so that the hot streams pour full upon the skin. Now any local irritable focus on the surface may be the seat of a burning sensation long before the general action is secured. The end of the penis, or the middle of the thighs, or the region of the patella, or the feet, may be the first to feel uncomfortably hot. Then have the patient draw the robe over such parts as he can protect with a layer of it, and on other parts as the need may arise lay a dry and small towel folded to cover the area affected. One or two layers of towel will usually be sufficient, but, if not, double the towel again.

By the time the séance is half through this adjustment of the conditions to the needs of the patient will be completed, and he will be prepared to enjoy the final rise of temperature to maximum where it will be maintained till the séance ends. It is only this latter half of the process that constitutes the active period of therapeutic treatment, but the gradual climb of the tissues with the thermometer is as indispensable as the maximum dosage.

When the front surface of the body has no particular indication which leads us to devote the entire time to it tell the patient to turn over and lie on his chest for the last ten minutes of the application. He does this without opening the machine, just as he would turn in bed, except that you must readjust the towel that was under the chin and fit the canvas sleeve closely around the back of the neck. Then continue the cooling of the head as before, and if any part needs protecting from irritable heat lay a towel over it as was done on the front surface. In opening the canvas at the foot of the machine to introduce these local protections close it again quickly to avoid loss of heat in the apparatus.

Make the first séance in the body machine only thirty minutes, and let the temperature rise only to the point of maximum *comfort*. The thermometer may read 230° or 240° F., more or less; perspiration may not be freely established, and at first the treatment is *preparatory* rather than therapeutic. Make the second séance forty minutes and note any increase in tolerance and facility of the sweat glands. At the third and future séances the tissues are accustomed to the method, the maximum dosage is ascertained, and the length of the treatment is adjusted to the effects. Bear in mind that the early part of each treatment is used in raising the dose to therapeutic activity, and that only about two-thirds of the time is actual treatment. Make forty or forty-five minutes the full average séance in this apparatus, and only exceed this limit in special cases.

Many will feel so cosily situated in the warmth and rest that they "want more," but unless indications require a full hour do not yield to mere desire of the patient. In the smaller applications to local parts longer séances are commonly cited, but do not induce too much relaxation by longer action upon the entire body. This is especially important when daily treatment is given, and tonic results will be turned into increasing debility if an excess of time is allowed.

Do not dose heat by a mechanical meter. Dose it by medical judgment aided by the thermometer and not by the thermometer alone. Do not begin by saying that you will give a certain new patient a certain number of heat degrees. The tolerance of patients for heat,

PLATE 247.—Hot-Air Treatment to Arm and Shoulder. Showing position for patient. Attendant is reading thermometer.

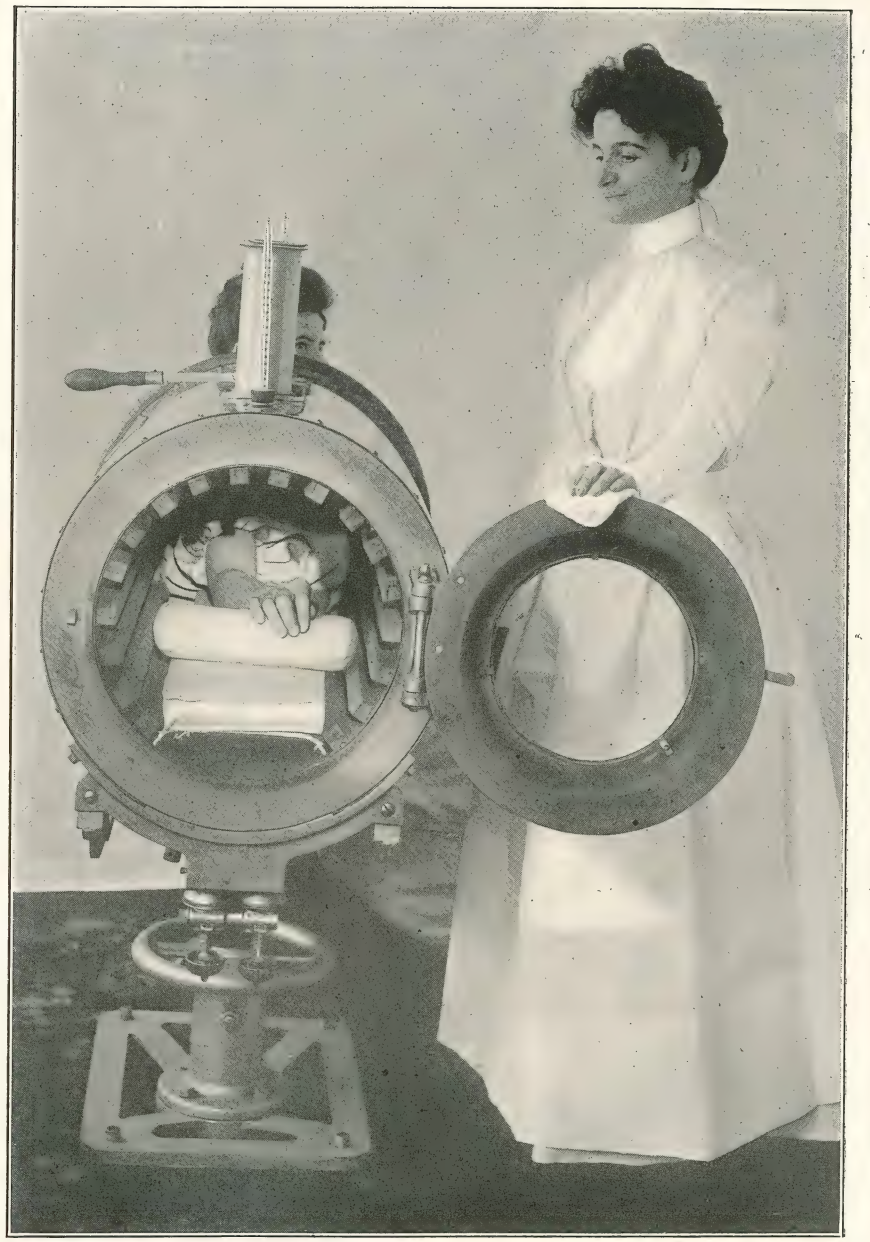


PLATE 248.—Showing Arm in Apparatus with hand resting on roll. End open showing entire interior ready to close for treatment.

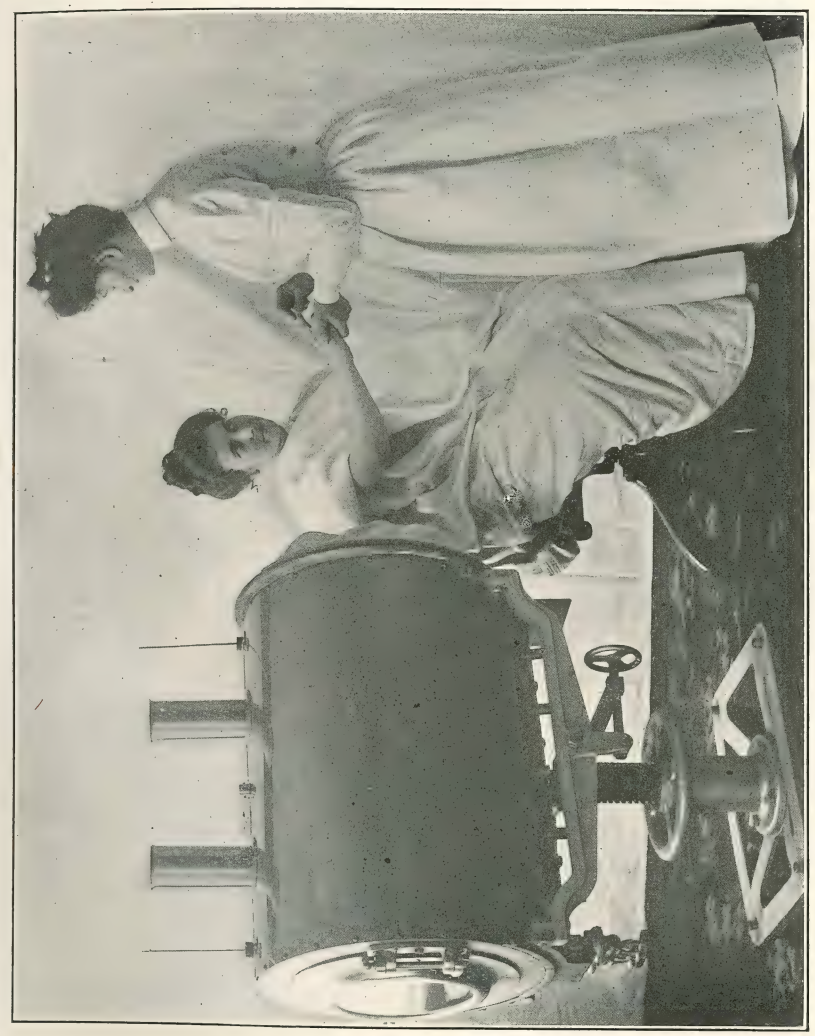


PLATE 249.—Manipulating Arthritic Finger-joints after Hot-Air Treatment.

PLATE 250.—Local Massage to Arm and Elbow after Hot-Air Treatment.

and benefit by heat, differs just about as cases differ in respect to dosage of drugs and electricity. As the mercury rises watch it and ask the patient if it still feels good. Coax it up to just the point where he ceases to say that the hotter it gets the better it feels, and then hold it there if it becomes comfortable, or slightly reduce it to comfortable general tolerance.

But if the thermometer shows that a therapeutic degree of heat is not yet reached when the patient reports *intolerance*, do not accept it as the proper dose as in the former case. Knowing about what the dose ought to be and failing to reach it with comfort, examine the part complained of and ascertain the cause of intolerance. If the skin is irritable in a local area cover it with a folded towel. If the cause is general and can hardly be attributed to the state of the skin look elsewhere. It may be that the head has not been kept well cooled. It may be due to a too-recent meal, or to some derangement of digestion, or the arterial condition. Seek and find the cause if possible, and if the treatment must be modified for the present séance do it with an understanding of the reason and take measures to have the next séance *secundum artem*. A favorable case which begins with 240° should thrive on 270° or 280° F., after four treatments, and if an active dosage cannot be reached within agreeable tolerance there must be a cause to seek and remove; 240° to 270° F. is a good average.

If the heat reaches maximum too long before the close of treatment turn down the gas to keep the heat even. If the thermometer drops a little later raise the gas as indicated. About five minutes before time to take out the patient turn out the gas. The next step is to open the cylinder and remove the patient to the massage-table.

When the full time has expired have the patient draw his robe over his body, if any part is uncovered, lift up the top of the machine, place the wooden fender on the side-arm over which the patient will climb out, and have him rise and step to the massage-table. If this is in an adjoining room put on his slippers before he walks. Also see to it that the room has been well ventilated and is not below seventy-four degrees. Too cool a room is undesirable, and any chill to the patient must be avoided.

Have him stand by the side of the massage-table, hold up in front of him a full-length sheet of turkish towelling, and ask him to throw off the damp wrapper and lie down on the table on his back. As he does this lay over him the large sheet of towelling, and, if he needs it, add a light single blanket. The covering will vary according to the season. In summer less is needed. If for any reason the patient has been unable to stay the full therapeutic time in the machine

—either because he is in a hurry, or the apparatus is wanted for another patient, or because his condition lacked tolerance—he can be taken out ten or more minutes too early, transferred to the massage-table, and allowed to complete his sweating there under extra blankets. The operator may wish to save his own time on occasions, and this little digression from regular technic is useful to know in practice.

The next thing is the sponging of the patient to remove sweat and debris. A hydro-therapeutic equipment and douches are important and well supplement hot air, but their consideration belongs to another treatise and we will only describe sponging here. This is done at once by the attendant. Have a pail (of about one-gallon size) half-filled with warm water. Also a very soft sponge as large as a baby's head. Add to the water in the pail about a dram of the soap solution and set up a little lather by squeezing out the sponge a few times. Then begin with one arm. Draw it out from under the sheet and sponge it off. Then dry it. Then dash a little alcohol on the palm and rub the arm as a cooling tonic measure. Repeat the same process on the other arm. Then lay the sheet off the lower part of one leg and sponge and dry it. Follow drying with the alcohol rub. Cover each part as fast as done and finish the two legs and the front of the body in sequence. If not ready to massage the patient at once have him sit up while the back is sponged and dried, but if ready to complete the massage treatment without delay have the patient turn over instead of sitting up, and sponge, dry, and finish the back with alcohol as taught.

Have the assistant begin massage at one foot and use gentleness at the beginning. Go over each leg twice. Let vigor of application develop gradually according to tolerance. Then massage the back for circulatory and lymphatic effects, turn patient on stomach and massage the anterior tissues as needed, and, lastly, do each arm. This is the rule in cases requiring no special *massage* therapeutics, and for whom this finishing treatment is only a tonic supplement to the cooling process. For others the masseur must meet the indications. If there is an inflamed joint begin the massage of that part above the inflammation. Good operators use cocoa-nut oil as a lubricant and again sponge off the skin after it. Plain liquid albolene would appear to be a superior and cleanly lubricant for this purpose. A motor-massage apparatus is admirable here.

The massage completes the full séance with the body apparatus. While a skilled masseur is a valuable assistant, yet manual massage takes considerable time, and by means of the new motor-vibration

machines the application can be very quickly done, as taught in our section on these instruments. Any one using hot-air apparatus may well supplement it by mechanical massage. The patient is now free to dress and be dismissed, unless he prefer to recline or enjoy a nap in a room provided for this purpose. Institutions will have such rooms, but in private practice the patient will dress and go home as quickly as convenient.

In warm summer weather a patient can safely dress and go out within a short time after leaving the hot-air machine. It takes the circulation and temperature an hour or more to attain normal, but after a sponge and alcohol rub the patient can dress and go home in a half hour with entire safety, but should be quiet and rest till after the next light meal. But at other seasons of the year the character of the day will decide the precautions needed to avoid chilling the lungs or body. On raw days with penetrating cold, sharp winds the patient had better recline in a side room more than an hour after dressing if he has far to go. If he can get home soon with little exposure he may start earlier. Ordinary medical judgment will advise him on this point. A little excess of caution is wiser than much risk, and hot air should not be blamed for ill-effects due to wintry exposures too soon after a séance. The general susceptibility of patients differ, and this must also be taken into account in bad weather.

With a female attendant these directions apply equally to the treatment of women patients.

The Leg and Arm Machine.—In this apparatus the application is more local and limited, and certain features of the *general* treatment are omitted. Action is concentrated on local indications, and the séance is managed differently.

About ten minutes before the patient is ready light the gas-burner (first removing the mat from the cylinder to keep it cool till the patient enters) and have the patient remove the outer clothing from the entire body, and all clothing from the extremity or part to be treated. We will first teach the preparation of the lower extremity.

When the thermometer shows that the machine has heated up to 180° or 200° F. it is ready for the patient. Have him walk to the side of it and sit on the treatment chair. This should be a stout wooden, cane-seated, revolving chair that can be raised and lowered, and have a comfortable back and casters. Now fold a medium turkish towel (about a yard long) so that it is about six inches wide by its full length. Wind this around the upper third of the thigh if the knee is to be treated, or just above the knee if the ankle-joint is to be treated. That is, wrap it above the site of the lesion requiring

the local action of heat. The object of this upper binder is twofold: it cuts off direct action on the tissues beyond the lower border and it serves as a base of attachment for the open towel next to be applied.

With the folded towel held in place by a thumb and finger, now spread over the leg from the binder to the foot another similar towel opened to a single layer and secure it to the binder with a safety-pin. Insert the pin so as to hold both towels together on the leg, but only pass the pin through the outer layers. A hot metallic pin against the skin may burn uncomfortably. Do not forget these little things. Next quickly adjust the level and height of the apparatus to the patient by a few turns of the set screws and insert the cool mat and the patient's leg. On each side of the leg place a roll of the same material as the mat to keep the leg and towels from contact with the hot and exposed sides of the cylinder which would scorch them. Tie down the canvas sleeve and make the patient as comfortable as possible. Now go to the other end of the machine to prepare the foot and areas which need protection rather than treatment. Remember that it is hottest nearest the roof, therefore instruct the patient to evert the foot and keep the toes flat on the cooler mat. Remember also that there is little perspiration from nails and knuckles, so that fingers and toes are less tolerant than thick soft parts which radiate heat by free evaporation from sweat-glands. Once in a while a patient reports a slight blister on some susceptible part after a séance in which he has been wholly unconscious of any burning sensation whatever, but as a rule all degrees of irritation can be spared the patient by simple attention to drying the moisture as it accumulates and by protecting tender exposed parts that must share the treatment.

If the knee-joint is the centre of treatment lay an extra folded towel over the foot and ankle. This will shield these sensitive parts from extreme heat where it is not needed. If the ankle requires treatment cover the toes and insert a layer of towel between each toe. In brief, expose to the greatest heat the area that needs it, and cover all other sensitive tissues with regard to the patient's comfort. For toes and many local applications some operators find layers of absorbent cotton preferable to the towelling. Experience will teach when to use it as an adjunct to the towels. About the foot it is especially adapted to protect the small joints.

The question of drink, so important in general treatment, hardly enters into a local séance. If the patient wants a drink during any particular séance give it to him. If not, omit it.

Having completed the above described measures it only remains

to let the thermometer rise to establish free perspiration of the parts exposed. This usually causes no care till the heat registers from 280° to 300° F., when the attendant must begin to regularly dry the skin as the dosage rises. With a small square of the turkish towelling in the right hand pull a convenient corner of the canvas sleeve just enough open to insert the hand and softly wipe away the moisture on the exposed part. In doing this reach under the towel that lies on the leg without removing it. If the parts near the foot need drying go to the lower end of the machine, partly open the door, insert the hand and dry the skin and quickly close the door again to avoid unnecessary loss of heat. Repeat this drying process every four or five minutes, or as often as necessary for the comfort and care of the patient during the remainder of the treatment. The maximum dosage will depend on tolerance and the area under treatment, but for the extremities a range of from 300 to 450 degrees is about equivalent to a range of from 240 to 300 degrees in the general body machine. The majority of treatments use about 400° F., though in stating exact temperatures we must have regard to the method of inserting the thermometer in the apparatus. Some run it through a cork collar, while some allow the tube in direct contact with the hot metal. This will cause a higher reading for the same internal heat in the vicinity of the patient, so that all reports of temperature are not of even standard. Get your experience from your own apparatus and regulate the dose according to effects on the patient, as taught in another paragraph of this section.

No cold application to the head is required in these lesser local treatments. The duration of a séance may be limited by various reasons to less than an hour, but an hour is an excellent time to allow, as the after-treatment does not require the full technic which follows the use of the body apparatus. About five minutes before the time expires turn out the gas, or reduce it earlier if the machine has large bulk to keep it hot for some time.

The hot-air séance is now ended. Open the sleeve and lower door, remove the part and also take out the mat and rolls so that they may cool. Sponge the limb with the warm soapy solution as taught in directions for the body machine and dry it with the alcohol rub. Then follow the indications for more or less local massage and the patient may shortly dress and leave. This after-treatment may either be done on the massage-table for the repose and pleasure of the patient, or if the foot only is treated it may be done while he still sits in the chair. As the general system is but slightly exposed during a local séance a long cooling-off rest is not needed, and in

summer no special delay is required. Wintry weather must be dealt with according to the condition of the patient, and on any but mild days a rest of a half-hour is advisable.

Upper Extremity.—We will now describe the care of an upper extremity. Light the machine and prepare the part and the heat exactly as for the exposure of a leg. Bring the folded towel under the axilla of the affected arm and over the opposite shoulder. To this pin the open towel close to the neck on the affected side and spread it in a single layer down the arm and over the hand. By means of the adjusting screws raise and tilt the cylinder to conform to the level and position of the extremity to be treated. Use the same canvas sleeves as for the leg, and when the thermometer reads 180° to 200° F. open the end door, insert the cool mat and two rolls, place the arm in the cylinder, push the patient's chair up close to the opening of the machine, tie the sleeve at the shoulder, and begin the séance.

The hand and elbow are sensitive areas. Cover with a double folded towel such parts of the extremity as do not require the direct application. Use the same judgment as taught in treating the leg. Lay a roll on each side of the forearm so that the patient will neither tend to push over to the lining of the cylinder beyond the mat nor cause the towels to scorch against the sides where the heat is greatest. But if a hand is being treated have the patient lightly grasp one of the rolls so that the surface of the hand is raised from the mat and opened somewhat to the heat. A protection of a layer of absorbent cotton is excellent for wasted and painful fingers, which in cases of arthritis are apt to feel intense heat acutely. Also pay sufficient attention to outer towels or any blanket laid over the opposite side of the patient to keep them from touching the hot metallic parts of the machine, as scorching them from carelessness is poor practice. It soon makes new blankets look old and dirty.

When perspiration is freely established and the heat rises to above 280° F., or a point of perceptible intensity to the patient, begin the drying care of the arm exactly as taught above in the case of the leg. Repeat it as needed during the séance, about every five minutes. Other details are the same as for the leg and need not be stated again.

Note that the Arm and Leg Machine has two canvas sleeves. The large one is for use in treatments of the shoulder, etc. When the shoulder or side of the body requires the heat in addition to, or exclusive of the rest of the arm, sit the patient so as to bring the area in the front opening of the cylinder, pin the usual towels in

place above and over the part, and attach the "shoulder sleeve" instead of the smaller one. Then proceed as before.

When great heat reaches up near the face the canvas is not only very hot itself but radiates more heat upward than is comfortable for the patient. Therefore lay a double fold of towelling closely against the neck and over the top of the canvas. This will keep an excess of hot air from the head and face.

In any exposure, either of an upper or lower extremity, do not let the patient who has removed much of his clothing complain that while he is "roasting on one side he is freezing on the other;" nor allow a patient to sit on the exposed seat of the chair with only undergarments on. Always throw a folded blanket on the seat of the chair and up the back of it in all seasons when it is needed, and cover the side of the body not treated with a suitable wrap or blanket. Keep the patient comfortable on all sides during the séance. Do not forget to take out the thermometers and shut the ventilating-funnel drafts while heating up the machine for the reception of the patient. Otherwise it will take longer to heat. Have the holes in the top closed by the canvas sleeves till the heat rises and the cylinder is opened to admit the part. Freshly air the treatment-room before and after each patient, as the atmosphere needs attention in this respect, both on account of the actual heat and to dispose of the products of combustion. Open the funnels as soon as the séance begins, for a circulation through the apparatus is required for treatment.

The leg and arm machine can be used for any single extremity, in whole or in part; for one shoulder; for a side of the body; for the hip-joint and lumbar region. When two hands require treatment, or two feet, they may both be well exposed in this cylinder, but when the main portions of two extremities need treatment at the same time there is generally a systemic as well as mechanical reason for using the body cylinder. Do not limit the séance to a local part, even if it will fit in the small cylinder alone, if the general state calls for constitutional effects. Much judgment may be exercised in the selection of the cylinder and the management of the treatment on a local or general basis.

In regard to sensitiveness of the skin it may be remarked that erythema and irritable states are sensitive to X-ray action, to labile electric-current applications, to friction with coarse towels, and to heat. A pale skin without foci of eruption is not likely to be sensitive, and tolerance can be expertly estimated almost at a glance. Conditions likely to be aggravated by heat are visible to the eye in a great many cases and annoyance to patients is therefore avoidable.

Study of Mistakes and Failures.—Thermæro-therapy has so large a destiny before it that it is important to consider some of the mistakes made by beginners in the uses of hot air in order that clinical investigation may not confuse the subject of results. The mistakes of the inexperienced lead to failures. These failures arise mostly from one or more of the following causes which we shall now discuss:

1. The use of poorly constructed and dangerous apparatus.
2. The application of this treatment to unsuitable cases.
3. Errors in the duration and frequency of treatment.
4. Failure to conserve the comfort and welfare of the patient during and *after* a séance.
5. Errors in the management of complications.

Every one knows that tools, bicycles, pianos, houses, shoes, and even drugs are made in different grades of quality. This is true of every form of therapeutic apparatus, and hot-air machines are no exception to the rule. If demand for low price clamors loud enough it will always create a supply of inferior work and material, and we may be allowed to point out that sometimes cheapness is dangerous. Since the popularizing of hot-air therapy various forms of apparatus have been devised—some constructed on the most primitive principles; others more elaborate, with all that ingenuity can suggest to secure the comfort and safety of the patient. A gas radiator to heat a hall bedroom may be light and movable as a lamp, but if a light and easily moved hot-air device was suddenly overturned by an unwitting movement of a patient, imagine the consequences. If it capsized with the gas out it would be bad enough, but if flames spread to the clothing, the patient, and the room, there would be a costly sequel to economy. But this is not the only consideration, and the essential requisites of a good apparatus are:

1. Massive construction to secure safety, stability, and endurance, and to hold the heat.

2. Mechanical arrangements which permit the temperature to be raised gradually and evenly to above 400° F., be sustained with ease at any dosage required, and be always under perfect control.

3. An automatic ventilating system to keep the hot air dry, *circulating*, and fresh.

"The products of combustion and the materies morbii thrown off from the patient's body should not be retained in the apparatus in contact with the patient but should be carried out through apertures for this purpose. A certain adjustability of position is also

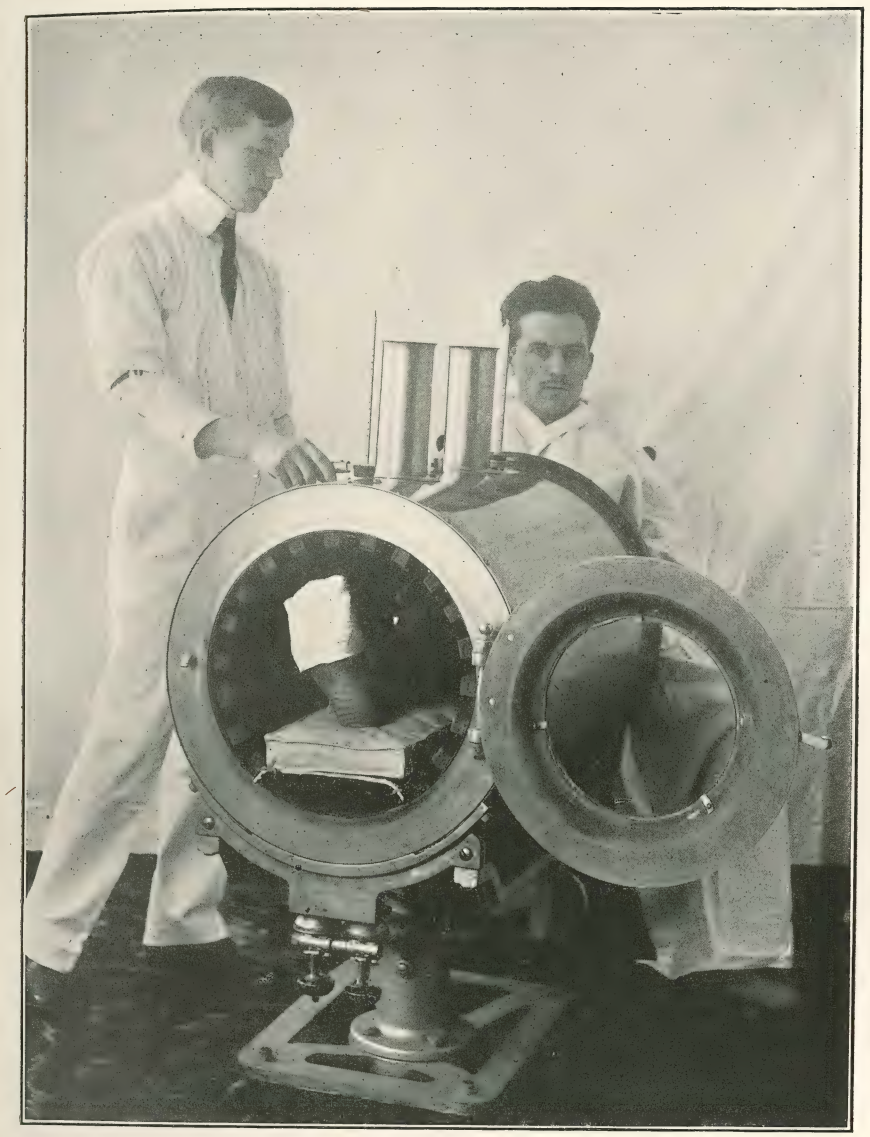


PLATE 251.—Showing method of protecting toes in leg apparatus. End open, leg on mattress, attendant opening ventilating funnels, and patient ready to have door shut and commence treatment. During séance have patient turn foot to either side so as to remove toes farthest from roof of machine.

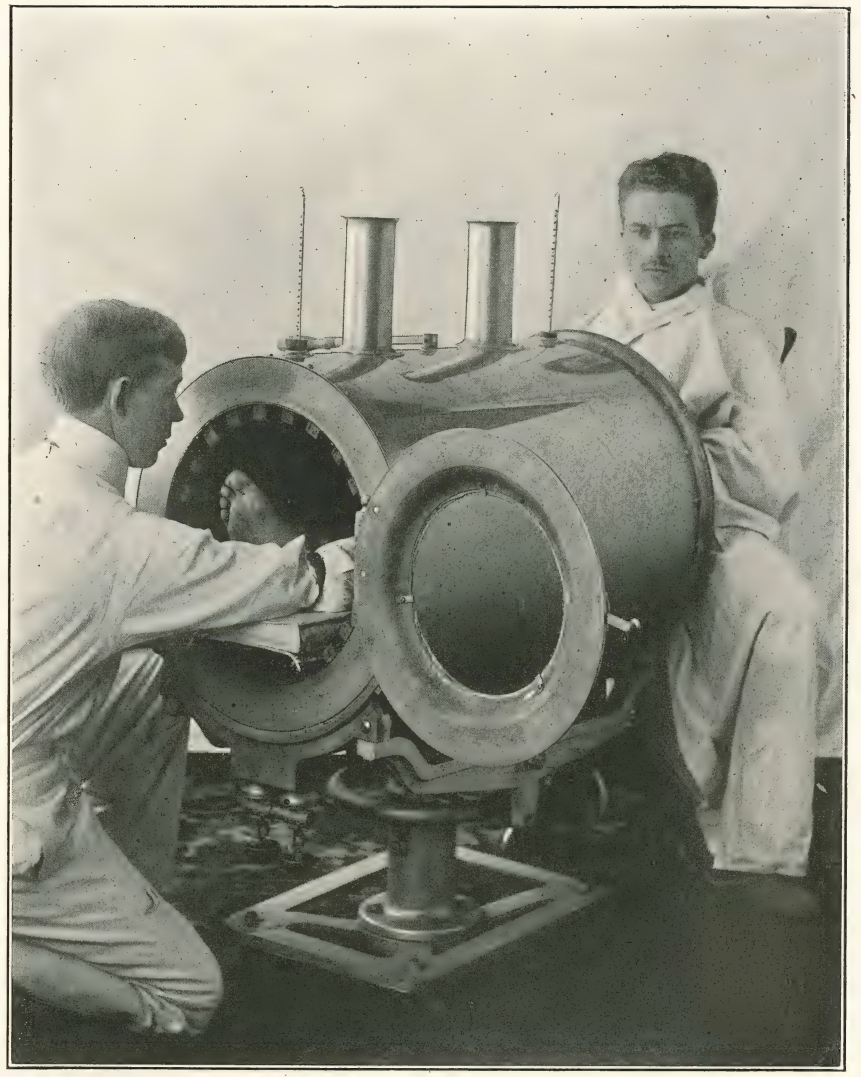


PLATE 252.—Showing patient midway in leg treatment begun in last plate. Attendant has opened the end door and is wiping perspiration from lower part of limb. To avoid escape of heat do it quickly and close the door as soon as possible.

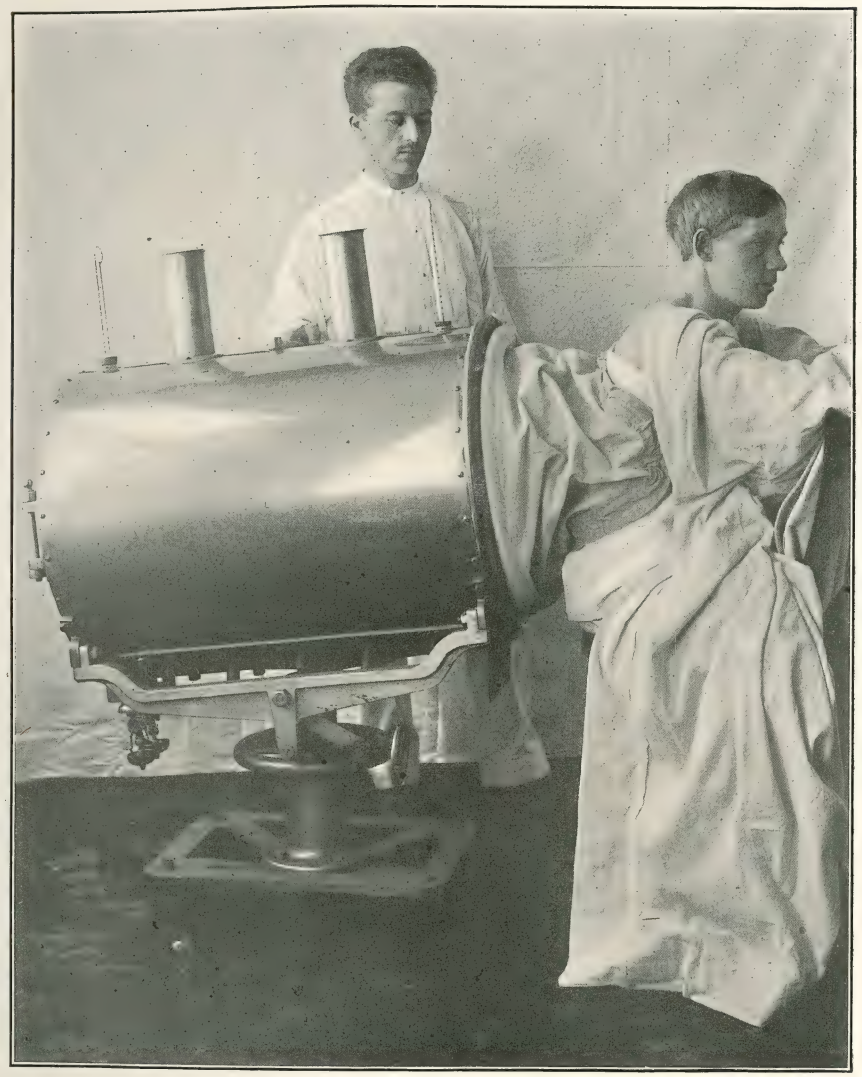


PLATE 253.—Local Spinal Application of Hot-Air by Sprague Method. Showing patient reversed on chair with canvas hood directing high-degrees of dry heat to lumbar region. Attendant is noting thermometer.

PLATE 254.—Hot-Air Application to Hip-joint. Patient resting on Massage table, and apparatus drawn up with canvas hood covering hip.

required, and free movement of the part (or entire patient) must be compatible with absolute protection from metallic contact or liability of any kind of burning or overturning. Speaking generally, the apparatus should be so constructed that with ordinary care a patient need never experience the slightest discomfort, and danger of accident be completely eliminated. Any machine, large or small, local or general, that does not meet these indispensable requirements will be a constant source of uneasiness and dissatisfaction to the practitioner himself, and will not confer on the patient the whole benefit he ought to receive.

The novice can hardly avoid applying this treatment to some unsuitable cases: nor can the expert at all times predict the result of treatment in advance, but practice and study reduce the percentage of failures from this cause. Study the limitations of scientific thermæro-therapy as well as its main usefulness and eke out its action by judicious supporting measures. Hot air may furnish but one crutch to a cripple when he needs two; supply the other with whatever means your skill and the materia medica enable you to prescribe.

Cases abandoned as incurable under other therapeutic measures have sometimes been greatly benefited by hot air, but do not expect radical and permanent improvement in every case otherwise hopeless, even though this conservatism conflicts with circulars you may have read. It is difficult to state in text the precise conditions which make a technic or a dosage applicable, for occasionally the most desperate cases respond marvellously, while others with apparently plain indications and prospects prove refractory. Clinical discrimination grows with experience, however, and in time most cases can be classified at sight or after one test treatment. As a general rule a very hopeful prognosis may be made in all acute and subacute conditions within the scope of thermæro-therapy. In chronic cases of the same kind results should still be good, but much depends on the length of time the particular disease has lasted. In arthritic disease the extent and permanence of the bony and cartilaginous changes that have taken place in the affected structures must be regarded by the beginner ere he makes too favorable a prognosis. The mistake of being more hopeful than the facts and sound practice justify is not an inherent fault of hot air.

But what are "unsuitable" cases in general? In the main they are those in which either or all of the three chief actions of hot air are contra-indicated. With this clinical guide any rational medical judgment can steer clear of very gross errors in advising patients

to take the treatment. Cardiac affections do not necessarily make a patient "unsuitable," as we have seen elsewhere, for vast numbers of rheumatic patients are also the subject of some form of heart disease. Happily the evidence that hot air is compatible with relief of rheumatism without injury, nay, even with benefit to the arteries and heart, is well-nigh conclusive. The immediate effect of the treatment is to dilate the arterioles and increase the vigor and ease of the heart's action by relieving part of its labor. It can therefore be readily seen that in all forms of cardiac involvement where stimulation is required (especially if compensation is failing or has completely broken down) the effect must be beneficial and that with reasonable care during the séance these cases are not to be rejected.

Let us now consider possible errors in the duration and frequency of treatment. The general principles governing frequency of treatment are nearly the same with all forms of therapeutic apparatus with which the author is acquainted. These are well understood, and under the instruction of experience are interpreted at sight. Acute diseases call for a short sharp attack; long lasting conditions need a deliberate siege. Haste will serve one purpose and defeat the other. The novice must master this basic principle of therapeutics once for all, and then, whether we teach hot-air, or mechano-, or hydro-, or electro-therapy, or any other means of influencing physiological actions the same rule applies to each, with proper allowance for different dosage and energy of action.

Daily séances for ordinary acute conditions and three times a week for chronic cases is the average rule, subject to such exceptions as circumstances soon lead us to make in our individual practice. But in thermæro-therapy there is yet a word to be said beyond this: when the patient's disease is both severe and chronic and vitality has been lowered by pain and sleepless nights the treatment must not be pushed too vigorously. Two treatments a week may be all that the patient will bear till the worst features of the case have been improved. And here it must be borne in mind that in certain cases the first treatment often not only does not give relief, but appears to aggravate the symptoms, particularly the pain. With the fourth or fifth treatment, however, improvement usually sets in and steadily continues, and then séances can be increased to three per week. In ordinary cases the sense of relief begins at once, and when this occurs the caution above referred to is unnecessary.

Further, the sudden cessation of hot-air treatment in chronic diseases is generally unwise, and may be actually injurious. It is a far better plan to gradually increase the intervals between séances

after a maximum of improvement is secured rather than stop abruptly. This is particularly important when the kidneys are diseased. We aim to secure benefit to the system by the vicarious action of the skin promoted to a high degree by dry hot air. To suddenly cease the free perspiration might tax the weakened kidneys more than they could perform. Shade off treatments to once a week, and then once in ten days before stopping a very chronic case who has had a long course of hot air.

Avoid the error of making first exposures too long or too high temperature. As a rule in chronic cases allow three séances for the education of the tissues to a state of full tolerance. Then you know your patient and have not lost any of his confidence by ten degrees too much the first day. Do not make any exposures too long or too frequent. Perhaps no mistake on the part of the novice reacts on him quicker than failure to secure the comfort and welfare of the patient during and after the treatment. A test treatment in the body apparatus on the physician's own person will explain why this is so. Many patients are very nervous when beginning a new and untried treatment which all know must be skilfully given. It is natural for them to suppose that the application of heat far above the boiling point of water must certainly pain or burn. Allay their fears by proper explantions and by a first séance kept well within the bounds of absolute comfort to the tissues. Let the dose rise very gradually as confidence gains the place of timidity. Or, first treat only one limb and advance as you can with care. Never handle the stranger to hot air as a veteran who wants it hot and wants it long. Work gently till benefits have banished neurotic fears and all goes well.

Be certain to avoid the mistake of giving any treatment, especially with the leg and arm machine, with the patient in less than the most comfortable attitude and position. It is often very irksome, for instance, for a patient with sciatica to sit with one leg extended in the machine and remain immovably in that attitude for an hour. Starting with the most comfortable position attainable let him shift the leg a little from time to time and assist the process so that the least disturbance will occur. Or, let the treatment be taken in the recumbent machine till he improves. In the body machine do not insist on keeping a man on his back the entire hour. Let him turn and twist as he needs for comfort. He can turn over twice if he feels taxed by lack of change in posture.

Do not make the mistake of attaching too little importance to cooling the patient's head during a body treatment. Follow the

teachings of this section in this respect. As to drink, do not let any patient pour into his stomach a large glass of ice-water. Nausea and shock may follow. Small quantities more frequently repeated are better. But one of the chief errors to avoid is a body treatment nearly on top of any meal, or less than two hours after a hearty meal. Local treatments may be given an hour after a meal. So may a body treatment an hour to an hour and a half after a very light meal, but if the patient has eaten heartily two hours should pass before digestion encounters a treatment which so alters the circulation and raises the temperature. Perhaps neglect of this precaution causes more distress than patients suspect, and a delay of the hearty meal till after treatment is taken will be good advice to many. But also avoid a hearty meal *soon* after a hot-air séance. Time to allow the circulation to settle is needed. Let the first meal after a treatment be light. Old frequenters of Turkish baths need not be told this, but the novice who is treated for the first time should have a caution. Burns rarely occur with the body apparatus and may easily be avoided in the local apparatus by proper care as herein taught.

But granted that the operator has made no mistake in a given case and yet the patient shows signs of distress, what then? If the patient complains of a sense of excessive heat and the heat is actually high moderate it at once; if the heat is not high and the patient feels unwell and none of the usual measures relieve the distress remove him at once from the apparatus to the massage-table. There cover him and let him revive at rest. This may happen with an old and accustomed patient who takes a treatment with some temporarily deranged state of the system which passed unnoticed till aggravated by high heat. The next time all may go well. The point is that when all is not well with the patient, and you do not find the fault so as to correct it, it is better to cut short the single séance than to persist for a half hour of dissatisfaction which the patient will not speedily forget.

Subsequent colds may usually be avoided by not permitting the patient to leave the premises, especially in cold and stormy weather, till the body has been thoroughly cooled that even if delay is irksome to a business man do not make the mistake of unwise haste on this point. A congestive chill is easily developed when a sharp north winter-wind strikes a patient who has been an hour in contact with 280 or more degrees of temperature with every artery and capillary dilated and the skin like a sieve.

The study of these sides of the picture, which usually dazzles us with nothing but clinical results brilliant beyond the wildest dreams

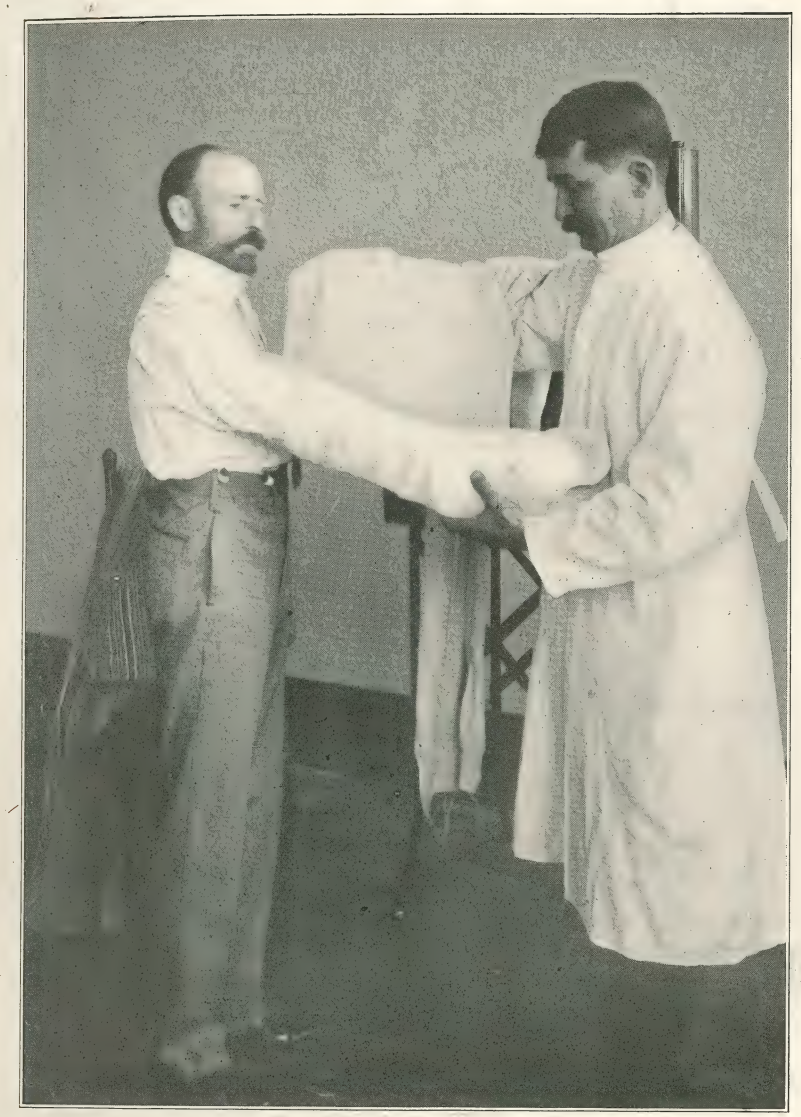


PLATE 255.—Method of wrapping patient's arm in heavy Turkish towelling preparatory to arm treatment in a Betz apparatus.

The series of fourteen Instruction Plates next presented demonstrate the Betz methods of treatment, and were photographed exclusively for this work.

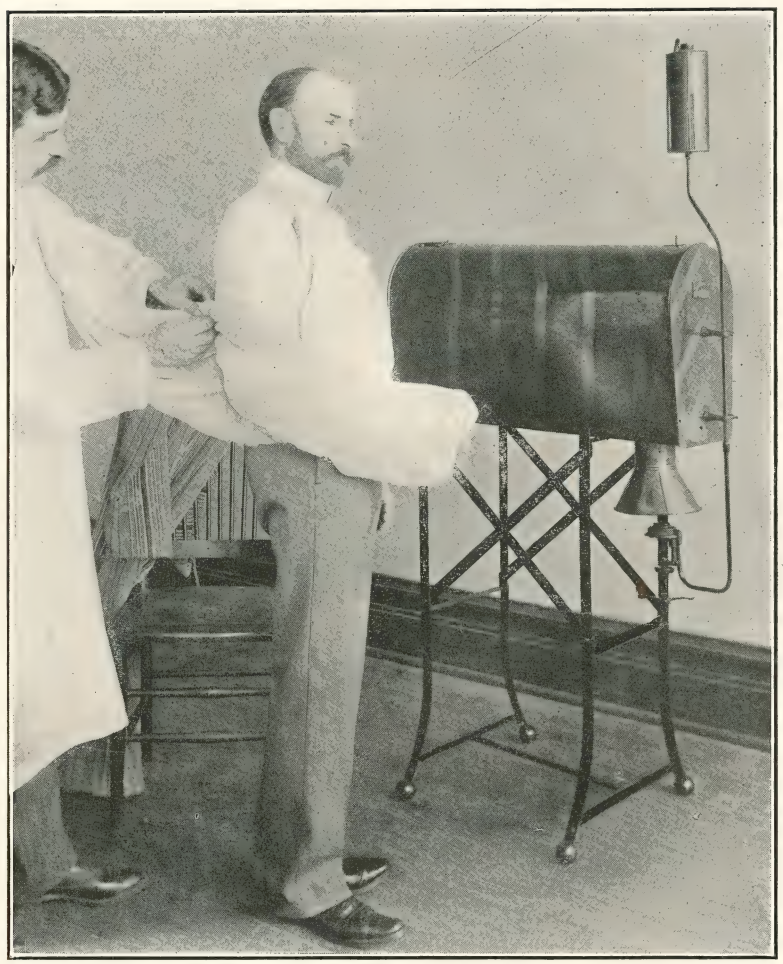


PLATE 256.—Wrapping of arm completed, and patient ready to insert it in cylinder, as shown in next plate.

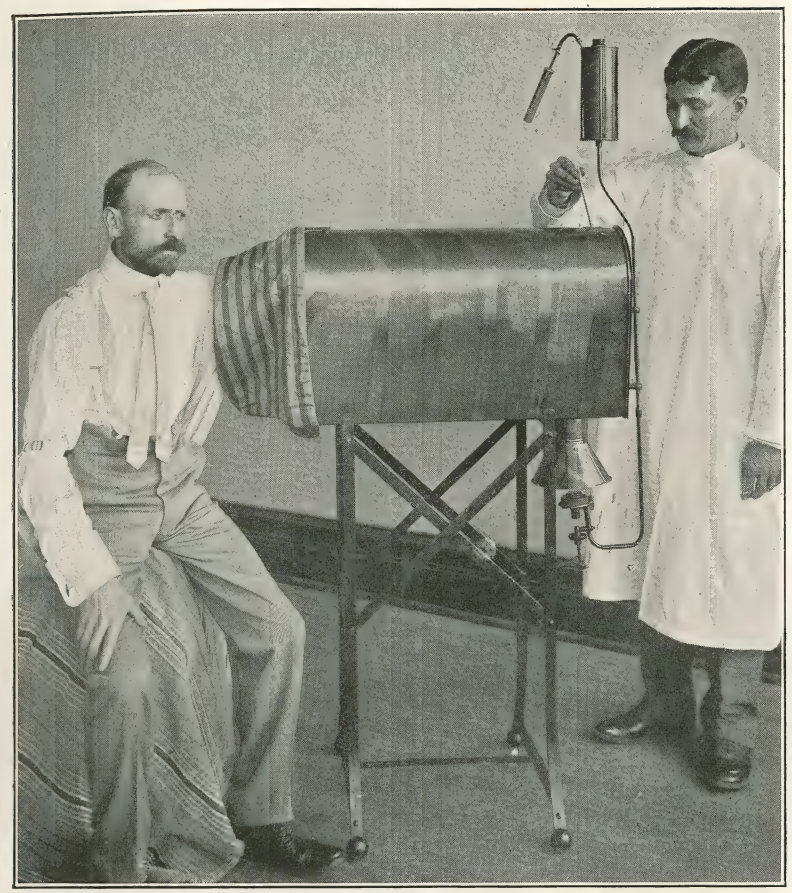


PLATE 257.—Showing arm in apparatus, and attendant reading thermometer.

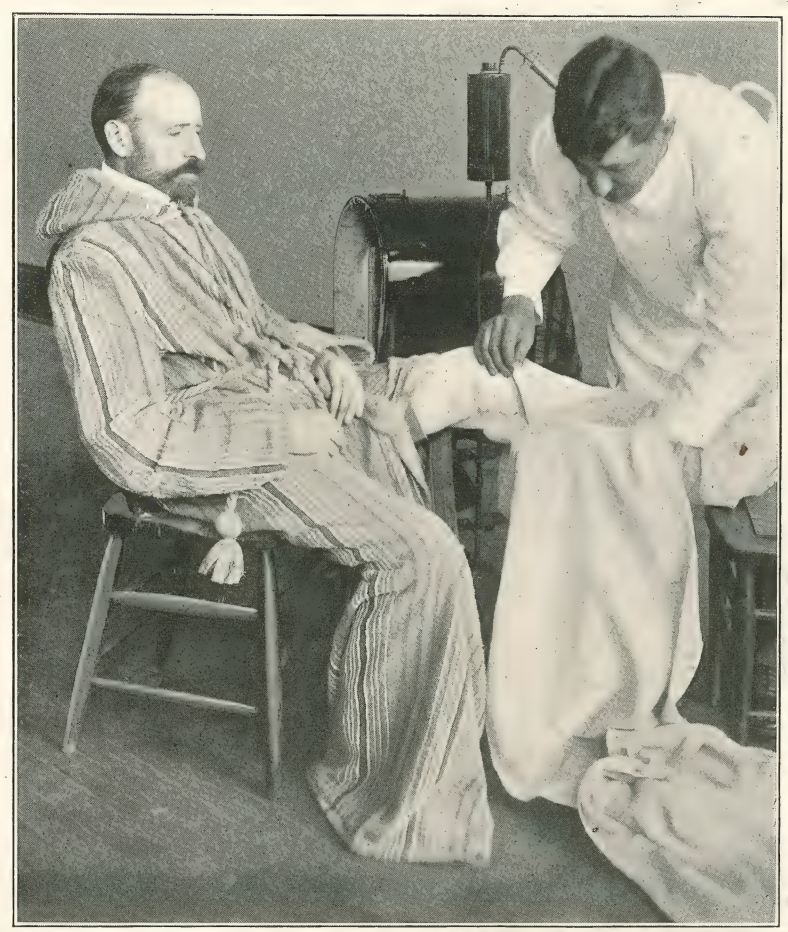


PLATE 258.—Showing method of preparing leg for Hot-Air treatment to knee in Betz apparatus, as shown in next Instruction Plate.

of Sydenham or Hahnemann, will profit much during the first six months of hot-air therapy. Simple precautions will minister greatly to the security and well-being of the patient and add to the success of treatment. They will prevent the accidents and unpleasant complications which have too often in the past discouraged the employment of this extremely valuable method of combating certain difficult diseases. And in closing this consideration of avoidable mistakes which interfere with the best results, let us briefly again urge every physician who uses either hot air or any other therapeutic apparatus to *avoid relying on its exclusive and unsupported action to meet the entire indications of every case.*

Study adjunct prescribing. Especially take note of personal hygiene and advise the patient in ways that will supplement the practical therapeutics. This is particularly needful in the use of hot air, which is often a last resort for cases otherwise resistant to prescribing; and one of the great functions of thermæro-therapy is not alone a direct curative action on an incurable disease, but rather a preparation of the tissues to benefit in an increased way by accelerated physiological processes and by adjunct therapeutics which were planted on barren soil till the tissues were warmed and wakened by full tides of hot blood set free by hot air.

Clinical Experience.—To know what others are doing with hot air is to know what we may also do with it ourselves. No one can tell whether a therapeutic claim is well founded or not till he tests it himself with such skill in technic that failure will not be the fault of inexperience. From lists of diseases successfully treated extract the *principles of action that must have established the results,* and then study to apply these principles according to the indications of your own patients. In this way mere imitation of others will give place to genuinely scientific therapeutics, with a great increase in benefit to all concerned. The following reports are therefore not cited to index a list of cases that may be treated with hot air, but to suggest lines of clinical study and instruction. In reading them aim to associate the physiological action with the diagnosis so that your own future prescribing of this form of therapy may be accurate and successful.

"A thorough and careful investigation of 200 cases (to which over 2,000 treatments have been given within the last twelve months), many of whom were under my immediate and personal care, has afforded good opportunity to note the wide repertoire of diseases amenable to this treatment, and the list is not yet complete, as from day to day new developments are brought forth by the continued

use of this manner of administering the dry hot-air as a therapeutic agent.

"The discovery of the very great benefit to be obtained in various complications and neurotic conditions was accidental, in so far as such a patient was at first present not for treatment of that existing chronic condition, but in consequence of localized pain, as Lumbago, Sciatica, muscular Rheumatism, etc., or of a bicycle accident or trauma of some sort. Such patients, being relieved of the original local or traumatic cause of the trouble which induced them to take the hot-air treatments, also found the general systemic effect so beneficial that not a few, on this account, continued treatments, and have thereby in many instances been entirely cured, and in others so satisfactorily relieved of uncomfortable and disagreeable symptoms that they have considered it necessary to continue. Under this observation come many cases of Anæmia, Chlorosis, Neurosis, and Insomnia, one each of Tobacco heart, Atheroma of the arteries, Pleurisy, Asthma, and Biliary Colic. Cases of Kidney, Liver, and cutaneous affections, and almost all diseases consequent to a gouty or rheumatic diathesis, have yielded surprisingly favorable results.

"We are convinced that its uses are far-reaching and radically and beneficially effective. Our experience leads us to believe that a diseased ovary, for which formerly there seemed no alternative but the surgeon's knife, may now, through this method, be retained by its possessor in comparative health; the subsequent condition of the patient comparing most favorably with others similarly affected who have sacrificed the organ. Cases of persistent Dysmenorrhea, Catarrhal condition of the Uterus, Endometritis, Cervicitis, etc., yield more favorably and permanently to this treatment of hot air than to the hot douche, medicated tampons, or the curette; while in Uræmia and the Albuminuria of Pregnancy it is a most valuable aid. The body hot-air machine is generally better adapted to all *systemic diseases and those of the trunk*. The arm and leg machine concentrates its power most favorably on local manifestations of both disease and trauma of the extremities, *e.g.*, Sciatica, sprains, bruises, bicycle accidents, etc. Lumbago, Myalgia, Tonsillitis, and Coryza have each been relieved in one treatment, but certain forms of Rheumatism and Gout require many and oft-repeated treatments. This is often noticeably the case in Rheumatoid Arthritis; the pain can be overcome often quickly and effectively, but the perfect mobility of the joints and the lessening, if not the entire eradication of the deformity, would require a long course of treatments. So far, the patients have been relieved of the soreness, pain, and *distressing* symptoms, and have felt so satisfied and comfortable with the improved conditions that a long continuance of the treatments was not persevered in, hence the possibilities of completely reducing the deformities have not been thoroughly tested, although in many cases there have been a marked decrease of the enlarged joints and entire disappearance of the gouty tophi. The concretions in and about the joint are broken up and these once solidified deposits become softened through the excretory organs. The blood becomes heated from one to five degrees and the circulation correspondingly accelerated, and to these facts are due largely the good effects, as the various avenues of the human system are stimulated to acting, and metabolism is promoted." (Dight.)

The treatment of all forms of arthritis from the simple traumatic case to advanced rheumatoid arthritis illustrates in a peculiarly interesting manner the reinforcement of hot air by static electricity. Take the tissues, warm and soft from the hot-air séance, with capillaries dilated and with intensified local vascularity, and immediately subject them to the alterative-nutritional-sedative-tonic action of special static treatment and the benefit to the patient will be very greatly enhanced. As the patient must wait any way to cool off it will waste no time.

Wring lightly out a towel wet in a soda solution of water as hot as is comfortable, wrap it around the joint and outside of this wind the regular chain used for connecting the patient with the machine. Have the patient sit in any suitable chair (or recline on a couch) placed on the insulating platform as for ordinary treatment. Hook this chain on the positive sliding pole and ground the negative pole. Push the poles together and start the machine into action. Gradually draw the poles apart till deep, firm, constriction or moderate muscular contraction is produced and maintain this dosage with rapid interruptions of the current for about ten minutes. Then reduce the speed of the plates, make very slow interruptions, and by pulling still further apart the pole pieces make a few stimulating slow contractions of the muscles to end the séance in cases in which stimulation is needed. When sedation is needed end the séance with the rapid interruptions and reduce them gently to zero. Then dry the part, dust it with toilet powder, and prepare the patient to go home. Massage is not needed with this treatment. In cases of the smaller joints use a water-bath contact for the current. These technics are all taught in the author's little book on "Elements of Correct Technique," and the water-bath treatment with a rapidly interrupted high potential current is peculiarly gratifying in cases of rheumatoid arthritis affecting one or both hands, and one or both feet. The combination of hot air and electricity is undoubtedly better than any one therapy alone.

"When the effusion is extensive, surgical means (incision or paracentesis) must be employed for its evacuation, but frequent topical applications of heat (400° F.) will prevent the reaccumulation of

serous fluid. The following case well illustrates this: Mr. S., aged twenty-two, a book-keeper, received, while at play, a blow with a base-ball, which 'laid him up.' The knee swelled and the attending physician tapped the joint-cavity, evacuating a glassful of fluid. The man returned to work. The fluid reaccumulated, necessitating another tapping. This procedure had to be repeated every two weeks. After the fourth tapping the patient sought my advice with a view of having arthrotomy performed. I removed about ten ounces of fluid and ordered the nurse to at once treat his knee for an hour with dry, hot air, raising the temperature as high as the patient could bear. He received five more such applications daily, and the knee has been in good condition ever since (five months)." (Blech.)

In the treatment of joint diseases do not make the mistake of restricting treatment to *local* hot air when a *constitutional* factor is present. In syphilitic and gouty arthritis and in all other cases failure to meet the constitutional indications will disappoint you with any local remedy. Use hot air as an adjunct of great value, but do not neglect to make your therapeutics *complete*.

"Hot air is a pain-relieving agent of unequalled value in those conditions where its application is indicated and possible, because of its very constant effectiveness, rapidity of action, and the absolute absence of deleterious after-effects. In rheumatism, at least, its action is so profound in connection with judiciously chosen drugs that it may almost claim a positive curative power of its own, and may certainly be said to be the most powerful contributing agent we now know of. Many cases cannot be cured by drugs without it, and in any case the victory over the ailment is much hastened and the victim maintained in comfort during the attack. On the other hand, we must remember that it appears to be rarely if ever capable of overcoming the disease without the aid of drugs.

"It is capable of stimulating tissue repair to a remarkable degree, as is demonstrated by its effect upon sprains, and, as I shall show in a future article, on at least many cases of intractable varicose ulcers. It is capable of influencing most happily septic inflammations of serous membranes, as shown by its action in peritonitis and pleurisy. It will many times at least give us the power of economizing nervous energy by relieving pain and other more or less dangerous conditions in pneumonia, thereby enabling us to refrain from sedatives and cardiac stimulation, and the nervous energy we may thus save for the patient will sometimes be sufficient to tide him over a crisis by which he would otherwise be overwhelmed.

"We cannot expect hot air or any other one measure to do everything. What I assert is that it will do a great deal, and that its powers are exerted in a direction in which we have hitherto been lamentably deficient; hence its addition to our armamentarium will enable us to increase by a large percentage the sum total of our

Plate 259.—Application of Dry Hot-Air to Knee. Attendant reading thermometer.

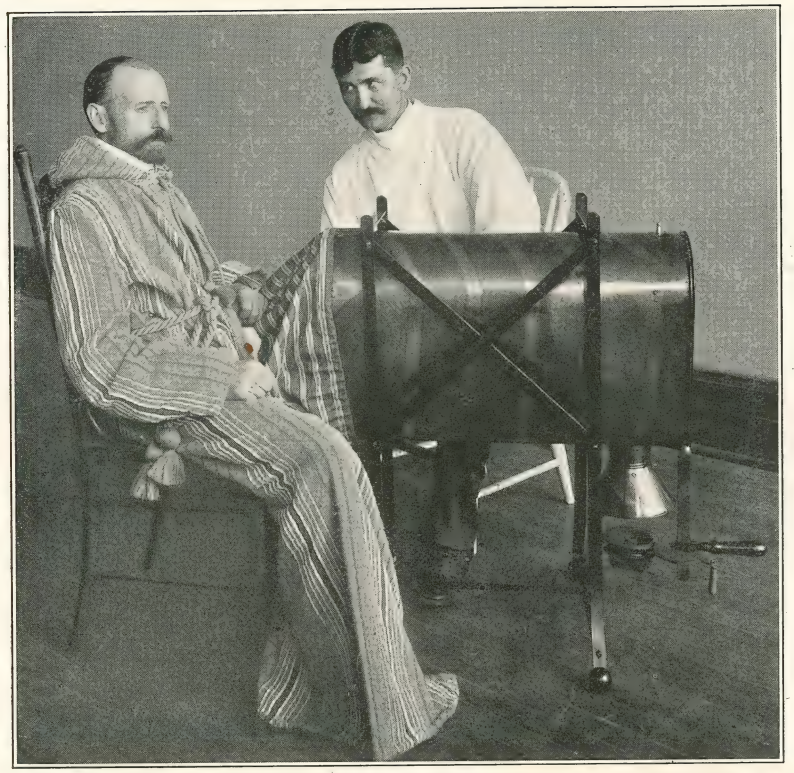


PLATE 260.—Showing entire leg under treatment in the Betz leg and arm apparatus.

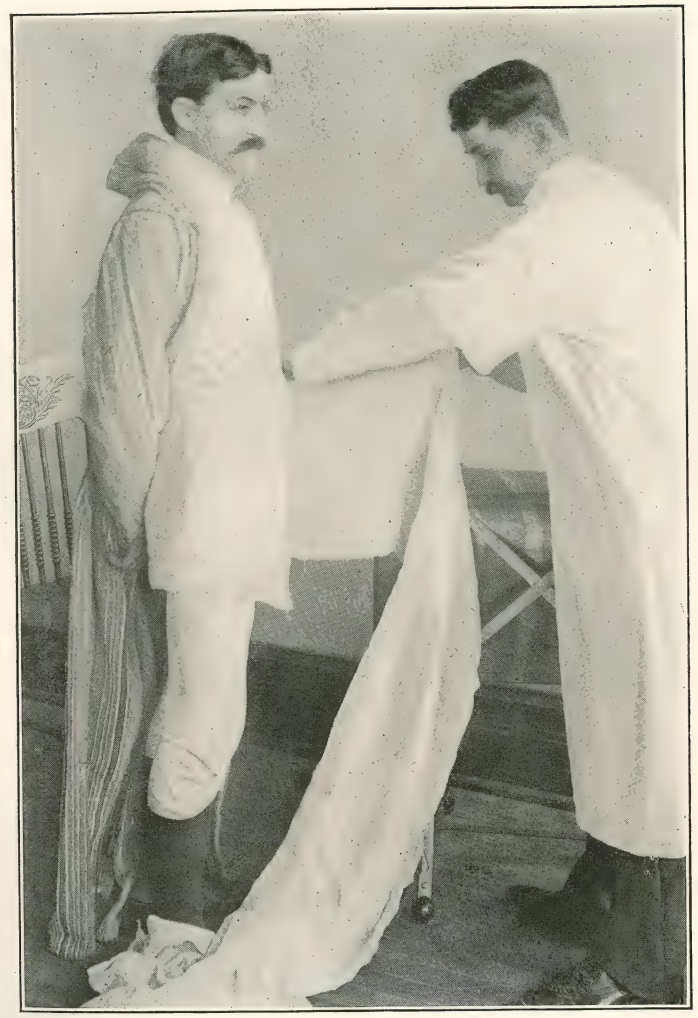


PLATE 261.—Wrapping the body in Turkish towelling for treatment of either lumbar region or abdomen.

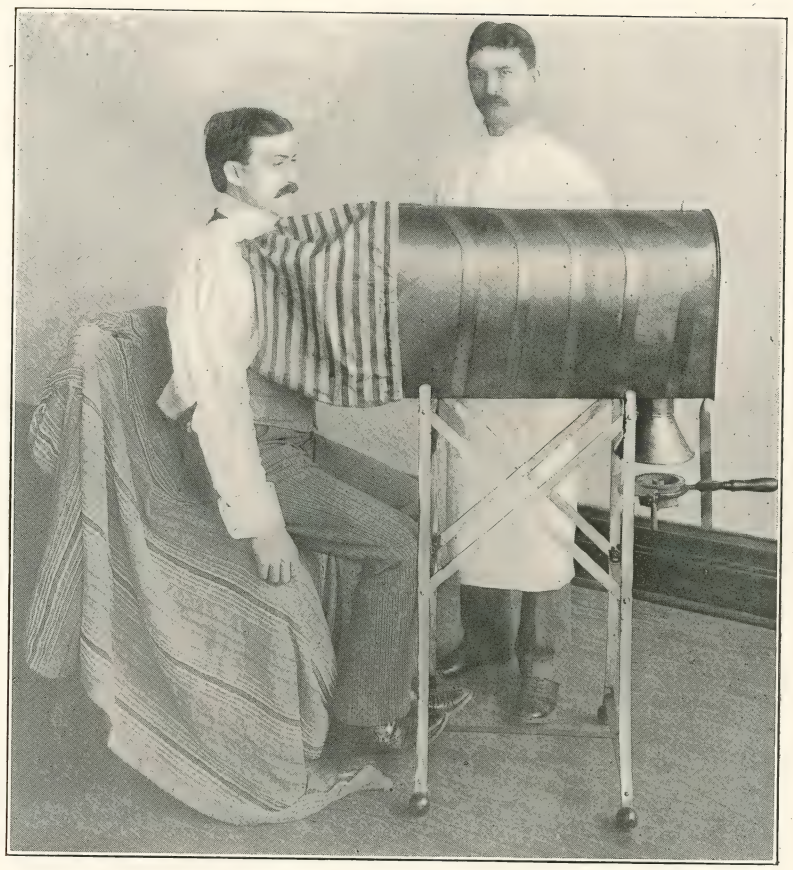


PLATE 262.—Showing application of dry heat to chest for bronchitis, pleurisy, pneumonia, etc.

power over disease. The capabilities which it has so far manifested, and we have as yet only begun to investigate them, are sufficiently weighty to justify belief that dry heat of high degree is destined to become a therapeutic agent of as great popularity as it possesses diversified applicability." (SKINNER.)

Dr. Skinner also discusses the aid of hot air in pneumonia, in which it is indicated and effective only as regards local lesions. He says:

"The indications for hot air are:

"1. To relieve pleuritic pains as a substitute for opiates, to which it is superior.

"2. To relieve the harassing cough instead of sedatives, to which it is superior.

"3. To relieve the heart from the strain of massive exudate instead of alcohol, digitalis, strychnine, etc., to which it is superior, primarily and secondarily.

"I have never seen any shortening in the duration of the disease. The characteristic respiration, the pulse rate, variations in temperature, prostration, sweats, etc., run their course. They may be somewhat mitigated in intensity, but whatever general benefit accrues is due to the relief of reflex disturbances and cardiac distension. The exudate has disappeared so that so far as physical signs would show, the pulmonary tissues were clear in from three to five days. In pneumonia hot air has not failed to give me the desired result much better than any other measures."

He has, however, found that convalescence after the use of hot air was, in some cases, very slow and protracted. Perhaps in such severe cases the patient would not have lived at all without the relief afforded the heart by hot air, but none who encounter slow recoveries or debility during convalescence need let their patients drag tediously along. Put them on the static platform; give them a few mild tonic sparks to the general muscles and counter-irritation to the spine, and one week of such treatment will speed them to recovery faster than months of routine advice. If the operator has the skill to do it a few properly dosed sparks on the chest and over the apex of the heart will strengthen respiration and pulse in a wonderful manner. Over and over again I have given regularity and volume to a weak intermittent heart and restored comfort to the patient by sparks on the apex and cervical centre—the application not taking ten seconds of time. The relief was as quick as the sparks. Therefore, use this adjunct with your hot air and avoid delay in convalescence when it is possible. It may be assumed that during the last five years every physician at all interested in scientific medical electricity has procured

one or more of the author's three major volumes on electro-therapeutics and is familiar with approved methods of administration. The author hopes to re-write his Static Manual and illustrate it in a manner similar to this course of instruction at no distant date. The necessity of attending to private practice is somewhat of a hindrance to much writing, however, and at present no plans can be begun.

Referring to the use of superheated air in chronic catarrh of the middle ear Dr. Hopkins of Cleveland writes as follows:

"Few ear diseases are so obstinate. Four years ago while using hot air extensively for various joint diseases it occurred to me that the same method specially localized might do good in such cases of otitis media as have ankylosis of the ossicles. Tests proved that when the obstacles to the local application were overcome the results were most brilliant. The method has since been employed in a large number of cases of this type with highly satisfactory results, and with improved technic the treatment has become simple, safe, and satisfactory. Of sixty-two cases treated during the last four years but four have been failures, all of them old people with extensive labyrinthine involvement. It would appear that any physician who will study the technique closely can secure equally good results.

"The intense heat seems to stimulate the circulation on the posterior side of the manubrium, causing absorption of the articular deposits, removing atrophy and relieving the rigidity of the tensor tympani. The ossicles lie so near the surface that they receive the full benefit of heat applied to the tympanum, and adhesions between portions of the ossicular chain and the adjoining bony walls of the middle ear are readily removed. Naturally much better results are secured in the same period of time in hypertrophic cases than in those of hyperplasia, but many cases of the latter type, which would ordinarily have been regarded as hopeless, have gradually improved under this treatment until marked benefit was secured. Arterio-sclerosis, serous effusions into the tympanum, and perforations of the tympanum have been regarded as contra-indications for this treatment, but more recently we have treated several cases in which small perforations existed without meeting any difficulty. Care should be exercised in these.

"Aside from headache there have been no troublesome after effects to require attention. Such accessory forms of treatment as may be indicated should not be neglected. An account of the first case treated will be especially instructive, as it has stood the test of four years time with no evidence of recurrence. J. L., aged fifty-three; good history and general health; has had nasal catarrh for fifteen years and gradually increasing deafness for ten years. Had a typical case of hypertrophic rhinitis. With left ear could faintly hear watch tick in very close contact. With right ear could hear tick at three inches.

"Diagnosis: Chronic catarrhal otitis media, with sclerosis and displacement of the tympanum, ankylosis of the ossicles, slight dilatation of the Eustachian tube, and some labyrinthine involvement. This diagnosis was confirmed by two colleagues of reputation as aurists before test treatment with hot air was begun. Before this treatment was tried he had derived no benefit from two years of regular systematic treatment on usual lines.

"Technic. The ear was thoroughly cleaned with alcohol for several days prior to the first séance. On presentation for hot-air treatment the ear was examined and found clean, the patient seated in a comfortable chair, the ear packed with narrow strips of dry gauze, and a large pad of dry gauze placed over the ear. The ear was then covered with the canvas sleeve of the apparatus and a current of hot air directed into the canal. The temperature was raised gradually till it attained 400° F. This was easily borne when evenly and slowly developed, the only discomfort being a severe headache after treatment, which was always relieved by a dose of codeine. See Instruction Plate No. 269 illustrating the method.

"Next, the Eustachian tube was inflated with a warm stimulating vapor from a nebulizer, and vibratory massage with the nebulizer completed the séance.

"The patient was kept in the office half an hour after treatment to cool the tissues before being allowed to go home and the ear was tightly packed with warm cotton before he went. The nose and pharynx received appropriate treatment with antiseptic washes, etc. Treatments were given on alternate days for three months. He could then hear the watch tick distinctly at thirty-four inches and responded to a whisper. All this treatment had been given the left ear. The right ear was then similarly treated, and in ten weeks an equally good result was secured. On examination the ears were normal in appearance. Careful tests at frequent intervals during the last four years have shown no tendency to recurrence."

From among a large number of studies of hot-air experience we select that of a physician to the N. W. London hospital as being concise, impartial, and instructive:

"In this communication I purpose to epitomize the results of several years' work on the treatment of numerous diseases by the local application of dry hot air. Since the publication of my articles on the subject a few years ago I have continued the investigations both in hospital and private practice, and as time has gone on I have become more and more convinced of the great advance in therapeutics which this form of treatment has brought about. The youngest patient treated was a child just three years old, a boy, suffering from epilepsy, and the oldest a woman of ninety-three, afflicted with chronic rheumatism, especially in the hands, accompanied by a considerable amount of pain. Both these patients were treated as out-patients, and

did well. More diseased conditions than might at first sight be imagined are benefited by local hot-air treatment. My rule at the hospital for some years has been, when a patient suffering from any complaint does not improve after a few weeks' routine drug treatment, to order the hot-air treatment, and I must say that in the majority of cases improvement very quickly shows itself, often to a marked degree.

"The cases for which this treatment is especially indicated are all forms of *arthritis*, whether of rheumatic, gouty, neurotic, tuberculous, or traumatic origin, particularly when the process is chronic. I can say with confidence that almost every kind of joint mischief, whether the result of injury or disease, is greatly benefited by local hot-air treatment. Under joint diseases the following would be included, gout (acute, subacute, and chronic), rheumatism (acute, subacute, and chronic), gonorrheal rheumatism, rheumatoid arthritis, scrofulous disease of joints (for example, morbus coxæ), synovitis, bursitis, periostitis, including syphilitic and all forms of adhesions. With regard to *injuries* (recent and old-standing), synovitis, bursitis, and all degrees of stiffness, adhesions, and various conditions of immobility a few words are desirable. Many of these cases are greatly improved simply by the local application of heat, but, of course, if severe or old standing surgical interference by breaking down adhesions greatly increases and accelerates the cure. It is in most cases better to give a course of local treatment before any attempt is made to break down adhesions. Then an anæsthetic may be administered and the adhesions broken down and joints freely moved and placed *immediately afterward* in a hot-air apparatus. This frequently prevents the subsequent effusion and greatly diminishes the pain; in fact, I have notes of several cases of severe old-standing adhesions treated in this way with little or no pain or even effusion following the operation and with very satisfactory results.

"*Hysterical joints* I have found to be amenable to this treatment: One case occurred in a woman, aged twenty-three, who when admitted into the hospital had been unable to walk for two years owing to contraction of the left knee-joint; she had had some stiffness of this joint for five years. After two months' treatment she left the hospital able to walk. So again, cases of either local or general *malnutrition*, especially cases of feeble circulation, due to local causes such as injuries to blood-vessels or nerves, chilblains, cold extremities, and deformities due to arrested nutrition usually improve, as do most forms of localized œdema. Most forms of *neuritis*, both gouty and those of a more directly nervous nature (such as peripheral neuritis and traumatic neuritis) do remarkably well; and also sciatica, lumbago, and allied affections, including neuralgia following herpes zoster, are usually cured. I have had most satisfactory results in a large number of cases of *chorea*. The movements of the limb under treatment rapidly subside while under the influence of the heat, usually returning with less severity shortly afterward. One of the worst cases of chorea I have seen occurred in a boy, aged thirteen, who was carried into the hospital quite unable to stand; the head was thrown back, his tongue was protruding from his mouth, and was almost bitten in half with the movement of his teeth; there were incessant involuntary movements of almost the whole muscular system, and the respiration was greatly embarrassed, especially the act of expiration. He would take several short rapid inspirations, and then with a great effort a long expiratory one; he was almost unable to swallow, great choking being produced on any attempt at deglutition. The pupils were widely dilated, the face pale, and the child was more or less unconscious, with high fever. The day after admission the condition became worse, and acute rheumatism set in in his knees and ankles. Within a few hours there was both endocarditis and pericarditis. Medical treatment seemed to have no effect, and the child appeared to be dying. As a last resource, dry hot-air baths were ordered. After the first the condition rapidly improved, and the patient left the hospital cured about three weeks later. His temperature when placed in the first bath was 101°. In the bath it went up to 102°, and an hour after it was 100.6°.

"*Epilepsy* appears often much benefited by treatment, in many cases combined with bromide taken internally. Some cases, however, have greatly improved both as to the duration and frequency of the fits with hot-air treatment alone. Some forms of *paralysis*, especially lead palsy and paralysis due to injuries to the nerve-trunks, do well under the treatment. Cases of old-standing paralysis due to central lesions do not improve to the same extent, but these, especially those associated with coldness of the paralyzed limb, are in time benefited, more particularly with respect to the nutrition and warmth of the part. Ménière's disease was in three cases greatly relieved. Chronic *bronchitis* (especially cases associated with Bright's disease and high tension) was greatly relieved, as were also cases of asthma and diabetes. I have found the cough greatly relieved in some cases of phthisis, even during the active stage of the disease, and patients have gained weight and expressed themselves as improved.

"A good deal might be said of the effect of the dry hot air on the *heart;* in fact, it would appear that what has been written on the Schott or Nauheim treatment might very well be applied to this. As probably the therapeutic effect of the saline effervescent baths is one primarily of gentle stimulation to the cutaneous nerves, so here again the application of dry heat is an excellent stimulus to cutaneous nerves and blood-vessels, and many cases of chronic heart disease undoubtedly do very well; indeed, my experience teaches me that cases need rarely, if ever, be refused to account of heart mischief.

"Many of the dry forms of *skin disease*, such as psoriasis and dry eczema, do very well, so also in cases of scleroderma (where the patient has never been known to perspire from the affected regions) the skin becomes accustomed to sweat after persevering with the dry

hot air. Chronic ulcers and local inflammatory conditions, such as boils, are cured, as are cases of erythema nodosum.

"It is frequently asked if we should administer the treatment to women during menstruation. The general effect of the heat is to increase the catamenia, and therefore in cases in which this is excessive it would not be desirable. I find that, speaking generally, cases of scanty, and especially of painful, menstruation are benefited by the application of heat to the pelvic regions. Amenorrhœa, especially in young anæmic girls, is an especial indication for treatment at about the time the period is due. It has recently been pointed out that many of the chronic backaches and pelvic pains of women are probably due to rheumatic changes in the pelvic and uterine ligaments and appendages. These are greatly relieved, and often cured, as might be expected, by this form of treatment.

"I must now allude to some cases which were not improved by the treatment.

"*Well-defined Locomotor Ataxy.*—A few cases I have treated did not appear to be altered so far as the lightning pains or the ataxic gait were concerned.

"*Cases of Paralysis Agitans.*—Although there was improvement in the general condition of the patient, and increased strength in the limbs treated, there was no apparent diminution in the movements, either during the process of exposure to heat, or as the result of treatment. To *writer's cramp* the same remarks apply.

"The question of the desirability of treating acute cases of gouty or rheumatic arthritis is a most important one, and I still feel unable to formulate definite opinions upon it. The doubt would seem to be particularly strong while pyrexia, considerable pain, and recent infiltration of the tissues in and around joints are present. The more localized the condition, with these symptoms, the more should I hesitate to predict the result of the first few baths. The immediate result of the treatment in these cases is sometimes to disseminate the inflammatory process and convert what was at first a local arthritis into a general one, with the consequence that patient and doctor became alarmed and the treatment is stopped. If treatment be persevered with, and often if in the first instance heat was only applied to one limb, then a whole bath is administered when the condition has become general, the disease rapidly subsides; but the possibility of such an exacerbation of symptoms must be borne in mind from the commencement. A similar result is commonly met with in acute gout with great tumefaction and excruciating pain in one joint. If the heat process be applied to this joint it will soon relieve the symptoms, swelling will subside, and pain disappear. Probably, however, the same condition (even sometimes more acute) will appear within a few hours or during the next day in the corresponding part of the opposite limb. This, of course, frequently happens in cases of acute gout when treated by drugs, but the likelihood of its occurrence after the heat bath must not be overlooked." (SIBLEY.)

Another author states:

"To give a fair idea of the time needed and the results obtained we append a few cases taken at random:

"1. Woman, aged fifty-two, chronic articular rheumatism, duration twenty-two years. Locomotion difficult for twenty years. Twenty-one treatments were given in three weeks, at the end of which she could walk and had painless use and control of all voluntary muscles.

"2. Woman, aged fifty, had stiff wrist, exuberant callus and fibrous adhesions of radius and ulna from old Colles' fracture. Four treatments in arm machine at 340° F. completely restored motions of wrist.

"3. Woman, aged sixty, neuralgia and chronic interstitial nephritis. Inversion of both feet. Severe burning sensation in soles of the feet. Ten treatments relieved pain of feet so that she could walk normally.

"4. Sciatica of two months duration in patient aged thirty-nine. Completely cured in ten treatments.

"5. Woman, aged fifty-two, rheumatic gout, duration eight years, helpless for five years. Treatments daily for two months, after which she was able to walk without pain.

"6. Woman, aged thirty-eight, gout, duration three years. Stiffness and tophi in small joints. Complete loss of power in the quadriceps extensor of the left thigh after the leg was brought to a right angle; muscles of the thigh very much atrophied. Passive motion of the knee-joint good. After four weeks of treatment the patient was able to partially extend her legs and walk a few rods without the aid of her cane. Chronic gout is much more resistant to treatment than rheumatism, but yields in time. This case is still under observation.

"7. Mrs. J. B., widow, aged thirty-eight. Diagnosis, arthritis deformans, duration about twenty-five years, including an attack of rheumatic synovitis of the knee in her thirteenth year, though the disease did not really begin until five years later, one year after her marriage. Helpless eight years. Patient is fairly well nourished; heart and lungs normal; digestion good; bowels irregular. Partial ankylosis of both shoulders, dorsal and cervical vertebræ. Complete ankylosis of the elbows, wrists, hips, and knee-joints. The fingers of both hands displaced toward the ulnar side of the hand and quite immovable. The legs were flexed upon the thighs and the forearms on the arms.

"*Treatment.*—The lower limbs were straightened under anæsthesia, and the patient subjected to daily hot-air treatment for two months; sometimes the whole body, and at others only the limbs being put into the apparatus. A sedative was given at night.

"*Results.*—Great improvement in the movements of all the limbs. Patient able to turn her head, flex her fingers, legs, elbows, and hips. Can walk a few steps without crutches, put her eye-glasses on, and

many other things that were impossible when first seen. The hæmoglobinometer showed sixty-seven per cent. hæmoglobin at the end of this time, so treatment has been discontinued until the autumn.

"8. Woman, aged twenty-three, subacute articular rheumatism of one month's duration. Stiffness and crepitation in both knees and one wrist. Ten treatments effected complete cure.

"9. Woman, aged twenty-two, posterior dislocation of radius and ulnar, with fracture of inner condyle of humerus. Fibrous ankylosis on inner side of humerus. Treatment: anæsthesia, adhesions broken, resetting. Hot-air treatment daily for six weeks. Result: absorption of callus and moderate motion of elbow regained.

"10. Woman, aged thirty-two, acute pleuritis of ten hours' duration. One treatment completely relieved patient and caused disappearance of friction sounds.

"11. Woman, aged thirty-eight, fibrous ankylosis of knee from an old pyæmic joint. Duration one year. Right knee fifteen and one-half inches in circumference, three and one-half inches from the table, with the patient on her back and limb as straight as possible. Patella absolutely fixed and very difficult to outline. Very slight movement of the joint. The adhesion had been broken down six times without much permanent good, and resulting in terrible inflammatory reaction. After four applications of hot air the adhesions were broken down under anæsthesia, and as soon as the patient came out of the ether her leg was placed in the hot-air machine and subjected to 312° F. for one hour. The pain was almost immediately relieved. Later the leg was placed in a splint to keep it straight, and when examined the next morning there was positively no inflammatory reaction. In ten days the patient walked out of the hospital with the aid of a crutch, and has continued to improve since.

"12. Male, married, aged forty-six years; lithæmia; duration about two years. Uric acid found in the blood and urine. No lesion of the joints; extremely nervous; neuralgic pains all over the body and limbs. Daily hot-air baths for two weeks, then three times a week for four weeks. No uric acid in the blood at the last examination." (KESSLER.)

Heat in the Diagnosis of Pus.—Lewin, of Berlin, claims that by the local application of heat we can determine whether or not a local inflammation, as appendicitis, has gone on to suppuration. "If the pus has not formed heat will comfort the patient. If pus is present heat will so increase the pain that a diagnosis of suppuration can be made with confidence."

"In cases of swelling of the knee, rheumatic or otherwise, fixation and heat usually give relief, but if pus is present pain is augmented and becomes intolerable." Lewin has tested this action of heat "in a number of cases sufficient to assure him of its diagnostic significance," and cites ten cases of appendicitis in which hot compresses were ap-

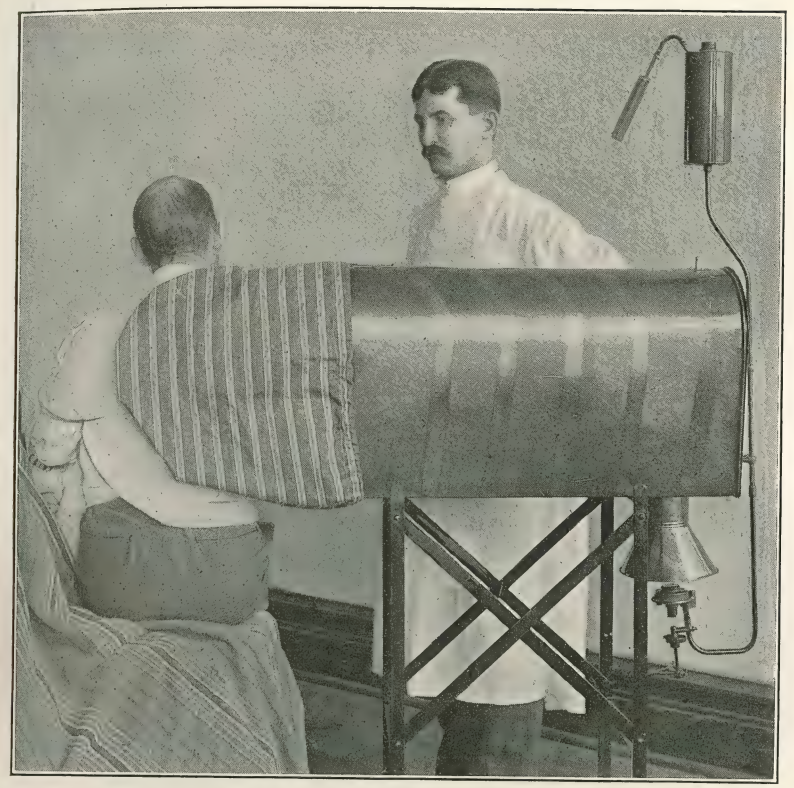


PLATE 263.—Application of dry heat to right shoulder of patient. Canvas sleeve fitted to conduct heat to the local part.

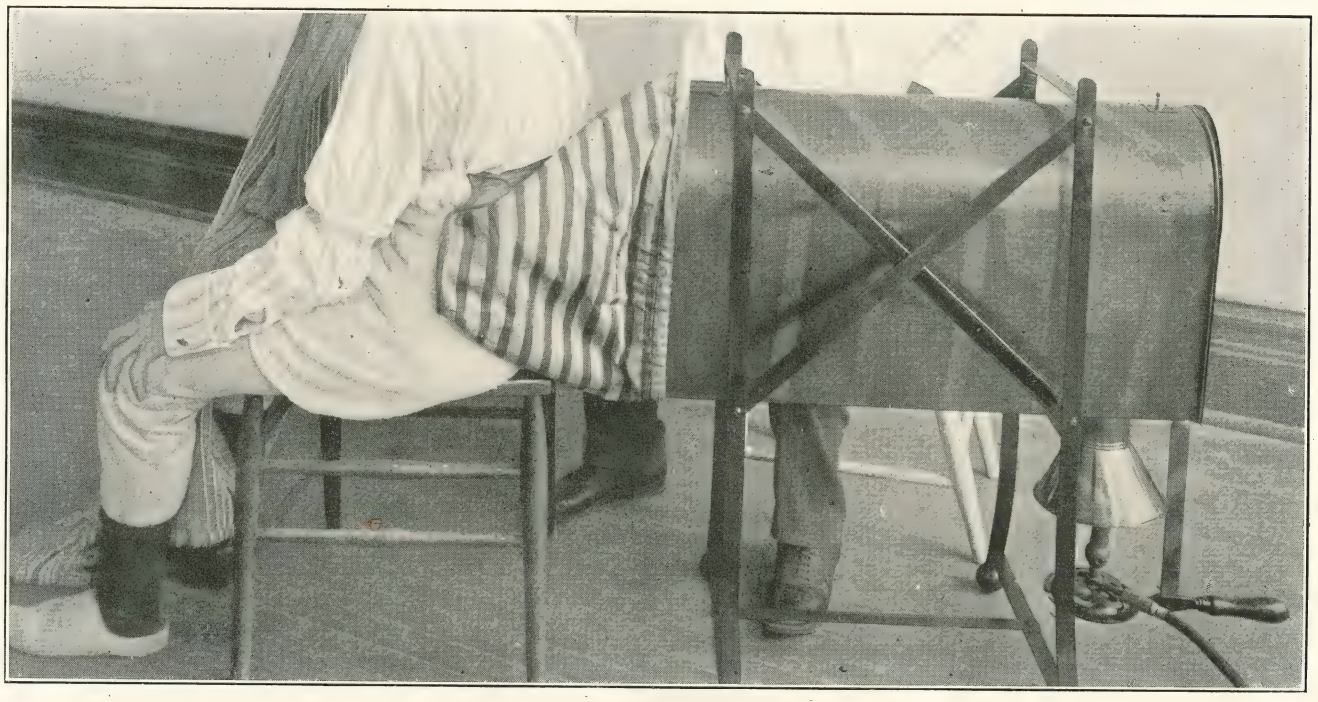


PLATE 264.—Showing method of application to sacral region as indicated in lumbago, etc. For either renal or muscular affections higher up attach the canvas hood similarly, but at the level of the affected parts.

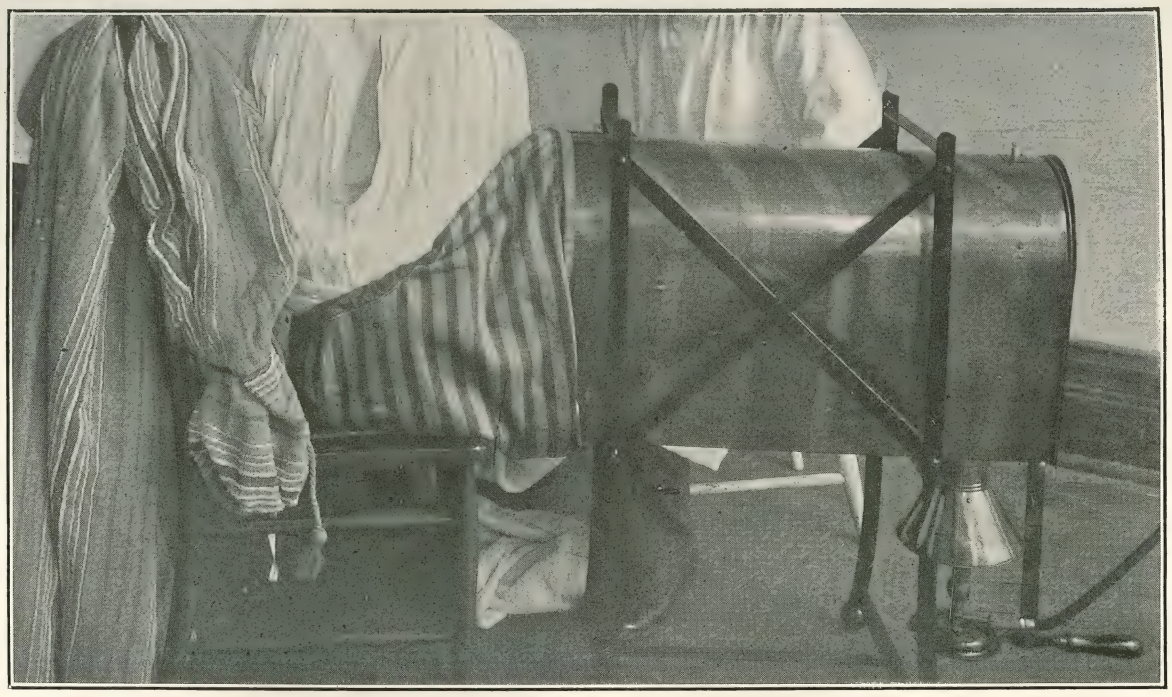


PLATE 265.—Showing special attachment of hood around right hip for treatment of this joint. By reversing the attachment the left hip can be treated in the same manner.

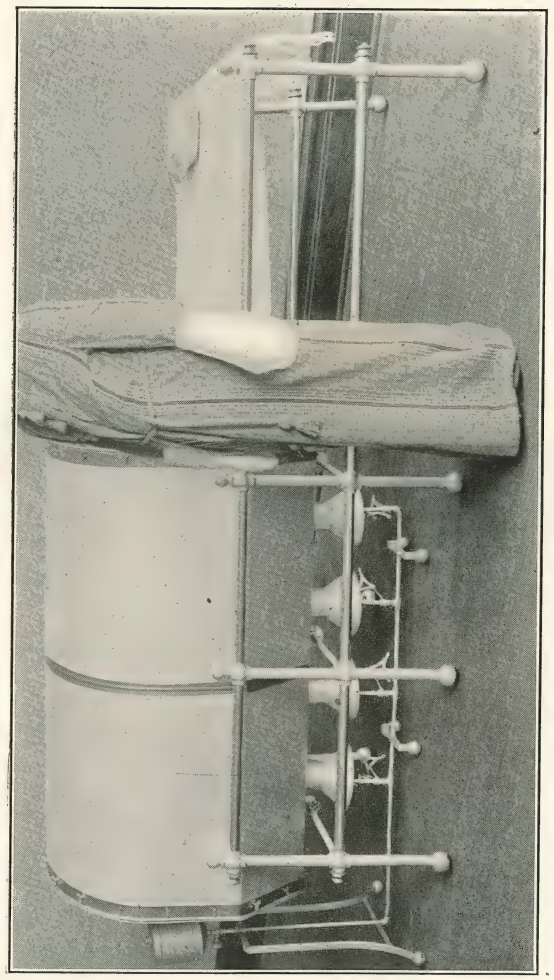


Plate 266.—Showing patient with hands protected ready to lie on the platform of the Betz Body Apparatus and take a general Hot-Air Bath.

plied for two hours each. Eight were benefited, but two had marked increase of pain and terminated fatally. In a case of perimetritis with aggravation instead of the usual relief from heat a large quantity of pus was later discharged from the vagina. Sphor of Frankfort cites fifteen cases of appendicitis in which the reaction to local heat confirms this conclusion. In the use of hot-air apparatus as well as the common routines of heat this possible explanation of non-relief should be kept in mind, and the presence of pus excluded before going on with the treatment.

Hot-Air Apparatus for Use in Bed.—According to Friedlænder of Wiesbaden in his classical review of all forms of baths the "Sweat Bath in Bed" occupies an intermediate place between the modern Dry Hot-air apparatus and hot vapor cabinets. A satisfactory means of administering in bed a general hot-air bath of from 180° to 300° F. is the portable Hot-Air Apparatus of Dr. Nöel. Higher degrees can be obtained if desired, but are rarely indicated. The unit of the apparatus is a neat zinc-lined wooden box a foot long and five inches wide and deep, in which are placed when heated the two stones which form the source of heat for the patient. These stones are a baked mass of clay, metals, and salts, ground together and made into a brick which is enamelled on every surface except the face from which heat is to be directed to the patient. The composition of the bricks gives them certain properties. They are very hygroscopic and absorb moisture to a great degree; they retain heat for three hours, and they will never wear out. A set of four or six units forms the complete apparatus.

In addition to the stones each box is provided with a metallic case for medicated vapor-baths when moist heat is desired instead of dry, and a screen of brass wire retains the contents of the box and protects the patient from contact with the heated bricks. At the suggestion of the elder Charcot a magnet has been incorporated with the device so that in its complete form the therapeutic result is of a complex nature. The heating of the two dissimilar metals sets up a thermo-electric field into which the magneto-electric and thermal factors bring a combined benefit to the patient which exceeds the action of high temperature alone. Each box weighs twelve pounds, is easily portable, and in outward appearance resembles a small hand galvanic battery.

Method of Use.—Over the mattress of any ordinary bed, couch, or cot lay a rubber sheet. On this spread the regular linen-sheet. On any stove, gas-range, or heater heat the bricks to suit. They can be given a temperature of 800° F. Then place them in the boxes with

the unpainted side facing outward. Insert the screens, place one pair of the units on opposite sides of the bed level with the knees and the other pair level with the middle of the trunk. Now have the nude patient get into the bed and recline comfortably in the middle space between the boxes, which are removed from the tissues about ten inches on each side. Then fix between each pair of boxes the bent reeds which form an arch over the patient to support the bed-clothes and also keep the entire apparatus in position during treatment. Draw over all the outer sheet and quilt which retain the hot air in the chamber below the neck. The patient's head remains in the free air of the room the same as in treatment in a cabinet.

Note the condition of the pulse as the treatment begins. Increasing the heat to any sufficient degree is merely a matter of time and keeping plenty of covers closely fitted over the patient. Reducing the heat at any time is merely a matter of lessening the covers and of admitting a circulation of outside air. The regulation of the dose is governed by the state of the pulse, sense of benefit, tolerance of the patient, and freedom from the familiar symptoms of distress associated with an over-dose of high-intensity heat. Cool the head as the comfort of any case requires, and as taught previously.

In from fifteen minutes to half an hour, according to the indications of the case, the effect on the patient, and the responsiveness of the tissues, remove the boxes, cover the patient comfortably, and let him rest in the gradually cooling heat for fifteen or twenty minutes. Then have the nurse quickly withdraw the old sheets and rubber protective, and replace them with a pair of fresh warm sheets. Let the patient enjoy the comfort of these for a quarter-hour or so, when he is ready for the selected after-treatment.

The after-treatment may be therapeutic to meet indications, or may be directed to simply restoring the circulation to normal with the least delay. A practitioner will be governed largely by his resources in this matter. A full regular massage treatment is usual in institutions using this apparatus. General faradization, any local or general application of the sinusoidal current, or central galvanization, can be administered while the patient is still in bed and cooling from the bath. Douches may be given. An alcohol rub, or a rub with a mixture of alcohol and camphor, or the addition of a few drops of tincture of iodine, have important place in the technique. The skin is in a receptive state. Medicated inunctions are valuable and much used by specialists. The intercurrent inhalation of oxygen during the bath is of practical use when indicated. The fact that this application of heat can be made not only in establishments, but at the

patient's home in family practice gives it a scope of use that no stationary apparatus possesses and makes the study of its actions far more comprehensive than the usual routine list of chronic hot-air cases. We shall refer to this presently.

The Vapor-Bath with the Nöel Apparatus.—When the skin is dry and the sweat glands act with difficulty, a few initial treatments with moist heat are useful. There are also special indications for a vapor-bath which the physician will meet in practice. After heating the stones as usual place them in the boxes flat with the plain face uppermost and in the space left between them and the side of the box lay the metallic case which has been nearly filled with the selected fluid to be vaporized. The case is so constructed that no liquid can escape till raised to vapor by the heat of the stones. A decoction of elder flowers is commonly used, but any medication can be employed, and when none is needed a simple perfume makes an agreeable addition to the bath. By means of this form of moisture the skin can be started into eliminative action in a very few minutes.

Therapeutic Indications.—To comprehend the scope of action of this portable and convenient apparatus study and modify to suit the case the actions of Turkish and Russian baths, which the device places at the command of the general practitioner in domestic practice in any part of the city or country; the claims made for all forms of Thermal Cabinet baths, which this device can duplicate in effect; the actions of the modern hot-air apparatus, which this portable device can take to the bedside of the patient and treat him in his own bed; and to these add the wet packs and hot fomentations, etc., of domestic hydro-therapy. It is particularly suited to emergency use in family practice and can be procured at a very moderate cost from Dr. Victor Nöel of this city, in whose Balneum it can be subjected to personal test if desired. Lack of space prevents full presentation of clinical matter here. A single extract can be cited, giving in part the experience of a practitioner. We may add that the apparatus will last indefinitely, the originator having one in use for sixteen years which is still as good as new.

"The baths are widely used in the Paris hospitals, and are advocated by the highest medical authorities. Such men as Professors Bouchard, Ball, Germain Sée, Vulpian, Lassègne, Hérard, Pajot Laboulbène, Charcot, Legroux, Lailler, Martineau, etc., have testified to the excellent results derived from this mode of treatment in a variety of pathological conditions. It is mainly in the broad field of the arthritic and infectious diseases that the Nöel bath displays its intrinsic worth. Almost every conceivable form of rheumatic or gouty ailment calls for this mode of treatment, and not only is relief constantly

afforded, but most often you will have the satisfaction of effecting a cure. Such will happen, for instance, in recent cases of arthritic neuralgia, no matter what region is affected. We can recommend it in sciatica. In the incomplete, abnormal, insidious forms of rheumatism and gout is the triumph of this bath. Used in conjunction with sulphur, it will help the system to throw off the burden that oppresses it. As to muscular rheumatism, it always comes within the scope of the bath; no matter how acute, it will do good, and very promptly. I have seen several forms of lumbago and torticollis entirely relieved by one single bath. You will also find that some rebellious forms of mono-articular arthritis, among which gonorrhœis arthritis is conspicuous, yield readily to this treatment. Whenever you can satisfy yourselves that you have to deal with some form of slackening of nutrition —let it be lithæmia, and acid dyscrasia, oxaluria, obesity, biliary or renal colic, or even diabetes—do not hesitate to resort to it. Obesity it will control, if persistently used, not, as is the mistaken belief, through the immediate loss of weight, which the bath superinduces, but through the improved nutrition and greater activity of all the functions. I believe that for non-diabetic glycosuria no better remedy can be found.

"This naturally leads me to speak of the indications of the treatment in nephritis. Now, while I have reason to consider the bath devoid of danger, and highly beneficial in all forms of acute, infectious, and toxic nephritis, I should refrain from using it in the later stages of Bright's disease. In the early stages, however, the bath, by relieving the renal congestion and the arterial tension, would appear to be decidedly indicated. In fact, whenever you are confronted by symptoms that point to a state of visceral congestion, especially of the abdominal organs—be it the liver, the kidney, the intestine, the bladder, the uterus—remember that the hot bath affords you a safe and prompt means of relief, such as no other method possesses in the same degree. As a corollary to this indication, you will do well to remember that most of the nervous and circulatory disturbances of woman's health at the climacteric easily yield to the regulating influence of the bath. It stands to reason that this is the time when the increased activity of the peripheral circulation, that the anti-spasmodic influence of sudation, and the increased elimination thus created must be particularly grateful to the feminine organism. And it is not unreasonable to suppose that by so relieving the uterine congestion we may possibly avert or retard the development of some lurking growth.

"Now we come to the most important class of infectious diseases, and first in line we find the eruptive fevers. Let me tell you that, in order to speedily bring out a tardy eruption, this bath is unsurpassed. Only you must abstain from ministering it to children below the age of five or six. By giving the bath during the period of eruption, you hasten the whole process, and considerably shorten the duration of disease. But it is especially in combating and preventing the dreaded

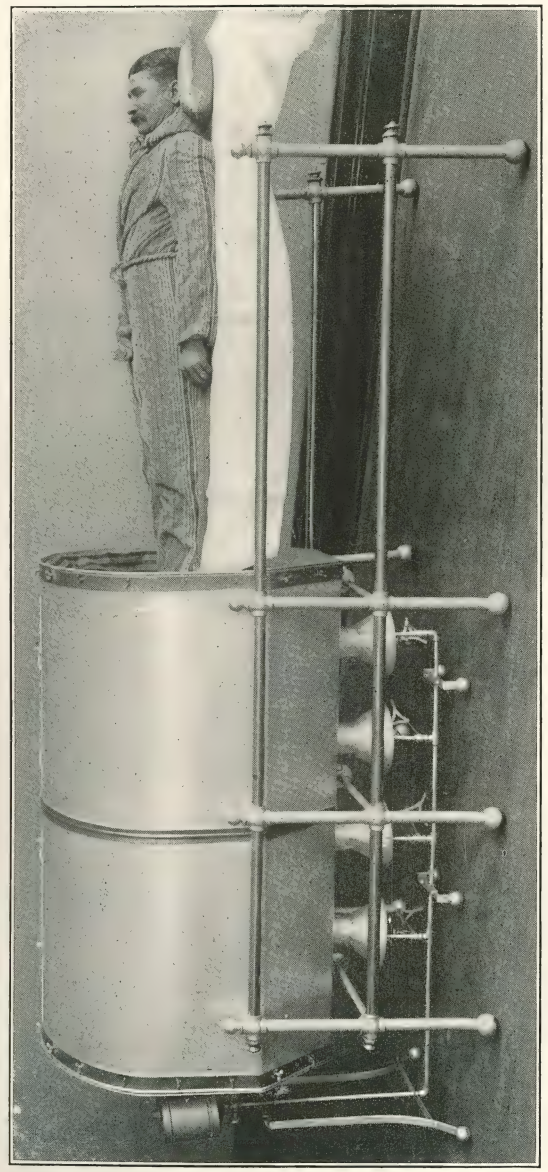


PLATE 267.—Showing patient recumbent on platform ready to slide into cylinder for the body bath.

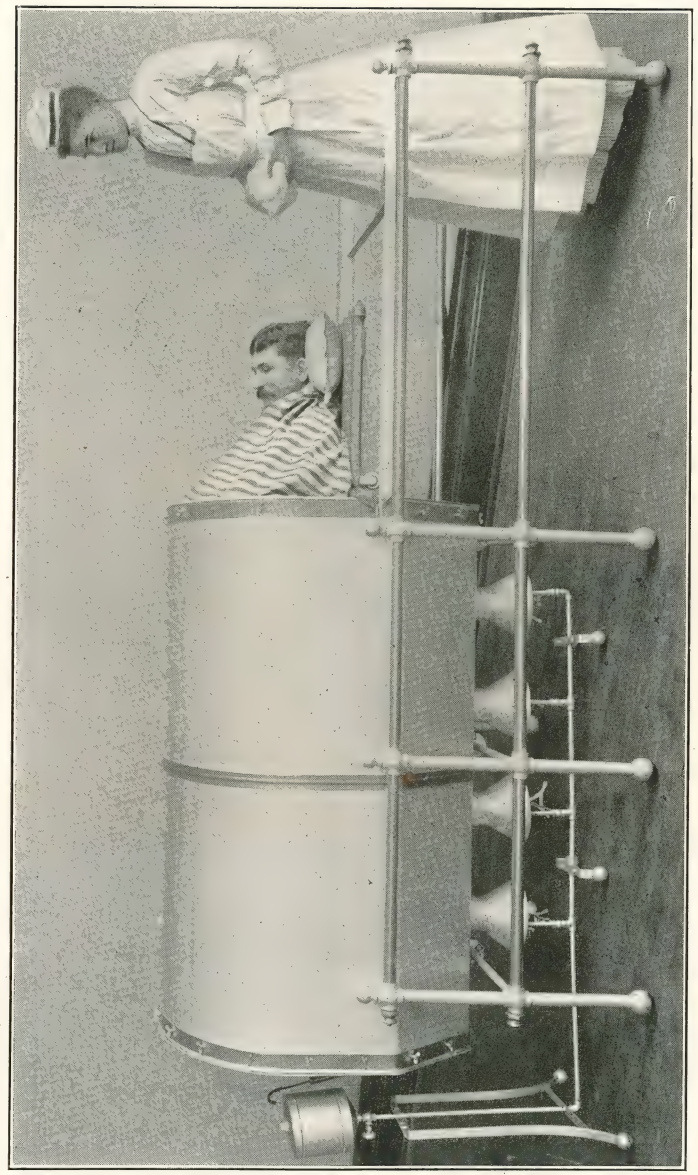


PLATE 268.—Showing patient completely arranged within the body apparatus with canvas hood adjusted to neck and nurse about to apply cold damp cloth to head. The two series of thirty-one Instruction Plates photographed exclusively for this course of clinical teaching illustrate the principles of technic so clearly that, with the aid of the explanatory text, similar treatment can be successfully administered by any practitioner.

PLATE 269.—Dr. Hopkins's Apparatus for Hot-Air Applications to the Ear.

"For generating the necessary superheated air the writer prefers the device illustrated. This apparatus is a simple room-heater operating either by gas or oil, and having a funnel-shaped top, which sends the hot air through the canvas sleeve to the ear under treatment.

A few points in the construction of this device are of importance: (1) There must be sufficient draught to secure perfect combustion, without having an excessive draught, which wastes heat, and (2) there must be at least one perforation in the canvas sleeve near the point of contact with the ear, or the dead-air space present will prevent hot air from reaching the ear.

The gauze packing within and over the ear takes up all moisture as rapidly as formed, preventing burning and making the application of very high temperatures easy and without discomfort.

Although it is difficult to introduce currents of hot air to a cavity like the ear, which is open only at one end, if the above-mentioned precautions are observed no difficulty will be experienced. The writer has experimented with a number of more elaborate heating appliances in these cases, but none has given better results than the simple one above described."

post-scarlatinal nephritis that this bath is invaluable. In order to illustrate its heroic action in an equally redoubtable form of nephritis—the puerperal variety—I shall cite the following case, reported by Dr. Lairac. Hotel Dieu, service of Professor Vulpian; case Mme. T.; age, thirty-six; gave birth to twins on January 8, 1885. Ten days later, on leaving the ward, she had a chill, and developed puerperal nephritis, promptly followed by a very severe attack of eclampsia. The convulsions succeeded each other every hour. Under the influence of the hot-air bath the paroxysms rapidly disappeared, and, in spite of the abundant perspiration, the flow of urine, which had been very scanty, became very free. The woman was up and about shortly afterward. Good results have been obtained in the treatment of typhoid fever, and also of typhus. In the former I would use the bath promptly from the start—at all events during the first week, and then during convalescence. Dr. Nöel has had considerable experience with the yellow fever at Panama, and has been fortunate enough in rescuing scores of sufferers, himself included, by the free use of his bath. All the practitioners who have given a trial to that mode of treatment in cholera are loud in its praise. The first symptoms of algidity imperatively call for it. Last, but not least, I would say a few words of the good work of this bath in the treatment of ' la grippe.' I positively know of no better treatment for ' la grippe.' This is also true of the sequelæ of that insidious disease, especially of those rebellious muscular pains, sometimes attended by atrophy, which will persist for months and years after the acute attack. I have seen a great many of these cases, and whenever I could have my way a course of baths and sulphur cured them. I recall the case of a young girl who came under my care three years ago. She had a severe attack of the grippe, which developed into generalized pseudo-rheumatism. Most of the joints were painful, though not swollen, and the muscles of the limbs and trunk were the seat of much pain. There was a great prostration of force; no appetite; no sleep, the fever was moderate. There seemed to be a total lack of response on the part of the nervous system. In spite of all I could do, after two weeks of treatment, the patient suffered more, and was growing weaker. I then prescribed a course of baths, and she promptly recovered.

" I would strongly impress upon your minds one principle, viz.: That the cutaneous surface is the easiest and safest way of exit for any virulent, or venomous, or septic matter, whether introduced into or developed within the organism. Therefore in case of bites from venomous animals, or of wounds from which septic poisoning may be feared, this sweat-bath ought to be immediately resorted to, and persisted in until all danger is passed. Nor is this all. We have it on the best authority that the bath does remarkable work in the treatment of venereal diseases. The experiments made in the Paris hospitals on syphilitic subjects leave very little doubt as to its efficacy. The rapidity with which the bath heals a chancroid is almost incredible. Drs. Martineau and Legroux cite cases in which a course of

three baths was all that was necessary to effect a cure. After all this you will find nothing wonderful in the statement that the best results have been obtained in the treatment of almost all forms of cutaneous affections, including rebellious varieties of eczema, and even of lichen. By way of conclusion I would say that a therapeutic agency, for which so much can be claimed, deserves recognition, for therapeutics does not consist entirely in the art of drug prescribing. Aside from drugs there are many helpful things, of which a well-informed and unbiassed physician is always eager to avail himself. This apparatus will enable you to successfully treat an amazing variety of diseased conditions, acute and chronic, from a simple chilling of the body to the most confirmed forms of rheumatism and gout; from a simple boil to the worst forms of blood poisoning. Dr. Nöel's apparatus is handy, safely carried about, and inexpensive. It is the only apparatus that will enable you to give a hot-air or vapor-bath to your patient in his own bed at a moment's notice, without hesitation and loss of precious time; an apparatus that will develop a high temperature, which, however, you can regulate at will; an apparatus from which you can derive powerful effects with perfect safety." (ARNULPHY.)

Studies in Vibration-Therapy

" One of the most important manipulations of the masseur is Vibration: the hand cannot compete with the machine."—(Zander.)

CHAPTER XLIX

VIBRATION-THERAPY

Scientific Massage by Electric Motor Power. Mechanical Apparatus for Concentrating, Intensifying, and giving Therapeutic Dosage to Local or General "Exercise." Methods of Treatment. A "Tissue Oscillator." Clinical Technics in Full. Portable Devices.

To many American physicians the term *Mechanical* Therapeutics has had an empty sound. But as the electric *motor* has wrought an industrial revolution in factories so it is making possible a variety of aids to office practice that must appeal to every physician who tests them. Twenty years ago who thought a *mechanical fan* was a convenience or necessity? The present widespread use of electric fans in summer to set the air in *vibration* is witness to the revolution in popular sentiment which has sprung from the miniature and practical motor. Ten years ago who expected a motor to *fan human tissues into therapeutic vibrations* and to furnish the highest type of scientific massage? To-day the miniature electric-motor drives devices which can place the combustion of local tissues under " forced draught " with the body at rest, and by precisely regulated dosage set muscle fibres at work transforming the applied energy into heat, increased metabolism, and improved physiological function. The term " massage " is so well known that it will occur to every one at the mention of passive exercises for the tissues, but ordinary manual massage compares with the resources of a swift, tireless, and flexible motor (with a score of attachments for precise dosage and an enormous range of effects) as a hand-drill compares with an electric drill, or the horse-car system of 1888 with the electric traction of 1902. These few words should open the reader's mind to the practical possibilities of new apparatus well suited to office methods and of very moderate size and cost. Some must see and feel a thing in order to appreciate it, but what is here said may suggest investigation. A single test will convince. There are three general classes of therapeutic machines which deal with the tissues by means of dosable movements:

1. Those which cover the field of slow Swedish Movements and Mechanical Gymnastics.

2. Those which exercise the tissues of a local part *en masse* in a series of oscillations of regulated stroke and speed, for a prescribed time.

3. Those which do not move the part as a whole but which transmit coarse or fine rapid vibrations (as prescribed) through the softer tissues and vessels by means of motor-driven hammer-strokes upon the surface.

The so-called vapor-massage is another interesting variation of the mechanism, and there are also others which those who desire may look up. A total of about twenty different vibration machines are now to be had, and special applicators for different parts of the body number more than a hundred.

The electric-motor has made this field of therapeutics second only in interest to hydro-therapy and electro-therapy. In particular, it supplements sweat-baths and hot air, the surgery of joints, and all measures that need tissue-change for their completion. To understand the indications for selected *rates of change* in vibrating or oscillating the tissues of any part simply apply the medical judgment gained by study of the effects of all forms of physical exercises—walking, horseback riding, cycling, golfing, rowing, swimming, fencing, swinging clubs, and dumb-bells, etc.—and all passive exercises by resisted movements, Swedish movements, medical gymnastics, every form of massage, and even all the claims of osteopathy. Add to this much of the local work of the faradic current as an anti-congestor, sedative, tonic, or stimulator of inert muscle fibres, and we about cover the range of work adapted to the different motor-driven swift substitutes for former slow and inferior methods. Coming to the practitioner's knowledge for the first time the best apparatus in this branch of technics is a surprise, but he already commands the principles of indications and needs but the revelation of a personal test to realize their value and desire their aid for his own patients. With this fact in view we need repeat none of the familiar physiology, but will note a few features of every-day importance in office practice.

In the *Lancet* of June 2 and 9, 1900, Bennett, of St. George's Hospital, London, contributed an article of great interest and importance on the use of massage in the treatment of all fractures, dislocations, and sprains. It is an article that may be read with advantage in connection with this section of our study. A leading American medical journal cited it at some length with this closing comment:

"These suggestions are by no means entirely new, but few surgeons of repute have given massage so thorough a trial as Bennett has, if indeed they have used it at all. The consensus of those who have used massage in treating fractures, dislocations, and sprains seems to be in its favor. A disadvantage is that it requires a large amount of time on the part of the surgeon, or else he must intrust it to some absolutely reliable assistant, which is not always convenient or possible. If it proves as valuable in the hands of all surgeons, as at present seems likely, *it will be necessary that a large number of intelligent and trustworthy masseurs or nurses be specially instructed in carrying out this work in the wards of our hospitals.*"

The idea that it must require *a large staff of masseurs* fails to take into account the electric motor. When carried out by hand no busy surgeon will think tedious manual massage within his dignity or proper function. We cite this extract here to emphasize the fact that with an improved vibration apparatus this work becomes an altogether different thing and can be carried out by the surgeon or his regular assistant with no impairment of dignity and with a minimum of time. The length of the séance can be reduced to a third. The benefits can be correspondingly increased.

Another point: pelvic massage (in gynecology) has its brilliant advocates and they report wonderful results, but when practitioners must supply the skilled technic with their own fingers the method has no value to the majority. But special applicators (motor-driven) give practical value and office convenience to what otherwise is impractical. Nearly the same is true of certain rectal and prostatic conditions in the male. Special applicators and a mechanical energy obtain in a few moments the best results of any form of massage. The séance is short; no third party—no non-medical masseur—is required. Limited and special massage of certain parts of the body, the face, for instance, is seldom prescribed or attempted by the physician. In this city most of this work is in the hands of people who rank with the manicure instead of the physician or surgeon. The motor-driven instrument brings it within the province of the regular practitioner, and once started the work should add a great deal to office earnings. Have you ever read Morrell's tribute to a little motor device that uses interrupted air-pressures to produce massage effects? It is a study in the value of posting up on modern therapeutic apparatus. We will cite part of it:

"Did you ever take a nervous, whining, sick baby, strip it to the velvet, put it in the centre of a big bed and see it coo and kick the air and get better every minute? There is a great army of invalids suffering from inactivity of the organs of the body, especially the skin

and its wonderful system. Their tissues need to kick up and get the air and not feed patent medicine vendors. Massage will do them good, but the drawback has been the great inconvenience and expense attached to its administration. How can we make massage *a physician's method* instead of a nurse's method? That is the question.

"The twentieth-century magician, electricity, has solved the question, and the electric-motor does in a simple and satisfactory manner what has heretofore been done only by the most perfectly trained masseur. It is a very simple, plain-looking machine, *but it is almost human in the way it takes hold of the skin and shakes it, and pats it, and rubs it, and beats it, and drops it with a little snap that is highly pleasing to the patient and wonderfully invigorating to the skin and other organs.* An old German who had received a treatment for facial paralysis, as he rose from the chair and examined the little apparatus, held up his hands and exclaimed: '*Ach, Gott, das ist wunderschoen!*' He was not far out of the way. It is wonderful, and only the beginning of a line of work that will have great influence for good in medicine.

"The clinical purpose of this method of massage (which uses compressed air as the medium of application instead of a hammer) is to vibrate, agitate, rub, stretch, or, in a single word, massage the skin and underlying tissues. So penetrating is the vibration that the periosteum and bone-cells are brought under the action. The nerve-centres are stimulated and greater activity is manifest in all the organs of the body. The inactive glands of the skin are restored to activity and facial blemishes are carried off by the increased blood supply. Wasted tissues are rebuilt and sunken places filled with healthy tissue, and the stomach, liver, and kidneys take on new life and carry on their normal functions in a satisfactory manner. The apparatus for the application of pneuma-massage is exceedingly simple and consists of a small motor, a massage pump, and a set of cup applicators. The pump has three valvular actions:

"1. The first is that of pressure. It forces a column of air against the part, like the tapping of a hammer. It has an almost human touch of great delicacy.

"2. The second is an alternating action that gives a vibratory effect, shaking the skin up and down from 250 to 10,000 times per minute, depending upon the speed of the motor.

"3. The third is that of suction or dry cupping. The extent and duration of the vacuum is under the control of the operator, who can instantly relieve the pressure by raising his finger even when the motor is at its maximum speed.

"It will be seen that all the movements of the skilled masseur can be made by the pneuma-massage pump. The cups can be made of any material, but glass is preferable for the reason that you can always see what you are doing and the smooth edges fit the parts. These cups can be made in all sizes, about six being all that are needed for general work. If desired, the galvanic or galvano-faradic current

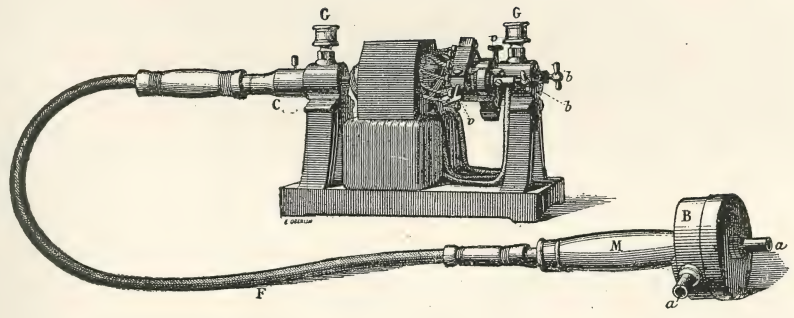


PLATE 270.—A Motor-Massage Vibration Apparatus. The various "applicators" attach in *a* or *a* in the rotating device at the end of the flexible handle running from the electric motor as shown in the figure. For further description see Plate 271.

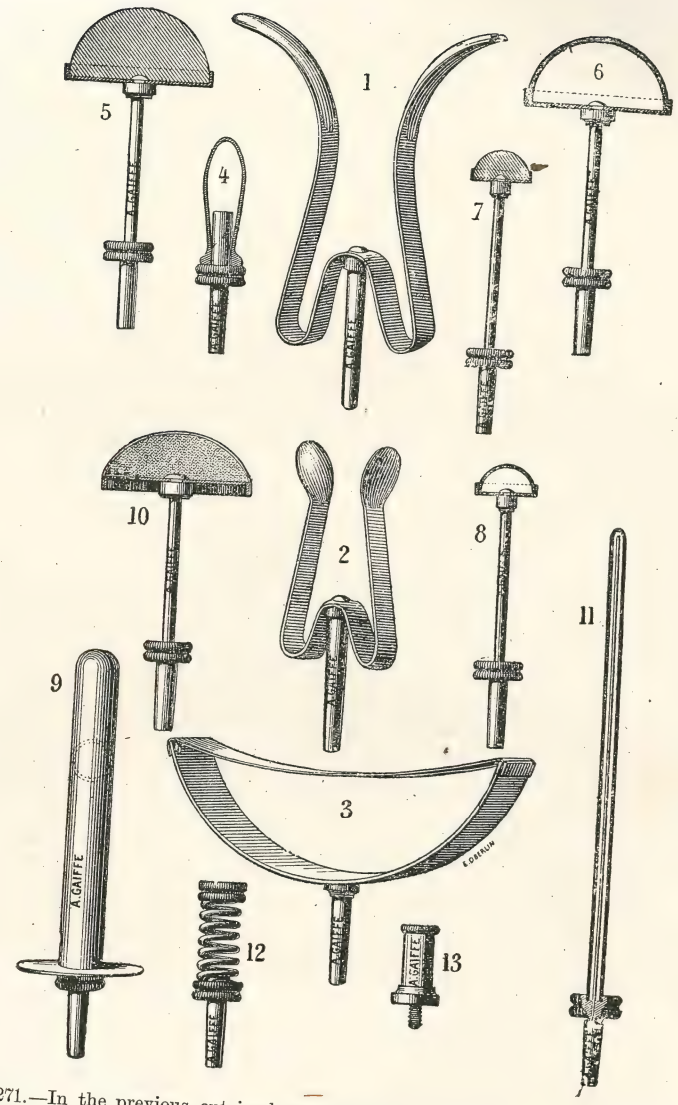


PLATE 271.—In the previous cut is shown the compact apparatus for motor-mechanical massage made by a manufacturer in Paris. At the end of the flexible handle is seen the rotating device (enclosed in case for protection) which imparts the vibratory movements to the selected applicator. The set of applicators furnished with this apparatus are identified by the numbers, as follows: 1. Spring applicator for throat; 2. Spring applicator for bridge of nose; 3. Band for frontal region; 4. Applicator for ear with cap of soft rubber; 5. General applicator of hard rubber; 6. Same in hollow rubber; 7. Local applicator of hard rubber; 8. Same in hollow rubber; 9. Vaginal or rectal applicator; 10. Vaginal applicator for tampon; 11. Intra-uterine applicator; 12. Spiral intermediary spring for use with all applicators to modify action. Many other applicators are made. Stems of various sizes serve for the interior of nose and ear: for mucous membranes a cotton-wrapped applicator carries medicated solutions when desired: a special attachment also conducts electric currents to combine with vibration when desired. These various applicators bear the same relation to vibratory apparatus that electrodes bear to medical batteries, and furnish an almost equally various means of treatment.

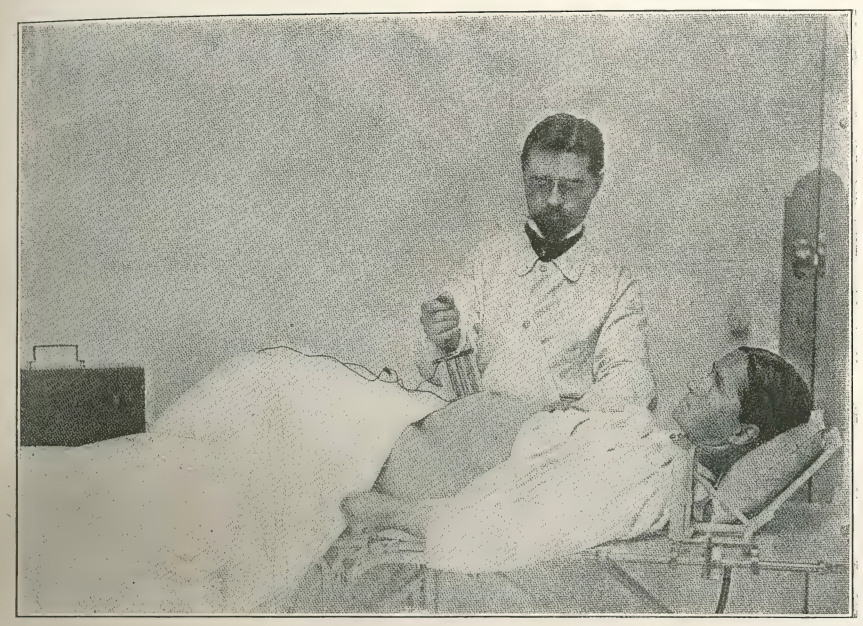


PLATE 272.—Local Treatment of Abdomen by a French Vibration Apparatus.

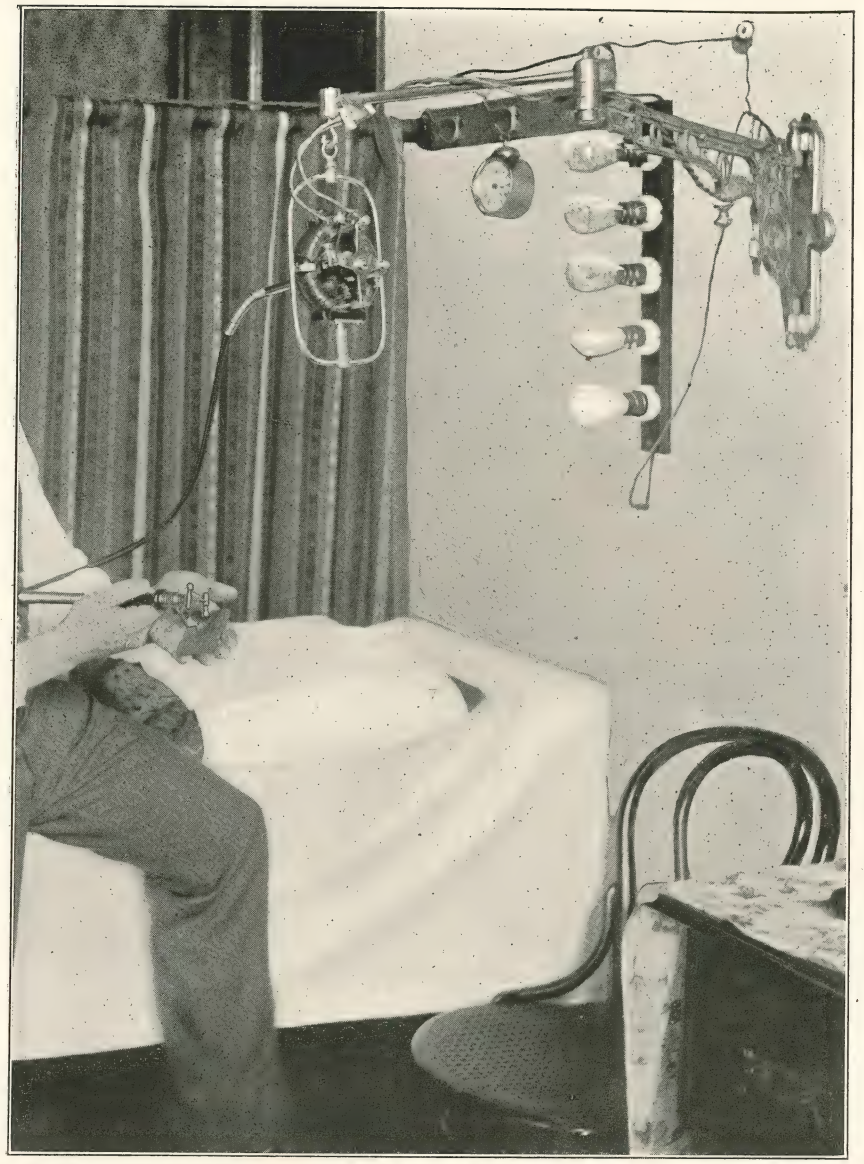


PLATE 273.—First Instruction Plate of this Vibration Series shows the Motor hung on a jointed frame attached to wall at head of massage table with bank of lamps as controller of the street current which runs the motor. The physician is seated on the edge of the table testing the applicator on his hand preparatory to beginning the series of self-teaching tests described in our clinical instruction. A regular rheostat is preferable to the lamps here shown.

It is to be understood that the therapeutic principles taught in this series of plates apply to other makes of apparatus as well as the one illustrated, which is used because it was available for the photographs, and without discriminating against others.

can be given at the same time by specially prepared electrodes, and it requires less current to accomplish results when used in connection with pneuma-massage. The general purpose of pneuma-massage is to induce activity in the skin and organs of the body. It has a wider field than manual massage, because of the deeper penetration of the vibratory waves. No human operator can compete with it or accomplish what it does. And last but not least, it is very pleasant to the patient and its effects are almost instantaneous, the general systemic tonicity being equal to that resulting from the application of the static breeze, with the added advantage that the effect is of much longer duration."

Experience has shown that regular muscular exercises with progressive exertion not only develop and strengthen the muscles, but eliminate morbid products from the tissues, energize the nervous system, accelerate the circulation of blood and lymph, and improve the functions of many organs. It is necessary, however, to base the exercises on physiological laws, and to be able to modify their therapeutic actions according to individual needs. A dosable mechanism is required. Scientific apparatus affording mechanico-medical effects fall mainly into three classes:

1. Those set in motion by the muscular power of the patient.
2. Those operated by motor-power.
3. Those combining motor-power with graduated resistances or tension on the part of the patient.

The Tissue Oscillator belongs to the second and third classes. While vibration is the most important of all manipulations in massage, yet it must be the most neglected, for no human machine can perform the labor of efficient applications by hand. In the development of Zander's system he gave special attention to vibratory apparatus and placed their employment on a scientific basis. "The vibrating mechanism, brought into contact with the soft tissues of the body, exercises on these an effect of *rapidly alternating expansion* and *pressure*. This accelerates the circulation in the capillaries and lymph-vessels, increases absorption and causes morbid infiltration of the tissues to disappear." Of still greater importance are the influence on the heart and blood-pressure. The researches of Hasebroek established the following results of vibrations:

"Lowering of the pulse rate.
"Improved tone of the cardiac muscles.
"Vasomotor increase of arterial tension.
"Increase of blood-pressure.
"Increased excretion of carbonic acid.
"Vibrations facilitate the peripheral circulation and improve the

nutrition of the muscles by stimulating the heart to a greater activity and by promoting (in valvular diseases) the compensatory hypertrophy so beneficial in these cases. They constitute an indispensable auxiliary to other physical methods of treatment. The essence of the treatment of heart diseases by mechano-therapy is:

"1. The acceleration of the peripheral circulation caused by the mechanical actions on veins and capillaries.

"2. The aid to the action of the heart rendered by lowering the arterial tension, either by reflex dilatation of the capillaries or by diverting a greater quantity of blood to the muscles exercised. The diminution of resistance acts in a measure as a cardiac sedative.

"3. The acceleration of the pulmonic circulation by the increased respiratory action which accompanies the exercise and which reacts beneficially upon the general system of the patient."

The great Zander system of mechanical apparatus with its seventy and more machines for all forms of active and passive exercise and Swedish movements is the prototype and leader in this field. But the truly magnificent equipment developed by Dr. Gustav Zander of Stockholm has far outgrown a private office. It demands the space of an institution; and in Europe more than a hundred of the bath resorts are fitted with Zander's contributions to scientific Mechanico-Therapeutics. The first visit of any educated physician to inspect the workings of this apparatus will excite astonishment and admiration and lead him to at once grasp the value of modified devices which can be used in his own office. The great aim of designers is to supply a tireless and adjustable (dosable) instrument suited to professional use which can substitute for the easily tired and variable muscular energy of human hands. It is obvious that an instrumental means of securing effects under direct medical technique will be for the patient as well as physician an immeasurable advance on laborious ways of old. This is the great point. Improved results in less time is another. Instrumental operative manipulation by the skilled practitioner proposes to do more for the patient in ten minutes than the average and irresponsible masseur does in an hour. Let us now study a selected few of these aids to office practice.

The vibration apparatus illustrated in the next series of Instruction Plates consists of a small dental motor run either by the street current or a portable battery of cells, a rheostat for current control, and an applicator which is connected to the motor by a flexible handle like that used by dentists on revolving drills. The applicator itself is a small thin plaque of vulcanite for direct contact with the skin or over thin clothing, and on this plaque a motor-driven hammer strikes a series of regulated blows which transmit vibratory impulses

to the tissues. The rate and force of the blows may be finely adjusted to all parts of the body. The maximum is about 4,000 impulses per minute. The effect is a powerful and very agreeable stimulus to skin, blood-vessels, muscle fibres, lymphatics, and venous circulation. We know of nothing more closely comparable to it than an extremely skilled "general faradization," but with the difference that it is neutral and bland on the most irritable skin, while an electric-current on such a skin will bite sharply and be disagreeable. Moreover, no wet electrode is used and diaphoretic effects can be set up when indicated. The wave impulse of the rapid resilient strokes seems to penetrate far into the tissues and has a power to contract muscles when applied to motor-points that again suggests faradization. Nevertheless there is no electricity in the application, and the only service of the current is to run the motor.

Great improvement in the hammer device has recently taken place and some of the defects of earlier models have been removed. It is essentially an instrument to see and try. A chapter on its merits would have less convincing force than two minutes of the applicator on the spine. It is very important to state in respect to all mechanical devices covered by this section that the teachings of the author apply only to high-grade apparatus and cannot vouchsafe for inferior workmanship. At the Paris Exposition in 1900 there were exhibited more than a dozen different Vibrators. How many designs there are now in this country and Europe we cannot say. But a careful selection is necessary. Some operate on a defective mechanical principle; some involve a crude construction of a good idea; some have had temporary defects that time will eliminate without doubt. An instrument that may spatter oil on the patient's garments; that may pinch the skin on certain pressures; that subjects the arm of the operator to fatiguing strain; or may, by the breaking of a pivot, let fly a hammer-head like a bullet from a gun, should be avoided. An approved instrument will have none of these needless faults and will secure the desired results with cleanliness, comfort, and safety to both operator and patient.

Technics of a Vibration Instrument.—Let us now begin a personal clinic with an electric-motor-driven massage instrument designed to relieve the hand of the masseur and concentrate an hour of manual work into ten or fifteen minutes of professional treatment—to reclaim an important therapeutic technic from non-medical manipulation and place it where it belongs with the practitioner or his assistant. Begin with a series of tests of action on your own tissues to acquire technic, dose regulation, pressure tactics, labile system, and familiarity with sen-

sory, muscular, and physical effects. Dosage depends on rate of speed, degree of pressure upon the hammer and upon the tissues, and the rate of labile change in the situation of the instrument. It is especially necessary to note the effect of deficient soft parts under the hammer. Bony prominences are not adapted to massage, which is suited chiefly to deal with vascular soft parts and act on muscle fibres, blood-vessels, organs, and nerve supply.

Connect up the vibrator with a source of current that will run the motor. In these Instruction Plates the Edison street current is used. A primary or small storage battery may be employed if no street supply exists, but these are less satisfactory and much more trouble. A rheostat is needed to regulate the speed of the motor. The bank of lamps shown in the Plates serves as a resistance controller, but a regular rheostat such as we use for motors on Static machines is much better. Slip off the outside coat, but first test the action through all other garments. Note how the vibration is transmitted through clothing and tissues in remarkable contrast to the conduction of electric-currents.

1. When all is ready take the handle of the instrument in the right hand as shown in Plate 273, not as you would hold a labile electrode, but more as you would grasp a hammer. Sit on the edge of the massage-table, start the motor into slow action, apply the plaque to the palm of the left hand and test the sensations and physical effects on both surfaces. Vary the pressure and run up the speed from very slow to very rapid and note the rate that is most sedative, most stimulating, etc. Note the difference between the same dosage on the ball of the thumb and on the dorsal surface. Modify dosage to suit the character of the given tissues under the plaque. Compare this intense massage energy with the common manual article. Note its superior "dosability" as well as its regularity of action. Note that it transforms a crude process into a scientific instrument of precision fitted to a physician's office. Promenade the vibrator up the arm and over both surfaces. Note the effects of a strong dosage on motor-points. Some of the action closely parallels certain electric-currents, but is wholly without the cutaneous sharpness of electricity on an irritable skin. It is therefore agreeable to tissues on which a local application of a galvanic or even faradic current for similar effects would be difficult to make. Its employment is in fact almost independent of the condition of the skin under ordinary circumstances. This is one of its many merits that appeals to patients.

2. Next recline upon the table or couch as shown in Plate 274 and test the action of varied doses upon every part of the anterior surface

PLATE 274.—Second Instruction Plate of this Vibration Series, showing practice tests of varied doses on every part of the anterior surface of the chest and abdomen, as taught in our clinical description.

PLATE 275.—Third Instruction Plate of Vibration Series, showing practice tests of different doses on spine and muscles of back, as taught in our clinical text.

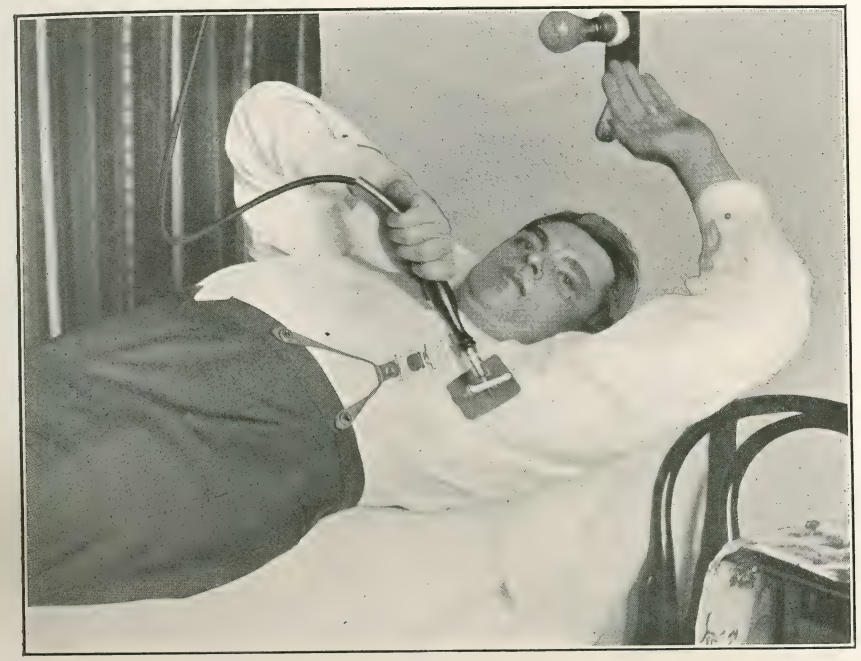


PLATE 276.—Fourth Instruction Plate of Vibration Series, showing practice tests on fields of neck and shoulder commencing in axillary region.

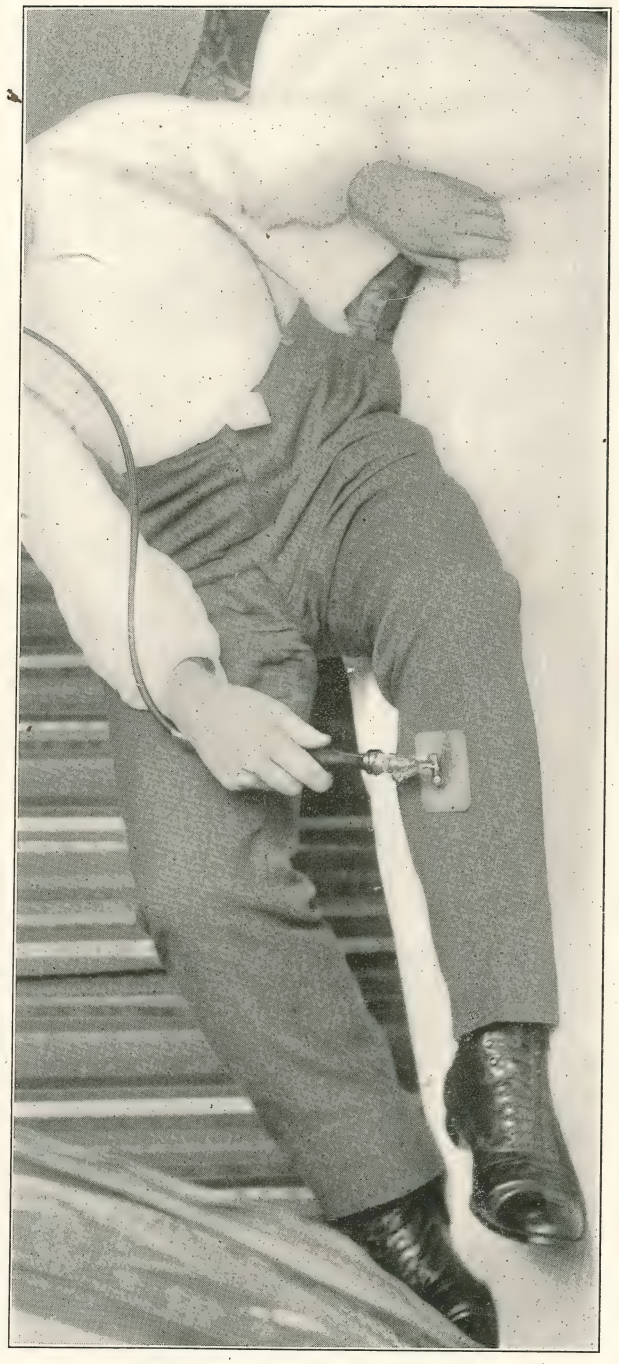


PLATE 277.—Fifth Instruction Plate of Vibration Series, showing practice tests on lower extremities through ordinary clothing with different rates of motor and different pressures on the parts.

of the chest and abdomen. Carry the vibrator over the course of the large intestine and note in this test the fine adaptability of the deep and peculiar massage to functional derangements and to local accumulations of fat. The nutritional action is as useful in chronic constipation and obesity as it is in gout, rheumatism, vascular stasis, etc.

3. Then transfer the vibrator to the back as in Plate 275. Test it up and down the spine and note the restful and tonic result. In equalizing the circulation it also tranquillizes the spinal nerve-centres in a way peculiarly comforting to over-active mental states and emotional conditions. Cross the lumbar region with variations of labile dosage and observe its applicability to lumbago, and its palliative usefulness in Bright's disease. Especially apply the plaque to the upper cervical centres and sides of the neck. Also with modified dosage to the occipital centres and note the sedative effect upon many headaches. Your back furnishes a fine field for study of dosage and special actions. The flexibility of the device enables the operator to test almost all applications upon himself without any assistance whatever.

4. Again turning upon the couch apply the plaque to the axillary region as in Plate 276. Act on the large blood-vessels, tilt up the chin and reach the larynx, the carotid triangles on both sides and muscles of the neck and shoulders. Note especially the cerebral sedation that can be effected in congestive headaches, etc., by influencing the jugulars and carotids in the neck. Apply your experience with electrical applications and bring to bear rational therapeutic principles and a valuable field of work with this instrument will open up.

5. Now pass the vibrator to the lower extremities as in Plate 277, still acting through the clothes. Compare the difference between mechanical vibration on masses of soft tissues, the thigh muscles, the gastrocnemius, and the thinly covered regions of the knee and surface of the tibia. The test supplies the indications for treatment. Once the action is felt by the physician, he needs but little further guide to know when to use it on his patients.

6. Now remove the shoe and stocking and test effects upon the foot as shown in Plate 278. Study all positions of the plaque and all rates of speed and pressure. Its value in cases of sprained ankle and other joints will be apparent at once.

After this series of tests through ordinary clothing test similar actions with close-fitting underwear only covering the part. Many treatments, especially with women patients, may best be given without removal of the underwear, particularly if it is fine and close fitting. It protects the skin from currents of air and will please many better

than to be asked to remove their entire clothing. Nevertheless it is often important to reach tissues in the most direct manner. Therefore, study the direct cutaneous effects upon the skin. Note the great intensity of therapeutic action. The circulatory and secretory organs of the skin respond more quickly. Diaphoresis is established, and in general it will be seen that many cases must be stripped for treatment in order to do them the most good. A local part can be exposed and treated and the remainder of the body covered with a sheet or light blanket as needed.

We are now ready to administer a general treatment of rapid mechanical massage to a patient. It is equally adapted to men, women, and children. Have the room warm and comfortable. Have the patient undress as may be needed, recline upon the table, draw over herself the blanket or sheet and announce that she is ready. In the following Instruction Plates the patient is a boy and the sheet is removed for the purpose of demonstration.

7. Ask the patient to rest easily and relax all the muscles. Stand at the side of the couch, take one arm from beneath the blanket and begin at the hand as in Plate 279. Work toward the centres. Regulate the dosage for the varying tissues and make systematic labile movements of the instrument over the entire arm to the neck. With the left hand made supporting pressure to the arm of the patient and flex and posture the arm during the applications so that in each area of local action the muscle-fibres under the vibrator will be relaxed. Do both arms in a similar manner.

8. Pass next to the lower extremities and manipulate them on the same principles from periphery to centres. Avoid exposure of any part except the field under the vibrator. See Plate 280.

9. Along the thigh muscles regulate the pressure and dosage to suit the increased masses of tissue and direct special attention to the points of tenderness, pain, or other symptomatic indications. See Plate 281.

10. Next thoroughly act on the abdominal viscera and walls. See Plate 282. Hold the plaque with deep and special pressure over areas of complaint. Thus comfort a tender ovary, strengthen lax and fatty walls which hardly hold up the flabby viscera of a sedentary and corpulent old person, stir up a sluggish liver, stimulate the functions of the stomach, tone up the solar plexus, subdue an enlarged and tender spleen, expel flatulence, allay nervous irritation, bring the blood to the surface capillaries in anæmic states, and, in a word, meet all local therapeutic indications in the given case. Flex the leg as shown in the plate to relax the abdominal muscles and keep the body protected except under the plaque.

11. Now reverse the patient and promenade the vibrator, as in Plate 283, over the surface of the spine and back. Close a general séance in this way. It is more soothing than any manual massage and leaves the patient rested and refreshed with the treatment. It leaves an irritable nervous system wonderfully quieted. It infuses into a sluggish state a most agreeable stimulation. Imparts to cold conditions a most delightful warmth. Gives freedom of movement and energy to stiffened rheumatic joints. Starts up nutrition. And accelerates metabolism and elimination. Particularly devote stabile pressure for a moment to the nerve-centres of each extremity of the spine. Over the sacrum and at the base of the brain are two important regions to affect.

12. If any myalgic condition affects the muscles of the head and neck apply the vibrator as in Plate 284. Use labile strokes down the course of the muscles to their lower insertions.

13. Aphonia, congestions of the vocal apparatus, pain and tenderness after laryngitis or tonsillitis can be treated as shown in Plate 285. Regulate the dosage and apply the vibrator to the affected region.

Duration and Frequency of Treatment.—Regulate these according to the indications of the case. For general massage effects allow two minutes to each extremity and three minutes each to the abdomen and spine. For local effects maintain the action till the desired result is obtained. Tests of time required to produce leading effects will speedily instruct the operator on these points.

When local treatment only is in question the rule obtains that stimulating effects need short séances, while sedative effects may need two or three times as long. Acute conditions are more quickly and more permanently relieved than chronic conditions, and chronicity is a greater factor than severity in determining the amount of treatment that may be required.

Treat acute and recent states daily till relieved. Treat chronic cases three times a week except when there exists a local indication for daily treatment. The physician who has had some experience with faradic electricity with modern scientific (not cheap) batteries will need scarcely any suggestions for handling vibration technics beyond making the series of personal tests taught in the foregoing Instruction Plates.

Note that a simple spinal application similar to spinal faradization may be made with the patient sitting on a stool without exposure. A woman with corsets well spread at the back and a thin waist need remove nothing for a sedative-tonic spinal application. A man can readily strip to his undershirt. The effect is very satisfactory.

A Tissue Oscillator.—We now come to one of the most attractive and satisfactory instruments within its scope of action which it has so far been our fortune to meet. It is the Tissue Oscillator of Hanfeld. It is compact, adapted to office practice, simple in technic, and of *self-evident merit.* Theoretical considerations at once become superfluous when the practitioner submits his *own* tissues to the actual experience of treatment. The physiological activities set at work are so apparent that no words are needed to discuss them.

The author first met this instrument in connection with a case of old synovitis of the knee having an acute exacerbation of trouble after a severe walk. The kind and quality of relief resulting from five minutes rapid oscillation of the tissues so impressed the patient and myself that further tests were given the apparatus. The gratifying results form the basis of this section. The essentials of the oscillator are two eccentrics mounted on a standard, adjustable to all desired strokes, and made to revolve as slowly or rapidly as required to produce needed effects. A small electric motor runs it. See Plate 286. The chief applicators are three:

1. A belt for general uses on the body. (See Plates 287 to 293.)
2. A foot-piece. (See Plate 294.)
3. A hand-piece. (See Plates 295 and 296.)

In addition to these direct mechanical applications means are provided for including faradic and other electric currents in the circuit at the wish of the operator. The Instruction Plates render a more detailed description unnecessary.

We will first consider the direct mechanical action of the Tissue Oscillator. It is distinct from either vibration or massage. To be rightly appreciated the action must be felt. The immediate action is localized by the situation and contact of the selected applicator, but oscillatory waves diffuse to greater or less distances in the surrounding soft parts according to the dosage—length and frequency of stroke—and these waves can be felt and seen by any observer.

The work of some drugs must be taken on faith; some eminent men with but a remote acquaintance with electro-therapy regard it as allied to the processes of "suggestion"; it may be open to doubt whether an "absent treatment" by one of our Christian Science friends is doing all its perfect work; but about the work of this Oscillator there is no doubt whatever. It tells its own story of energetic physiological activity to every sense of the patient and leaves no part of its motive to the imagination. Add to this that it demonstrates a wide range of usefulness in practice, does not require entire removal of clothing, makes no other demand on skill than regulation of the

PLATE 278.—Sixth Instruction Plate of Vibration Series, showing shoe and stocking removed to permit practice tests on bare tissues. Particularly study the actions around ankle-joint with reference to the treatment of sprains. Learn how to avoid sensitive areas little padded with soft parts, and to regulate the dosage according to the situation of the applicator.

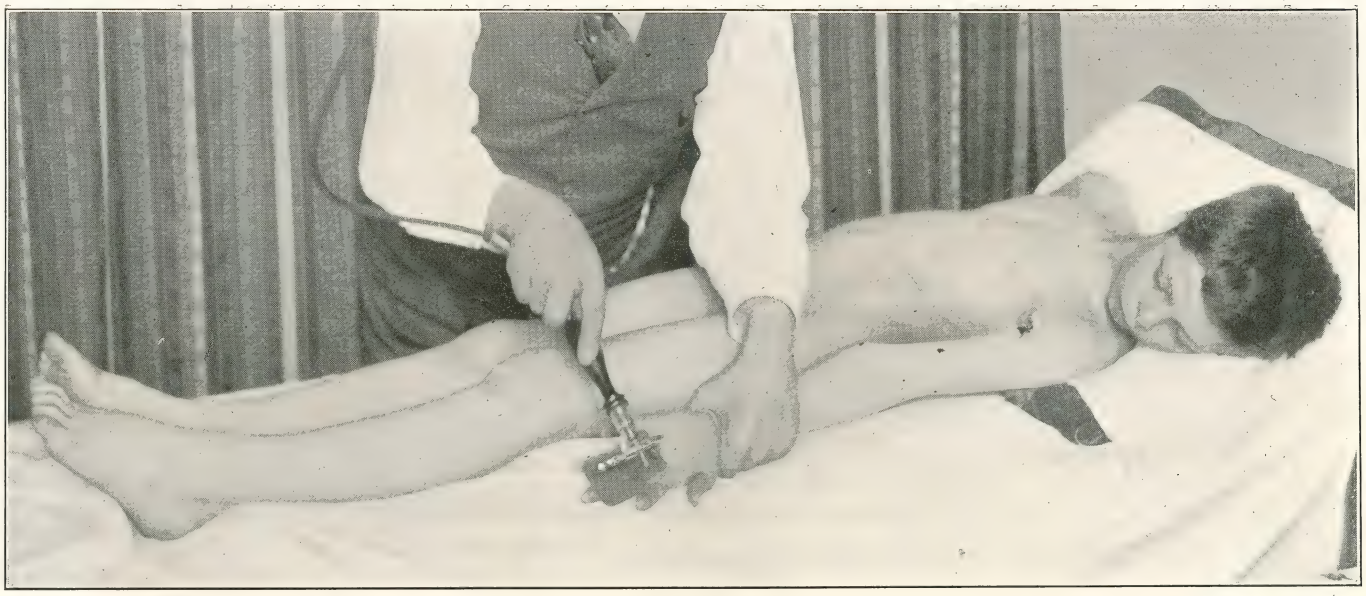


PLATE 279.—Seventh Instruction Plate of Vibration Series, showing patient stripped and on massage table for general treatment to entire body, commencing at one upper extremity as taught in the clinical text. In actual practice the patient is covered with sheet or blanket and no exposure occurs, but the covering is removed in the photograph to better illustrate the technic. For many effects treatment may be equally well given through close-fitting underclothes, but for intimate action upon the cutaneous nerves and blood-vessels the application is best made upon the bared skin.

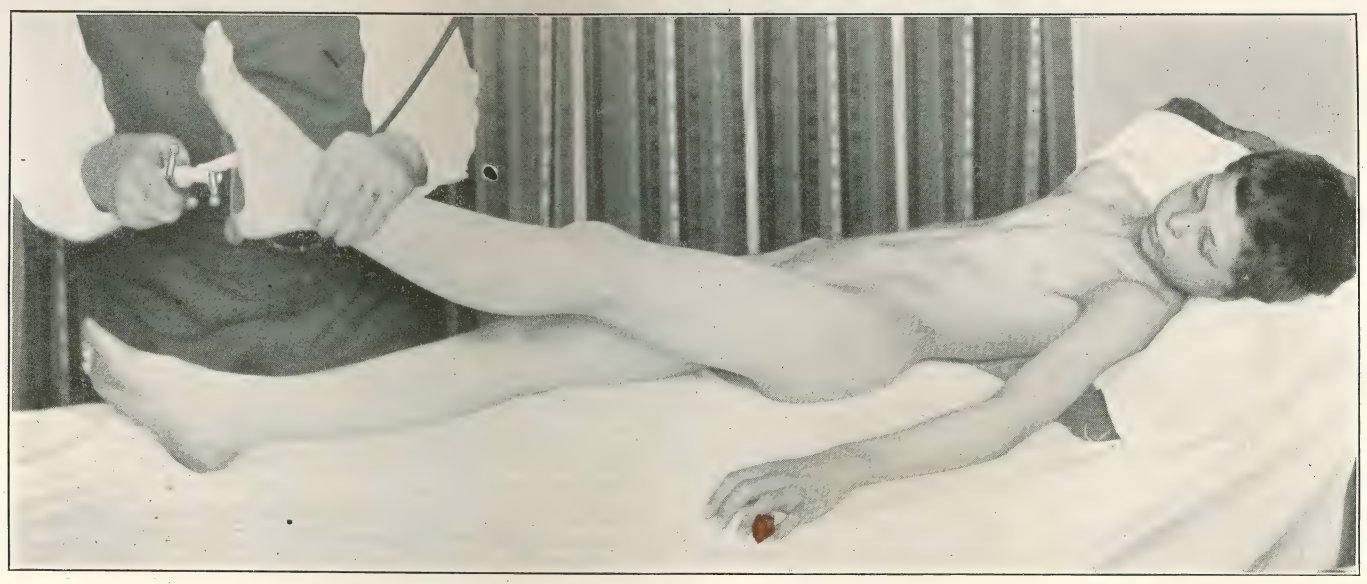


PLATE 280.—Eighth Instruction Plate of Vibration Series, showing motor-massage beginning treatment of the lower extremities at one foot, from which it will proceed upward toward the centre, as seen in the next cut.

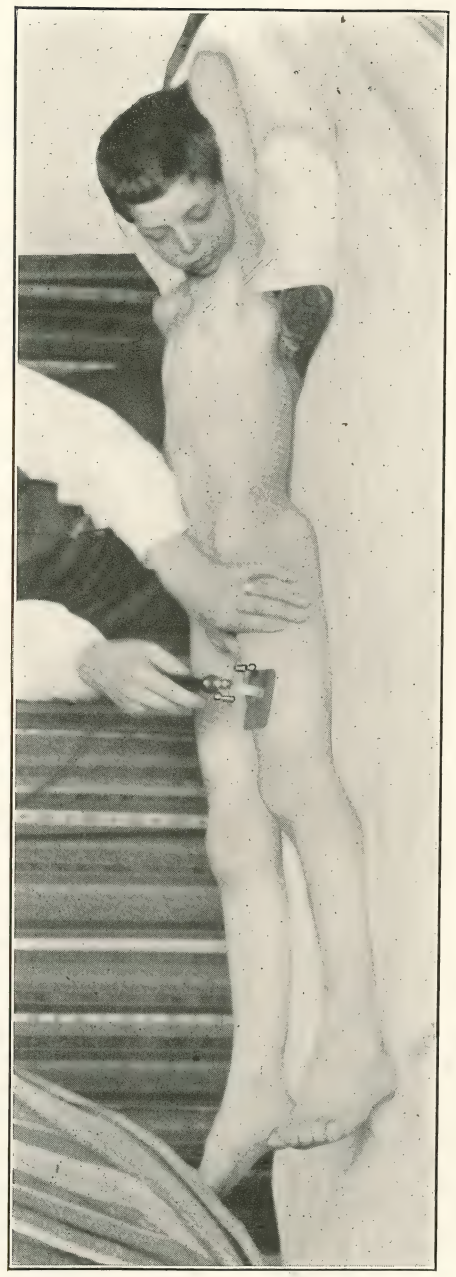


PLATE 281.—Ninth Instruction Plate of Vibration Series, showing continuation of the treatment along the lower extremity to thigh. On these thick muscle-masses regulate the pressure to suit the increased mass of tissues and hold the applicator stabile on any points of tenderness or pain, as taught in text.

dose, and takes but an average of five or eight minutes for a séance, and the value of the device will appear.

The physician who has read any treatise on the Zander effects needs no instruction as to the general physiological actions and therapeutic indications of a closely related Oscillator, and space will not be taken to review what should be so well known. Suffice it to say here that whatever else this deft machine may do its main appeal to the physician will be its local action upon tissues—to increase *combustion* in states of excessive inertia or adipose; to increase *nutrition* in states of deficient adipose or oxidation; to give sets of muscle-fibres active work with the system passive; to energize the general circulation; to determine a greater supply of blood to a given part, or to scatter stasis, abate congestion, and dilate the capillaries of the skin; to stimulate the cutaneous nerves, set up the heat of intense tissue-activity, relieve the pains of cold conditions, and when all is done to leave the patient rested, benefited, and refreshed. The many minor effects growing out of the above will develop in practice and need not be dwelt on now.

This Oscillator is in effect a means of inducing *direct local exercise* in the tissues of a part of the body which otherwise would remain inactive or out of balance with the normal energy of the body. As muscular exercises are "*effective means, impossible to substitute,*" for maintaining the equilibrium of the heart, nerves, and organs in a vigorous state, so a means of applying a definite dosage of potential energy by mechanical power to exactly localized regions without a general tax upon other tissues which may not need it is one of the primary requirements of physical therapeutics.

Zander recommends medical exercises (mechano-therapy) for all the valvular lesions and their progressive states, in idiopathic hypertrophy and dilatation from over-work, chronic myocarditis, fatty degeneration, cardiac neuroses, stenocarditis, nervous palpitations, arterio-sclerosis, etc. In diseases of the nervous system vibratory treatment may play an important part. In neurasthenia, irritability, debility, hysteria, insomnia, excitement or depression of mind, in the recovery from neuritis, in neuralgias, as an aid in the treatment of paralysis, wherever the special actions of locally applied mechanical energy are indicated, we may use vibratory and oscillatory apparatus with benefit. Rapid nutritional vibration may be applied to the thorax in such respiratory diseases as need vascular sedation or stimulation, to the larynx in simple laryngitis, and to the frontal and nasal regions in nasal catarrhs.

As an adjunct to regular remedies in anæmia and chlorosis and

attendant symptoms such as headache, dyspepsia, constipation, tenderness in the epigastric region, coldness of the extremities, backache, general lassitude, etc., the local actions of the motor-driven high-intensity tissue-work set up by an efficient vibration apparatus will help wonderfully. The immediate sense of warmth resulting from the improved distribution of blood becomes gradually permanent, the general nutrition improves, the liver and bowels take on more competent action, and the general progress toward normal health is accelerated. As a foot-warmer the rapid oscillation of the extremities has few equals. In muscular pains and stiffness of the kinds responding to heat and static counter-irritation—lumbago, myalgias, sciatica of certain forms, local congestions in the muscles of a rheumatic character, etc.—the direct heat under the oscillating belt and the frictional application is one of the most satisfying things that can be offered a patient. The appreciative remarks of patients are also one of the most satisfying things that can come to the physician's ears.

By testing the vibratory effects the practitioner can feel for himself (and need take no one's word) that a regulated dosage has useful place in many unexpected conditions, such, for instance, as chronic intestinal catarrh with diarrhœa, in simple and recent hemorrhoids, in chronic cystitis with atony of the bladder, in a host of local atonies wherever met, in disorders of menstruation and many of the diseases of women. It is almost superfluous to speak of the value of motor-massage and tissue oscillation with regulated dosage in chronic gout and rheumatic conditions; in old cases of synovitis, in sprains, contusions, and local states that a flushing of warm blood through capillary stasis can benefit. We need not seek theoretical reasons to guide us in the prescription in most of these cases nor need the beginner search far and wide to learn the experience of others; simply let him test the physiological actions on every part of his own body and he can ask no further guide to direct practice. This is a great merit of the apparatus and clears hesitation away.

But there are two especial conditions in which motor-mechanico-therapy takes pre-eminence. Many forms of energy will excite muscles to contract and cells to secrete, and enhance oxidation in the tissues, but few means equal and none surpass the direct and forceful action of Hanfeld's Oscillator. Under the heads of *chronic constipation* and *obesity* we will say more on these subjects.

Obesity.—To combine with other rational management of obesity cases we believe that the mechanical action of the Oscillator rounds out the sum of treatment in a manner not surpassed by any other prescription. Far more expressive than our written opinion, however,

will be the results of practice. But while the Oscillator can with benefit and entire safety assist corpulent people the degree of relief depends on persistency of treatment. A reasonable expectation of results is wise. Before citing a case let us note the observation of a distinguished European specialist in the bath and gymnastic management of dieted obesity: "Obese persons have every reason to be thankful if we succeed in *diminishing their increase in volume.*"

By the transformation of mechanical energy into tissue work the Oscillator causes a consumption of fat in the soft parts of the body, in the omentum and the covering of the intestines, where it is the greatest inconvenience. After a week or two of primary daily treatment the patient becomes more mobile, more enduring and energetic, gets rid of his troublesome palpitations of the heart, of his shortness of breath, and flatulent distention and various other symptoms. The actual weight lost in pounds may be very little directly due to the Oscillator, but the advantages gained make it of little moment whether the loss is more or less, provided that further increase is arrested.

The following result was obtained by the author without regulation of diet, or aid of sweat-baths, purgatives, salts, mineral waters, or any other treatment except the Oscillator: Mrs. ———, aged fifty, had for several years complained of abdominal fat. Subject to flatulent distention, a neurotic heart, great lack of physical endurance, frequent pain in side, complete dependence on drugs for action of bowels, irregular sleep, etc. Her "high stomach" was a cause of great mortification. Daily treatment with the Oscillator was begun as follows: Half-inch stroke; rapid speed of motor; belt first over lumbar region, then a half-turn bringing belt over side and liver, then turning to bring belt over stomach and gradually slipping it down the abdomen to the symphysis. See Plates 287, 288, 289, 290. At first the séance was limited to three minutes, then five, and later ten minutes, as tolerance to the muscular exercise improved. All symptoms were ameliorated, the trim of the stomach and figure around the waist was greatly improved and the sense of benefit was far more than was shown by the scales. The first week of treatment was rather disturbing than comforting; the second week was beneficial, and the third week witnessed decided results that were very satisfactory. The technic and action is especially adapted to the lax and flabby abdominal wall often so troublesome to old ladies after much child bearing in earlier days.

Chronic Constipation.—In the treatment of ordinary cases of this complaint the general practitioner will derive the greatest satisfaction from the Oscillator. Colombo's experiments on animals in the labora-

tory of the College of France showed that the mechanical vibrations augment the production of gastric juice, increase the secretion of bile, and develop the muscular tonicity of the abdominal walls, giving increased power to peristalsis. The eccentric stroke of the Oscillator sets up a circular wave which acts both back and front and to the right and left of the immediate contact, and, therefore, enables us to attack adjacent tissues and internal organs which are not directly in the direct line of contact of the belt. Unless there is some persisting and unremoved cause for inaction the results of Oscillatory treatment will please the patient. An example will suffice: (See Plates 287, 288, 289, 290.)

Mrs. ———, aged about forty-nine, no stool without a cathartic; could not remember so far back as to recall when her bowels had acted naturally. Had had several children and now presented a lax and distended abdomen; stools indicated great lack of secretion; very dry, and very difficult to expel. Said it was often like "a bornin'" to her. Had been absolutely dependent on laxatives for ever thirty years. Stopped all medication; made no change in diet or habits; applied belt to lumbar spine, to side, over liver, and to abdomen. Daily séance, gradually extended from three to five and seven minutes. Stroke at first six millimetres; later increased to ten millimetres. Motor speed adjusted to patient's sense of greatest efficiency, which was usually the full rate.

After two days she reported a somewhat dry stool but of fair color and relief. For a week she had irregular actions, giving evidence of a gradual working down of high accumulations, some of which were like black bullets. During the second week she felt great encouragement to persevere without the aid of drugs and remarked evidence of improved flow of bile and intestinal functions. With the third week physiological action seemed to have resumed sway for the first time in her recollection. In color, consistency, odor, thoroughness of excretion, and in all that pertains to normal functionation the result appeared to be complete. Treatment was stopped twenty-six days after her first séance.

Owing to the patient's great interest and delight at her prospect of release from the slavery of pills, salts, etc., my observation of the quality of improvement was particularly close and it deserved notice. During a wide experience with many forms of extra-drug treatment of similar cases, especially referring to my past writings on the good effects of sinusoidal currents of coarse quantity and moderate voltage, I have never seen any other treatment equal the physiological character of the results given by the Tissue Oscillator. It seems to me

PLATE 282.—Tenth Instruction Plate of Vibration Series. Next act thoroughly upon the abdominal viscera and walls, beginning at the upper border of the stomach. Make deep and special pressure with rapid and strong vibration over each area of complaint. Flex the leg or legs to relax the abdominal muscles and keep the body covered except directly under the applicator. Note the great difference in the relation of the physician to this technic of skill and instrumental treatment and the manual labor of tedious hand massage. While a masseur can, of course, assist the physician and apply this treatment, yet it is not more unsuited to medical hands than is the application of a surgical bandage. The skill that is desirable can best be displayed by the competent practitioner.

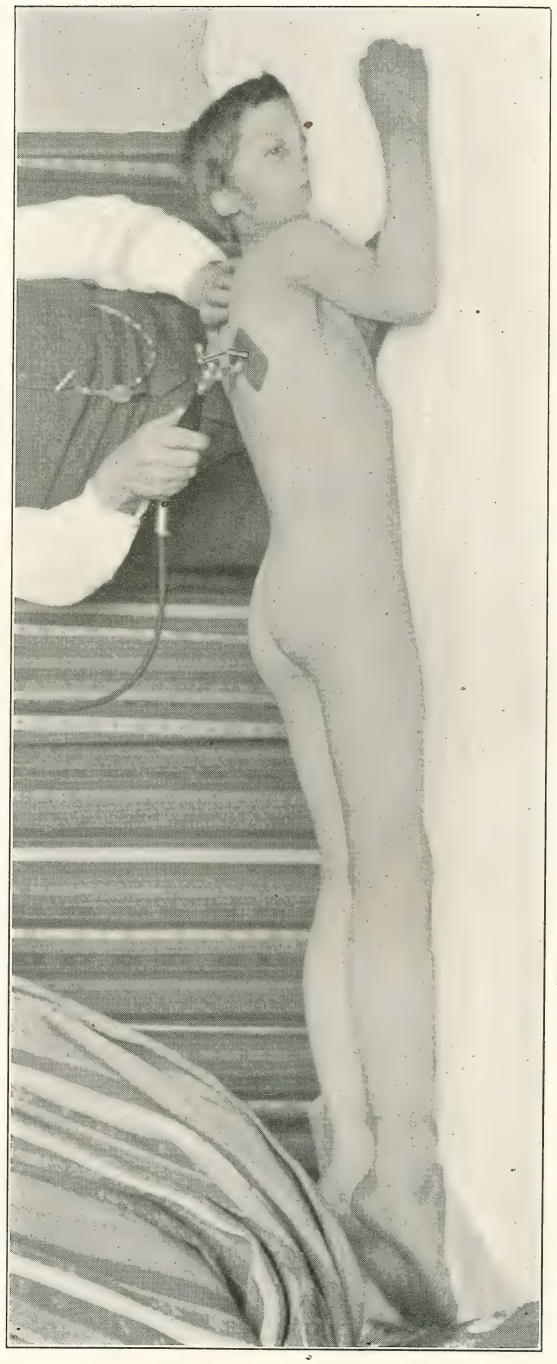


PLATE 283.—Eleventh Instruction Plate of Vibration Series, showing treatment of spine. End a general séance in this way. Promenade the applicator along the spine and over the muscles as taught in the clinical text. This and many of the local applications can also be made with the patient sitting on a stool or chair.

PLATE 284.—Twelfth Instruction Plate of Vibration Series. If any myalgic condition affects the muscles of the head and neck apply the vibrator as shown in this plate, commencing at the upper insertion of the muscles, and making labile movement down the course of the affected fibres. Some external massage can also be administered to the ear, tilting the placque and securing the proper contact. In this plate the sheet covers the patient except on parts being treated.

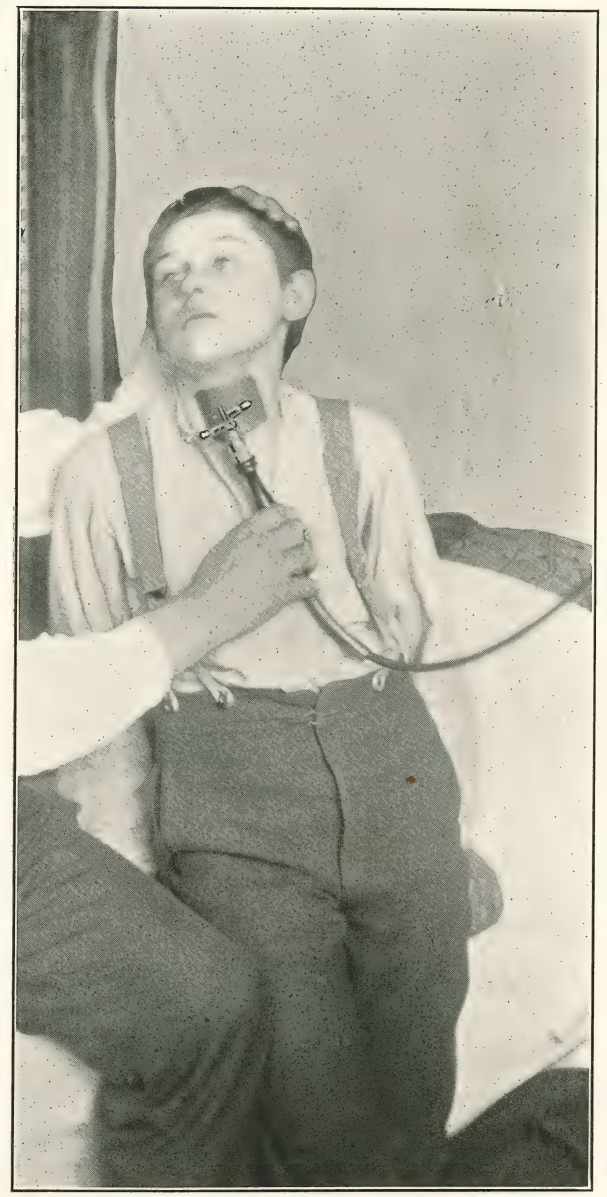


PLATE 285.—Thirteenth Instruction Plate of Vibration Series, showing application to throat. For aphonia, congestions of the vocal apparatus, pain and tenderness after laryngitis or tonsillitis, regulate the dosage and apply the vibrator over the affected region with slow labile movements as taught in our clinical text. There are many forms of applicators and of motor-massage devices now in the field, and not all can be illustrated in this work, but the principles of practice are here adequately laid down, and may be carried out with any efficient instrument for the purpose. Study the descriptive text in connection with the plates, and a few tests will make plain the treatment of patients.

that this fact alone will appeal to many practitioners. No complete list of diseases and their treatment by the Oscillator is needed here, for the application of the therapeutic principles involved is easily within the general medical judgment, but a few hints may be given to aid the beginner.

Flatulence.—Belt on lumbar and abdominal muscles. Gives splendid results.

Floating Kidney.—Belt as above. Have noted better relief from pain and distress than patient had obtained from any other method in fifteen years' experience.

Scanty Menstruation.—Belt over sacrum and lower parts of the pelvis in front. Also on thighs just below pelvis. Increases the blood supply in the parts.

Commencing Impotence in Male.—Belt on front, side, and back of each thigh just below pelvis; also across front of both thighs with genitals under the belt. French investigators report that all secretions (and spermatazoa) are increased, and it is palpable to the crudest test that warmth and a determination of blood extend to the parts.

Splanchnoptosis.—In his excellent monograph on this condition Robinson cites fourteen predisposing factors and seven specific causes for at least two-thirds of which in their entirety the Oscillator would furnish one of the best correctives. He gives three lines to massage and two lines to electricity in the treatment. In all his non-surgical cases the potent action of the oscillatory exercise on the relaxed skin, abdominal walls, and underlying structures which have lost their contractile elasticity in whole or in part, would appeal more to experienced medical judgment than his inadequate suggestions. Try this method with the belt over all the indicated parts. Its simplicity, convenience, gratification to the patient, and positive effects, easily place it among the first of therapeutic measures in this field. Employ a suitable electric current in alternation.

Palpitation of the Heart.—Functional neuroses dependent on flatulent dyspepsia and reflex causes improve during the treatment of the main indication. In the author's experience palpitation has been entirely removed by the belt application around the trunk for the improvement of digestive functions.

Frontal or Occipital Headaches.—A fine and narrower belt may be applied to either region and very short stroke and very rapid oscillations employed for sedative effects. As a rule congestive states of the head will feel some aggravation from the action after the séance, while opposite states will benefit. Consult indications more carefully

about the head than any other part when setting up a mechanical disturbance. Conditions which call for quiet, repose, rest, immobilization, etc., do not call for motor-oscillation. The principle covering contra-indications is simple.

Many have either seen or read of Charcot's vibrating helmet for headaches. The hand applicator will enable the operator to manipulate the head from the eyes and frontal region over the scalp as needed to the occiput and base of the brain, with very similar action to Charcot's helmet. As the author has experienced both methods he can vouch for the similarity.

Revulsive Effects.—Apply the belt and local action on a distant part.

Cold Feet.—Place both ankles in the belt and apply rapid tonic oscillations.

Fibrous Ankylosis of Principal Joints.—Direct application of the belt to the joint affected.

Neuralgias Below the Neck.—Apply belt over seat of pain. Aid by posture which gives best effect during treatment.

General Tonic Exercise.—When no disease exists and in all cases employing the Oscillator for general exercising actions with sedentary people pursue the same plan as described for constipation. It is an excellent local gymnastics with diffused effects. Ten minutes such exercise a day would keep busy sedentary people from the ill-effects of insufficient tissue-change.

Aural Massage.—Specialists in diseases of the ear may not only use the Oscillator for many other actions, but may produce the same vibratory effects of other apparatus by using the hand-piece and making pressure as desired with a single vibrating finger-tip. The technic can extend also over the course of the Eustachian tube and over the pharynx and larynx. A test will demonstrate the action.

Gynecology.—Physicians may take a leaf from the teachings of advocates of extra- and intra-pelvic massage, and apply the required actions by means of the hand or belt. Many claims are made for skilled use of the Oscillator in ovarian and uterine derangements, and the principle of thus treating many non-inflammatory conditions, especially those of venous inertia, is sound. The expert in advanced electrotherapeutics will be struck with the similarity of action between many coil and sinusoidal effects and vibration.

Acute Pains.—Among the acute pains removable by sedative or stimulating oscillation are most of those regularly treated by coil, sinusoidal, or static currents, but dosage and method of application must be suited to the part and to the etiology of the pain. The experienced physician needs no list of technics other than his general command of skill.

Rheumatism.—Muscular and chronic varieties are well treated by this apparatus. Use the belt or hand applicator according to the area and extent of parts requiring contact.

The Face and Scalp.—To improve the nutrition of the scalp or to "massage" the face for various reasons, the hand-piece of the Oscillator is available to the practitioner.

Neuritis.—Vibration and sedative-tonic oscillation both have a place in the treatment of neuritis. During the stages of paralysis and recovery the application will assist other measures with great comfort and satisfaction to the patient.

Paralysis.—What has just been said of neuritis is true of paralytic affections, whether of the curable or incurable class. The final effect will depend on the nature of the case, but the immediate action upon circulation and warmth is excellent.

To continue tabulated directions is unnecessary; we may only say further that almost without exception the treatment elicits expressions of delight from the patient. It is enjoyable during treatment and leaves comfort behind it. This is a not unimportant feature in private practice.

Technics for Treatment.—For the various forms of administration we need three kinds of chairs: a revolving piano stool, a stout cane-seated, high-backed ordinary chair without arms, and a chair with side arms. Have no casters on any of them. Put a pair of rubber tips on the front legs of the second chair; partly to tilt it back a little and partly to keep it from slipping forward under tension.

For treatment with the *belt* have men remove coat and vest. (Plate 286.) If still more active effects are desired have the patient strip to under-clothing. For direct effects to secure the maximum of capillary dilatation and frictional stimulation on the skin, especially of the abdomen and pelvic region, apply the belt on the exposed surface. This will rarely be a very great advantage. For the feet and legs most work can be done through trousers and shoes, but when action with the foot-piece is wanted on the soles of the feet and the shoes interfere take them off. This need rarely be done.

Women patients must have freedom from pressure of corsets about the abdomen when the trunk of the body is treated, but otherwise no special removal of clothing is needed as a rule. Very heavy skirts may at times interfere with some local application, but they can be managed without removal. Management of other parts is about the same as for men. The effects are really best the nearer the skin we

place the applicator, but in practice the effect is not seriously impaired by ordinary garments except the corset. It is well to have a thin and loose wrapper to throw around women after they remove their waist and corsets, and especially if they also prefer, as some will, to take off the outer skirt to secure the best effects.

For most treatments between the neck and the knees the patient may best stand, unless special reasons exist for sitting. It is much the best to apply abdominal and lumbar treatment with the patient standing, as the oscillatory waves are then transmitted more generally throughout distant tissues. Have the patient sitting for applications to the head, arms, knees, ankles, and feet, and persons with impaired ability to stand may sit for applications to the trunk also. The Instruction Plates show a suggestive variety of methods.

Length of Stroke.—Each eccentric has a millimetre scale marked on its side. Both must be adjusted to the same distance from the centre of the axis. Loosen the set screw and shift the eccentric as far from centre as will give the length of stroke best suited to do the work in hand. Then shift the other to the same scale. Tighten the set screws of each and the adjustment is complete. The shorter the stroke the finer the vibration or oscillation. For sedative effects the principle of *fine* and *rapid* vibrations is here the same as in the uses of a high-tension coil, as taught in "Elements of Correct Technique." Test the action with the hand-piece on the root of your own nose and the work to be expected of this dosage will be apparent. One millimetre is a very fine stroke. Two millimetres is as coarse as most uses of the hand-piece require. A range next of from four to eight millimetres with the belt will give tonic and circulatory effects without much work upon muscle-fibres. These strokes do not tax endurance or require the gradual development of tolerance in order to avoid fatigue or muscle-soreness after the first treatment of indolent muscles.

A stroke of about ten millimetres is stimulating and excites the muscle-fibres to intense work, according to the speed of the motor The range of stimulating strokes is from eight to sixteen millimetres. These are chiefly employed on thick masses of soft parts, such as the lumbar region, thighs, abdomen, and especially on local deposits of fat. To know just what stroke to use with belt applications make a few tests on your own person, and the subject will require no further reading. Intimately related to the length of stroke and dominating it in securing effects is the rate of speed.

Speed of Oscillator.—The principle is the same as in the uses of slowly or rapidly interrupted electric currents. A slow walk will

TISSUE-OSCILLATOR SERIES.

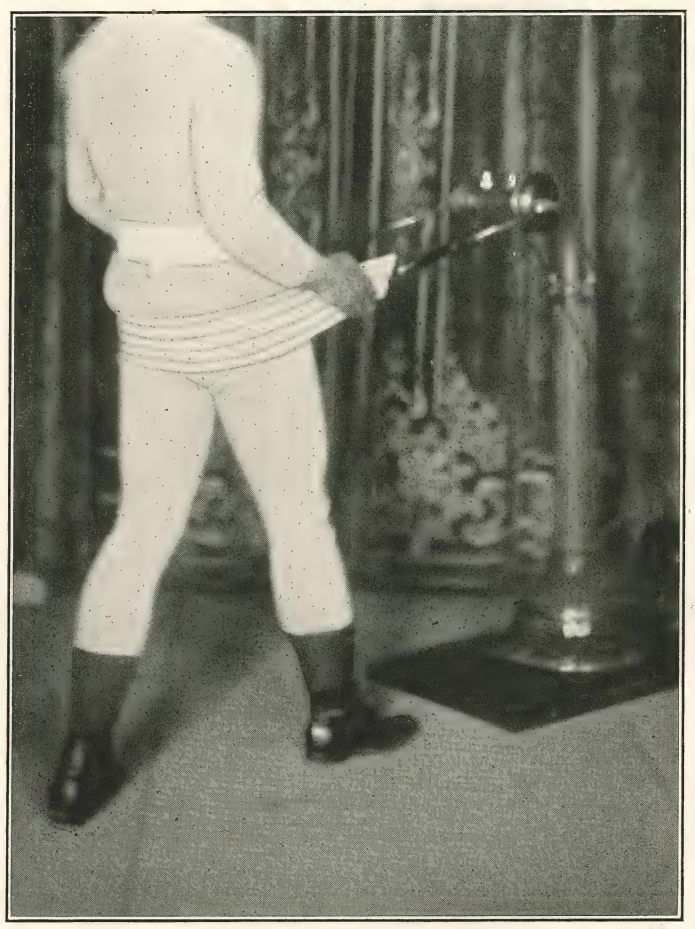
PLATE 286.—The Tissue Oscillator with electric motor behind it on heavy oak base, which must be firmly screwed to the floor in a convenient corner of the office for use. Begin a general tonic treatment with the belt as shown, and gradually slip it down across the lumbar region, then over the liver, abdomen, and spleen in turn, ending with any local application indicated. Pressure of the foot against the edge of the base aids the patient to keep tension on the belt. Steady it with the hands as shown in the figure.

TISSUE-OSCILLATOR SERIES.

PLATE 287.—Showing position of patient with belt to lumbar muscles, and operator steadying belt by loose pressure of his hands. With the patient well in line with the shaft the handles will run very steadily without attention, but at times, and when the pull is out of line, a little steadying is needed to check a side-throw. The patient should lean back upon the belt with twenty to thirty pounds pressure to maintain an even tension on it.

TISSUE-OSCILLATOR SERIES.

PLATE 288.—Showing the patient with outer clothing removed, and a side lean upon the belt to act on the region of the liver. Reverse side for spleen. It is useful to place a chair as seen in the photograph to steady the patient in his posture. Dose rate of speed and length of oscillating stroke as taught in the text. All the shiftings required to act on the trunk are made without stopping the motor or relaxing the tension of the belt. Simply turn the body as needed.



TISSUE-OSCILLATOR SERIES.

PLATE 289.—The patient in underclothing has completed the body applications, and is now seen with belt over pelvic region. Here a decided effect on the rectal region is obtained, and by turning from side to side and in front the hips and vesical region can be treated in the same manner. Besides other indications, muscular pains and some cases of sciatica are relieved by a regulated dosage. There is a very marked revulsive effect. A counter-irritant action can be induced by direct application to the skin when desired. Steady the even action of the belt by a light pressure of the hands as shown.

set up very gentle circulatory alterations in the tissues. A more rapid walk will quicken the effects. A brisk running gait is an altogether different exercise. So it is with the Oscillator and slow, medium, and quick rates of speed.

A very few conditions need to be treated by a very long stroke at a very slow rate of speed. It wastes time as a rule. Sedative effects require the most rapid speed of the motor, and a proper motor should be wound for this work to give about 2,500 revolutions per minute. With a rheostat this speed can then be regulated at will to all cases, from fast to very slow.

When medium-length strokes are employed turn on the current with the rheostat all in. Slowly increase the speed till it reaches the rate that does the most active work in the tissues with the greatest sense of comfort and benefit to the patient. Then hold it at that point. By tests on yourself the adjustment of speed becomes intuitive. It is not to be regulated by count, but by effects.

Always begin a new patient with a moderate stroke and a short séance when muscle-work and stimulating effects are indicated. Otherwise the tissues will be somewhat sore next day and will need "breaking in." Begin gently and tolerance will develop in a few séances. If sedative effects are sought reverse the above and begin with a long séance of fine stroke, just as you would with a fine coil-current for sedative effects. Remember that sedation does not tire, while muscle-work may. Once past the breaking in of new and lax tissues there will be no further need of caution and each patient will want "more." Some advocate much slower speed with long strokes than personal experience teaches me are most efficient when carefully managed. The high rate of speed *intensifies* the effects, and some effects can only be obtained by high speeds; but there is one drawback which a beginner must guard against: At high speed the oscillation of the eccentrics tends to throw the handles to a rather troublesome extent and requires the operator to steady one or both of them with his own hands. This is minimized by keeping the patient in correct line with the shaft and sustaining firm pressure on the belt. It is a feature that will no doubt be eliminated by mechanical improvements in the apparatus.

Duration and Frequency of Treatment.—A single sedative application to one region may be five to eight minutes. Applications for circulatory and tonic effects may be about the same length of time, but in practice stop the motor when the desired effects are secured without exact regard to the watch. If only one locality requires treatment the entire application is limited to the time needed to meet the

carry the belt around the patient's back or around the back of the chair.

Some permit the patient to hold the belt in the hands, but this is often laborious and a fixed support is preferable. Put the feet in position with the legs fully extended so as to exert firm pressure on the soles. As the length of the limbs varies in different persons adjust the belt to the proper distance. With the patient now ready start the current with slow speed of the motor and increase the rate till the best effect is obtained. When the feet are finely warmed, and before fatigue begins, stop the motor and close the sitting. With a stroke of about four millimetres a tonic action on the circulation will be produced. If greater action is desired on the muscles and an extension of the effects up the legs to the knees or above them, increase the stroke to one centimetre.

Application of Hand-Piece.—All other treatments employ both eccentrics and oscillations; the hand-piece is usually employed as a fine, rapid, vibratory treatment with a single eccentric, as two hands cannot well be devoted to applicators at the same time. The free labile movements of other Vibration applicators having flexible handles pertain to a different class of work. The chief uses of this hand-piece will relate to stabile or but slightly labile applications to small local parts to which the fingers and thumb of the operator are dexterously adapted. The action from the machine is then transmitted through the operator's hand to the patient, something as in the old method of labile faradization.

Close one eccentric so that its handle will remain still. Adjust the other to a fine stroke of one, two, or three millimetres as desired for needed effects. Unscrew the lower part of the regular handle and screw on the hand-piece. Run the hand into the two small loops so that the longest clasps the centre of the palm and the other holds the middle finger tightly at the inner phalange. With the patient seated so as to bring the part into exact reach of the operator's pressure with a rigid extension of the handle-bar, make contact with the tips of the thumb and fingers, and start the motor into rapid action. During the séance direct the *pressure* upon the tissues of the region to be treated till sufficient effect has been obtained. This is without any electric-current in the vibrations and concerns mainly the head —nose, ear, forehead, throat, and small local parts needing sedation or delicate nutritional alteration. See Plate 295.

It is well-nigh superfluous to describe the sensory and physical actions of this technic. They can best be felt in a personal test. The applicator can be attached below the spiral spring of the handle

TISSUE-OSCILLATOR SERIES.

PLATE 290.—To secure most effective action on either gastric or intestinal regions in a variety of cases with atony, chronic constipation, obesity, or any indication for vigorous local exercise, apply the belt with the patient kneeling on a hassock so as to throw the leaning weight and position of the body on the belt. This gives a superior action on the tissues. Corsets must be removed. The patient's hands steady the belt as seen.

TISSUE-OSCILLATOR SERIES.

PLATE 291.—Showing a patient with belt acting on single thigh. Lean part of the body weight on the chair. Turn and shift the direction of pressure on the belt to affect front, side, or back of the thigh. Slip belt to any desired position. With it high up as shown a decided warmth and determination of blood to the genital organs is produced in cases of simple and incipient impotence. Treat both sides. Tonic, derivative, and analgesic effects may be obtained to meet special indications.

TISSUE-OSCILLATOR SERIES.

PLATE 292.—Application to knee. Rheumatic conditions, chronic synovitis, stiffness, swelling and pain, when rest is not the absolute indication, can be remarkably relieved by this treatment. The sensation during and after the séance is among the most pleasing to the patient afforded by any resource of therapeutics. Regulate the dose as taught in the text. Push back to keep the belt-tension steady.

TISSUE-OSCILLATOR SERIES.

PLATE 293.—To secure tonic, warming, derivative, nutritional, muscular, analgesic, or other possible effects on the lower extremities below the knees, prop the feet against a hassock with enough pressure to give a fixed base for the oscillations of the soft parts under the belt as shown above. One or both ankles, calves, or legs, can be treated in the same manner. Push backward enough to keep the belt taut.

so as to yield an elastic vibration; or, it can be attached above the spring and yield a more rigid action; the patient can operate the hand-piece and guide the fingers by his own sensations, or, the operator can manipulate it as first taught. A short stroke driven at speeds above 2,000 per minute gives the best results. Both the sensory and tetanizing effects on motor points of small muscles remind one strongly of a rapidly interrupted fine coil-current, although there is no electricity in this dosage at all. Make the following series of tests with the applicator secured upon your own hand:

Apply the fingers flat upon the frontal region; do same upon occiput and sides of neck; clasp root of nose between two finger-tips and thumb; manipulate sides of nose and forehead with same; knead cheeks with finger-tips and rapid vibration; with hand maintained in line of axis and patient on revolving stool just touch surface of skin with tips and slowly turn patient so that all parts of the face will successively undergo "facial massage"; with firm pressure by the palm manipulate the entire scalp; slipping down the neck and round to larynx clasp it between tips of fingers and thumb; press index tip on tragus, on the tissues just behind, below, and in front of ear, and in external auditory meatus (Plate 296), and become familiar with all the above actions with strokes of from one to three millimetres, and all speeds from fast to slow. Some of the effects are remarkable and will surprise the practitioner who meets them for the first time. No table of therapeutic indications will be needed after these tests are made, for the clinical work of the technic will be obvious.

Next adjust a little more vigorous stroke and with palm and tips in turn (according to the part) press, knead, or grasp sections of the opposite forearm, arm, ankle, knee-joint, regions over liver, spleen, stomach, intestines, with deep pressure over gall-bladder and such parts of lax abdomens or seats of pain, impaired function, etc., as may require same. Knead the course of the large intestines. Palpate over chest, but not directly over the heart. And with a female patient add to these tests similar ones upon the external parts surrounding the pelvic organs. The practitioner who aims to get out of the hand-piece all the work it will do will find it a very versatile device, although those who have extensive office equipment of other apparatus will naturally turn to what is most convenient for the given case. The great advantage of a variety of apparatus covering related actions and useful in similar cases is not so much the command of different effects as the command of necessary effects with a choice of the most convenient technic in different cases. For some regions the hand-piece

of this Oscillator is convenient, while for others it is not. A choice can be made to suit.

Hand-Piece Combined with Electricity.—As conducting cords can be attached to the metallic arms of the Oscillator it is possible to add to its mechanical action the action of any suitable electric-current from a battery placed near the apparatus. In practice this will be chiefly a portable battery of the faradic or galvanic type. Two terminal connections are attached to the standard of the Oscillator. By the usual conducting cords connect one pole of the battery to the standard and the other to a second electrode. The application of the electrodes, regulation of current, etc., then proceeds as if it was an entirely separate matter. The current acts conjointly with the vibration upon the tissues and may be employed or not at the discretion of the operator.

The Belt Applicator.—The belt is the chief and well-nigh universal means of oscillatory treatment, and is the distinctive feature of this apparatus. Belts longer or shorter, wider or narrower, and of many materials may be used, but all should be firm, substantial, and non-elastic. Soft goods absorb waves, and what the patient needs is a belt that will transmit waves with little absorption. Do not wind belts around a part in the hope of improving the result. The true principle is firm contact on one surface with free movements of the tissue fibres in all other directions. The novice overlooks this point and tries many experiments on wrong principles.

With the belt a coarser stroke is used than with the hand-piece. The dose may vary from a medium tonic wave to a strong stroke which works the muscles like a piston-rod. Between these extremes a range of dosage of from eight to twelve millimetres will cover the average of cases. As the physician can best and most quickly learn how to treat patients by first testing the belt on himself, we will now begin a home clinic for instruction which cannot be gained in any other way.

With the eccentrics adjusted to a medium stroke oil the bearings, atttach the belt, throw off the coat and vest and face the machine, standing. Place the belt around the lumbar region and lean back so that the handles are in line with the revolving shaft and tense under a pull of about twenty or more pounds. This tension must be steadily maintained during all treatments with the belt and puts no tax on the patient, as it is merely leaning against a support.

Now start the motor into slow action and gradually increase it till the best working speed is attained. If the handles tend to fly a little shift the line by slightly moving the body to the right or left till the greatest steadiness is secured. With a brief study of this

feature a knack can be acquired which will render steady action almost automatic. If necessary, however, lay one palm lightly against the shaking handle on the wooden part and press it enough to temper its oscillations. Meanwhile, never let up on the tension of the belt. Keep it taut all the time.

Having tested this preliminary action let us take up a complete study of the effects and management for the entire body. Put the belt high across the shoulders and adjust the motor to as rapid speed as the length of stroke requires for maximum stimulating work. Maintain this dosage and the tension on the handles by leaning away from the machine and shift one arm out so that the belt is diagonal, under one arm and over the other. (See Plate 286.) Then reverse the slant, and by various positions of each arm test how the muscles of the upper back and shoulders can thus be exercised and circulatory effects secured. Two minutes will suffice.

Next slip the belt down across the dorsal spine by a skilful inclination of the back without relaxing tension or stopping the machine. It is the next step in a general tonic treatment. Now throw the pelvis outward; now the shoulders; advance one foot to give better balance; note the variations of action, and let the belt slip to the belt-line. While doing this use the hands to advantage; feel the waves of widespread oscillation on distant tissues, feel the larynx vibrate; with a palm on the thorax, the abdomen, the thigh, and on all parts within reach, feel what work is transmitted through the soft and shaking masses. With the eyes look down on the effect. He who does not recognize its therapeutic significance can have made no study of therapeutics.

Now gradually make a half-turn sidewise to the right to place the liver and adjacent organs under the contact of the belt. (See Plate 288.) The diffusion of movement that results must surprise the unprepared practitioner, for now the nutritional impulses spread over the entire side, across the abdomen, and take in the liver, gall-bladder, stomach, and large intestines, reach down the pelvis and stir the blood in the genital organs, set the thighs and thorax in a quiver, and if the person speaks the larynx reflects the tremulo. By slight shifts of the trunk let the belt slip lower, and now turn till it crosses the umbilicus. Keeping tight tension pass it down the epigastrium till it stops over the bladder at the pubes. If the stroke is vigorous and the speed rapid the physical work this application means to the tissues needs no description, for words are not felt as the belt is. It speaks for itself.

Test the same action over the spleen and left side and then turn

again to face the machine and slip the belt down over the sacrum and gradually cover the outlet of the rectum. (See Plate 289.) Note the astonishing effect; the sense of fulness of the rectum; the contraction of the muscles; the influence on the venous circulation; and the peculiar glow that follows.

After sufficiently testing a few changes of speed and stroke to ascertain what is most effective for different indications stop the motor, bring the revolving stool near enough to the standard to reach with the belt and repeat the above actions sitting down. The revolving seat permits all the necessary turns without difficulty. During the treatment there may be less active effect on the circulation of the lower extremities in the sitting than in the standing posture, but the after-results can hardly differ enough to make the choice other than one of convenience to suit the patient. Let old and feeble persons sit during treatment of the trunk, but prefer the standing position for all who can as easily stand as sit.

Next take in order the hips, acting on each side as for local fat, and over the sciatic for neuralgia; remove one leg from the belt, and with it close to the groin on the other leg test front, side, and posterior positions and effects. (See Plate 291.) Note the possibilities of determining increased blood-supply to the pelvic organs and adjacent parts. Stand during these tests and shift the position of the feet during all the above work so as to add the aid of muscular posturing to the primary oscillations of the force applied.

For the remaining uses of the belt sit in a chair with a back. First test the effect on one knee-joint (Plate 292); then on both at once; then let the belt slip down to the middle of the legs (Plate 293); next to the ankles; and then lift one leg out and note the action on one alone. During these leg tests have the chair far enough from the standard to put the belt on sufficient tension by the weight and pull of the parts to keep the handles taut and steady under rapid oscillations. Also keep them in line with the shaft and as nearly parallel as possible.

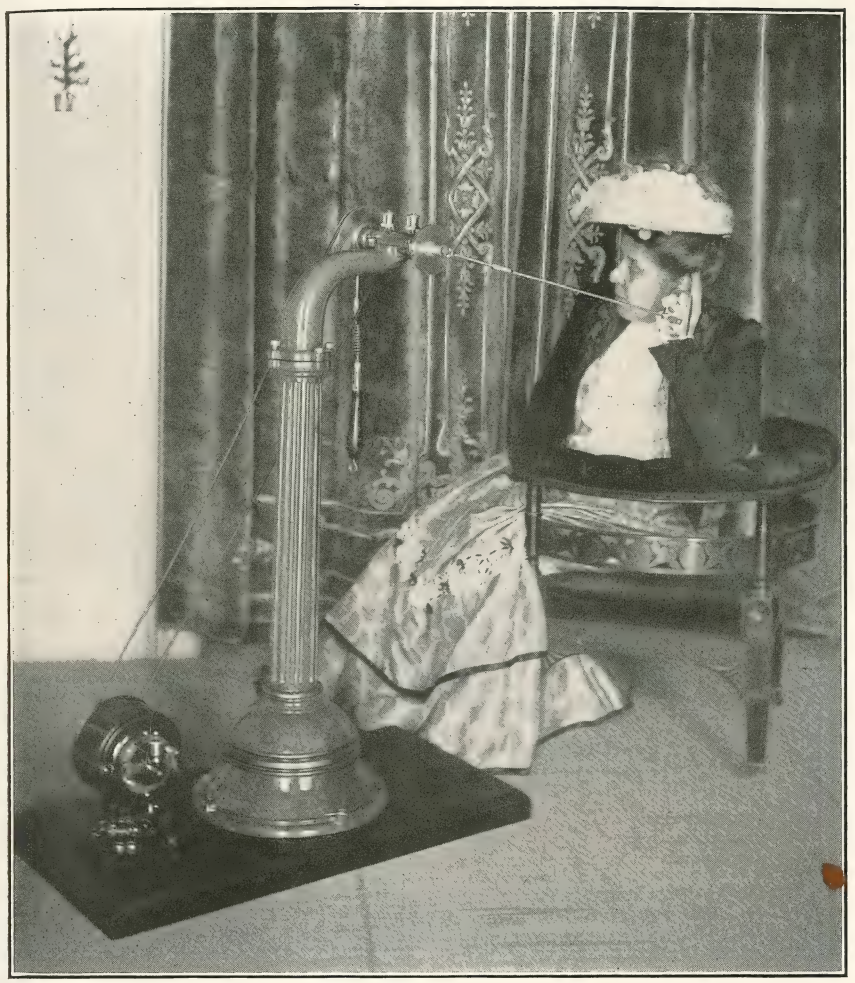
At other convenient times repeat some of these tests with the belt over underclothes only, and also in contact with the bare skin. The importance of direct contact or contact through only thin garments is most felt in treatments around the lower part of the trunk. Observe the reddening and warmth of the skin that quickly develops from direct application. In cases of the class commonly called "bilious" the cutaneous irritation will set up itching for a time, but this is merely an indication for a suitable medical adjunct to the treatment till the drawback ceases, and is not a fault of the Oscillator.

TISSUE-OSCILLATOR SERIES.

PLATE 294.—Showing an application with the "Foot Piece." Seat the chair sufficiently back from the standard to have the feet clear it. Use a long belt passing round the back of the patient so as to be self-supporting without effort. Press the soles of the feet against the foot-board and steady the belt at the sides with the hands. Regulate the stroke and speed to suit the indications. The circulatory effects on cold and clammy feet are pleasing. The shoes can be removed if desired, but most cases are treated with the shoes on. The stockings are negligible.

TISSUE-OSCILLATOR SERIES.

PLATE 295.—Showing an application of fine rapid vibration with a single hand-piece held by the operator. The effect and the technic closely resemble the early method of applying a faradic current through the hand of the physician. See text for general directions. The firmer the pressure on the part the deeper the action of the vibrator.



TISSUE-OSCILLATOR SERIES.

PLATE 296.—Showing the patient holding the hand applicator and administering vibration to the ear. Any part of the face within reach can be treated in the same way. It tires the hand somewhat.

Note also that with a coarse stroke and either food or drink recently in the stomach, or accumulation of urine in the bladder, the application of the belt over the part sets up a request to desist till a more proper time. In expert practice all these little details instinctively receive attention without troubling the operator.

Having thus put your tissues to a personal test of the main actions of muscle-oscillation there is still something to learn from comparison with others. It makes little difference about the extremities, but on the trunk of the body the adipose and muscular structure of the patient has much to do with the extent and quality of the oscillating waves. A thin subject has little to transmit the waves; a fatter subject has more. With a thin patient an abdominal or side application of the belt may affect the trunk to the shoulders and the thighs to the knees, but often we may see the cheeks and hair of a stout person share in the quiver and can feel the reflected waves down to the ankles. The very widely distributed action therefore makes the treatment quite different from a merely local massage, and supplies us with a rationale for its use in many cases which would not seem at first to be within its reach.

One more interesting study requires a moment or two before we estimate the value of this device. While setting up vigorous oscillations with the belt on different parts of the trunk of various patients palpate adjacent and distant surfaces with both palms, especially the front and back of the chest, and abdomen and lumbo-sacral regions. It will be a revelation. That a mere machine can exert such evidently valuable therapeutic actions, transforming external force into internal functionation and physiological work, must be unknown as yet to the majority of medical men who have not investigated physical therapeutics. Owing to its simplicity and convenience the apparatus can be used in every office.

Belt Applicator with Electric-Current.—Connect one conducting cord from the selected pole of any desired battery to a pad electrode moistened as usual. Connect a second electrode to the terminal on the standard by another cord, and attach a third cord between the standard and the remaining pole of the battery. Place the pad electrode under the belt and press the other on the opposite surface. Regulate dosage of current as usual before starting the motor. The application must be made on the bare skin. The skilled manipulator of all forms of electric currents with full equipment at command will most often employ their actions independently rather than combine them with mechanico-therapeutics. Both supplement each other superbly, and both are indispensable in nearly all practice beyond febrile and contagious cases and a few specialties.

Important Caution.—It is the rule that patients are delighted with the action of this Oscillator, but one caution is necessary. Do not agitate the stomach and intestines with recent food or drink in them. All other parts of the body may be treated a half hour or so after a meal, but abdominal mechanico-massage must not disturb the stomach when it still needs time for quiet action. Therefore do not blame the apparatus if a patient feels distress when treated at an improper time. To apply rapid muscular movements to the abdomen soon after a person has taken a glass of water or beer, or when food is still in the stomach, or during a "bilious attack," will cause the patient to feel faint, or nauseated, or otherwise distressed, instead of deriving the expected benefit. This is simply a temporary effect *due to treatment at the wrong time in the given case.* Begin all abdominal treatments with caution as to time and dosage, and during the first two or three séances stop too soon to cause fatigue. In this way chance of disappointment will be obviated.

If a patient who has had but one treatment returns with the report that it did not agree with her, that she felt sick after it and was so sore next day that she could not wear her corsets, the physician should realize that all the trouble was due to lack of trained care in the above respect, and should not be likely to occur again. Such a temporary effect must not deter a patient from continuing treatment which is indicated, and, when rightly employed, "feels pleasanter during treatment and leaves a more comfortable feeling after it" than almost any other method in therapeutics.

Portable Device.—Unlike the larger Vibration Instruments designed to be fixtures in the physician's office a small device is made as portable as a medicine case or faradic battery. It is designed to enable the physician or surgeon to *carry his masseur with him* and apply high-efficiency mechanical massage at the home of the patient as well as in office pratice. This is made possible by employing a spring vibrator device instead of a revolving hammer, and by operating it by a small battery of dry cells instead of a street-current motor. It is to the stationary apparatus what the portable galvanic battery is to the large cabinet.

Tests of the endurance of the cells have shown them capable of giving nearly 1,000 treatments averaging eight minutes each, which is about the time allowed for local applications. The applicator is connected to the cells very much as an electrode is connected—by flexible, silk-covered cords, but no current is employed on the tissues. The action is mechanical and reflex. The number of vibrations can be regulated from 500 up to 5,000 strokes per minute, and their striking force varied as desired so as to incorporate in a treatment the kneading, pressing, stroking, rolling, and frictional effects of skilled manual massage, together with a delicacy and power much beyond the hand.

No claim is made, of course, that the apparatus of lesser power will equal the effects of the larger and much more powerful machines. Also, as principles of technic and administration are unchanged no series of Instruction Plates is required to demonstrate the portable dry-cell instrument.

Studies in High-Frequency Currents

(From X-Ray Coils)

"The application to therapeutic purposes of 'Currents of High-frequency' is chiefly due to the work of such eminent men as d'Arsonval, Oudin, Doumer, and the late Apostoli, and the results obtained are—even in the short time that has elapsed since their introduction—of such importance and promise that it is safe to predict a great future for this new treatment."—(Isenthal.)

CHAPTER L

"HIGH-FREQUENCY" MEDICAL ELECTRIC CURRENTS

X-Ray Coils and Static Machines made High-Frequency Apparatus by Step-Up Transformers. Explanations for Beginners. Studies of Electrodes, Actions, and Therapeutics. Results in Tuberculosis. A Simple Alternating-Current Solenoid. A Therapeutic Novelty. Its Physiological Actions. Uses and Technics.

This section of our present study will inform every practitioner who has an X-ray coil that by a small addition to regulate dosage he can make it one of the most valuable therapeutic instruments in his office. Nearly 5,000 of our leading surgeons could to-day be profiting by this fact *if they knew it.* Every one who in future buys a fine X-ray coil can know it and profit by the knowledge if he reads this course of Instruction. The X-ray coil and High-Frequency attachment for therapeutic uses is but the familiar faradic battery grown to full scientific stature and brought up to date by mechanical improvements. To simply point out the fact that it affords the nearest possible substitute for a fine Static machine will indicate to the profession the nature of its medical capacity and scope of usefulness. Let us proceed at once to get acquainted with this practical apparatus.

About a year ago the author received from a prominent physician in London, England, a letter which read in part as follows:

"There will be no need for us to bother any more about Static machines as they will undoubtedly be superseded by the High-Frequency, which will do all that Static will do and a lot more, besides working well in this country in all weathers. The '*effluve*,' or spray, from the terminal of a High-Frequency is very like the Static spray and the sparks are much less painful. For treating the whole body you either insulate on a stool as in static treatment or put the patient into a Solenoid from the windings of which the current reaches the body from all sides. This Solenoid is made up as part of a couch on which the person lies, the hoops being jointed to let the patient in and out. The same couch is designed also for X-ray work. (See Plate 300.)

"Another electrode is a metal tube with an insulated handle which positively exudes painless electricity from its whole surface, and can be applied into vagina or rectum. ——— sells the outfit for £12, and this is worked from an ordinary X-ray coil giving a ten-inch spark. You will have to strike out all you have said about High Frequency in your book on 'Treatment of Disease by Electric Currents.' If you take an ordinary incandescent lamp bulb in your hand and present it to the High-Frequency spray it will glow, and you will feel absolutely no sensation whatever. We are using the High-Frequency here for skin diseases, phthisis, and neurasthenia mainly," etc.

We began to hear of this form of electric-current about 1891-93. For the next three years it was in the stage of investigation. The most scientific electricians in Europe (and a few in this country) made thousands of tests with it, and determined its physical and physiological actions. During 1897-1901 the apparatus rose on the wave of X-ray development, and with more powerful currents at command it fast demonstrated a great and attractive clinical value. Many began to use it, and reports of its results increased in medical literature.

But what is it? Is the High-Frequency apparatus a new *battery?* Is it anything like a faradic battery? or a sinusoidal machine? or a Static machine? Probably most physicians think of it only as some new and strange sort of battery, complete in itself, different in some unknown way from other batteries, but quite impractical and not likely to be useful in their own office. But it is not a *battery* at all, nor is it a mystery. It is not complex and merely experimental and useless. It is simply an intermediate regulator of *a current already derived from a "battery."* It is connected *between* the "battery" and the patient to alter the quality of the dosage. Its simplicity is great, and it need not be expensive. Every one can use it, and its future career is assured.

What is called the High-Frequency apparatus is, in plainer phrase, a *transforming attachment* for large X-ray coils and also Static machine currents as well. It is designed to alter the quality of the secondary-coil current into a more refined current of therapeutic quality and dosage, which, when successfully accomplished, enables the X-ray coil and its expert operator to duplicate many of the therapeutic actions of Static-machine electricity. (See Plates 298 and 299.) When the same device is adapted to the large Static machine some of the effects and uses of High-Frequency apparatus are practically the same as when it is excited by a coil. This simple statement will bring the matter down to the level of ordinary understanding and remove much of the vagueness now in physicians' minds as to the

nature of this valuable instrument. References, decolorized, formless, meaningless, from French writings on "*Action des Courantes de Haute Frequence*" have signified as little to American physicians as music to the deaf; but once see the apparatus, see it work, witness its effects, translate its language into practical therapeutics and office practice, and the thing that was ignored before becomes alive with interest and commands immediate admiration.

It is true that the term "High-Frequency" is not a good name for an apparatus. To the ordinary medical man it conveys no idea whatever. It suggests no mechanical picture to the mind; nor does its electrical significance reach automatically out into a profession that has read almost nothing of the terms, signs, and electro-mathematics which are the daily bread of the technical electrician. If the doctor grasps the idea after some explanation that a High-Frequency current is one which is in a state of rapid oscillation during its "flow" it is enough. The rest is dosage and administration. And when the doctor understands from clinical demonstration that dosage and technics are only about as difficult as is the skilled use of scientific faradic currents we may accept the high-frequency phraseology as a matter of habit, just as we do "static currents" in common usage, though the latter term is intrinsically absurd. "Static" is short, simpler than "Franklinic," and easier than "Electrostatic," so we use it apart from its literal meaning. So we do the word *wire.* A wire is a strand of metal, but we *wire* a message as well as a battery, and if you *wire* a surgeon to meet you at the hospital to *wire* a patella there is no confusion about it. Hence our friends of the technical schools may bear with us in our unfortunate electro-medical phraseology. We know it is not scientifically exact, but hair-splitting in parts of speech has to be secondary to clinical results in the work of the average physician.

The great merit and claim to attention of the High-Frequency apparatus is that it doubles the value of an X-ray coil and makes it a therapeutic instrument of the first rank. Every owner of such a coil who bought it thinking that it could only be used for X-ray work can now put it to clinical uses of which he did not dream before. As there are several thousand X-ray coils in this country the importance of extending their uses into the highest fields of therapeutics cannot easily be over-estimated. To plainly picture the apparatus, explain its operation, and teach the American medical profession exactly how to use it in their treatment of patients, will be the purpose of this section on High-Frequency electric-current apparatus.

In following the instruction now to come lay aside all preconceived

notions of electro-therapeutics derived from the common faradic battery, and realize that in respect to therapeutic and physiological efficiency the popular "faradization" of tissues is as a pony to a locomotive, compared with the tremendous but refined and harnessed energy of giant X-ray coils and scientific high-frequency transformers. To judge Twentieth Century progress in electricity by the misguiding impressions of an inferior apparatus is an example, set, indeed, by some of our most eminent teachers of medicine, but which rational men who *practice* medicine may wisely leave to others. We can learn more of the truth in a day by personally testing apparatus according to teachings that tell *how to do it* than we can by hearing the greatest surgeon in the universe tell us that "nobody knows anything about it." Distrust "knownothingism" wherever it sticks up its head, either in medicine, politics, or business, and let us rather see what can be learned by following the light of experience and knowledge.

An English author of a very excellent work on Practical Radiography writes the following summary on High-Frequency currents of High Potential:

"Bearing in mind that the High-Frequency Apparatus is only a transformer of electric energy we have to consider the sources of the primary energy. Of the three typical possibilities—the Static machine, the Tesla coil, and the Induction coil—we will here only consider the latter on account of its simplicity and general adoption by the profession. The Induction coil with suitable interrupters and when properly wound, forms at once the most economical and convenient intermediate transformer. Its adoption is furthermore either indicated or desirable because it is the almost universal source of the high electrical voltage necessary to produce X-rays, and there can be no doubt that any medical man who uses X-rays, either for diagnostic or therapeutic purposes, will gladly extend the usefulness of an expensive coil by adopting High-Frequency treatment, while the specialist who makes use of the latter can by the addition of a few instruments add the X-rays to his professional armament.

"For the practitioner who already possesses a coil for radiographic or radio-therapeutic work we may state that (however powerful it may be) it will operate the High-Frequency attachment both safely and satisfactorily, but coils of less then six-inch spark rating are insufficient. The only alteration which may be required is the substitution of some good form of high speed rotary interrupter for the platinum or vibrating mercury break if the coil is fitted with one of these. The High-Frequency obtainable with the D'Arsonval-Oudin instrument rises with the number of interruptions in the current of the coil which feeds the High-Frequency attachment. With certain adaptations of the apparatus various forms of mechanical and electrolytic interrupters can be used.

"The application to therapeutic purposes of 'Currents of High-Frequency' is chiefly due to the work of such eminent men as D'Arsonval, Oudin, Doumer, and the late Apostoli, and the results obtained are—even in the short time which has elapsed since their introduction—of such importance and promise that it is safe to predict a great future for this new treatment. We are often asked what ailments 'High-Frequency Currents' will benefit. It has been proved that they are efficacious in the following cases, but it is equally certain that from the directness of their action upon the cells of the organism an ever-widening field will present itself as soon as their application has become more general: Superficial ulcers, syphilides, psoriasis, eczema, acne, affections of mucous membranes, neurasthenia, neuralgias, insomnia, migraine, hysteria, sciatica, lumbago, rheumatism, rheumatoid arthritis, dyspepsia, constipation, hemorrhoids, pulmonary tuberculosis in early stages, anæmia, chorea, vaginitis, etc.

"The High-Frequency rate of Interruption of these currents, which so radically distinguishes them from ordinary interrupted currents, is produced by the discharge of Leyden jars. To charge the jars we use a coil or Static machine giving a current of high potential connected to the inner coatings. An adjustable spark-gap regulates the dosage of the discharge and the outer coatings are connected either to:

"1. A Solenoid of copper wire, or
"2. To a Metal sheet, or
"3. To the 'Resonator,'

according to the mode of treatment proposed. These are as follows:

"1. Auto-conduction. The outer coatings of the Leyden jars are connected by a solenoid of such circumference that the body of the patient may be conveniently enclosed in it without touching the convolutions of the solenoid. Smaller solenoids for local treatment of arm, leg, or abdomen, may be employed. Currents are thus induced in the tissues of the body. (See Plate 300.)

"2. Auto-condensation. The outer coatings of the jars are connected by a small solenoid, one end of which is in electric connection with a large sheet of metal underneath the mattress of a couch on which the patient reclines while the other end of the solenoid is connected to a metallic handle grasped by the patient. (See Plate 303.) This sets up a general electrification of the entire body. The 'condensation' or accumulation of the current and the action on the patient is nearly equivalent to the accumulation of high potential current on the insulating static platform with machines having sufficient plates in parallel to generate a thick current. (Machines with only eight or ten revolving plates are not large enough to be most effective.)

"3. Bipolar Method. One terminal of the small solenoid is connected to a large 'indifferent' electrode—often a foot bath—while the other terminal is connected to the active electrode, which may be

held by the patient or manipulated by the operator as labile faradic electrodes are applied. For local applications with nebulized discharges in vacuo a great variety of low vacuum tubes are employed with a mono-polar connection. This treatment may be considered ' first cousin ' to X-ray therapy, the source of electricity being the same but the vacuum of the tube being much lower. The discharge within the tube seems very like the so-called ' cathode stream ' of the Crookes tube when a low resistance makes it visible.

" 4. Resonator Treatment. The transforming device known as the Resonator is a vertical Solenoid terminating above in a metal pole and ball spark-gap, while the lower terminal of the spiral wire may be connected to one of the windings of the small horizontal Solenoid. (See Plate 302.) Then, according to the position of this connection with respect to the terminal of the solenoid, and the regulation of the spark-gap at the upper terminal, we obtain more or less high voltages at the terminal of the Resonator. The sprays and sparks from electrodes connected with this terminal present the characteristics of static electricity, and may be applied to the body in a similar manner. (See Plate 304.) They are modified in degree by the step-up Solenoid, and with suitable dosage may be deprived of the sharp sting which accompanies the ordinary static spark. Effects can be made similar by technique."

In answer to the question " What are currents of high-frequency? " M. Paul Renaud, of Paris, has written an account from their germ of origin in 1855 to their practical start in 1889 and development since. It is too technical to present to physicians without much electrical education, but after describing other features Renaud passes to certain phenomena of these currents which it will interest us to examine.

" Currents of high-frequency are distinguished from ordinary alternating currents by three essential properties, which are due not only to the rate of high-frequency, but also to the high voltage.

" 1. They produce induction phenomena of a very intense kind.

" 2. They move on open as well as closed circuit so that contact with a single pole is sufficient to produce current.

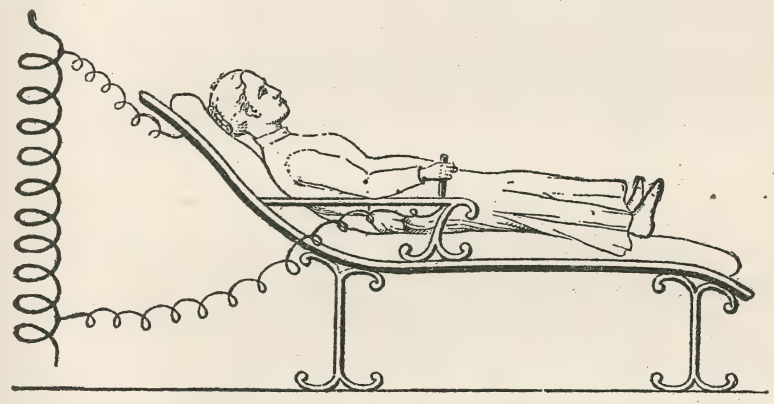
" 3. They produce remarkable resonance effects.

" Examining these points in detail: the E.M.F. induced in a conductor by a neighboring conductor is proportional to the product of the current by the frequency. One ampere at a frequency of 600,000 will, other things being equal, produce in a spiral the same induced E.M.F. as 100 amperes with a frequency of sixty circulating in 100 turns of wire. Therefore, with a high ' frequency ' of oscillation in the current the induced E.M.F. (voltage) in a single turn of wire, whether by self-induction or by mutual induction, is very considerable. Hence in a large solenoid one turn of the wire is sufficient to light, by mutual induction, a lamp of one ampere and eight volts. The beautiful therapeutic method called ' auto-conduction '

consists in the application of this principle. Here we utilize currents induced in the circuits formed by the mass of the human body.

" High-Frequency and high potential enables a current to pass on open circuit as soon as the opposite polarities present a certain surface. Thus are explained the uni-polar currents and sparks which occur on touching a single point of the Solenoid. In this case the body of the patient constitutes an insulated surface which, at each oscillation, receives a charge which is almost constant in quantity when the distance from the solenoid is suitably adjusted for the treatment. The corresponding charge of opposite polarity is found upon those parts of the solenoid which are at a different potential at the same moment. This explains the fact that the sparks obtained from a solenoid are greatest at its extremities and smallest at the middle of the turns.

" The lighting of lamps by these currents without contact is explained by condensation effects. The glass plays the part of the



Anti-Condensation Couch for High-Frequency Electrification.

dielectric, the vacuum and the filament forming one of the electrodes and the moist skin the other. From these phenomena two other of d'Arsonval's therapeutic methods are derived: local uni-polar applications which require no special apparatus, and Auto-condensation, the principle of which is shown in the accompanying figure.

" The patient in this case constitutes one pole of a condenser, and thus a mean current of more than 100 milliamperes can easily be made to traverse the human body. Practically all that is said above is familiar in practice to users of large Static machines which easily produce high-voltage effects. To those who use only ordinary coil currents the phenomena will seem new.

" The phenomena of ' resonance ' occur whenever a circuit presenting self-induction and capacity has the same ' frequency ' as the generating current. This fact results not only in interesting experiments, but in therapeutic applications. Without entering into technical details suffice it to say that the effect of the inducto-resonator

is to produce from the coil current nearly the equivalent of the thick positive spray from a large Static machine with a grounded point electrode. By means of the newer coils we can obtain a great range of effects, from very powerful to very slight, by varying the length of spark of the static condenser, and the device itself needs no regulation, the inducing and secondary being always in accord. By placing the movable coil in the middle of the induced we can have two poles or two spray discharges; or we can ground one pole, as is done with the Static machine, by placing the movable coil at one end and either grounding the other or attaching it to the patient by an indifferent electrode. One single large and regular spray is thus obtained for treatment without any disagreeable sparking. The improved bi-polar resonators are of great interest, as they create a zone of greater density of current between the two poles, when it is desired to make a local application. (See Plate 301.) Dr. Oudin reports four cases treated with the recent form, two of them being very rebellious cases of chronic pruritus, and two cases of pulmonary tuberculosis.

"The universal galvanometer is necessary in treatment. It enables us to measure either the volts induced in the secondary circuit, or the mean electro-motive-force of self-induction upon one or many turns of the solenoid, or even the current passing through the patient by uni-polar or bi-polar applications.

"Trials in the laboratory and in actual installations prove that with an installation upon an alternating-current street circuit we obtain:

"With direct bi-polar applications, intensities reaching 500 milliamperes.

"By Auto-condensation on couch, intensities up to one ampere.

"By Auto-conduction method in large Solenoids, a self-induction of twenty-five to thirty volts per turn of wire in the spiral.

"When the Resonator is giving its maximum spray there is an intensity of 300 milliamperes passing between the high-frequency circuit and the resonator.

"The mean current exciting the primary of the new high-tension coils is three to four amperes."

It is a simpler matter to make efficient discharges with alternating current supply than with continuous current coils.

In our section on X-ray therapy, Chapter XXXVIII., will be found reference to the use of a High-Frequency transformer for an alternating-current coil in the treatment of lupus, while we here append part of a report on a High-Frequency transformer used with a Static machine by a leading dermatologist in this country. The High-Frequency attachment employed was made in New York and is already becoming familiar to users of new Static machines who

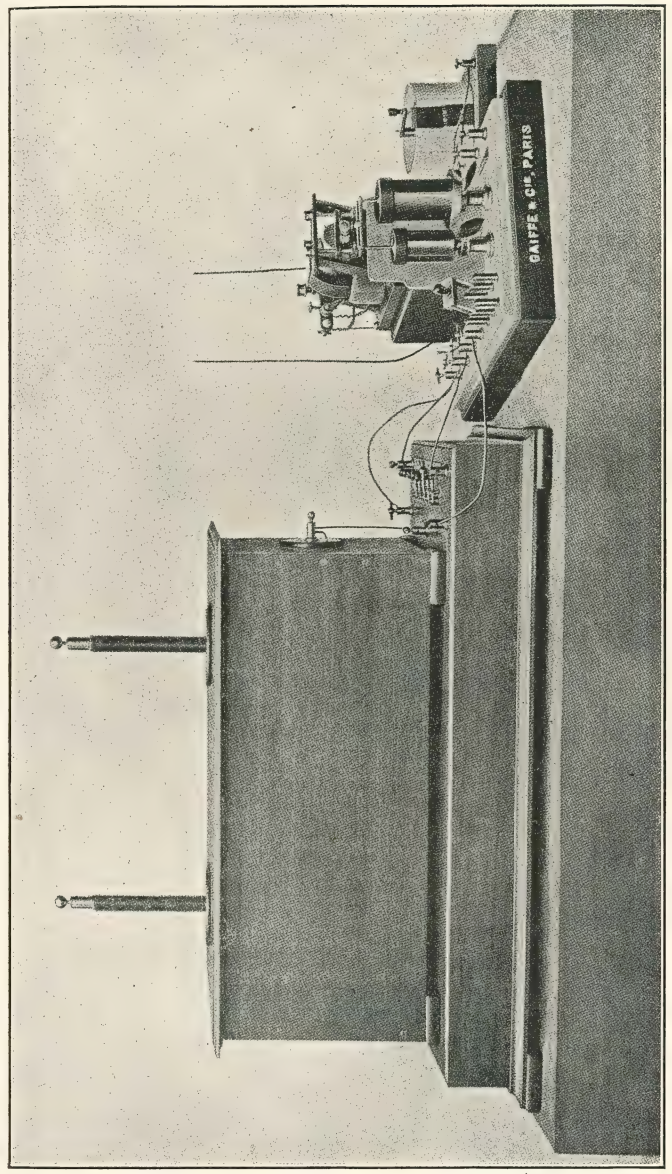


PLATE 298.—This Plate shows a High-Frequency attachment connected with an X-ray coil. It will be seen that the current on its way to the patient starts from the street supply or a cell-battery, and is first transformed to a high voltage and given a type of character by the induction coil. It then passes through the second transformer and becomes what is now called a high-frequency type of current. It is simply the coil current lifted up to a more refined dosage. Fine trituration modifies the action of some drugs, as mercury, for instance, and the refinement of the coarser coil-current lends a modified character to its therapeutic action. This is about the philosophy of H.-F. attachments in scientific electro-therapeutics.

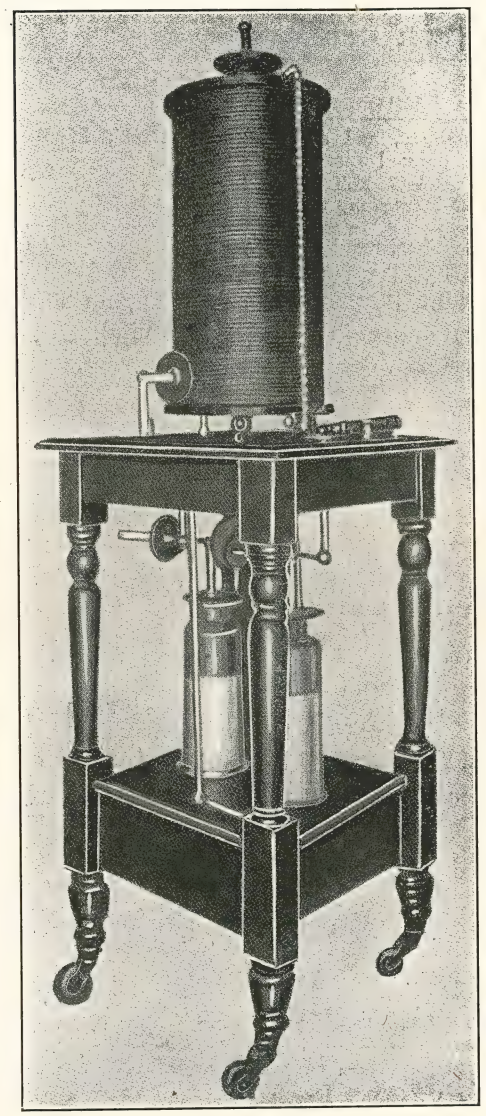


PLATE 299.—This Plate presents another variety of High-Frequency attachment showing the Leyden jars below the table and the solenoid on top, the whole making a neat and practical device on rollers, which can be moved near to the X-ray coil for use and retired when not needed.

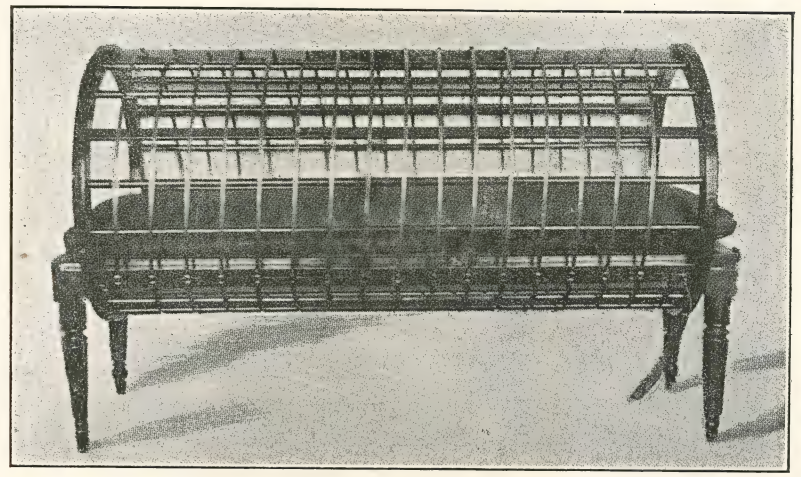


PLATE 300.—Couch with jointed metallic hoops for auto-conduction treatment with high-frequency current, and also for X-ray exposures by folding the hoops back.

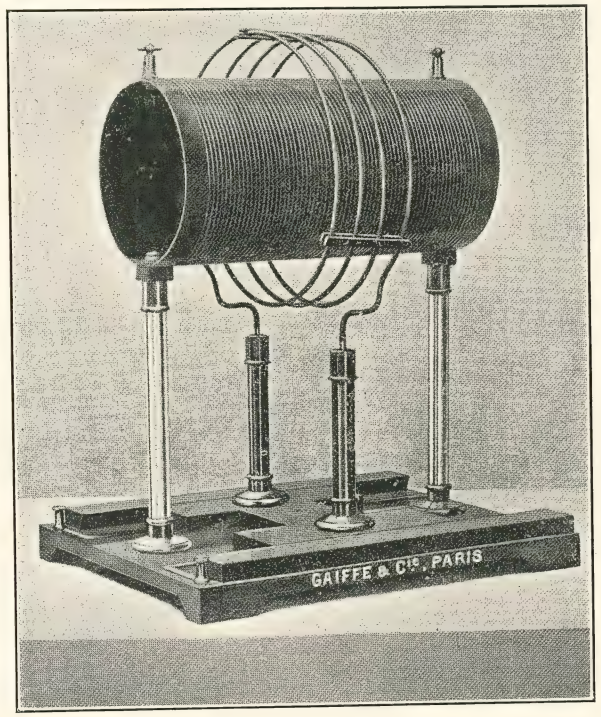


PLATE 301.—Large Bipolar Solenoid of D'Arsonval. An example of large Solenoid for bipolar applications with high-frequency currents. When in use it is connected by a pair of wires to the H.-F. attachment, and the electrodes are connected to the terminals seen in the cut. The application then is similar in manipulation to that of sinusoidal or faradic treatment, the main difference being in the quality of action induced.

procure a full equipment of electrodes and accessories with their apparatus. It has been in the market nearly two years at this writing.

"Static electricity and High-Frequency currents have for some time been successfully employed in the treatment of certain cutaneous affections, more in Europe than in America, and I am enabled by personal experience to corroborate in great measure the claims that have been made in their behalf. The High-Frequency transformer which I attach to my Static machine consists of an inner coarse wire, the terminals of which are connected to the outer coatings of a large Static machine. A long coil of fine wire surrounds this inner coil and the whole is insulated like a Tesla coil. (It is itself a modified Tesla coil of small size.) The outer case measures seven by twelve and a half inches. From one side project the terminals of the primary, and from each end project the terminals of the secondary coil.

"When the Static machine is started into action with a spark-gap of two or three inches between the sliding poles the therapeutic High-Frequency discharge occurs from the terminals of the secondary coil of the attachment. Selected electrodes make this discharge either a spray or a small and gentle spark of very short length. If the dosage is right it is soft on impact and painless and unlike the direct Static sparks from the main machine. If fifty or a hundred of these rippling and non-muscle-contracting sparks are let fall on a single point of the skin the skin becomes slightly reddened, and the blush remains for several hours or even a day or two. On close contact with either or both terminals we feel no sensory effects, but by the interposition of a dry resistance over the tissues the discharge is made irritant to any degree desired. I have used this current so far only with the local electrodes, the point and metallic-lined glass tube. My use has been chiefly in connection with chronic infiltrated eczema, rosacea, acne, localized pruritus, pityriasis capitis, the localized eczema seborrhoicum and seborrhœa oleosum, in all of which resolution of the lesions has been accomplished more rapidly than by any means previously at my command."

In Europe the efforts to improve High-Frequency effects have led to the introduction of coils aiming at higher potentials and the nearer approach to a rich static brush discharge without the addition of a double solenoid. D'Arsonval and several others have designed coils giving bi-polar sprays and an increased range of dosage to the High-Frequency attachment. The entire apparatus of 1902 is an immense improvement over the apparatus of 1896-97.

The first High-Frequency attachment seen by the author in this country was brought here in 1893 to exhibit at the World's Fair in Chicago. It had a low efficiency and was not viewed with enthusiasm by those who tested its action. Not till X-ray coils afterward developed a great field for accessory therapeutics did the High-Frequency

attachment receive the attention and improvement it deserved. In America its career is all before it as yet. The author has urged several manufacturers to import a full set of the latest apparatus of this type for the benefit of the profession, but without success. Lately he has been advised that Mr. Howard Jackson, of Boston, is experimenting with apparatus which it is hoped will shortly be available for use. Tests of it made by the author were encouraging, and certainly so simple a matter as a supply of proper devices which are elsewhere abundantly obtainable should not longer deter American practitioners from enjoying the benefits of this valuable therapeutic agent. In this country quite a number are using the vacuum local electrodes, but none so far known to the author have apparatus for the general administrations of d'Arsonval and Oudin. Until the whole technic is employed results cannot be compared. Moreover, it must be noted that a great deal depends on the efficiency of the exciting current and men who employ an apparatus otherwise efficient will fail to equal reported results if they use inferior means to operate the apparatus.

Special Electrodes.—Some of the High-Frequency electrodes resemble those already familiar to users of Static machines and need not be described. There are two newer electrodes which can be used by both High-Frequency and Static currents for local applications, and these we shall here consider. One of them is a section of glass tubing filled with graphite or lined with tin-foil as a conducting material and fixed on the end of a vulcanite handle having a screw-eye for the attachment of the usual conducting cord to the source of current. One maker calls this a "Condenser" electrode, while another calls it an "Induction" electrode. It differs from a Leyden jar in the manner of its discharge, though it resembles in part the principle. The metallic conductor carries the current down within the tube, the glass wall acts as a dielectric, the attracting tissues of the patient on which the outer surface is placed in contact induce a corresponding discharge of spray or spark, and this sets up the therapeutic action desired. The other means of making local applications consists of a great variety of shapes and sizes of low-vacuum bulbs entirely of glass and having a one-pole connection with the source of current by the usual flexible cord. Examples of these electrodes are seen in Instruction Plate No. 305. The author has a number of other shapes and sizes.

The *High-Frequency vacuum electrode* is a low-vacuum tube shaped to suit contact applications to the part treated. The exact degree of low vacuum does not alter the effect except that the higher resistance in a tube requires more current to excite it. A pink discharge

indicates a low tube and a blue discharge means a higher tube. The discharge behaves much like the cathode stream when visible in a low X-ray tube. It deflects to the place where the tissues (or any other conductor) touch the glass, and where the stream strikes the glass wall of the electrode it sets up the apple-green phosphorescence associated with X-rays. But owing to the low tension of the bombardment no X-rays are produced, though on close contact the screen of the fluoroscope will slightly illuminate. The action is much like a very low X-ray tube, but in X-ray therapy the Crookes tube is a bipolar vacuum tube of higher resistance.

The single exciting pole may be positive or negative, the other being grounded, and a spark-gap employed to intensify the discharge. The poles exhibit their usual differences of discharge, the positive tending as usual to sharper needle sparks while the negative has the usual character of a softer, warming breeze or spray. The effects resemble those obtained with conducting (metallic) electrodes when a regulated dry resistance is placed between the surface of the tissues and contact of the electrode, and all therapeutic actions and effects of the vacuum electrodes can be duplicated without them, the controlling factor being a regulated *resistance*. In the case of vacuum electrodes the resistance is partly supplied by the glass wall of the tube and the vacuum, and is thus transferred from cloths used by the author with a metal electrode to the similar resistance furnished by the tube from which the current discharges. The principle of action is practically the same, and the therapeutic effects can be made alike.

The excited electrode will glow one, three, or more other vacuum electrodes when held near or against them. When the interrupted current which produces the pink or blue stream in the electrode is subjected to a secondary interruption at rates similar to a slowly interrupted faradic or galvanic current (say seventy-five to 150 times per minute for slow muscular contractions) the effect is the same as that of other slowly interrupted currents employed to contract muscles for exercise.

The rule of "painlessness" follows that (as taught by the author) of all high-potential rapidly interrupted currents and is in accordance with the dosage. This depends on the mass (or lack) of soft parts under the "blows" of the discharge. All discharges can be made painless by keeping the dosage within tolerance, or can be made painful by exceeding the comfortable dosage. Many state that high-frequency currents are without sensation, but obviously this is only true of certain applications of *certain doses* to certain parts of the tissues. The local application of vacuum electrodes follows exactly

the same rule of density per area of contact that all other currents follow. Grasp the tube in the palm and it will not be felt with a dosage that is mild for the area of large contact, but reduce the contact to two finger-tips and the strong denser action hurts.

Also, when contact discharges are without sensation owing to the free passage of the current through the slight resistance of the skin, we have only to jump the current through a small air-gap resistance before it reaches the skin to cause sharp needle-sparks to fly, which are intense according to the amperage and voltage of the bombardment and the length of air-gap. Sensation follows the familiar rule of all coil-currents used in therapeutics and diminishes with the lessening of the amperage. The matter is quite fully taught in the author's treatise entitled "Elements of Correct Technique in Electro-therapeutics." No currents are exceptions to these general laws of action.

With the ordinary contact application of a vacuum electrode insulation does not much alter the effect. If the patient is connected with the grounding wire employed with Static machines through a large contact, as, the feet, he will feel no marked increase of the dosage, but if the grounding chain is held in one hand the small contact will intensify the muscular effect on the hand holding the chain. The energy of the discharge through the patient's body is probably increased by the attraction of the closed circuit, but the effect is little seen or felt at the vacuum electrode, at least with the author's apparatus.

Dr. Strong, of Boston, has devised a handle for use with vacuum electrodes which the author received too late to illustrate here as expected. It consists of a hard-rubber handle about sixteen inches long, similar to the insulating handle of the familiar static electrode. At one end is a three-inch piece of open brass tubing running back to a brass disc three inches in diameter with a single row of brass pin-points three-eighths inch long near its rim and facing a duplicate disc with pins situated four inches back on the rubber handle. The handle of the vacuum electrode is fitted to slip in the open tubing just described, which makes a metallic sleeve over the glass and gives a large area of electrical contact.

Just behind the internal disc is a short brass sleeve carrying the ring for connecting the chain or cord used between the electrode and the source of current. This disc is movable on a spring which slides inside the rubber handle. It is worked by a trigger with the thumb and forefinger of the operator's right hand during treatment. Have the patient sit as for a faradic application; have him hold in one hand a metallic electrode connected with the opposite pole of the

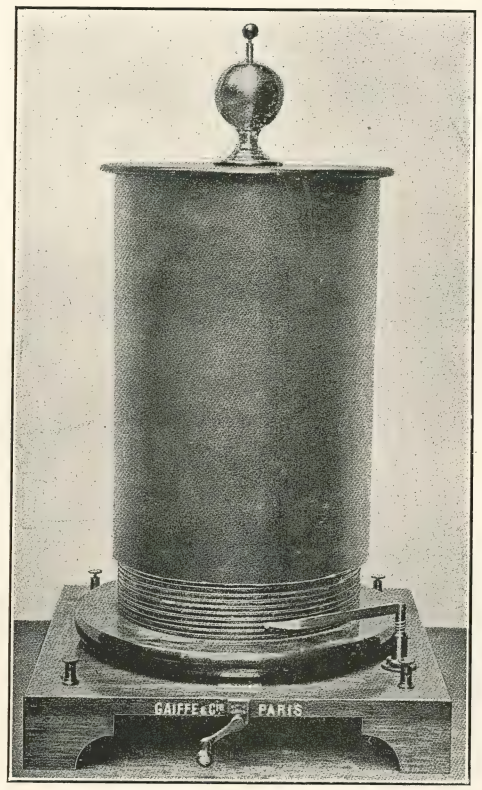
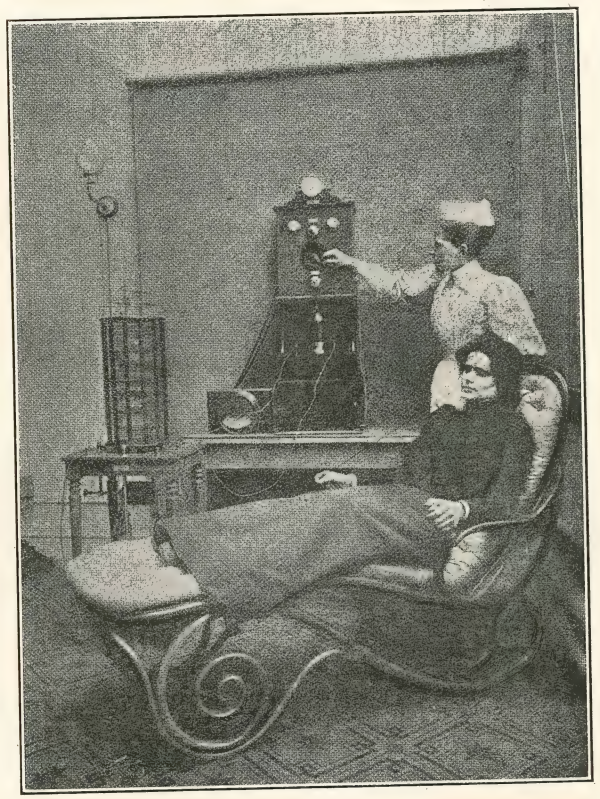


PLATE 302.—This figure illustrates one of the newer models of the "Resonator of Oudin," which is the means of enabling the coil to imitate the static spray for local treatment. It has been varied by different makers and is improved over earlier forms. It is a means of accumulating the current at a high voltage and discharging it in the form of a brush from a pointed electrode.



AUTO-CONDENSATION METHOD.

PLATE 303.—This is the couch on which patients receive an imitation of Static Electrification from a coil current transformed by the H.-F attachment. The position of the patient clasping the handles and resting on the metallic plate which connects with the other pole are shown, as well as the solenoid on the table near, and the nurse cutting out the current at the switch-board.

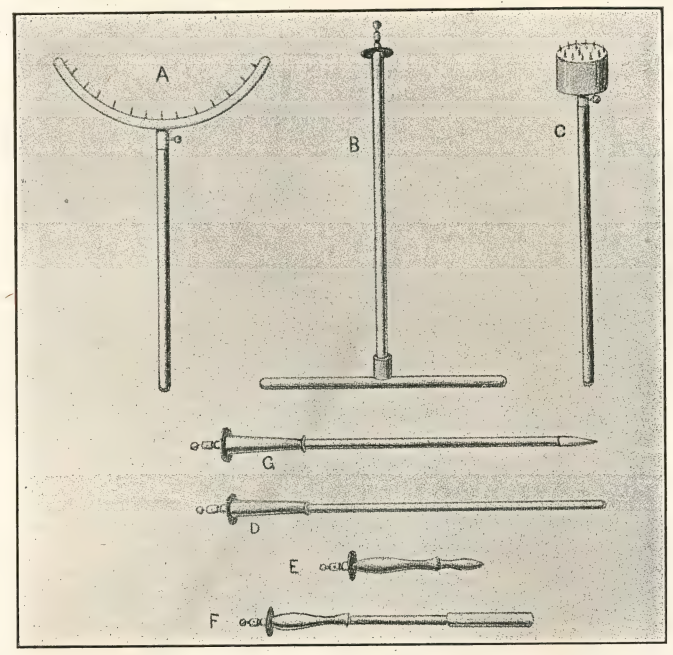


PLATE 304.—Examples of French High-Frequency electrodes. Note the crude resemblance to the author's Static electrodes. By simply understanding that the whole aim of this H.-F. transformer device is to produce with an X-ray coil effects similar to those so readily obtained with efficient Static Machines the mystery of High-Frequency currents is cleared away, and it is seen that everybody who has a large coil can use them to advantage.

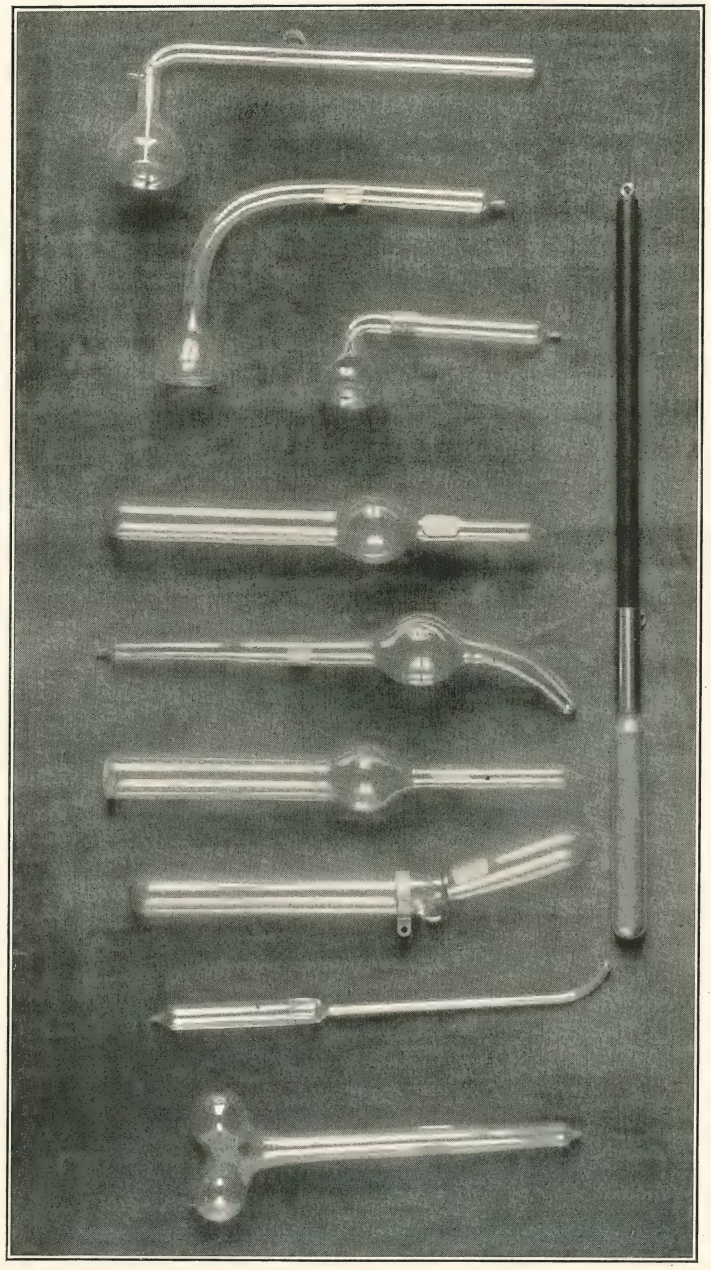


PLATE 305.—A variety of Vacuum-electrodes for use with High-Frequency current. They can be made in all shapes and sizes, to fit any surface or cavity, and adapted to any desired labile or stabile application. The so-called "condenser electrode" with vulcanite handle is shown on the right.

High-Frequency attachment; start the current into action with the discs of this electrode-handle wide apart and by pressure with the thumb slide forward the rear disc till the multiple points nearly meet and complete the circuit of the current and develop the amount of discharge that is required for treatment. The action is self-evident to observation, and a few moments' test will make the method plain. It may be added that these easily made and simple vacuum electrodes are an entirely different matter from Crookes tubes of difficult construction. Some of them are illustrated in Plate 305, but an assortment of fifty will easily be collected by an experienced worker. They are all connected by one metallic terminal to a single pole of the current, and thus differ entirely from the two-pole, high-vacuum tubes for X-rays. They can be made to suit almost any purpose from a rectal, vaginal, urethral, or general electrode to a single or double tube for the eye, or ear. The cost may vary according to size and shape, but simple designs have been only a few cents in price. A dollar has bought any of the medium sizes, and only the large tube to mount as a transformer as described in another paragraph will be expensive. This may cost about $3 or $4.

To our many readers who have large Static machines without as yet obtaining the high-frequency attachment it will be of great interest to procure a variety of vacuum electrodes and use them in the following manner: have a main transformer tube made of straight glass tubing about two inches in diameter and three feet long. Have the vacuum just low enough to create a full rich pink internal stream and mount it like a curtain-pole in convenient relation to the case of your Static machine. Place on it a loose curtain-ring of brass that can slide along its entire length. Put both interrupters on the poles of the Static machine as if for X-ray work and draw the poles wide apart. Ground the positive pole. Connect the negative pole by a flexible cord or chain to the nearest terminal of the large tube, start the current into action and regulate the spark-gaps to excite the tube as desired. Sit the patient on the platform with the surface to be treated exposed as for a faradic application. Connect the selected vacuum electrode with the loop of the curtain-ring by a well-insulated flexible cord just long enough to reach between the ring and the patient without getting in the way.

With the machine at a standstill have the patient take the handle of the electrode and apply the surface of the bulb to the part needing treatment, if within reach of the patient's own hands. If otherwise, the physician holds the electrode himself. Now start the current into action and move the curtain-ring along the main tube till the

amount of dosage is regulated to suit. When the ring is nearest the connected terminal the discharge will be densest; as the ring is shifted along the tube toward the opposite terminal the density decreases and the dose lessens. The resulting action is of a warming sedative-tonic-nutritional-alterative nature near the actual contact, but does not yet spread widely through the tissues. To secure diffused effects apply an attracting contact (the hand or a grounded electrode) to the tissues opposite and the current will pass through the parts as it does between two galvanic electrodes. In treatments about the head, in the treatment of pulmonary tuberculosis, and various other conditions this technic of securing deep action is invaluable to the practitioner.

The whole subject opens up a field of Static electro-therapeutics as yet unwritten, for it was not developed when my Manual of Static Electricity was published (1897), and it has so far been the only textbook devoted to this important apparatus. But if time permits the present author to again take up the work and re-write the now enormously enlarged therapeutics of Static electricity there will be many surprises for readers who infer that sparks, the breeze, and old routines are all the story. The author's system of using direct Static currents by spark-gap interruptions* (described by me in 1893) has lately become remarkably popular and awaits fuller description from my pen. Under the substitute name of "wave currents" my methods have been enthusiastically taught and highly praised by several others during recent years. In the present volume we can only make brief mention of the fact and must limit our teachings to high-frequency attachments of the coil.

With a series of these electrodes the student can make various tests of action and effect upon himself, and in a couple of hours learn to regulate the dosage and manipulate the selected instrument. Begin with the electrode in contact and vary the current. Then vary the situation of the electrode on the surface of the part. Then test the effect of lifting it from close contact and observe the air-gap required to develop all degrees of stimulation and finally irritation, as mild or intense as may be desired. See how nearly the sharp fine needle-sparks resemble those of the Static machine when the electrode is lifted just beyond the limit of convection and the air-resistance forces a commencing disruptive discharge. While new to the coil-student all these tests and actions are familiar to readers of our other works. At

* A description of this method was first published in the *Times and Register*, September 9, 1893, under the title of "A New Static Interrupted Current; a New System of Therapeutic Administration of Static Electricity Based upon the Principle of Potential Alternation." It covers all known methods of employing the direct Static current with spark-gap interruptions, in contrast with the Leyden jar currents.

this point we may note the presence of ozone in large quantities in these sprays, and also the following item regarding their richness in ultra-violet rays of great therapeutic energy. The author long ago pointed out the fact that spray discharges from high-potential sources of current, such as the Static machine and the Oudin Resonator, must be rich in ultra-violet rays and possess a similar action. Dr. H. Strebel makes the following statement (1901), which is instructive:

"Kindly assisted by Dr. H. Ghent, Professor of Physics at the Munich Polytechnic, I have succeeded in proving that the invisible rays of a powerful spark-coil are capable, even through a dense medium of quartz, of completely destroying at some distance and within a short time, say twenty minutes, strong growths of bacilli, as, for instance, Micrococcus prodigiosus. The inductive spark being in itself very rich in ultra-violet rays, the proportion of these may be enormously increased by employing certain substances as electrodes, and by making use of a Leyden jar as the regulator and accumulator of electricity. For myself I utilized electrodes of aluminium and cadmium, with the result that the invisible part of the spectrum, rendered apparent to the eye by a projection on a barium platino-cyanide screen, overlapped its visible part by more than four times its length. My experiments with Finsen's lens-filter have shown that, after the passage of the luminous rays through the system, the real ultra-violet rays had been completely absorbed in the apparatus, and further that the chemical-bactericidal action of the apparatus is due to the chemical-bactericidal force of blue-violet in particular. Inasmuch as the latter are comparatively weaker in their chemical action than the invisible ultra-violet rays, the success of my experiments points very clearly to an improvement of the photo-therapeutic method, to wit, the increased bactericidal influence of the light, the simplification, and, above all, the cheapening of the process. For whereas the Finsen apparatus requires eighty amperes, considerably weaker currents are necessary for the working of the induction spark. Any one provided with a radiographic installation is able to verify my results at a small expense, and, finding them conclusive, to undertake treatment by light. I am at present engaged in testing the permeability of various media by ultra-violet rays, and the action thereof on sundry bacilli. In addition I am examining whether the Becquerel rays, those of uranium and cadmium, which, like the Roentgen rays, act through media impervious to light, do not lend themselves to bactericidal purposes. This might be of considerable therapeutic value in many skin diseases."

Studies in High-Frequency Therapeutic Actions.—Passing now to the practical use and clinical results of High-Frequency currents we find a number of scientific investigators on record as to the nature and value of this agent. The uninformed critic who has never studied any form of electro-therapeutics beyond the toy crudities of "farad-

ism" or a red acid galvanic battery without meter, interrupter, or accessories, is prone to assume a lofty and oracular "scepticism" on the subject of High-Frequency currents and pretend that "a great deal is not known about them." But to the many who have devoted hundreds of hours to research and investigations in all branches of scientific electro-therapeutics these currents of High Frequency and High Voltage seem but old and faithful friends in a new guise which only alters their actions and enhances their sterling worth.

Oudin's report to the International Congress, Section of Electro-therapeutics and X-rays, Paris, 1900, has been summarized as follows:

"The effects of High-Frequency currents can be divided into the following actions:

"1. On motor and sensory serves.

"2. On the circulation.

"3. On oxidation generally.

"4. On micro-organisms.

"The effect on motor and sensory nerves varies according to the technique and amplitude of the oscillations of current. D'Arsonval in his experiments used a frequency so high that neither motor nor sensory nerves were excited, but with lower frequencies and with the continuous generation of the current interrupted, the nerves will be excited as with other interrupted currents. The action upon circulation has been observed by many authors. A lowering of blood-pressure at the time of application, and also an intense vascularization of the skin are observed. These currents can therefore cause a most active draining of the circulation. The action of high-frequency currents on oxidation in the organism is an effect fully established by the works of d'Arsonval. An increase in respiratory exchanges and in the quantity of the excreta is observed. These facts have been confirmed by a great number of writers, but they have recently been controverted by others. This difference of opinion must be attributed to a difference in the instruments used in the experiments, and will be cleared away by further work.

"We owe to d'Arsonval and Charrin most of our knowledge of the action of high-frequency currents on microbes and toxines. If the increase of temperature be eliminated they have but a weak action on the vitality of the microbe, but some of them can be attenuated and probably further research by improved methods will disclose more."

Doumer supplemented Oudin's remarks as follows:

"The therapeutical effects of high-frequency currents of high tension are much more distinct and precise than their physiological effects. In diabetes, gout, rheumatoid arthritis, Bright's disease, etc., their effects are no more efficacious than those of static electricity (by Monell's methods). As early as 1893 static electricity was applied to

local affections of the skin, either as a spray or sparks, and cured certain skin diseases, both moist and dry, with surprising rapidity.*

"This treatment of skin diseases by static electricity has become a classic method, and it is observed not only that the area treated is cured, but a deep and general result follows which extends to the whole organism. The High-Frequency currents obtained with the Oudin Resonator seem to be more efficacious than static currents as we have applied them. As early as 1897 we applied High-Frequency currents to the treatment of anal fissure with results so good that a cure was the rule, and benefit was often obtained on the first application. The congestive phenomena in the pelvis which so often accompany fissure are removed by High-Frequency currents. As the author announced in a former paper, hæmorrhoids are, in the majority of cases, susceptible of cure by this current.

"These currents are not less useful in the female. They quiet local pain, cause the absorption of the products of former inflammation, and if they do not immediately cure metritis they at least relieve it even when it is gonorrhœal. In a word, all inflammatory states justify this form of application.

"Their curative action on chronic pulmonary tuberculosis is one of the most recent demonstrations of these currents. We have arrived at the conclusion that by the application of high-frequency currents the general condition is improved, the bacilli diminish, the anorexia and fever decrease, and the pulmonary lesions cicatrize, even to a complete cure in many cases. The results obtained are constant. Most of the therapeutical properties of these currents by their general methods of application are due to the increase of tissue resistance which they help to establish. Nature does the rest."

In a note on the action of High-Frequency currents upon elementary respiration and the activity of exchanges between the blood and the tissues (June, 1900), M. Tripet studied the effects of High-Frequency currents in reducing the oxyhæmoglobin. An abstract is as follows:

"MM. Apostoli and Berlioz have proved that under the influence of High-Frequency currents the production of urea is increased and brought near the normal amount, viz.: twenty-seven to thirty grams in twenty-four hours, in cases where defective nutrition showed itself by a marked 'hypo-azoturia.' Cases were watched for two years, before, during, and after treatment. The examinations of the blood were carried out by means of the hæmato-spectroscope of Henocq, the activity of the reduction of hæmoglobin being ascertained by his procedure of elastic ligature of the thumb and the results were marked on special charts. The examinations were made every four weeks from the beginning to the end of treatment. Some of the cases were

*"Static Electricity in Cutaneous Affections" by S. H. Monell, M.D., *Medical Record*, November 18th, 1893.

thus followed during more than six months. The results of treatment may be summed up as follows:

"1. In thirty-seven cases High-Frequency currents (as applied) enhanced the reduction of oxyhæmoglobin, and this was especially apparent in cases of impaired nutrition—rheumatism, fibroid tumors, etc.

"2. In six cases the treatment reduced an existing hyper-activity to normal.

"3. In six cases the activity of the morbid processes was unchecked.

"From these observations it is concluded that:

"(*a*) In case of the failure or perversion of nutrition treatment by High-Frequency currents has the effect of regulating the activity of the reduction of oxyhæmoglobin.

"(*b*) When the activity is below normal treatment increases this activity and maintains it at or near the normal standard.

"(*c*) When this activity is exaggerated—for example, in diabetes—treatment diminishes the activity and brings it down to normal."

A private resumé of the subject by a Boston physician (Dr. Strong) concludes as follows:

"I have been engaged during the past five years in studying the therapeutic action of currents of High-Frequency and High-Potential.

"One of the most striking effects of the High-Frequency current is its action on the Sympathetic Nervous System. Applications of the vacuum electrode over the solar plexus will almost immediately relieve, and later, permanently cure, cases of long-standing nervous dyspepsia, hepatic torpor, constipation, renal insufficiency, and, finally, all conditions due to lack of vasomotor stimulation. I have seen patients whose feet and hands had been cold and numb for months at a time, react immediately to application of the vacuum electrode over the epigastrium. The flesh below the nails becomes pink, sensation returns, and the patient goes away feeling a glow all over the body. The immense glandular stimulation of these currents is seen from the fact that after holding a metallic electrode for a few minutes the hand will be found to be bathed in perspiration. As a result of the vasomotor stimulation produced by these currents, all local congestions are promptly alleviated; particularly congestive headaches.

"I feel convinced that High-Frequency currents are destined to play an important part in the therapeutics of the future, more so, indeed, than any other form of electricity known at present. They seem to be the nearest approach to artificial nervous energy that we have as yet been able to produce."

From a paper on the High-Frequency current by an American physician whose experience with this apparatus was restricted in

technics to far less than the full scope of English, French, and German methods and appliances, we take the following published in December, 1901:

"I have succeeded in producing a healthy base in a very unhealthy ulcer by the discharges of the local foil-lined glass electrode. I have also succeeded in curing one very obstinate case of neuralgia which involved nearly every one of the intercostal spaces and centred with great severity and persistency over the solar plexus. This case had resisted all forms of treatment, both medical and electrical. The Static breeze afforded slight amelioration, but it was only slight. The High-Frequency current was applied with the foil-lined glass electrode over the back, over the nerve-roots, over the entire chest, and especially centred over the solar plexus. It required only nine treatments at the rate of three per week to entirely relieve this patient.

"There has been an apparent success with this current in my hands in a form of disease in which I little expected it, and that was a very chronic case of rheumatic deformans. The patient had suffered with more or less arthritic pains, accompanied by deposits in every joint, for the last fifteen or twenty years. He had finally reached the point that he was no longer able to work, and last of all his hands became about twice the size that they were normally. Every joint, carpal and metacarpal, was involved. He was unable to close them sufficiently to hold anything in them, or even to button his clothing. He was a dreadful specimen of this terrible disease. I began treating the hands simply with the high-frequency current, using the glass-lined electrode, and giving sparks about one-half or three-quarters of an inch in length. The hands were showered with these sparks for fifteen or twenty minutes, three or four times a week. They were the last to be affected, and consequently, I reasoned, would be the first to show signs of improvement, and therefore I selected them for treatment. However, they had been in a useless state for five months when treatment was begun. To my surprise they decreased in size so rapidly that I began to feel the deposits in them were not of the same character as were in the rest of the body. They became more limber; he was able to button his clothing, finally able to close his hands. I then concentrated the treatment upon a knee-joint which had been enlarged for more than two years and which was accompanied by some contraction of the hamstring muscles. I found, also, that this joint decreased, and that the pain and soreness and stiffness decreased in proportion to the decrease in the size of the joint. This is the only case of rheumatic deformans in which I have given the high-frequency current a fair trial, but I propose to continue investigation in this line. Just why it should relieve such a condition I do not pretend to say; in fact, was surprised at the result. One thing is noticeable here, and that is the action seemed to be purely local, results being obtained only on the parts that were treated.

"When we consider the enormous rate of vibrations which take

place with these discharges, we cannot tell what may be the result upon the nutrition, upon those forms of deposits which have a lower rate of vitality than the normal tissues have, such as these deposits certainly do have; and, last of all, what results it may have upon the circulation and circulating fluids.

"Doumer and others have treated numerous cases of fissure of anus with uniform success as follows: The electrode is carefully introduced sufficiently deep to include the whole of the sphincter muscles. The violet sparks are then applied for from five to eight minutes. He claims that improvement is usually rapid; the pain gradually diminishes, the fissures become cicatrized, and spasms yield readily. He also claims that he has treated gonorrhœa very successfully. His method is to carry the current to the part by inserting an instrument into the canal, or a glass-tube electrode located on the perineum. Excitation at once diminishes, nocturnal troubles disappear, œdema decreases, and while the discharge keeps up sometimes he has seen a cure in ten or twelve days. He claims that in epididymitis and prostatitis the results are marvellous. They yield to a single application, improve at the end of three or four minutes, and next day there is no pain at all. Oudin has reported numerous cases of eczema and psoriasis cured in a remarkably short time by high-frequency discharges. I would say that it is generally admitted by all who have used this form of electrical manifestation that it has a great future before it in the treatment of heretofore incurable skin diseases.

"I might go on citing hundreds of cases cured by this form of electrical manifestation, for, while it is yet new to the field of electrotherapeutics, its popularity is so great with all who have used it that hundred of cases are already on record, but time will not permit."

The following is taken from the report of a local surgeon on his experience with High-Frequency currents in a limited form of treatment with vacuum electrodes only:

"The current is conveyed to the patient through a vacuum glass electrode and is devoid of sensory disturbance other than a sensation of warmth. The effect of the treatment on the blood is shown in an increase in the number of red blood-corpuscles and in the percentage of hæmoglobin, together with a diminution in the number of white blood-corpuscles. As a rule in chronic cases where daily applications are given an ordinarily good result will be manifest in a month.

"The author reported 250 cases and concluded that the method was of value in both acute and chronic conditions. He had observed the benefit from its use in tuberculosis, syphilis, carcinoma, locomotor ataxia, neuritis, torticollis, paresis, nerve exhaustion, impotence, diabetes mellitus, Bright's disease, septicæmia, oophoritis, dysmenorrhœa, anæmia, and leukæmia. A considerable number of cases of pulmonary tuberculosis associated with fever and bacteriological evidence

of mixed infection had been treated. In these cases two treatments were given daily, and in each instance the sputa had become more liquid, the night sweats had diminished, and food which had previously been rejected was retained. In a week or two there was an improvement in pulse and respiration, with free expectoration of shreds of tissue and a very large number of bacilli. The cases were advanced ones and were treated only to observe the effect, but not with any expectation of cure. The action on the bacilli was demonstrated by daily examinations.

"In external suppurative inflammation results were secured which in two or three instances were little short of the marvellous. The benefit was especially noticeable in cases of mastoiditis where operative measures were apparently indicated.

"In ten cases of diabetes mellitus the results were gratifying. The quantity of sugar averaged in these cases from one and one-half to four and one-half per cent. Brilliant results had been obtained in both acute and chronic alcoholism. In cancer the general health had been markedly improved, with diminution of the pain, odor, and discharge. Twenty-five cases of muscular rheumatism were treated with complete success. In rheumatoid arthritis the results were equally good though obtained more slowly." (November, 1901.)

Dr. Riviere's experience with Resonator sprays and localized High-Frequency applications on malignant tumors was as follows: *

"Case 1.—A medical man with epithelioma of face came under my care in April, 1899. He was averse to surgery and desired to test High-Frequency currents, with which he was familiar. Trusting to the modifying power of the Resonator spray upon phagædenic and infected wounds I began treatment at once. The lesion had first shown itself as a small wart on the left cheek which subsequently disappeared. Some time afterward there was a brown incrustation on the same place, which the patient kept removing. The crusts had been succeeded by an excoriated surface which was two centimetres in diameter at the time I first saw the case. It involved the entire thickness of the skin as well as a certain amount of subcutaneous cellular tissue.

"It was covered by deep yellow incrustation. Its margin was perpendicular and indurated, the surrounding tissue being infiltrated and vascular. The glands were not much involved. The patient was aged sixty-two; two of his ancestors had died of cancer. His general condition was fairly good.

"I applied at the first sitting short thick sparks and sprays, produced by a coil giving a twenty-five centimetre spark, and the small resonator (first model of Gaiffe). The exciter consisted of a small sponge moistened with Van Swieten's fluid, and carried on the end of an insulating handle. The sparks caused a good deal of pain at

* Journal of Physical Therapeutics.

first, but were better borne toward the end of the sitting, which lasted one minute. The patient experienced great relief at the time he left me, and told me the next day that he had suffered much less from the ulcer during the first few hours that followed the treatment. The serous discharge was more abundant, the crusts had fallen off leaving a smooth red surface. The indurated margin was less apparent. The swelling of neighboring tissues was much diminished. Like all patients after high-frequency treatment he had slept better and felt stronger.

"I made another application; and to render it less painful I used an electrode made of a glass handle, the interior of which was traversed by a metal stem (condenser electrode). The end of the tube, cleansed in the first instance by Van Swieten's fluid, was applied to the base of the ulcer before putting the apparatus into action. The very small sparks which passed between the metal and the glass inclosing it produced no pain, and I made an application lasting three minutes. Under the influence of the current the ulcer became blanched, but after a little time regained its red appearance. Next day the patient felt relatively well, the pain and feeling of tension of the ulcer and neighboring tissues were diminished, the serous discharge had become very abundant, and an eschar had appeared instead of the incrustation. I advised a rest for three days, and I then resumed daily treatment of one minute duration.

"At the end of ten days the eschar had separated, leaving a healthy granulating surface, but the size of the ulcer had increased. The surrounding tissues were no longer infiltrated, the indurated margin had disappeared and the ulcer presented the appearance of an ordinary healing sore. I continued a one-minute application every three days; as new crusts formed from time to time, it was necessary to remove them, and this delayed the healing. After a month's treatment the ulcer affected only a small portion of the skin and did not measure more than one centimetre in diameter. The patient was obliged to leave for Belgium. There he heard of a doctor who cured cancer by means of a special process. He underwent this new treatment and got well in eight days. Two months afterward the affection reappeared, and got rapidly worse in spite of the treatment in Belgium. Death resulted recently, after the patient had undergone two operations.

"On comparing this case with those which I am about to relate, I feel inclined to attribute the first disappearance of the affection to the electrical treatment. The failure of the second method of treatment, which is evident by the relapse which occurred, seems to prove that such treatment was of no avail when acting alone.

"*Second Case.*—The patient was a man of sixty-five, brought to me by a *confrère*. He suffered from a small cancroid about the size of a pea, like a wart, with indurated edges, upon the ala of the nose. I simply touched the tumor for one minute with a small steel rod attached to the Oudin resonator, and carried upon an insulating handle (the spark of the coil being thirty centimetres). The point touched became blanched and then resumed its normal color. Next day the small growth presented a brown color. I repeated the applications of one minute duration upon four days in succession. Twelve days afterward the small desiccated tumor fell off, leaving no trace behind it.

"*Third Case.*—The patient was the wife of a medical man, and I had attended her for a month without any apparent result, excepting perhaps an improvement in her general condition. She had undergone an operation two years before for an adeno-sarcoma of the left breast. All the glands of the thorax and neck were involved; radiography had shown that the lungs were infiltrated at certain points. Daily applications of effluves from the large Oudin resonator, employed simultaneously with injections of cacodylate of soda, had not apparently produced any change in the local condition. It is necessary here to note the difference in the result; this seemed to bear a relationship with the difference in the nature of the affection, this adeno-sarcoma being of a very different nature anatomically, and doubtless etiologically, from the above-named epithelial tumors.

"*Fourth Case.*—I have also had under my care two epitheliomas of the uterus, not admitting of surgical operation. The first was treated by means of platinum needles thrust into the growth and attached to the end of the small solenoid. In the second a *tampon* impregnated with salol or Van Swieten's fluid was applied upon the tumor, the tampon having previously been attached to the resonator. The result was the same in both cases; abundant sero-sanguinolent discharge during and after the operation. After a few sittings the fungating growths fell off as a dead tissue, the sores seemed to be improving, when the patients, who hitherto had shown no appreciable results, suddenly ceased to attend. The pains had not diminished, and the sanguinolent discharge had increased, but the *malodeur* had improved.

"*Fifth Case.*—A female patient, operated on for carcinoma of the breast a year ago, noticed that the infiltrated and swollen edges of the cicatrix took on a normal color, and the appearance of healthy tissue after forty localized high-frequency applications carried out every second day, by means of a large moist roller electrode. When I commenced the treatment a relapse had seemed exceedingly probable.

"*Sixth Case.*—A patient sent to me by a *confrère*. Has been under my care for four months. On arrival she presented a sarcoma (which had returned after operation) as thick as the wrist, in the utero-rectal region. She was unable to defecate without mechanical procedures. Under the influence of daily treatment, lasting a quarter of an hour, the tumor diminished more than two-thirds. The stools are regular and her general condition is considerably improved. She says that she feels fifteen years younger. In this case I used a glass cone filled with metallic filings attached to the Oudin resonator.

"It would appear from the foregoing that high-frequency currents cure small epitheliomas of the face, and in certain cases influ-

ence for the better the evolution of malignant tumors. They produce in the first instance a thermo-electro-chemical action, which has the effect of eliminating the neoplastic tissues and admitting the parasitic theory, of destroying the micro-organisms and their tissues. In the second place their action is tropho-neurotic and curative, restoring the vital processes to their normal condition. There is no question of employing this thermo-electro-chemical action for the purpose of dealing with large tumors; for such—complete ablation remains the only treatment; but even in these cases the procedures above indicated ought to be employed with a view of preventing the return of the disease. High-frequency currents, and especially the effluve of the Oudin resonator, seem to produce the effect just mentioned by modifying the vitality of the new regions contaminated by the operative lesion. This special application of electricity certainly appears to be at the present moment one of the few therapeutic measures available in the case of tumors that do not permit of operation."

High-Frequency Methods and Consumption.—It is a remarkable fact that while International Congresses on Tuberculosis and enthusiastic specialists in Phthisis-Therapy probe theories as deep as wells and sweep the skies with scientific telescopes in search of some toxin for bacilli they yet leave the patient in practice to nature's "open air," and medication a generation old without advance, and all the time the rational and most valuable remedy known is treated by the majority as if it was an enemy to those who so sorely need it. Nine-tenths of the politico-medical agitation about tuberculosis would be obsolete if the agitators accepted the aid of high-efficiency electric-currents and skilled methods of treatment in combating the disease. Having for some years demonstrated in practice results equal to any that are claimed in the following pages I herewith submit reports as to the benefits of High-Frequency methods, with the remark that nothing in medicine is more certain than that as good or better results can be at the command of the entire profession if desired, and can be bestowed on 100,000 patients as certainly as on 100.

Dr. Chisholm Williams read a short paper before the Tuberculosis Congress in London, July, 1901, on "The Treatment of Pulmonary Tuberculosis by means of Electrical Currents of High-Frequency and High-Potential," in which he followed the clinical methods now well known and formulated by Professor Doumer, Drs. Oudin, Riviere, and others. His closing remarks state in brief:

"The coil used gives a current of High-Frequency, large quantity, and high voltage. The secondary terminals of the coil are connected to the inner coatings of two Leyden jars. The outer coatings of the jars are connected with the Solenoid from which the High-Frequency

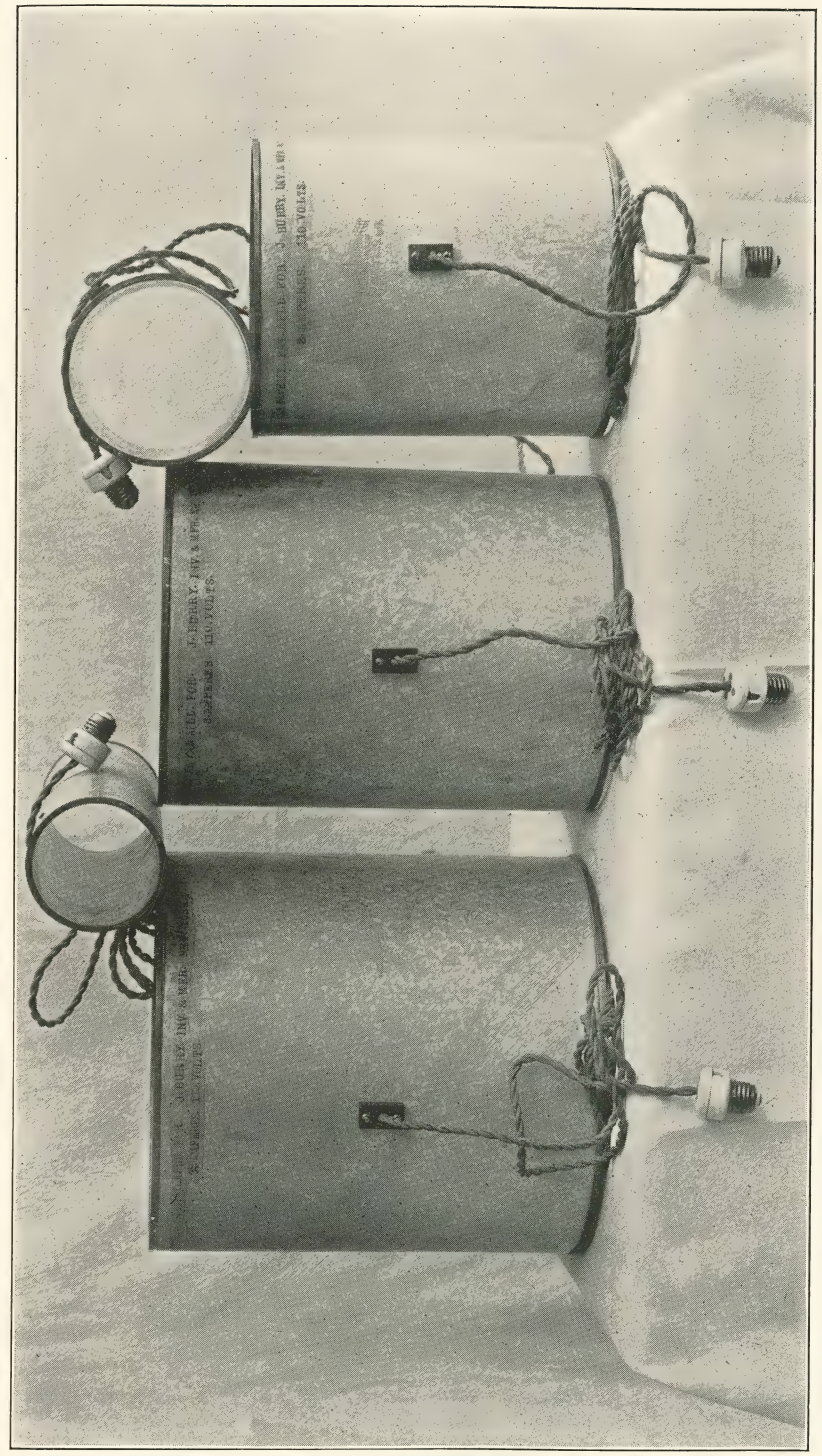


PLATE 307.—Set of Alternating Current Solenoids showing sizes for different parts of patient. For use simply screw plug in lamp socket.

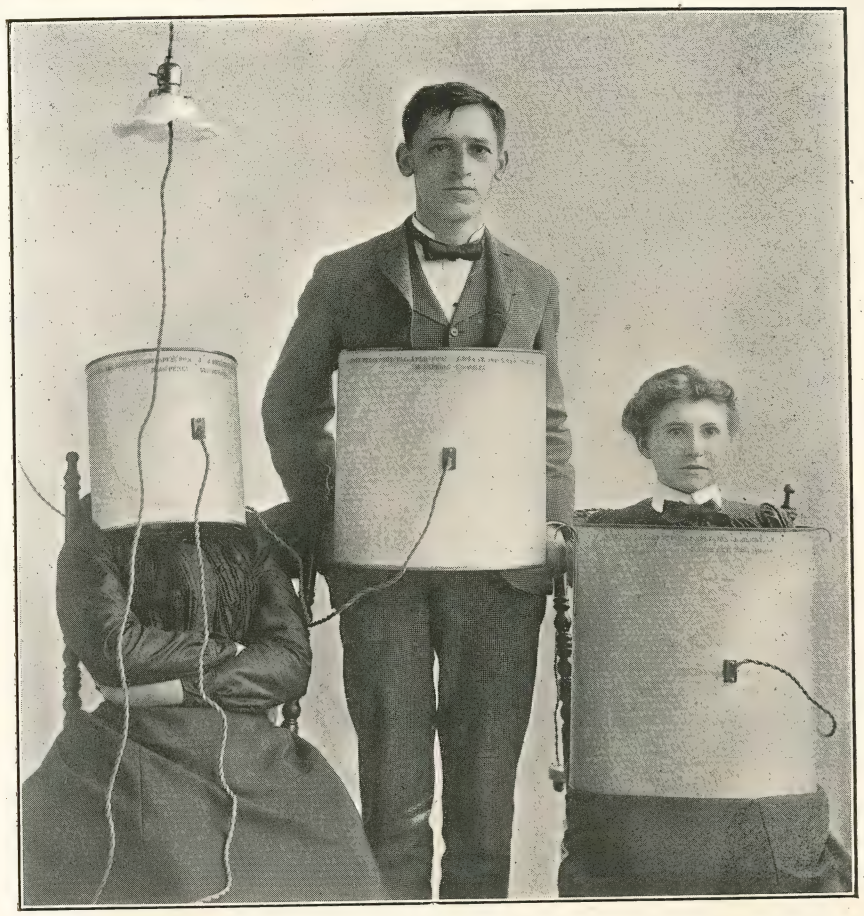


PLATE 308.—Three applications of Alternating Current Solenoid. The central figure shows the body tube slipped up the trunk after the patient has stepped into it and the man is now ready to sit comfortably for treatment as is shown by the next figure on the right. At the left is seen an application of a tube over the head for the relief of pains, etc. No clothing is removed and the only sensation is the mild heat. If this gradually becomes too warm during a long séance simply change to a cold tube or wrap a large towel around the part. The body treatment as seen in this plate has been efficient in many general diseases, and in pulmonary tuberculosis is one of the best nutritional tonics. The pelvic circulation is equalized and pains of neuralgic and congestive dysmenorrhœa are relieved.

SOLENOID.—As many physicians and surgeons have no idea of what a solenoid is or what its purpose, we will here cite the definition of a leading dictionary: "Pipe-shaped; a channel; a spiral of copper or other conducting wire wound in the form of an open cylinder so as to be nearly equivalent to a number of equal and parallel circular circuits arranged upon a common axis. The ends of the wire are brought to the middle point," and when a current is passed through the circuit the solenoid behaves partly like a magnet and partly like an induction coil. When a body is placed within the cylinder of the spiral through which a current is passing the action depends on the quality, character, and amount of current, and on the relation of the windings to the current but when constructed for medical work the body in the solenoid is acted on by induced-magnetic lines of force, which have nearly the effects of general static electrification when the patient simply sits on an insulated platform connected with one pole of the Static machine. It is essentially a general tonic nutritional influence upon the physiological processes of the system. The use of the solenoid is but one of four chief ways of treating patients with what is called High-Frequency electricity. To possess therapeutic energy the exciting current must have the requisite qualities, and other degrees of current would be inefficient. This explanation should make the matter plain to the average reader.

PLATE 309.—A delightful séance for gouty or rheumatic feet. Simply place the feet in the tube and turn on the current. Relieves pain and improves condition.

PLATE 310.—In this manner children may be placed in the large body Solenoid and given agreeable and beneficial treatment in convalescence from all exhausting diseases. As no undressing is necessary and no irritation is caused the child it is a measure of great convenience as well as value. The sedative action of the potent Alternating Current taken directly from the electric-light circuit has also benefited acute cases. For instance, a girl with pertussis was placed in the Solenoid daily for a half hour and it seemed to modify the disease materially.

currents are obtained. Three methods of treatment are used for these cases.

"1. Auto-conduction. The patient is placed in the large Solenoid which is charged from the coil and induced currents are set up through the tissues within the electrical field.

"2. Auto-condensation. The patient is placed on the couch as shown on page 627. (This method enables the coil to imitate the familiar general electrification of the Static machine in which the current charges the patient on the insulated platform. The effects of the two methods resemble each other and vary less in principle than in dosage. Small apparatus of either kind will produce little effect, while efficient apparatus giving large currents will have great therapeutic energy.)

"3. The Resonator of Oudin. This is a Solenoid ending in a spear which enables the coil to imitate the familiar Static spray application. The other end of the Solenoid is connected to the outer coating of the Leyden jar.

"These are the methods used in consumption. Long sittings produce a rise in temperature. Dosage is regulated by the reaction. Ten minutes is the usual time for a treatment. The bacilli may increase for a few weeks and then disappear. Daily treatments are given for the first month; for the second month, three times a week; for the third month, twice a week. Three months is usually sufficient to cure the early stage." Williams considers it necessary to administer the general electrification till, at each séance, the body temperature is raised to above 101.4° F., and this usually requires ten minutes.

A further contribution to the action of currents of high-frequency upon tuberculosis was published in July, 1901, by Dr. Riviere of Paris, whose large equipment affords him ample scope for investigation. We here present the substance of his report:

"Since the memorable experiments of Professor d'Arsonval and Dr. Charrin I have been fully persuaded that tubercular patients would derive great benefit from High-Frequency treatment. I have had the opportunity to treat many cases of pulmonary tuberculosis by means of the large Solenoid of d'Arsonval. They have been treated for twenty minutes every second day and I have invariably been able to verify the results announced by Professor Doumer of Lille to the Academy of Sciences, February, 1900, and by our learned confrère, Dr. Oudin. Their technic seems superior to mine, and I have used it ever since.

"Patients under treatment have felt their general health improve from day to day, and in certain cases the physical signs of the lesions have completely cleared up. I ought to add that my patients have followed at the same time the classical treatment of phthisis and I have also alternated my High-Frequency séances with exposures to X-rays and inhalations of ozone. It has seemed best to stop this treatment during febrile or congestive aggravations. Chronic cases have responded best to the electrical treatment.

"I now wish to call attention to two convincing results which I have obtained in localized tuberculosis. The first was a man, aged fifty-five, with tuberculous ulcer a little less than an inch below the middle of the left clavicle. It measured three centimetres long and two centimetres wide by one and one-half centimetres deep, and was filled with yellowish-green cheesy purulent matter. The edges were indurated and two of the axillary glands were large as pigeon's eggs. It began in a painless infiltration of the skin which took on a nodular appearance and broke down and ulcerated.

"I commenced by applications of the High-Frequency spray (effluve) from the Resonator of Oudin. The ulcer became less painful; the discharge changed from purulent to serous; the base took on copious red granulations, and in less than a month it completely healed and became covered with a soft and fine white membrane. This process of healing was in marked contrast to what had occurred on the opposite side with a similar ulcer three years before, which left a hard cicatrix like a small keloid after a whole year of scraping, and other treatment. The daughter of this patient recovered from the first stage of consumption under the combined influence of High-Frequency auto-conduction in the large solenoid and X-rays. Her age was thirty, and her treatment lasted three months.

"Two years ago I had under my care a young man with an arthritis of the knee of a suspicious nature. The epiphyses were first attacked and the joint was much enlarged. The articular surfaces of the bones were thickened; the peri-articular structures were swollen; the limb was a little bent at the thigh; and there was pain from time to time. After eighty sittings of localized High-Frequency treatment the joint had recovered its functions, the knee had diminished in size, the swelling of the soft parts and the pain had completely disappeared, and the general health seemed excellent. The patient left for the country, and two months later wrote that his health had been completely re-established. I am persuaded that he was suffering at the beginning from tubercular arthritis. The applications were made by means of one or two dampened plates attached to one or both extremities of the small solenoid.

"But the most convincing case of the favorable action of High-Frequency currents in localized tuberculosis is the following: Mr. ——— had been sent me two months previously. He had been operated on a year before for tubercular glands of the neck. There was now a recurrence. He had five cervical glands rather smaller than a hen's egg and there were four fistulous openings freely discharging.

"I gave him a daily application of a long spray from the Resonator of Oudin for five minutes. From the next day the discharge was changed in character; it became serous instead of purulent, and at the end of the tenth application the fistulas had dried up. The swelling of the neck steadily disappeared, and on the thirteenth application at the end of one month's treatment there remained only one sublingual gland enlarged, and it was only the size of a pigeon's egg.

Business obliged the patient to suspend treatment for a month. He then returned with a fistulous discharge which seemed to come from the gland in question. After four fresh applications of the spray the fistula dried up and the gland considerably diminished in size. He left then for the country, and on his return we shall hope to complete a cure. This patient, like all the others who have been similarly treated, reported that under the influence of High-Frequency currents his strength increased, and sleep and appetite were equally improved.

"Since the interesting communication of Professor Doumer with reference to the cure of anal fissure and fistula, I have had the opportunity of trying the procedure in such cases on six occasions. The cases of fissure got quickly well; two fistulas disappeared after a treatment of one or two months. In the first instance I introduced a small stylet into the fistulous track; this stylet being attached to the Oudin resonator. After four applications of this kind I used a glass cone filled with metallic filings, and attached to the resonator (condensing electrode). Two other patients who suffered from complete fistula did not complete the treatment. But in every case the purulent and fetid discharge of the first day gave place to a comparatively slight serous discharge with a less offensive odor; the pain rapidly disappeared. In the last two cases, to accelerate the treatment, I had also used creosoted suppositories.

"I might add that at present I have an English lady under my care who has an osseous fistula in the heel. Radiography showed a small opaque cone-shaped excrescence half a centimetre in length at the lower end of the os calcis. After three weeks' treatment by localized high frequency the fistulous opening seemed to have dried up, pain had disappeared and walking was much easier. During the last few days she has benefited by the bi-polar effluve of the new d'Arsonval transformer. The discharge, although it had disappeared, has unfortunately become re-established, and therefore I am not able to affirm that there will be an eventual cure. But the three radiographs which I have taken show that the osseous changes have gradually but completely disappeared.

"It follows from the foregoing that high-frequency currents exercise a certain curative action upon tuberculosis, pulmonary and localized. The microbe cannot resist the repeated application of these currents; its reproductive power and the virulence of its toxines become attenuated, a fact which had already been proved by the laboratory experiments of Professor d'Arsonval. It appears that, at the same time, the human organism under the influence of these currents gets stronger, its enemy, the microbe, grows weaker. It is also probable that under the influence of this form of electrization the beneficent action of the phagocytes increases in activity. It thus appears evident that in these conditions the attacked organism recovers its strength and (aided by phagocytes) finally prevails against the bacillus whose vitality the electric concussions had already imperilled. It is, there-

fore, sufficient to place the patient in the best conditions of food and hygiene to avoid the return of the diseases. It is in this way that some of my patients sent south after the treatment are now completely recovered. I regret that I have never had the opportunity of treating true white swelling, or Pott's disease. I am under the impression that these two localizations of tuberculosis ought to be materially influenced for the better by the spray, mono-polar or bi-polar, of the Oudin Resonator (Rochefort model) or of the new d'Arsonval transformer." (*Journal of Physical Therapeutics*, London.)

Another corroborative note was presented to the French Academy of Sciences in April, 1900, by Dollmer, describing facts which demonstrated an improvement in the condition of tuberculous patients subjected to the action of High-Frequency currents.

"After five or six applications the night sweats diminish and totally disappear after about fifteen treatments. An examination shows a systematic diminution in the number of bacilli present in the sputum. After regular treatment the appetite returns, emaciation is stopped, and the body weight increases. Experiments were made on twenty-seven patients of both sexes, and in various stages of the disease, and the constancy and clearness of the observed results left no opportunity to doubt that the results were actually accomplished as stated."

The following report of clinical work in London was published in this country on January 25, 1902. The captions and some part of the account are omitted. While these accumulating evidences of the efficacy of electric-currents in the early stages of tuberculosis are received as new and wonderful by practitioners who observe them for the first time, yet it must be noted that they all have an old familiar resemblance to results reported with high-potential currents down the whole line of nineteenth-century experience (and nearly half of the eighteenth-century) with static electricity in pulmonary disease. It widens the scope of therapeutic resources to be now able to obtain these results with attachments for coil currents.

"Experiments are being made on a most elaborate scale in London, with high-frequency electrical currents, in the treatment of consumption. It is stated that some remarkable results have been achieved. These experiments, for the most part, have been conducted by Dr. T. J. Bokenham, an eminent West End surgeon, in the course of his private practice, but with the knowledge and approval of leading consumption specialists. Dr. Bokenham has had fitted up a most elaborate apparatus for the production of electricity in the particular form in which it is used, the net result of which is that a current of 80,000 volts is produced, of such high frequency and administered

PLATE 311.—Showing a sick child placed in large solenoid for tonic effects in asthenia.

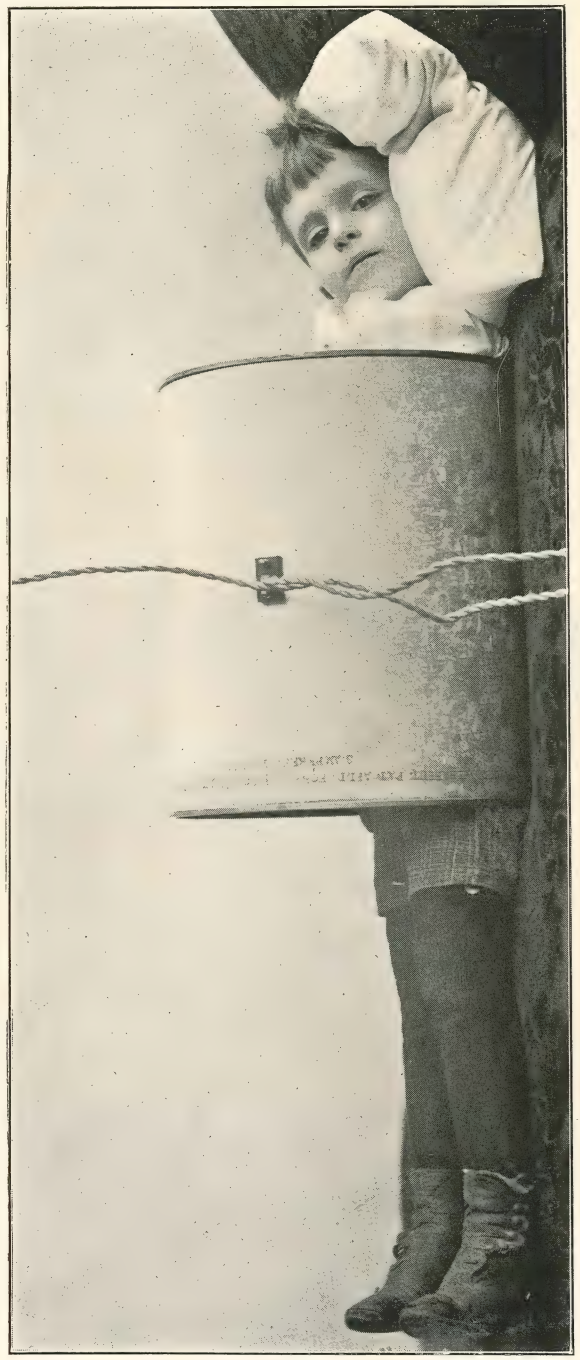


PLATE 312.—Showing boy recumbent on couch with solenoid drawn over trunk of body for general tonic effects during convalescence. Patient can turn to any desired position and recline on either back or abdomen.

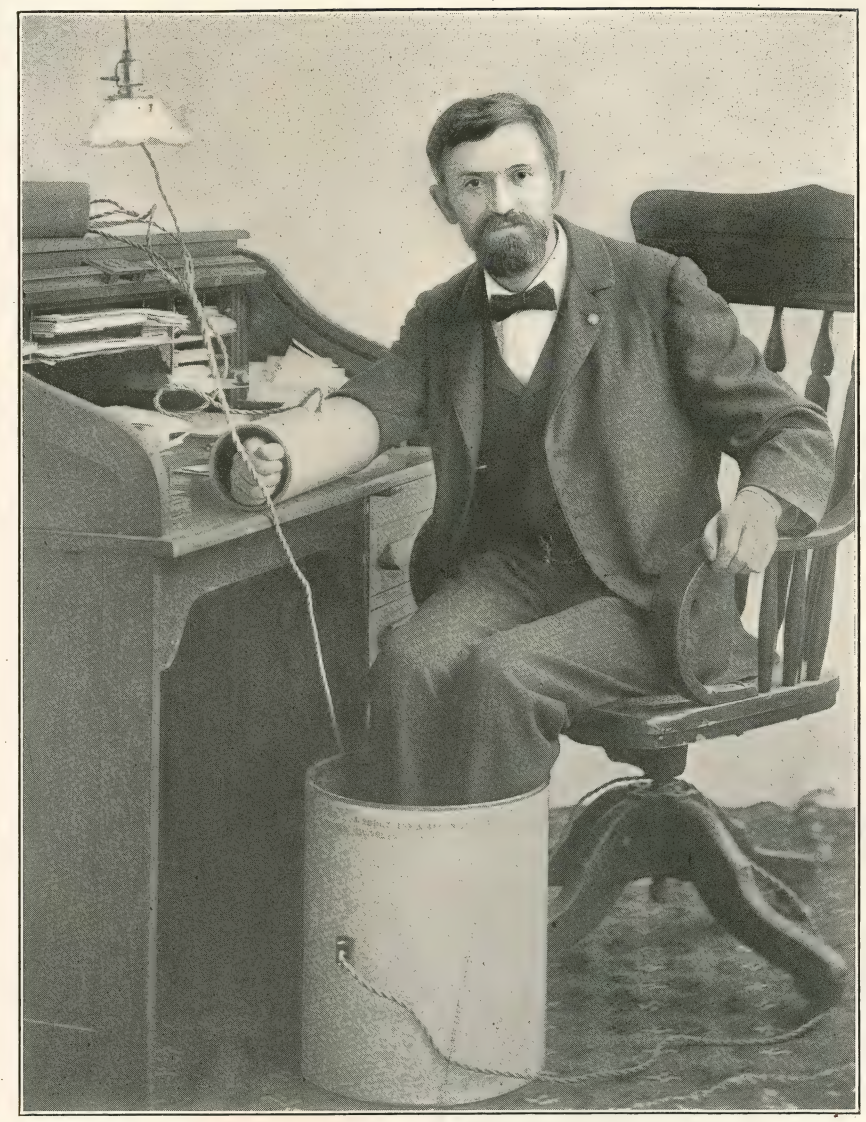


PLATE 313.—Apart from bedside use the general tonic action of the alternating current may be well utilized for professional men by the aid of this convenient solenoid. This plate shows a gentleman at his desk with feet in tube for simple warmth in cold weather, or the relief of any painful condition. He can swing it under the desk and keep at his work. A tube on the arm is shown also to illustrate the use of the solenoid by writers who suffer from fatigue of the pen muscles. Owing to the general nervous tone imparted to the system by the auto-conduction of the current this resource would be an advantage to many busy physicians for self-use in their own offices during periods of strain and anxiety.

PLATE 314.—This Plate illustrates a prescription of either foot or arm solenoid for half-sick women at business, stenographers, typewriters, secretaries, etc. The special indications need not be repeated here. The application of a body solenoid around the pelvis during dysmenorrhœa has afforded great relief to the pain, and worn a half-hour daily between periods has brought about an improved state of the circulation in simple cases of functional types.

in such small quantities that the consumptive patient may receive it without the slightest injury.

"By one method of this treatment the patient is laid in a reclining position on a chair. The chest is laid bare, or partially bare. The back of the chair is insulated. Thus when the patient receives the current from the electrical machine a complete electrical circuit is established through the floor. The current is applied from a brush electrode held a few inches from the body. When the apparatus is set working, electricity is discharged from the end of the brush with a faint smell of ozone, and the appearance of a number of lines of electrical blue fire. Thus is the current passed through the chest, a slight warmth only being experienced by the person receiving it. This is the mono-polar method.

"By the other method, the one which Dr. Bokenham is inclined to favor, the patient, in the same posture as before, simply takes hold of a handle like that of an ordinary galvanic battery and receives the current till he is what is described as super-saturated with electricity. He feels nothing whatever, but, if the attendant touches his skin, sparks fly out in all directions. When he is using this treatment Dr. Bokenham applies his finger to the most affected parts of the patient's chest, thus concentrating the electricity there for the time being.

"With both systems the application lasts from ten to fifteen minutes at a time. The treatment is undergone three or four times a week, or daily. The first result is, on each occasion, that there is a pronounced rise in the patient's temperature. Usually it rises two or three degrees, but in at least one case the rise has amounted to as much as six degrees. The improvement in the patient in some respects is beyond all doubt.

"Dr. Bokenham's experience is that in very bad cases of consumption the cough has been greatly reduced, night sweats have disappeared, the appetite has improved, and there has been a great gain in weight and general health. So that even if the consumption bacilli have not been destroyed, it is certain that their virulence has been much decreased; that they have been brought under control and that the patient has felt cured. In one case a remarkable result has been effected by it. A gentleman was, after every other sort of treatment, to all appearances in the last stage of consumption. It was said he had no healthy lung tissue left to breathe with. His business had been abandoned. For a long period he had practically been confined to his room. He received the electrical treatment daily. He has now to all appearances recovered, and he has resumed his professional work."

An Alternating Current Solenoid.—The therapeutic apparatus shown in the next eight Instruction Plates (307 to 314) will be an entire novelty to the majority of the medical profession. It is new. It is strikingly simple. It costs as little as third-rate faradic batteries, yet is a scientific instrument producing effects resembling the general

physiological actions derived from d'Arsonval's high-frequency auto-conduction solenoid. It also combines with the field of electro-magnetic stress in which the patient is placed the auxiliary action of low dry heat. To a very useful extent it is a " hot-air " apparatus as well as an electrical appliance. Wherever facilities exist (or can be procured) for screwing the terminal cord of the solenoid into a lamp socket with an exciting current of the alternating type this apparatus can be made almost indispensable to both medical and surgical practice. To derive a comprehensive idea of its actions study the physiology of heat, general static electrification, general faradization, galvanic electrotonus, the sinusoidal bath, and high-frequency electrization. The indications for these beautifully obtained actions as modified by this alternating-current solenoid are numerous.

It requires no technical skill. The medical judgment of the practitioner suffices to prescribe the treatment for perversions of nutrition and states below par, and the only other requirement is the alternating current. Dosage is made automatic by the initial construction of the solenoid. It is the nearest approach to placing " electricity on draught " for general-health and tonic purposes that has yet come to our notice. As an active practitioner may have several nurses at a time out among his patients under his directions and subject to his control so the same man might keep a score of these solenoids under his direction in both office and family practice. It is also especially adapted to institutions. Confident of the merit of the appliance and esteeming its worth we do a service to the profession to here make known and teach its uses.

Stated in the simplest terms and without technicality this therapeutic apparatus consists of an induction coil made to be worn *around the body* or part of the body instead of being wound in the usual manner over a primary helix or core. In other words, it is a solenoid lined with a brass tube and inclosed in an iron jacket. In appearance it is a short section of hollow tubing and these tubes are made in a series of seven sizes adapted to admit the arm, leg, head, feet, chest, and trunk of the body. It is almost distinct among therapeutic apparatus for the reason that its operation is automatic and requires no technique beyond that of turning on the current. To secure a remarkably high class of physiological actions and the relief of many forms of pain the solenoid makes only the same demand upon the physician's manual skill that is made by the electric-light at his office desk. To secure the light he must switch in the current, and that is all he need do with the Burry solenoid. It can scarcely be abused and is difficult to injure, and offers a combination of advantages which

actually give to the physician for domestic practice among his patients a *scientific realization* of many of the fictitious claims put forth in the advertising circulars of quack electrical devices sold to the credulous laity. This may be deemed high praise, but those who use the appliance with the judgment of educated electro-therapeutists (solely within its capacity, and remembering that it does not contract muscle-fibres and has no sensory effects), will find that it supplements prescribing in gratifying and numerous ways. In a moment we will consider some of these ways.

Wherever an alternating street current is available for electric lighting a lamp can be unscrewed and in its place, connected by a flexible cord and plug, the solenoid is ready for use. The continuous commercial current will not directly operate this solenoid nor can it be excited by a high-frequency apparatus, but when no alternating circuit is within reach and only the Edison constant current supplies the lighting mains a motor-generator " transformer " will enable the physician to use the solenoid with the direct current. During the past three years the inventor has made many tests of windings for various phases of current and has conducted an empirical clinic in which some 2,000 persons have been treated. The resulting actions have closely resembled those of the similar applications of the more elaborate device of d'Arsonval, which in nearly the same manner places the patient's tissues in a field of " auto-conduction." An incandescent lamp held in the centre of the solenoid will glow without contact with any circuit. The most marked physical action is the gradual heating of the appliance. With windings suited to the current this heating is regulated so as to attain its maximum in about twenty minutes, and does not exceed a comfortable warmth.

Experience has led the maker to settle upon the following graduated scale of capacities for his various sizes of solenoids:

Arm size	1	Ampere.
Knee size	$1\frac{1}{2}$	"
Thigh size	$1\frac{3}{4}$	"
Head size	2	"
Feet size	$2\frac{1}{2}$	"
Chest size	3	"
Body size	$3\frac{1}{2}$	"

With construction adapted to these currents the heat during treatment rises to comfortable tolerance, and in many cases is a factor of benefit to the patient. While the smaller solenoids are safely used in the ordinary lamp socket, yet it is the author's experience that

soon as it tends to establish itself, either by a magnetic field or by an air-jet. With this current and under this arrangement the effects are the same, that is, the positive and negative waves produce the same inductive effects. The oscillations are renewed from 120 to 150 times a second according to the frequency of the current employed (60 to 125 cycles)."

Taking then the solenoid of Burry and exciting it by an alternating current as taught we have very nearly the same physiological action of auto-conduction as that claimed for the solenoid of d'Arsonval when excited by the high-frequency attachment of an induction coil. As the main features of High-Frequency therapeutics have been taught earlier in this section we need here only consider that in the simple device excited by the alternating street current as described we have the valuable effects of the more famous method. This, of course, refers only to the one technic. The varied uses of electrodes possible with a complete high-frequency equipment are not administered with the solenoid, and are an entirely different technic.

Owing to its simplicity and general usefulness and the fact that it has already been subjected to three years of test before being put before the profession, it would seem reasonable to assume that every practitioner commanding the requisite exciting current could employ it to his advantage. It is an appliance which should be kept within the profession and out of the hands of charlatans. Costing but about the same scale of prices as low grade and almost worthless "Medical Batteries," too often bought by patients on mistaken advice, this scientific solenoid will contribute vastly more to the welfare of humanity than all the thousands of faradic boxes purchased by the *laity* every year. Its therapeutic activity and efficient impression upon the tissues is not a merit of the device *per se*, but is a consequence of the fact that the device is rendered active, not by one or two insignificant "dry cells," but by the great therapeutic properties of the potent alternating current, *one of the most energetic agents of the entire materia-medica.* The difference is akin to the difference between attaching dry cells to a trolley car and connecting the same car with the current from a dynamo.

Author's Note.—In closing this latest work from my pen a few words of explanation are necessary. To present the important knowledge in the most compact manner, as physicians need, the text has been condensed by careful editing into 350 fewer pages than as first written. The difficulties in the way of carrying out my full wishes in the Photographic Instruction Plates were insurmountable. After many delays, broken promises on the part of others, and almost prohibitive expense, the volume must go to readers as it stands.

Viewed from the labors of the author the individual reader may well regard it as nearly a clear gift in its great mass of information, much of which cannot be got in any other way. Had it been possible to manufacture the finer work intended the cost must have been doubled.

In regard to previous writings, it daily appears that many are misinformed as to the scope of my several books and it is necessary to relate the facts. The little quiz-compend on "Rudiments" (165 pages) is simply a primer for the undergraduate student to read. It aims to correct his judgment and start him right when he begins to study practical methods, but it does not teach technics at all. It was not written for the physician, but for the medical student, and serves its purpose if it prevents him from leaving college with prejudice against a great therapeutic agent. He can study clinical methods afterward. My Manual of Static Electricity (670 pages) was written in February, 1897, and has never been revised. It sold out and was reprinted four times, but the four editions were the same except as to a few verbal corrections. Its X-ray part was written about one year after the beginnings of X-ray work, and should now be charitably laid aside. Most writings of five years ago on this subject are obsolete to-day. Working then with a smaller static current we obtained many ideas which time has shown do not apply to the type but to the dosage of current, and some of those early theories have not only been misquoted, but have been twisted far out of my original design. This work, therefore, displaces the X-ray part of my Static Manual.

The author's earlier writings on therapeutic uses of static electricity now seem primitive and not half complete. Fully twice the clinical work described can be done with this flexible agent, and a wide range of methods now employed do not appear in the Manual, but await my leisure to write them up. Those who have any copy of this historical work may prize it beyond its cost, as no more will ever be printed. It served its pioneer purpose and has been outgrown. My work on The Treatment of Disease by Electric-Currents (1,100 pages) was written early in 1897, and has not been revised, though now in its second edition. It teaches the greatest variety of clinical methods for the three chief currents (Static, Faradic, Galvanic) that were in use at the time of writing. No other work has yet taken its place, though it needs many additions to its technics.

My clinical book on "Correct Technique" in electro-therapeutics (314 pages) was designed to supplement my previous larger books and bring them up to date by additions to methods of using all four currents, the sinusoidal being included. It was written in August, 1900. It is an absolutely unique book of clinical instruction such as was never written by any one before. No matter what other works on electricity the reader may have he needs this to direct his study in practical experiments on himself. It puts into written form much of what the author taught in regular clinics before demands on his time compelled him to abandon them. Therefore, with the excep-

tion of static therapeutics placed in the "Treatment" book from the Static Manual none of the five major volumes repeat each other. As some have thought that the large volume contained all the rest the error is here corrected.

We may also add that those who know from personal experience what it is to write amidst the distractions of busy private practice, and know, too, the little recompense that fame brings the medical author, will appreciate the missionary spirit which has induced me to record my teachings for the benefit of beginners whose troubled path I once trod myself. Defects are more apparent to the writer than they can possibly be to others, but if any book was held back from press till the author had time to make it satisfy him it would never reach those who need it, defects and all. Fine literary work and attention to patients do not get on well together, and when it is considered that the task of writing the text is but one-fifth of the work which such a book as this devolves upon me I must either write no books or write them as best I can, craving indulgence for faults that are unavoidable under the circumstances. The above list does not take into account pamphlets and lesser writings, or papers written for Correspondence Instruction Courses. With time at command, and wider support from the general medical profession, the author could more adequately present the important subjects on which he has written, hitherto under very difficult conditions and under disadvantages which have destroyed many of his plans for improving and illustrating the text.

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