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NIELS R. FINSEN—HIS LIFE AND WORK.

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THE beneficial action of light, not only in maintaining health merely, but also in combating various forms of disease, has been recognized from time immemorial in a general way, almost intuitively, and often unwittingly. Sunlight has ever been acknowledged a most potent restorative. The ancient Greeks were in the habit of anointing their bodies and thereafter exposing themselves unclad on the flat roofs of their dwellings to the direct rays of the sun, not only on the score of health, but also as a luxury.*

Vestricius and Cicero mention that the Romans similarly indulged in the sun-bath, followed frequently by cold sponging of the surface of the body. At a later period in their history they erected special outbuildings for the purpose, which they called Solaria and in these took their sun-bath, or Heliosis.

Herodotus especially advises sun-baths for those whose muscles are weak and flabby. Antyllus goes into the matter more fully still, detailing the effects of the sun-bath and its action upon the system, and directing in what diseases it may be found useful. Herodotus, C. Aurelian, and Antyllus recommend sun-baths in the treatment of diseases of the skin. And many other of the writers of antiquity have advised the use of the sun-bath as a curative agency in quite a wide range of diseases.

This early belief in the health-giving power of the rays of the sun is found among many nations and is well nigh universal. Natives of South and Central America and Mexico may be seen at mid-day stretched full length on their backs for hours at a time in the blazing tropical sun, as a remedy for consumption; a method which is said to antedate the advent of the Spaniards.† And in China, Japan, Hayti, and Mexico not only

* Freund, "Radio-Therapy."
† Rogers, "Lucotherapy."

is the beneficial action of the sun's rays accepted, but the hurtful effect in certain cases is also known; thus, while sun-baths are given to some patients, others are kept from the light.*

Systematic treatment of disease by means of light may be said to date from the beginning of the nineteenth century, when Professor Lobel of Jena set forth in definite terms the conditions in which light treatment might be employed with benefit, and those in which it was to be avoided, and described a special apparatus by means of which such treatment could be carried out. From this time forward, much careful investigation has been carried on, and much patient work has been done in placing light treatment upon a scientific basis.

But it remained for the immortal Finsen to gather together these varied threads of evidence in favour of the powerful influence of light upon the health, to crystallize the many and most valuable discoveries of other learned men to whom he never failed to render due credit for their service to the cause of science, and to carry on his own most ingenious and extended series of observations, remarkable most in their strange simplicity.

Born on the bleak Faroe Islands, the greater part of his youth—until his twenty-first year—was spent in Iceland, the weird land of storms and wintry night, and strange contrasts of light and darkness, almost dramatic in their vividness. Even in his boyhood the effect of light possessed a great charm for him; he noticed the action the rays of the sun had upon some animals, and well he knew the depressing effects of sunless days. All this proved an incentive later on to study most searchingly the action and influence of light upon health.

When he graduated from the University of Copenhagen in 1890 as Doctor of Medicine, after spending eight years there, he was already a confirmed invalid, although only thirty years of age, in fact he had been in wretched health since his twenty-third year, and now his heart, liver, and organs of digestion were so hopelessly deranged that active practice of his beloved profession was absolutely impossible. Immediately upon graduation he was appointed Prosector of Anatomy at the University of Copenhagen under Professor Chiewitz; they still use at the Anatomical College a dissecting knife invented by him. For three years he contented himself with acting in the capacity of prosector at the University, and here we find him in 1893 in the little city of Copenhagen, poor, unknown, handicapped in body, but with keen powers of observation, the faculty of investigation highly developed, a rare intelligence, and with an indomitable will in spite of his almost constant physical suffering. From before the close of his student life he had been experimenting with light, always

* Freund.

keenly anxious to probe its mysteries, and now he has a story to tell, and the whole world of science waits to hear, sceptical at first, but convinced ere long.

To enter fully into the nature of the researches and experiments of Finsen, and all the discoveries which led up to them, while most interesting and instructive, would yet demand the presentation of an amount of scientific data incompatible with the time at our disposal, and the limits of a paper such as this; but, in order that the whole matter of his work may be fully comprehended, and yet be confined within reasonable bounds, it may be permitted to sum up briefly a few of the main theories, but only a few, upon which the experiments of Finsen were based; in a word, what was the foundation upon which he was to erect his splendid superstructure?

And, first, omitting all that led up to it, was the theory that light is composite in character, consisting of various coloured rays, and that when it is broken up into its component colours by suitable apparatus a beam of light appears to the eye as a band or strip of red, orange, yellow, green, blue, indigo, and violet, each shading off gradually and blending with many intervening tints into the succeeding colour; this colour series being termed the visible spectrum.

The rays of light are wave-like, and all the waves are not of the same length or height, nor do all vibrate at the same speed. The red waves vibrate the most slowly, only about four hundred billion vibrations per second, and the rate increases as we ascend the series until we find the violet rays vibrating at just double that speed, namely, eight hundred billion vibrations per second. The red rays, on the other hand, are the longest and least easily diverted from their course, or kept back, hence they pass most directly through a prism and appear at the foot of the spectrum, while the violet rays are of the shortest wave length, and are most easily retarded, and diverted, and being most bent out of their course in passing through a prism, appear at the top of the spectrum.

But these rays, red to violet, constitute merely the visible spectrum, for beyond and below the red rays, and vibrating still more slowly, too slow to be visible to the human eye, are other rays, termed infra-red, or ultra-red; and beyond and above the violet rays are others still, which are known collectively as ultra-violet, more rapid, too rapid to be detected by the human eye, and shorter and also more active than the violet, but, unfortunately, yet more easily diverted from their course and less penetrating.

There are many other differences in these varying rays, but differences in degree only, not in kind. Thus, while all parts of the spectrum are capable of giving rise to heat, this quality is most marked towards the red and infra-red portion; also, while all parts of the spectrum are capable of giving rise to chemical changes, this action is most marked, as a general rule, towards the blue, violet, but especially at the ultra-violet portion. And so we speak in general terms, if not quite correctly, of the heat rays, meaning thereby the red rays, and of the chemical or actinic rays, meaning the blue and violet rays. Red glass allows the red rays of light to pass through it, but absorbs the chemical rays, not permitting them to pass. This is why the ruby light is used in photography when one wishes to examine a plate which would be spoiled if the chemical rays of daylight—"white light"—were allowed to reach it just then, but the red light is so weak in chemical action that it will affect the plate very slightly. Yellow has the same deterrent effect on chemical rays.

Much more than these bare facts was known to the world of science when Finsen, towards the close of his student life, began his experiments with light. His first investigations related to the injurious action of the so-called chemical rays of light, and with marvelous acumen he turned the researches of others to account; their results he was enabled to interpret, and their theories he was able to put to practical use.

In one of his earliest contributions to medical literature in 1894 he admirably states the position of affairs up to that time as follows: "It must be acknowledged that, with the exception of the influence of light upon plants and upon the organ of vision, our knowledge of the physiological action of light and its effects, whether good or bad, is very limited. In undertaking now the study of one of the properties of the chemical rays, viz., their injurious influence upon the animal organism, I do so, not because I regard this property as the only influence of the chemical rays, but because it constitutes the very foundation of our subject."* In July, 1893, he had set forth some striking theories with regard to the action of light,† and now he proposes to expound and elaborate them.

He draws attention to the fact that the deleterious or fatal influence of light upon the majority of bacteria (germs) is already known, that one writer, Duclaux in 1885 had said that "sunlight is the best, cheapest, and most universally applicable bactericidal (*i.e.* germ-killing) agent that we have," and others, for instance, Downes and Blunt in 1878 had shown that this effect was due almost exclusively to the chemical rays. It had been noted by Graber in 1883 that if earthworms (lumbrici) were placed in a box covered with strips of different coloured glass—using the colours of the spectrum—the worms always crawled to the darkest places,

* Finsen, "Phototherapy."

† N. R. Finsen, "Hospitalstidende," July 5, 1893

namely under the red glass, and Dubois in 1890 had shown that the proteus, an animal like the earthworm, preferring darkness, was least comfortable in white light.

In 1851 Brucke had explained that the chameleon changed its colour by means of pigment cells in its skin, which came closer to the surface in light, and in darkness lay deeper; a slow change from darkness to light producing a scale of colouring in the animal which became successively whitish, gray-green, then spotted with black, and finally brownish-black; the pigment cells in the skin of the animal being moved nearer to the surface to protect it against a disagreeable light impression. Paul Bert observed (1878) that red and yellow light had no influence on the pigment cells, while the blue and violet rays produce a strong reaction; and in 1887 he observed further that if one-half the body of a chameleon were illuminated through a red glass, and the other half through a blue glass, the half under the red remains for a long time whitish, while the half under the blue glass becomes almost instantaneously blackish.

Finsen had noticed that horses and horned cattle were subject to the so called "sun-burn" (solar erythema), as well as man, and many veterinary surgeons had informed him that this erythema was limited to non-pigmented parts of the skin, almost exclusively. Wedding in 1883 had described an interesting observation, the truth of which had been confirmed by Virchow, namely, that cattle and sheep fed upon buckwheat are subject to skin eruptions with the formation of vesicles, which was much more marked in the whiter animals and those exposed to the light or direct rays of the sun. Animals kept in the dark were not affected by the disease, and a white cow which had been coated on one side of its body with tar had the eruption on the opposite side only. An especially interesting observation had been made by Livius Furst, that when calves with a dark hide were vaccinated, in preparing animal vaccine, the pustules did not form well, and that consequently those with a light skin were preferred for the purpose. Volkmann in 1891 noted this fact as learned practically, but did not try to explain it.

Moreover, Unna of Hamburg in 1885, Widmark of Stockholm in 1889, and Hammer of Stuttgart in 1891 had definitely demonstrated that the chemical rays of the spectrum, and particularly the ultra-violet rays were responsible for erythema solare or eczema solare—commonly termed "sun-burn"—and the pigmentation of the skin of human beings —or "tanning"—and that these were not the effects of heat, for explorers in the polar regions and tourists on the glaciers, even when the temperature is below zero may suffer severely from "sun-burn," caused by the strong reflection of sunlight from the fields of ice. Widmark also demonstrated that the inflammation of the skin caused by a very strong electric light was identical with erythema solare.

Finsen regarded pigmentation as nature's way of protecting parts from the injurious action of the luminous rays, the colouring matter preventing the rays from penetrating too deeply and thus protecting the skin against their inflammatory action. Finsen proved this himself apart from any one else, and not knowing that others were experimenting in a similar direction. He was trying to account for the cause of the pigmentation of the skin of negroes. To imitate the colour of the negro's skin he painted a band of Indian ink about two inches wide on a part of his forearm not usually exposed to the sun, and normally quite light in colour, and exposed the arm to a very hot sun for about three hours. He then removed the Indian ink, and the skin under it was quite white still and normal, while that on either side was red. After a few hours inflammation, pain and slight swelling developed and lasted several days, and finally the parts became fairly strongly pigmented, but the protected portion remained normal throughout, even the little irregularities in the edges of the black band being clearly defined. The arm was then again exposed to the sun, but without blackening it this time. The result was completely reversed; the white zone became the seat of the inflammation, while the parts on either side were not changed in appearance, except perhaps that they were a little more pigmented. Oarsmen who get their arms "burned" early in the season, find the protection of the subsequent "tanning" later on.

In animals, the surface most exposed to the sun is generally the most coloured; this is noticed in furred animals, whales, reptiles, birds, fish. Fish need this protection, because, while water absorbs the red and ultra-red rays to a high degree, it allows the ultra-violet to pass freely. "Among polar animals, pigmentation seems to vary in relation to light. There exists a connection between the black colours of the summer, which is so rich in light, and the whitish hues of the winter, which is so dark."*

Too much light is injurious to plants, and provision is made by nature to protect them in various ways, a colouring matter being deposited in certain cells for that purpose.

The acute effects of the chemical rays upon human skin vary from a feeble irritation through all degrees up to inflammation followed by exfoliation, depending upon the intensity of the light and the proportion of chemical rays which it contains. Ordinary lamps give proportionately less, and electric light more chemical rays than the sun. The intensity

* Finsen.

of effect depends also upon the duration of exposure, the amount of pigmentation of the skin, and perhaps the thickness of the epidermis.

This inflammation is unlike all others of similar duration, in leaving a pigmentation of the skin. Unlike that caused by heat, it does not develop immediately, and does not attain great intensity until from twelve to twenty-four hours after the exposure. It only develops upon parts directly exposed to luminous rays, while heat rays may act through the clothing.

Finally, it had been noted that men who worked at a foundry where metals were smelted by electricity, suffered very severely from the effects of the light upon their skin and eyes; that this was due to the action of the ultra-violet rays alone, and not to heat rays was proved by Widmark.

As far back as 1859, Charcot had expressed the opinion that it was the chemical rays and not the heat rays which are active in the cases of erythema solare, and that the dermatitis caused by a very strong electric light was identical with erythema solare. But it was not until 1889 that Widmark gave the scientific proof that such was the case.

Widmark caused the rays of an electric arc of twelve thousand candle power to pass through a layer of water thick enough to absorb the heat rays. Under the influence of this light, which contained all the rays except the heat rays, the skin subjected to it developed the characteristic inflammation; but when the light was passed through a plate of ordinary glass, which excludes the ultra-violet rays, the skin subjected to its influence was unaffected.

Having thus considered the phenomena of light apparent to the unaided eye, reported upon by other observers, and having studied the particular form of inflammation that was caused by a special irritant, Finsen wished to find out what the microscope could teach him about the changes produced, and whether the inflammation was a simple one, or complex in character. And so, early in 1893 he carried out some experiments upon tadpoles. Wrapping their bodies in filter paper kept moist and cool by cold water, thus keeping them alive and at the same time excluding any effects of heat, he placed them upon the stage of the microscope, exposed to the rays of the sun. After ten to fifteen minutes the capillary vessels were dilated, the circulation of the blood slowed, then ceased, leucocytes and red corpuscles escaped through the walls of the capillaries, as in simple inflammation, and the red corpuscles contracted, becoming compressed and more round. This demonstrated that light had a direct action upon the smaller blood vessels (capillaries) and also upon the blood itself; others had shown that light could cause the contraction of living protoplasm, and its general influence on the system, especially through the optic nerves, needed no confirmation.

Nature's defence against this injurious action of the chemical rays being pigmentation, the manner in which the pigment was laid down should lead to the discovery of the very part of the skin requiring protection. In man, the pigment is placed in the deeper layers of the epidermis; there are no capillaries in the epidermis, but there are in the layer of skin immediately below it. In animals pigment cells are more scattered and often met with along the vessels of the skin. In reptiles complete tubes of pigment are seen around the vessels. From all of which it would appear that the blood vessels and the blood need protection.

As to the absorption of light; it might be permitted to reason from a law in physics that only the light absorbed by bodies could act on these bodies, the chemical influence of light being in direct proportion to the light absorbed. Applying this law to the animal organism it is found that no living tissue absorbs so much light as the blood does, and, more than that, it absorbs a considerable quantity of the violet rays.

Besides all the foregoing conclusions, other experiments showed him that light had a considerable influence upon the nervous system, at least in the lower animals.

Having thus summed up his theoretical and practical evidence as to the irritant character of the chemical rays of light upon the healthy body, he reiterates the fact that his researches do not exclude the beneficial action of the chemical rays when in moderation, but regard the harmful action as due to exposure to too great a number of the rays, and for too long a time.

Attention was then directed to acute diseases of the skin which might be produced by the chemical rays, and next to those diseases of the skin, which while not due to the chemical rays were unfavorably influenced by them. If chemical rays could produce a severe inflammation upon healthy skin it was most natural that they should exert an injurious influence upon a diseased skin.

While deep in these researches and experiments, Finsen found in the library of the University of Copenhagen some articles bearing on the unfavorable action of light upon the course of small-pox. One of these was by Picton of New Orleans and published in 1832; it merely mentioned the fact that some soldiers confined in dark dungeons during a certain epidemic of small-pox, had contracted the disease and recovered without suppuration or scarring, but did not attempt to offer an explanation of the phenomenon. In 1867 and 1871 the English physicians, Black, Barlow and Waters had published articles noting the action of light upon small-pox, but little attention had ever been paid to them. With Finsen it was different; he solved the mystery. His interpretation was that theoretically these observations agreed with the fact that the face and hands, the parts most exposed to light, were the seats of the deepest scars, and those most prone to merge into one another.

In his own words; "I saw clearly that the chemical rays would play an important part in this, and that is why I proposed in July, 1893, to treat patients suffering from small-pox in rooms from which the chemical rays had been excluded by filtering the light through thick red curtains. At the same time I showed the theoretical principle of the treatment, which had hitherto been wanting, and soon afterwards the method was tried." His proposed treatment was based upon theory only, but an opportunity to put this theory to a practical test soon presented.

There was much small-pox in Bergen, Norway, at the time, and Dr. Lindholm, chief physician of the military service, and his assistant, Dr. Svendsen, made the first trial, but two months after the publication of Finsen's proposition, namely, in August, 1893. Eight patients were subjected to the red light treatment, that is light from which the chemical rays had been filtered by red materials, four being unvaccinated children, and bad cases. The result was that the most painful and most dangerous stage of the disease, the stage of suppuration, did not appear, the temperature of the patients did not rise, there was no swelling, and the horrible pitting did not occur. A very marked contrast to the results of former methods, and a justification of Finsen's theory.

These happy results were repeated by other physicians in various parts of the world, and in those cases where failure was reported, it was usually found to be the old story of the "just as good" plan. Either some essential detail was omitted, or treatment was commenced too late to be of avail.

Finsen also pointed out that where any preceding method to avoid scarring in small-pox had achieved a measure of success, it had been through the very principle for which he contended, namely, the exclusion of light from access to the skin, but used without actual knowledge of the rationale. Thus, the face had been painted with tincture of iodine which turned the skin red, or with lunar caustic which turned it black, both efficient filters of the irritating rays. Or the face had been covered with a mask coated or soaked with various fatty substances, or many other things, the success of which depended upon the extent to which light had been excluded from the skin.

Even red had been used in days gone by in the treatment of small-pox. "John of Gaddesden, who wrote the famous medical treatise, the earliest in the English language, 'Rosa Medicinæ,' and who died in 1361, treated the son of King Edward I. for small-pox by covering him with scarlet blankets and a red counterpane, placing him in a room in a bed with scarlet hangings, gargling his throat with mulberry wine, and having him suck the juice of red pomegranates, and the patient recovered, never showing any trace of small-pox." * * * "Also back in the time of Queen Elizabeth, the value of red curtains, red coverlets and red glass about the bed in small-pox cases was loudly proclaimed by certain doctors, who were regarded, as was John of Gaddesden, as charlatans by the orthodox physicians of the day." (Cleaves', "Light Energy.") So there were red bed-covers, and red globes in the bed for small-pox in the middle ages. Children were clothed in scarlet cloth, or kept in beds with scarlet curtains early in the 18th century in France, and the same custom prevailed in Japan. In Roumania, a custom from time immemorial is to cover the patient with red cloth, thinking that this attracts the eruption to the surface, and prevents complications. In Tonkin, the patient is placed in a sort of alcove, from which all light is excluded by numerous red hangings, and in a number of other diseases the same procedure is carried out; the custom is of great antiquity.

Finsen's plan involved absolute exclusion of the chemical rays, "small-pox patients must be protected from the chemical rays with as much care as the photographer uses for his plates and paper." A candle was permissible for artificial light while examining the patient, and while he was at his meals, but no brilliant illuminant was to be used. Treatment must be started as soon as possible after the rash appears, there is less hope after suppuration is established. Treatment must be continued until the vesicles have dried up. Even a short exposure to daylight would nullify the treatment. It was not claimed that death would always be prevented, but that if taken in time and all rules strictly carried out, suppuration would generally not occur, the patients would recover without scars, or only with almost invisible ones.

Four years later, 1898, Finsen published an Appendix to his paper on small-pox, setting forth the subsequent good results of many observers, still further confirming his plan.

Had Finsen contributed nothing more to the sum of human knowledge, he had well merited the gratitude of the entire civilized world, and his name would ever have been honoured on the roll of science, not alone for what he had actually accomplished, but even more for the new avenues of research opened up by his incessant labours. But great as was this triumph, a still greater was to be the reward of his unassuming genius.

In 1895 he published a paper which has been as a light in the darkness to many an afflicted, hopeless, despairing sufferer, a revelation of many a mystery in life's mystic volume, an interpretation of many a dream of the plodding, patient investigator, an inspiration and incentive to all his co-workers in this most alluring of scientific fields, the dawn of a brighter day.

Hitherto he has dwelt upon and conclusively proved the irritant properties of light in certain conditions and under certain circumstances, and shown us how this knowledge may be put to practical use in a negative manner, by avoidance. But, as there are always two sides to every question, both of which may be right, so, on this great question of light, he throws fresh light, and bids us look on the other side of the picture and behold light in a happier mood, "Light as a Stimulant." In this contribution, as in the former, one cannot fail to be struck by the humble character of the experiments, contrasting so strangely with the value of the results obtained thereby. But as the skilled conjurer performs his most wonderful feats with the most homely, insignificant objects at hand, so to the true scientist, often a veritable latter-day wizard, no object in nature is too humble to wrest its precious secrets from, and score his greatest victories, and lay the world in triumph at his feet.

And so with Finsen; in observing the development of the eggs of the frog, he noted that movements of the embryo were considerably increased by the influence of direct sunlight, and that with the eggs of the salamander (Triton cristatus) the movements were still more marked. This set him thinking. By using coloured glasses, and occasional shading with the hand to imitate darkness, he found that the embryos responded more to some colours than to others. All sorts of precautions were taken to avoid mistakes, the exact period of exposure to each coloured ray was noted, and the exact number of movements, the water in the dish containing the eggs was kept cool to avoid errors due to the possible effects of heat rays. The result of the experiments proved conclusively that light provoked movement in the embryos, and that this must be attributed especially to the violet rays.

Next, attention was turned to salamanders an hour old, and others a day and a night old. Placing them in a dish of water, their natural element, and placing the dish in the shade, but where a beam of light could be reflected upon them by a mirror, it was found that under the influence of light they darted ahead, but otherwise remained motionless. Placing the dish half in the light and half in the shade, the salamanders moved about excitedly until they reached the shady portion, when they became motionless again. Red, yellow, and green rays did not affect them, blue light alone provoked as rapid action as compound light. In this case the exact time in seconds which elapsed before movement occurred after exposure to the coloured light was carefully noted, likewise the possible effects of higher or lower temperature of the wate . The great value of these experiments, as pointed out by Finsen, lay in the fact that salamanders of this age rarely move at all, without a violent external cause. The strength of light used, and the quality of the glass as to the rays which would pass through certain shades were carefully noted also. The latter is a factor frequently neglected by experimenters; the glass in this case was examined spectroscopically, in order to be positive.

When tadpoles were kept in the shade for some weeks, it was noted that they became very lively when exposed to daylight when the water was changed. Another interesting point was noted; a number of tadpoles had been raised from eggs which had been kept under light of different colours, but all received daylight every twenty-four hours, when the water of the aquarium was changed, at which time those raised in red light became very excited because unaccustomed to light, while those raised under blue light were quite indolent.

The experiments with the earthworms, placing them in an oblong box, with a lid of glasses, red, yellow, green, and blue, were repeated and varied by turning the cover after the worms had gathered at the dark end, thus exposing them to different strengths of light, but always with the same result, namely, the worms were uncomfortable in and avoided the blue light and sought the red. Some worms that were kept for feeding the salamanders met with an accident, some died and some were very weak; to save as many as possible various expedients were resorted to, such as moistening them, but without result. On exposure to direct sunlight, three or four began to react and recovered.

Experiments with the earwig (forficula) in the box with the glass cover quickly showed their desire to avoid the blue light. Thus, "when on turning the cover, the blue light fell upon the animals, their extraordinary evolutions were curious to watch. Their antennæ began to vibrate, the animals at once became restless, running to all sides, until they finally came to rest under the red glass. The experiments were frequently repeated, and at last the adults seemed to understand the situation, for after several changes of the light, they no longer mistook the road, but made off without hesitation towards the red light." Woodlice (oniscus) and beetles (pterostichus) placed in the box behaved as did the earwigs.

These animals are among those which dislike light, because of the excitation of the chemical rays; but how about those which like it?

To elucidate this point eleven butterflies (pieris) were placed in a large oblong box, half covered with red glass, and half with blue, and exposed to direct sunshine. At first, all beat their wings violently, but soon those under the red glass were mostly quiet, but those under the blue moved incessantly. "Later, when the sun ceased, the butterflies influenced by the blue light became quiet, and an hour afterwards they were disposed in such a manner that ten butterflies were in the blue zone and only one in the red." Inverting the cover, "at the end of an hour eight butterflies were found bathed in the blue light and three remained in the red." The experiments seemed to indicate the preference of these insects for the chemical rays, and the influence of these radiations upon their movements. Experiments with twenty or thirty meat flies (Musca vomitoria) did not give such positive results, ascribed to the great number and the variety of their motives of movement. But towards evening they collected behind the red glass and slept behind it, very rarely one remained under the blue glass and some under the orange. Placing sugar behind the blue glass did not attract them to sleep there. On placing opaque plates before the blue glass, rendering that end of the box the darkest, and illumining the red end, all the flies but one were found in the dark part, showing that flies like to sleep in places where the excitation of light is most feeble.

The conclusion drawn from these researches is that the action of the chemical rays (blue-violet) on these animals, compared with that of the heat rays (red), and light rays (yellow) is very considerable. It likewise demonstrates the extreme influence of the chemical rays upon the organism, which may broadly be defined as an excitation of the nervous system, which is so pronounced that it may provoke well-marked reflex actions (in the embryo), and in other instances produce very powerful and special reactions (in light-shunning and blanched animals) and it can truly be said that these chemical rays are promoters of life and energy. This action is constant and of daily occurrence and must be of great importance in the carrying on of the vital functions. Rays charged with such energy when absorbed by the body must have this energy transformed in many ways, the most marked transformation seeming to be this excitation of the nervous sytem, which, no doubt, influences in a secondary manner all the vital functions.

If the chemical rays possess such an influence over inferior animals, why not over man? And so unhesitatingly Finsen says: "I believe implicitly that in the future use will be made of this new therapeutic agent, and the proof experiment once made, it will be easy to carry it out practically under the form of light baths; and lastly to determine whether they are to be blue or violet, the variations in their strength and duration, and whether natural or artificial." In this connection Finsen noted that light baths had been used in antiquity, and that General Pleasonton had used blue light to cultivate vines and other plants, for rearing animals, and as baths for the sick; not however pure blue, for every blue square there were three clear ones. His book was published in Philadelphia in 1877, under the title of "The Influence of the Blue Ray of the Sunlight and of the Blue Color of the Sky in Developing Animal and Vegetable Life, in Arresting Disease, and in Restoring Health in Acute and Chronic Disorders to Human and Domestic Animals." He had concluded that since the sky was blue this colour must be of great importance to animals and plants, and he also discussed the remarkable chemical qualities of the blue rays. Finsen remarks of him: "He thus approached the truth; but his faulty experiments, and, above all, his tendency to look upon blue light as a universal panacea—the very title of his book indicates this—have not contributed to show the value of a biological agent whose importance is beyond discussion. The General's book, printed on blue paper and bound in blue, makes one think, however favorably disposed one might be, that its contents could hardly fail to be 'coloured' also."

As a final argument on behalf of light Finsen cites the special effects of direct sunlight upon all organisms. "Sudden transitions from a cloudy to a clear sky make us feel it much more than continuous sun. If the sky has been overcast for part of a day, and the sun suddenly comes out, it is as if nature has been brought to life. The insects fly and hum gaily; the reptiles bask in the bright sunlight; the birds chirp; and we ourselves get a feeling of well-being and of fulness of life. This somewhat indefinable effect is none the less very marked. One might say that light is an 'exciter of life,' in the sense that it excites living activity and promotes movement. I believe I am right in saying that this quality has hitherto been attributed to the 'psychical' action of light and to that of heat. It seems to me that both my positive and negative experiments have sufficiently shown that we ought to refer the greater part to the chemical rays, which possess a stimulating influence on the lower animals."

This later work which we have been considering deals with researches carried on in the spring and summer of 1894, and published in February, 1895, and is only a mere fragment of a series of observations which he was conducting, but being interrupted, was unable to continue. In 1899 he published an Appendix to this paper, in which he detailed experiments carried out in the spring of 1895, in which he observed strong secondary effects of light upon the embryos of the frog which seemed to supplement his former results, and besides, stamped the ultra-violet rays as the essential exciting cause of the action.

The experiments were carried out with great care and many precautions, in bright sunshine at mid-day, just as the embryos were emerging from the eggs. They were exposed to various colored lights, also to clear light and to shade, for stated times, and the movements carefullv noted and counted, and showed that movements in the shade increased proportionally to the repetition of the experiment. Then they were allowed to rest in the shade undisturbed for several hours, when their movements were again counted. Suspecting some error, the experiment was carried out in another form. Three embryos being placed in the same flat dish used throughout, and being in the shade for five minutes, during which time only one movement was noted, were exposed to direct sunlight for five minutes, and then removed to the shade, and kept there for the remaining observations. During an exposure of five minutes to direct sunlight 45 movements were counted; during five succeeding minutes in the shade 107 movements were counted; during the next five minutes, still in the shade 112; then 75, 30, 32, 29, 22, 28. This experiment is quoted thus fully to illustrate how simple may be researches, fraught with immense potentialities, provided the observer possess the genius of interpretation, It meant that the effect of the chemical rays was only evident after a certain time, and might even attain its maximum after exposure to them had ceased, and, finally, suggested opportunities for new researches.

In this same paper Finsen alludes to another matter. Recalling his former suggestion of utilizing the chemical rays as a method of medical treatment of disease by light baths of the whole body, he draws attention to the fact that some charlatans, wishing to trade upon the reputation achieved by his researches, were employing incandescent electric light baths, pretending that they were based upon his work, and likewise using his name in a manner most distasteful to himself. Therefore he is impelled to remind the medical profession that the influence of light as a germ killer, and its power to cause inflammation and pigmentation of the skin, as well as its stimulating action, are dependent upon the chemical rays, and the light from incandescent electric lamps contains much less chemical rays than ordinary diffuse daylight, and that such baths acted by reason only of the heat rays given off by the lamps, and are simply of use to promote perspiration.

Proper light baths, on the contrary, are cold, and cause a marked effect upon the skin. His recent researches proved that the dilatation of the capillaries and bloodvessels of the skin produced by the light is not merely temporary, but of long duration, and by causing a dilatation of the vessels and a more active blood supply, better nutrition of the skin is promoted, and greater functional activity. In Finsen's sunlight baths, the patients walk naked about a courtyard; to avoid the production of perspiration, water is frequently sprinkled about or douched over the patients. In the electric light bath, the room is divided by radiating partitions, and the patients lie naked upon couches. In the middle of the room, about six feet from the floor, a couple of large arc lights of 100 amperes are suspended. The temperature of the room is kept so low that artificial heat is necessary to prevent chilling of the patients.

But Finsen's greatest victory was yet to be won. Not content with the debt he had laid the world under already, he must invade yet another stronghold of disease, and conquer.

There is a disease quite common in some climes, not so frequent in our highly favored land which has so much to be thankful for, but present even here; a disease which was formerly thought to be cancer, and was called by the laity "wolf-cancer," but now is ascribed to the presence in the skin of the same germ (bacillus tuberculosis) which causes consumption when attacking the lungs or other parts. It is not called cancer any more by those who know, but its old name sticks to it, and it is called "wolf" just the same; Lupus Vulgaris, common lupus, the Latin term for wolf. It well deserves its name, for it is a cruel, gnawing, wolfish thing, rarely conquered, except at the cost of great scars. Attacking chiefly the face; sometimes the nose, or the lip, or the cheek; going on, sparing nothing, gnawing away, rarely killing directly, but leaving behind such disfigurement often, that death would be a glad relief indeed. "Hideous mutilation may be produced, destruction of the eyes, contraction of the mouth."*

But Finsen has been thinking as he wrought, and has caught a glimpse of a ray of hope, and bids the whole world rejoice with him and share anew in the glad pæan of praise that has been reverberating down through the countless ages since "the morning stars sang together," the praise of light.

In 1897 Finsen gave to the world his epoch-making paper entitled, "The Treatment of Lupus Vulgaris by Concentrated Chemical Rays," a form of treatment he had been putting to a practical test for two years, ever since 1895. In it he starts off by noting that the powerful germ-killing influence of light is now well recognized, hence, theoretically everything is in favour of its use in superficial skin diseases caused by germs, but its use for this purpose has been practically neglected. Some had

* Jacobi-Pringle, "Dermachromes."

already used light for the treatment of lupus, but it was either the heat rays of the focussing glass, or if light rays were used they were in too weak form to be of value. And so he determined to take up the s udy of this question from the beginning, as he seems to have done with every subject he investigated. And, as this germ-killing action of light is slow, it is necessary to concentrate it by mirrors or lenses, taking care to exclude the heat rays, the ultra-red, red, orange, and yellow, which would destroy the tissue by combustion, while the more easily diverted rays above them are the more active germ-killers.

Before constructing any apparatus to put to practical use his many discoveries, he first made sure that the germ-killing action of light actually did increase in proportion as the rays were concentrated. To do this, he coated the insides of two flat bottles with gelatine peptone, a material used for the cultivation of germs, and this soil he sowed with cultures of germs in pure bouillon (Bacillus prodigiosus which causes the red mould on bread, and Anthrax bacillus). Outside the bottles he gummed paper black on one side, white on the other; the white side out to avoid absorption of heat rays, the black side next the glass to prevent the light affecting the cultures where so protected from it. Several round openings were cut in the papers, and across the openings were traced on the glass in Indian ink numbers, indicating in minutes how long each opening was exposed to light. From one to two hours after sowing the germs, the flasks were exposed at the same time, one to direct sunlight, the other to concentrated sunlight. They were then kept from one to two days in darkness to allow the cultures to develop, in which time the results were very apparent, for "the numbers indicating the space of time in which the light had killed the bacilli were clearly marked on the culture by the colonies which had developed in the shelter of the parts colored black. In this manner the bacteria themselves indicated the time of exposure necessary to kill them." By many similar experiments he proved that sunlight concentrated by means of his apparatus killed microbes fifteen times more rapidly than direct light, and that the effects of the concentrated arc-light are very much more intense.

As light penetrates all tissues, even the bones, and as oxygen is necessary to enable light to kill germs, and as blood contains more oxygen than any other constituent of the body, Finsen first thought that the more blood there was in the part to be treated by light, the better it would be. But he soon found out his mistake and tells us of it. Placing a piece of photographic paper (papier ariosto) behind the lobe of his wife's ear, he allowed a cone of blue-violet light from his solar apparatus to fall upon the opposite side of the ear. At the end of five minutes there was no change in the paper, but on repeating the experiment while pressing the blood out of the lobe by means of a piece of glass on each side of it, the paper was blackened in twenty seconds. So that blood has a very great deal to do with preventing the penetration of the chemical rays. Therefore he devised glasses of different shapes to press the blood out of parts while being treated.

He was now ready to try this plan of treatment by concentrated chemical rays in different germ diseases of the skin, and especially in lupus vulgaris, which he considered presented especially favorable conditions, for it is caused by the tubercle bacillus, is local, is frequently superficial, and light can kill the Bacillus tuberculosis, and not only kill the germ, but also excite and stimulate nutrition and excite activity in granulation, thus assisting recovery.

FIG. 1—Finsen's Original Solar Apparatus.

The method of treatment varied somewhat according to the severity of the disease, and the tolerance of the tissues to the action of light. An area of from one to three centimetres in diameter was subjected to the concentrated chem˙cal rays daily, for several days or several weeks as the case might be. The treatments lasted at least two hours at first, later, with improved apparatus, one hour. When one spot seemed to have been sufficiently treated, another was attacked until the whole affected area had been gone over. Then, if any suspicious spots were left, they were attacked. Patients were examined occasionally after some months, and treated, if necessary, until no further spots were to be found. Each patient had a nurse who kept the spot in range of the rays, and saw that the rays fell perpendicularly upon the pressure glass. The immediate effect of the treatment was to cause inflammation of the skin (erythema) which was sometimes quite severe, depending upon the intensity of the light and also on idiosyncrasy; sometimes there was swelling of the parts, sometimes blistering, and crusting over.

When the parts had been sufficiently treated, the raised edges became flat, the redness disappeared, the parts became natural in appearance, and if there was ulceration it healed over. Scars were quite insignificant. The effect of the treatment continued for some time after the treatment was stopped, sometimes for several months.

The first apparatus used was one for concentrating sunlight, it consisted of a hollow plano-convex converging lens, 20 to 40 centimetres in diameter, filled with water colored blue by methylene blue or an ammoniacal solution of sulphate of copper, to exclude most of the heat rays. Later, the coloring matter was omitted as excluding too many useful rays. Blue cut out most of the ultra-violet rays, while clear water absorbs the ultra-red rays largely, and it is chiefly the latter rays which cause the heat. Through this simple apparatus mounted on a forked stand, which could be raised or lowered, the rays of the sun were focussed upon the diseased area, the patients sitting in chairs, or lying on tables out in the open air.

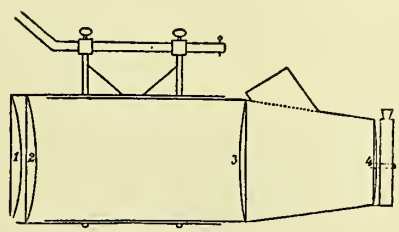

FIG. 2—Diagram of Finsen's Original Arc Light Apparatus, showing large glass lenses and heat filter.

But, as the sun's rays were not always available, the voltaic arc was utilized, the rays of which being divergent, unlike the parallel rays of the sun, required a different contrivance somewhat like a telescope, consisting of two cylinders, each containing two plano-convex lenses. Two close together at the outer end of the outside tube, and having their plane surfaces towards the source of light, to cause the divergent rays to become parallel; the two other lenses so arranged as to make the parallel rays become convergent into a cone, which is allowed to fall on the part under treatment, but not at the focus but a little in front of it. Between the two latter lenses there was a layer of distilled water, and outside at the end next the patient a light filter of blue solution, which was later discarded. The intensity of the arc light used varied from 35 to 50 amperes. The apparatus was suspended from the ceiling of the room, and to economize the electric current, four tubes were placed about the arc-light at an angle of 45 degrees, so that four patients could be treated at the same time from one lamp.

During 1897 Finsen made several improvements in his apparatus;

he used an arc-light of 80 amperes, and had his lenses constructed of rock crystal, (quartz) which allows the ultra-violet rays, which are absorbed by ordinary glass, to pass; the power of these rays to destroy germs being much greater than that of the visible chemical rays. The effect of these improvements was to increase the curative effect, as well as the rapidity of treatment. With it he was able to kill the bacillus prodigiosus in one minute, and a lupus the size of a pea disappeared completely after a fifteen to twenty minute exposure. Unfortunately, rock crystal lenses are expensive and can only be obtained of small dimensions.* Further improvements n the apparatus consisted in placing an additional cooling chamber surrounding the lower portion of the tube; and also the distilled water chamber between the lenses. By means of inlet and outlet tubes connected by rubber tubing to a source of water supply, the cold water thereby kept circulating in the chamber kept the distilled water between

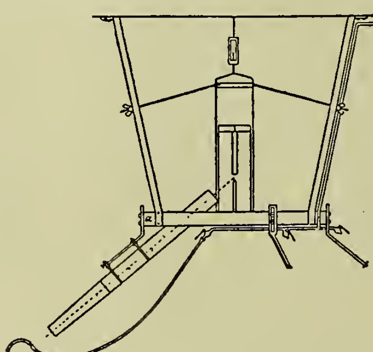

FIG. 3—Diagram showing Improved Tube, its relation to the arc and cooling device of pressure lens.

the lenses cool, otherwise it became boiling hot. But in spite of this extra cooling device the light was still too hot for the patient, so Finsen devised a hollow compressor, consisting of a plate of rock crystal (quartz), and a plano-convex lens of rock crystal, set in a conical ring, leaving a space between; an inlet and an outlet tube in the ring permitted a constant supply of cold water; by means of arms projecting from the ring, the compressor could be either firmly fastened on, or held by the attendant nurse. The pressure exerted upon the part, driving the blood out of it and thereby permitting better penetration of the chemical rays, which passed more readily through the crystal and contained water than through the former glass.

Finsen recognized that the method was capable of much improvement, the greatest drawbacks being the length of time occupied by each

* "Quartz is very prone to break along its line of crystallization and the cutter never knows when this accident may befall. The author has been informed that as much as a ton of quartz was used befor a perfect single focal lens of quartz two inches in diameter was obtained." Cleaves' "Light Ener gy."

treatment, the time necessary to effect a cure, and the expense of the apparatus.

Finsen's first patient for treatment by the concentrated chemical rays, had been trying for eight years since the lupus had appeared, various forms of treatment without avail; the side of his face had been operated on twenty-five times; had been cut, scraped, burned with acids and with hot irons. In the autumn of 1895 Finsen began to put his theory to the test. The apparatus used was of the simplest description; the rays from an ordinary electric arc light were converged upon the diseased side of the face daily for one or two hours, by means of a hand lens, a reading magnifying glass, the heat rays being filtered out by passing through blue solution in a glass capsule. In six months the patient was cured, and the irritant chemical ray, so harmful where small-pox is concerned, was proved a stimulant, and a positive curative agent in lupus vulgaris.

Finsen saw at once the possibilities of light cure in this and similar conditions, but recognized that in order to carry on the treatment properly, expensive apparatus was necessary, and a suitable place for patients

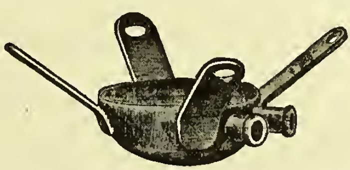

FIG. 4—Pressure Lens of Rock Crystal with cooling device.

undergoing treatment. All this required money and he was a poor man. At first, of course, there was much scepticism manifested, as this disease had hitherto proved so refractory to all manner of treatment. But soon two wealthy Danes, Mr. G. A. Hagemann and Mr. Vilh. Jorgensen came to his aid with financial assistance, and largely through their generosity the Light Institute was founded in Copenhagan, in April, 1896. The Commune Hospital of Copenhagen, the municipal hospital, gave space in its gardens for several small buildings, and in these Finsen's experiments went on, in more extensive form. Such good work was done at the Institute, that the Danish Government came to its support, the State granted a loan free of interest, and on August 12th, 1901, the Institute was removed to Rosenvaenget, a pleasant suburb of Copenhagen, and was also considerably enlarged, being comfortably housed in a handsome stone building with large airy and bright rooms, and provision for treating two hundred patients daily. It contains laboratories and a clinic for the carrying out of phototherapy, and particularly for the treatment of lupus and other diseases of the skin by concentrated chemical light. The program of the Institute is, "To make and support scientific research concerning the action of light upon living organisms, and especially to apply the results to the service of practical medicine." Finsen fully recognized that his discoveries, important as they were, could only be regarded as a first step, not as a finality.

It is said that in the first six months of its existence, only ten or twelve cases came to the Lys institut, and one nurse sufficed, but since its establishment, over two thousand patients, coming from all parts of the world have been treated, with a record of about 98 per cent. of cures; there are now six doctors on its staff, and it employs about sixty nurses. The work done there is chronicled in a special publication in Danish and German. McClure has a capital description of the way work goes on at the Institute written by Cleveland Moffett, and I cannot do better than give you his charming word picture in full.

"Suppose we look in now at Finsen's Light Institute and observe something of its practical working. One is struck first of all at the beauty of the place, set in the midst of lovely gardens, shaded by fine trees, and walled about with vines and flowers. No cheerless hospital this, but a handsome villa in the choicest part of Copenhagen. Here are the laboratories and Finsen's home, and just adjoining, a long white two-storey building where patients are treated; all this a gift of the Danish Government. As you glance through the hedges, you see a glow of red light like a foundry and figures moving behind wide-open doors. These are the lupus patients, and the glare is that of the red-shaded Finsen lamps, for each lamp has the intensity of thirty-five thousand candles, and there are seven in one large room.

"The seven lamps with their glowing red curtains are seven centres of cheerfulness, and under each one you are surpired to see laughing, chattering groups, eight people to a lamp, four patients and four nurses. The patients lie comfortably on high cots and receive the light from four down-slanting tubes like telescopes, in which are the costly rock-crystal lenses and the water for eliminating the heat rays. These tubes the nurses move into position so as to focus an intense concentrated beam, yet sufficiently cool, upon the surface under treatment, usually some part of the face, and they also press the surface with a water-filled glass which serves the double purpose of freeing the tissues from blood and still further cooling the rays. That is about all there is to the treatment, which goes on thus in seances of an hour and a quarter a day for each patient, and, being quite painless, leads naturally to pleasant sociability in the various groups.

"In moving about the room one sees patients of all ages, from four to seventy, and more women than men. They come from different countries and speak various languages. Several are from England, attracted by the small cost of treatment, only sixty kroner a month (about eighteen dollars) for the very poor, or 100 kroner for those in better circumstances. Fancy being cured of lupus, actually cured, for a dollar a day: Here is a German girl busy with her sewing while she waits her turn at the lamp. She was meant to be pretty. Here is a man with his collar off, taking the treatment fast asleep, as often happens. And watch the nurses, very neat in their gray and white frocks, as they bend over their charges. Red spectacles guard their eyes against the dazzle, their arms are bared to the elbows, their hands are busy with the light, and on their faces is a glow which is partly an up-reflection of the rays and partly an outward reflection of kind thoughts, for there is a peculiar dignity and sweetness in these Danish women.

"So the seance drowses along with a low buzz of talk and the regular clicking of the lamps as the clockwork feeds down the carbons. Sundays and week days alike throughout the year, the light cure is in operation, and has been now since 1896, in which time the actinic rays have shown abundantly what they can do in destroying the bacteria of lupus. Not in a few weeks, it is true, but surely, after such time as is required—sometimes months, occasionally years when the disease is very bad. And it should be borne in mind that most of the cases received up to the present have been bad ones, lupus of twenty, thirty, or even forty years' standing."*

The stimulating action of light is clearly manifested in another manner also at the Lys-institute, for "both patients and nurses in Finsen's clinic acquired a thicker growth of hair on those parts which were exposed repeatedly and for a long time to the powerful electric ray."†

The results claimed for the treatment of lupus vulgaris by concentrated chemical rays, about 98 per cent. of cures, is a truly wonderful record, when all the failures of the past are reviewed with all their hopelessness. And, so, many attempts have been made, and in many lands, to improve upon the original apparatus of Finsen; for the initial cost of the lamp, and the cost of its maintenance, and the cost of a special nurse for each patient, together with the length of time consumed for each treatment—one hour or more—and the prolonged period of treatment, several months, or perhaps years, have combined to render this form of treatment rather unpopular. It is quite impracticable to treat cases satisfactorily unless at a public institution, such as the one established by the great discoverer himself, or in a room specially arranged for the purpose and devoted to no other use. But, ingenious as many of the

* Cleveland Moffett, "Dr. Finsen and The Story of His Achievement." "McClure's Magazine," February, 1903.

† Freund, "Radio-Therapy"

substitute contrivances are, none of them can compare with the original lamp of Finsen. Many of them give out rays very rich in the ultra-violet light, some much richer than the original lamp, and capable of killing germs comparatively near the surface in very much less time; but these more rapid germ-killers labour under the universal disadvantage that their rays do not penetrate so deeply as those of the original Finsen lamp, which gives out rays of much lower rate of vibration than they do, although deficient in the upper ultra-violet rays as compared with them.

The result of all this most meritorious striving for better things has been not only the exercise of much ingenuity, but also the attraction of much earnest thought in the direction of light and light-treatment, that else had trended otherwhere. In many styles of substitute lamp, the great aim has been to bring the source of light energy closer to the part to be treated, also to have fewer lenses intervening, hoping thereby to husband many of the active rays that would otherwise be absorbed in the lenses and the intervening space. Again, others have incorporated different metals with the carbons which go to form the arc; and others have substituted iron or other metals for one or both carbon electrodes, thereby effecting a marked saving in the amount of electricity consumed,

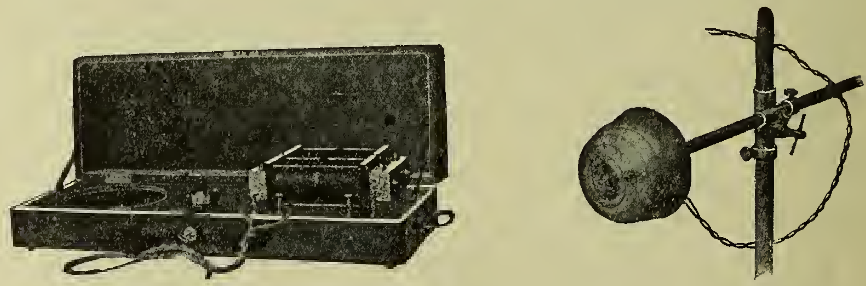

FIG. 5—The "Ultra," with iron electrodes, one of the many outcomes of the Finsen Light.

and increasing notably the proportion of ultra-violet rays given out, the vapour of the burning iron giving a spectrum very rich in the wished- or bactericidal ultra-violet. But these while gaining in ultra-violet, have lost proportionately in the less refrangible, more penetrating rays of lower frequency, and this fact miltates against, or even prohibits their successful use in deep seated affections. Were lupus confined to the surface of the skin alone, the victory would lie with the "improved" apparatus.

But, in spite of all that has been done, the original Finsen lamp, with such modifications as have been introduced by the originator of this treatment himself, remains to-day the only reliable means of carrying out his light treatment in the more severe and deeper seated cases.

And yet, wonderful is the law of compensation; all this ingenuity is not lost, for the advent of the smaller and cheaper instruments has opened up a far wider field for treatment than would fall to the lot of the Finsen light proper, in diseases due to germs, parasites and fungi, and not so deeply seated as is lupus. Indeed, many of the apparently hopeless cases of lupus itself are amenable to the iron electrode arc rays, even after twenty-five years' standing.

Finsen's assistants have played no small role in the development of the minor instruments of iron arc and others, for, being thoroughly unselfish, he encouraged all who were trying to improve on his methods.

Then, another thing happened. In the quest for a substitute for the time-consuming lamp, the x-rays were tried, and it is an undoubted and chronicled fact, that the first successful use of the x-ray as a curative agent, was in the treatment of the same disease, lupus vulgaris, in which the light treatment was so successful. This is more than a mere coincidence. And it is interesting to note that the only hitherto successful claimant to the honour of being able to cure this horrible disease in its worst forms is the x-ray. And, to-day, the very best treatment consists in the careful discriminating use of these two agents as the main features; anything else of value is merely secondary. Which is one more debt we owe Finsen.

And the vast fields opened up, not merely in diseases of a purely local nature, but in those of a general character also, add fresh lustre to this already most brilliant reputation, and attest anew how deep and how full of hidden riches were the caverns of knowledge he explored, and how unfailing and far reaching was his greed for light, and to know what it was and what it could do. He planted, and we are only beginning to reap the harvest, and to realize in a very small measure how well he wrought and how much we owe to him.

It was but natural that such a self-sacrificing student of nature and her wondrous hidden ways should attract to him kindred spirits, warmed by his enthusiasm, cheered by his counsel, encouraged by his example, fired with his ambition to know all, letting nothing escape their keen scrutiny, and alike with him exact with exceeding exactness. And such indeed was the case.

It was his privilege and in part his reward, to surround himself with many such, and the results of their combined labours merit naught but unstinted praise for the accuracy of their observations, and the clear manner in which they have elucidated many a problem otherwise obscure, and for their exactitude in chronicling the time in which the different sources and varieties of energy produced certain effects, establishing thereby a standard of dosage, as it were, for particular cases, according to the source of energy.

What did the world of science think of Finsen while he was still alive? Let us hear the testimony of the most widely accepted continental authority on light-therapy, Dr. Leopold Freund of Vienna. After chroncling a long list of honored names of those who had also labored in this most alluring field, and setting forth all that they had accomplished, he says; "None, however, has done such work for the furtherance of light-therapy as Finsen (from 1893 onwards). He first made careful experiments of his own, and tested thoroughly those of others, and then, having laid a sound theoretic basis, he constructed the apparatus by which he was able to prove the usefulness of light when applied in its most intense form to malignant growths such as lupus."* Like praise is accorded by one who has done by far the most valuable work on this continent in light-energy, Dr. Margaret A. Cleaves of New York. In her recent splendid volume, "Light Energy," alluding to the fact that precisely similar apparatus had long been used for experimental purposes, Professor Freund having cited that in the Vienna Institute for Practical Pathology, Dr. Cleaves goes on to say: "All of which is illustrative of the fact that the means to the attainment of a definite end in all matters of scientific development lie at our door awaiting the interpretation of and application by the intuitive intelligence. Such is the order of the genius possessed by Finsen, and having proved by his experimental work the action of light he was at once able to supply the needed apparatus for the utilization of the intense chemical frequencies of light energies from an electric arc." "It is not necessary to corroborate Finsen's work in lupus vulgaris by that of any other. It stands unparalleled and needs neither proof nor disproof."

It was Finsen's rare privilege to be appreciated by his confreres and the public ere he passed away. And that was another great reward. Paintings of merit acquire more value as they grow older and after the artist's death; and a man's life work usually requires the perspective of time before its true worth is acknowledged; but it seems as though Finsen in upsetting many theories with regard to light, likewise upset this utterly wretched theory with regard to life—which is so akin to light—and was the recipient of sincere and unstinted praise and honour from most varied and unaccustomed quarters, during his all too brief existence.

The Royal family of Denmark became deeply interested in his work very early, and in this manner Her Majesty, Queen Alexandra, then Princess of Wales, and her sister, the Dowager Empress of Russia, while

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* Freund "Radio-Therapy."

on their customary yearly visit to their father, King Christian in Copenhagen, investigated the work at the Lys-institut for themselves and saw there what was being done, and were so much impressed with the results that were being obtained, that on returning to their respective countries they took steps to have the whole matter looked into by independent observers of highest repute. And so, in 1898, the Prince of Oldenburg was sent from St. Petersburg to Copenhagen by the Empress of Russia, and was accompanied by three very eminent physicians to study the methods of Finsen. On their return, they had a most favorable report to give, and, as a result, a light institute was opened in St. Petersburg.

Nor was the Princess of Wales less impressed, or less active in this praiseworthy mission of help for the helpless, for in a private visit in July, 1899, to London Hospital in Whitechapel, the poor man's hospital in the poor man's district, the Princess enquired at great length as to the treatment carried out with regard to lupus cases, and informed the rather incredulous surgeons that a compatriot of her own had discovered a cure, and that she had personally seen results of the treatment at Copenhagen, offering at the same time to present a Finsen lamp to the Hospital, which generous offer was gladly accepted and arrangements made for the installation of the apparatus, and on May 29th, 1900, the lamp was ready for service. Meanwhile the senior physician of the hospital, Dr. Stephen Mackenzie and Dr. Sequeira set off for Copenhagen to study the treatment; two nurses were also sent to be trained in the methods, Her Highness doing everything possible to make their visit pleasant.

As soon as treatment was commenced at the London Hospital a tremendous number of patients presented themselves, and a second lamp was soon added. But even this did not suffice to accommodate all the sufferers. Each lamp was of thirty thousand candle power and could be utilized on four patients at once. The cost of working one of these four tube lamps amounted to about $3,000 per year; this added greatly to the burden already borne by this great charity. The wonderful work that was being done came to the notice of Sir Alfred Harmsworth, and he and Mrs. Harmsworth decided to endow one of the lamps in perpetuity. Soon after this Mr. Percy Tarbutt raised a sum sufficient to endow the second lamp, namely, $50,000. Other lamps have recently been added, together with some improved and smaller ones, so that at present twelve patients can be treated at once, each requiring a nurse.

The good example of royalty was followed soon, and lamps were installed at Charing Cross and Westminster Hospitals, Liverpool, Manchester, Royal Hospital in Dublin, and elsewhere in Great Britain. But even with all this provision, the capacity of the lamps is overtaxed at all times and the "waiting list" is lamentably long.

Chiefly through the influence of the Queen of Greece a Light Institute was opened at Athens, and among other places where treatment by light is now carried on may be mentioned Hamburg, Cologne, Munich, Vienna, Buda-Pesth, Paris, Cairo, New York, Baltimore, Washington, Chicago and Toronto.

Crowned heads seemed to vie with one another in their homage to this remarkable man. On the occasion of his last visit to Copenhagen not only did His Majesty King Edward and Queen Alexandra visit the Light Institute but called on Professor Finsen at his home afterwards. The Emperor of Germany when in Copenhagen a little over a year ago, was also a visitor to the Institute, and before leaving it said to the Crown Prince, "See that you erect a monument to Finsen during his lifetime." But the Lys-institut is Finsen's best monument. It is also related that the Dowager Empress of Russia, calling upon Finsen and finding that he was too ill to be seen, pleaded with his devoted wife to be allowed to see him, and on being admitted to his study, wept bitterly in sympathy with his suffering. And incidents like these might be multiplied almost indefinitely, all going to show the keen personal friendship that existed between this brave, uncomplaining invalid, and all the members of the Danish Royal Family.

What like was this man, who seemed to draw with irresistable magnetism, all who were privileged to come within the influence of his charm? What of the man himself? for we have dealt merely with his work. In answer it may be said that his work was his life. One writer has said of him that his "life was almost wholly the life of a mind; he had few physical capacities left him. All the physical strength he possessed merely entailed for him so much power to endure physical suffering. That is the great fact which makes his life marvellous; and see how much work, and what wonderful work, his courage enabled him to get through."*

Let us go back a bit, not far, for he died young. Forty-five years ago the world had not known Niels Finsen, and the whole world was just that much poorer, for many a hopeless lupus sufferer died utterly unaided in his loathsome disfigurement. But now, from the altar of a life of almost endless pain and suffering there ascendeth, and shall ever ascend the sweet incense of hope and health for the sick and weary. Of him it may truly be said, "He gave his life for the sick."

Niels Ryberg Finsen was born on December 15th, 1860, on the Island of Stromo, at Thorshavn, the capital and chief town of the Faroe Islands, which lie between Iceland and the Shetlands, and belong to Denmark.

* "The Spectator," London Oct. 1, 1904.

His father was domain judge, and was descended from an old Icelandic family, hence some of Finsen's early years were passed at school in Reykjavic, the capital of Iceland, where he remained until his twenty-first year, passing his student examinations there. He then entered the University of Copenhagen in Denmark, at which he remained for eight years, graduating as Doctor of Medicine in 1890 at the age of thirty. As a student, he lived in the famous old Copenhagen Home for Students, the Regensen, the *Collegium regium*, built by Christian IV.

It is related of him that even as a young student he evinced that love of true freedom which became such a characteristic feature in the man. "It was at the time when the policy of the Estrum Government roused the ire and the wrath of its opponents to a degree rarely seen in Denmark. In some places the peasantry refused to pay their taxes, thereby incurring certain personal inconveniences, for which their sympathisers tried to recompense them by hailing them as a kind of martyrs. Some of these men had come to Copenhagen, and Finsen and his *Contubernal* (the student who shared his room), thought the Regensen ought to honour these champions of the good cause in some way. They knew, however, that the master of the College, the "Regensprovst"—dean—as he is called, was distinctly adverse to this kind of demonstration, but his permission was necessary, so they innocently asked his leave to entertain a few friends from the country, and it was readily given. The next day the worthy dean was much surprised at seeing paragraphs in the papers about a party of "Shattenägtere" (tax refusers) having been entertained at the Regensen with his, the dean's permission. Finsen naturally was jubilant."*

It is said that from the standpoint of examinations, (a most fallacious standard often) he was only moderately successful as a student, graduating in the second class. This was perhaps largely due to his attention having been already directed very specially to the influence of light upon living organisms; ascribed to the observation that he was able to work better in the well-lighted room of a fellow-student than in his own.† He knew that he felt less well when, for a time, he occupied a room facing the north.‡ Wihle yet a student he had begun those investigations and experiments that were destined to make him famous, and at the same time his inventive genius found scope in devising an improved breech-loading gun, cool summer houses, a new cooking apparatus, and later a variety of hæmatine lozenges. The investigations started in a small attic of the old Surgical College building. Sophus Bang, a fellow-student, believed with him that a complete revolution in therapeutics was necessary. Both became ill, and while Bang went to Switzerland to strive to regain health,

* Bröchner "Pall Mall Magazine."

† "Lancet," London. ‡ "Pall Mall."

and is now one of the foremost anatomists of Europe, Finsen stayed in Copenhagen to conduct his researches in its foggy and cold atmosphere.

For the first three years after his graduation, up to 1893, as has already been said, Finsen had to content himself with the humble post of prosector in anatomy to his University; but with the publication of his first paper on the action of light upon small-pox he became famous, and after 1893 he was relieved of the necessity of teaching, and enabled to devote all his attention and energy when health permitted to his investigations in the nature and properties of light, and its applications to the treatment of various diseases. Wealth and a life of ease had no charms for him, he declined to make money out of his discoveries, or to patent any part of his apparatus, and was well-content with his modest salary from the Danish Government of $1,200 a year.*

The result of his self-sacrifice we have already seen. A fellow-countryman of his, Jacob A. Riis, says of him as he met him in 1899, while recovering from a fever: "I would sit in his little office down in the corner of the hospital grounds by the lake and watch the patients who had come in pain and gloom, go away, carrying in their faces the sunshine which had given them back their life. And I came to look with a kind of reverential awe upon this patient, silent man, whose every thought was for his suffering fellows, while he calmly counted the hours to his own relief from racking pain. I learned from his own lips the story of his great temptation; how when he found what he sought he lay awake one whole long night, debating with himself whether to turn it to account in private practice—Finsen is a poor man—or to give it and his life to the world. He chose poverty, and the world is the richer for his sacrifice; how much we can hardly realize under our brighter American skies, where the disease with the ravening name (*lupus*—a wolf) is comparatively rare." . . "Cradled in the island of storms and wintry night, he loved the sun. His eye lighted up when he spoke of it: 'Let it break through suddenly on a cloudy day.' he said, 'and see the change. Insects that were drowsy wake up and take wing; lizards and snakes come out to sun themselves; the birds burst into song. We ourselves feel as if a burden were lifted. In our daily life we give to the sunlight the place that belongs to it, without question. The housewife "suns" her clothes. We shun dark rooms, especially bedrooms.' . . With the spirit of the true investigator he went back to nature and considered the ant and the lizard, and their ways."†

Another writer, Cleveland Moffett, says of him! "It is fitting that a

* Moffett. "McClure."

† Jacob A. Riis, "A Word About The Man," ("McClure's Magazine")

great discovery touching the treatment and cure of certain diseases *by light alone* should be given the world by a man who lived in Iceland until he was twenty-one, and knew through all his boyhood the depressing influence of too much night." One of the first things Finsen said to him when he went to see him in Copenhagen was this, and he said it with touching humility: "All that I have accomplished in my experiments with light and all that I have learned about its therapeutic value has come because I *needed* the light so much myself. I longed for it so."*

A writer in *The Spectator* already quoted draws our attention to the fact that, "He was only twenty-three when he found that his heart and liver were hopelessly diseased, and, as if that were not enough to crush his desire to work, he was attacked by dropsy. He was, it is said, actually 'tapped' to relieve the dropsy more than thirty times. He had to realize, and realized with sheer bravery, that he could only keep himself alive by the strictest and most rigid discipline of diet. Every ounce of food and drink that he took was weighed,—for twenty years. Possibly in that time he lost—just possibly he never possessed—the desire to live naturally and joyously as most men live; but even if he never possessed such a desire—and there are some men who do not possess it—he as a student of medicine and biology, was always intimate with the possibilities and capabilities of a man's body; and the amazing keenness of his intellect must have brought home to him a poignant sense of loss which a blunter mind perhaps, would not have been able to realize. Yet he determined to live, not in the hope that life might bring him eventually freedom or partial relief from physical disability and grinding pain, but simply because, however painful life might be, the fact of being alive meant the ability to think."

This man who knew the very depths of suffering, would laugh at pain that would have rendered helpless many another. He even studied the diseases which he knew were to kill him some day; watched their progress; wrote articles on them for the medical papers, and on one occasion remarked with a humorous gleam in his eyes that he much regretted his inability to be present at his own post-mortem examination. A few weeks before the end, he sent a paper to the London *Lancet*, in which he maintained his unshaken confidence in the therapeutic value of the red light treatment of small-pox, stating that some who had recently had unfavorable results had not given the method a fair trial, in that all their patients were placed under treatment too late. This paper was published in November, 1904, after his death.

Finsen's home life was a very happy one, in spite of suffering. His

* "McClure's Magazine."

wife was a daughter of the aged Bishop Balsley, and helped him very faithfully in his great work, and he was a devoted husband and father. He had three children, the eldest about nine years old and the youngest about two. He was a staunch friend; his intense devotion to his favorite pursuit, his constant struggle against his physical disabilities, with such rare courage, his unusual modesty, and his total absence of self-seeking endeared him to all who came in contact with him.

When the Nobel prize in medicine was awarded to him by the Norwegian Parliament in December 1903, he said laughingly, "They gave it to me this year because next year would have been too late." He seemed to actually dislike money, perhaps as a friend of his has said, because he wished his son to be able to say in the words of the charming Danish poet, Holge Drachmann, "I thank thee, my father, thou wert not a wealthy man."* And so when the prize came, he at once wished to hand the whole amount, 100,000 crowns (about £8,000) over to his beloved Lysinstitut, and it was only with the greatest difficulty that his friends were able to persuade him to allow one-half the amount to be placed at interest for the benefit of his family, the remainder going to the Institute to carry on the work he initiated. But his old friends M. Hagemann and M. Jorgensen comforted him immediately by presenting the Institute with an additional 100,000 crowns.

Finsen was very fond of music, but did not play any instrument himself; he was also much interested in art, and used to paint a little when too ill to go on with his researches.

His devotion to his work was so intense that his friends despaired constantly; he scarcely took time to sleep or eat, and his death was doubtless hastened by overwork aggravating the diseases from which he had suffered since manhood.

The Copenhagen *Daily Vort Land* paid this tribute! "According to ordinary human reckoning, Finsen's life was too short, yet he was given time to accomplish great things and to prepare the way for his followers. The universal judgment of him will sound like a universal thanksgiving—thanks from the land whose honored son he was, thanks from the scientific world for which he opened up new avenues of achievement, thanks from the unfortunates from whom he lifted the heavy burdens of disease.

"Himself an invalid since early youth, his first and last thoughts and desires were to aid others. What he has accomplished has been indorsed by all civilized countries, and more than twenty great sanatoriums in as many cities throughout the world stand today as lasting monuments

* Bröcher. "Pall Mall Magazine."

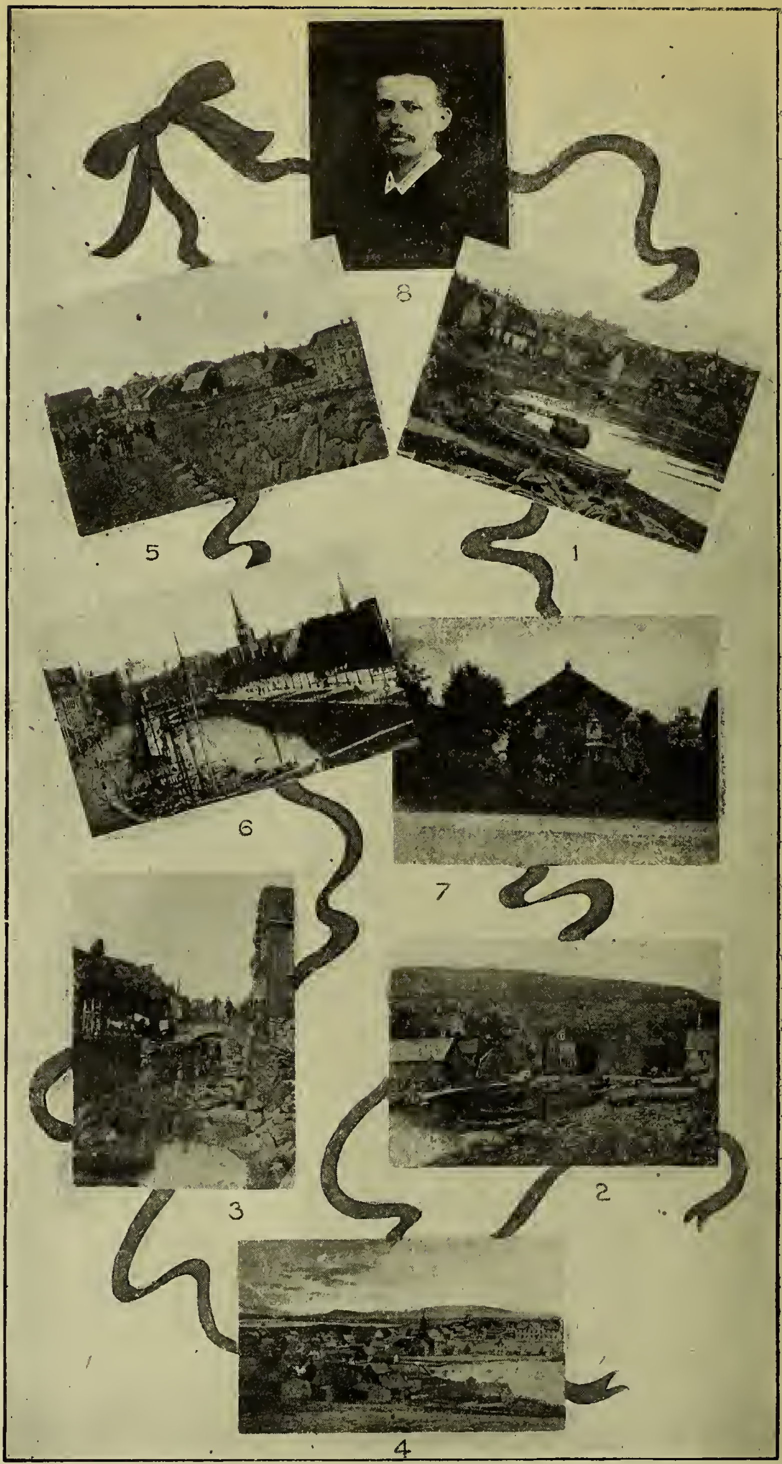
to his fame But he who did so much for others was himself a sufferer from a disease which baffled medical men. A few days before his death he requested his physicians and friends to perform an autopsy on his body in order that, even in death, he might serve his profession. The dissection revealed the fact that he had been suffering from slow ossification of the heart membrane, a rare disease, which generally results fatally after a much shorter period than it did in Finsen's case. His remarkable will-power no doubt prolonged his life for several years; he simply *could not* leave the labour he loved."*

And so, on Saturday, September 24th, 1904, the "wolf-slayer" went home to rest at last.

Copenhagen mourned as completely as when six years before her beloved Queen Louise died. The whole two miles of the procession was lined with respectful, silent crowds. The ceremony took place in the Marble Church. The services were attended by King Christian of Denmark, King George of Greece, Her Majesty Queen Alexandra and the Princess Victoria, the Dowager Empress of Russia, the Crown Princess of Denmark, all the Royalties in Copenhagen at the time. Queen Alexandra brought a beautiful wreath, and King Edward sent another from England. A deep impression was made when some two hundred persons who had been cured of lupus by the late Professor, took their seats among the mourners.†

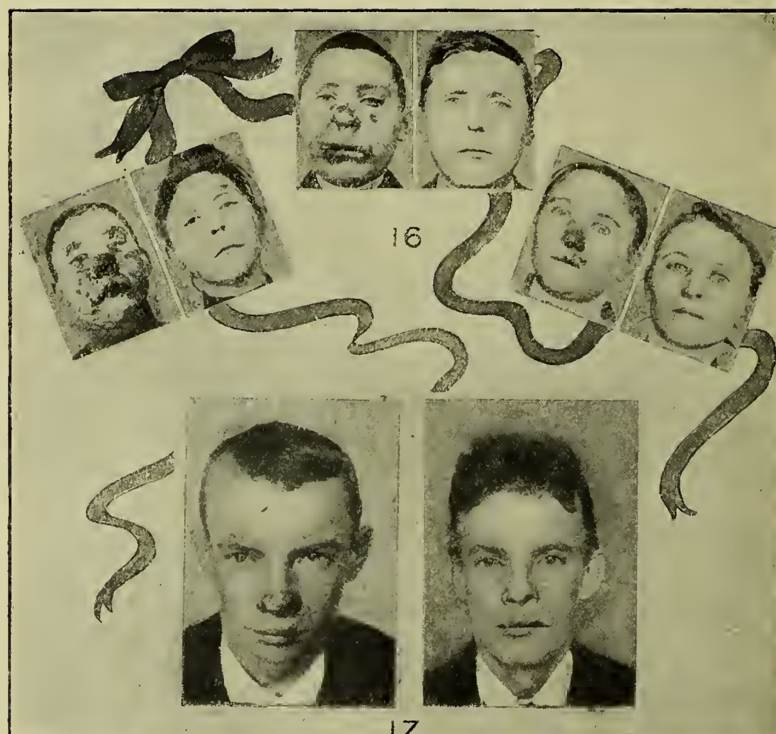
This paper cannot more appropriately be brought to a close than by quoting again from *The Spectator:* "One passage out of the many fine passages in which Robert Louis Stevenson has written of life and death, rises to the memory as a comment on the life of Professor Finsen. . . . 'It is better to lose health like a spendthrift than to waste it like a miser. It is better to live and be done with it, than to die daily in the sickroom. By all means begin your folio; even if the doctor does not give you a year, even if he hesitates about a month, make one brave push and see what can be accomplished in a week. It is not only in finished undertakings that we ought to honour useful labour. A spirit goes out of a man who means execution, which outlives the most untimely ending. All who have meant good work with their whole hearts, have done good work, although they may die before they have the time to sign it. Every heart that has beat strong and cheerfully has left a hopeful impulse behind it in the world, and bettered the traditions of mankind.'"

* Quoted in "Literary Digest."
† "The Graphic," Oct. 8. 1904

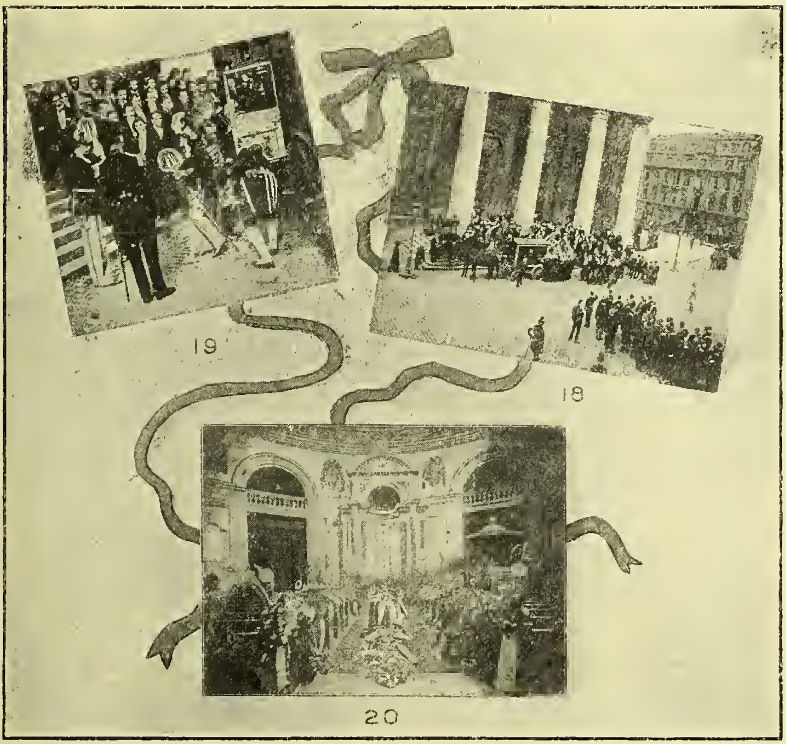


1. Thorshavn, Stromö, Capital of the Faröes, from the Harbour, Government House.
2. South Harbour, Fish Stores, etc.
3. The Stream through Thorshavn.
4. Reykjavik, Capital of Iceland.
5. Business Quarter of Reykjavik.
6. Copenhagen, Capital of Denmark.
7. Finsen's Home, Copenhagen.
8. Niels Ryberg Finsen, "The Wolf-Slayer." Born Dec. 15th, 1860, at Thorshavn, Stromö, Faröe Islands. Died Sept. 24th, 1904, at Copenhagen, Denmark.

9. Finsen ready for work. 10. Royalty at the new Lys-Institut at Rosenvaenget, Copenhagen. Main Room. Visit of Queen Alexandra, Dowager Empress of Russia, Crown Prince and Crown Princess of Denmark, April, 1903. 11. The first Finsen Lamp in England. Presented to London Hospital by Her Royal Highness Alexandra, Princess of Wales, completed May 29th, 1900. 12. The first large Finsen Lamp in America, at Chicago. 13. The original Arc Light Apparatus at the First Light Institute (showing the tubes with large glass lenses). 14. Treatment by Concentrated Sunlight at Copenhagen. 15. King Edward and Queen Alexandra at opening of new Finsen Light Room, London Hospital, June 11th, 1903.



16, 17. Cases of Lupus cured at Finsen's Lys-Institut, showing also increased growth of hair from effects of light stimulating the scalp.



18. The Funeral Procession leaving the Church. 19. King Christian of Denmark entering the Church.
20. The Lying-in-State.