tute a portion of the bismuth by tannin or iodoform or both. When the pain in deglutition is severe, you can give your patient the greatest relief by the application to the ulcer, by means of the laryngeal brush, of a solution of tannin and carbolic acid in glycerine; I use four grains of morphia, thirty of tannin, and twenty of carbolic acid to the ounce of glycerine. The relief which I have been able to procure some of these cases by this application has given me more satisfaction than anything else during my professional life. In illustration, I will cite only a couple of cases: A gentleman called on me some time ago, in a most piteous condition, who, on account of the pain, had found it impossible to swallow for a week. Upon laryngoscopic examination, I found a large and deep ulcer on the lingual surface of the epiglottis. I brushed this solution well over the surface of the ulcer, and he returned to me the next day, having eaten his supper and breakfast without the slightest difficulty. I made another application, and then saw nothing more of the patient for about two months. On his return, he told that me he had not suffered in the least since the last application, until the last few days. I made another application, and the patient has not again returned.

In another case, there was a large ulcer on the ventricular band of the left side, and extending to the inter-arytenoid fold; the pain being so great on attempts to swallow, that the patient was unable to take either fluids or solids. I made an application which relieved the pain entirely, and made the patient comfortable for nearly two days. Subsequently the applications were made nearly every second day, for several weeks, each time giving the patient almost complete immunity from pain, for from forty to forty-eight hours, with the result of allowing the ingestion of food and drink, and prolonging life for a couple of months, until the patient succumbed to the constitutional disease.

Original Articles.

THE USE OF MECHANICAL RESTRAINT IN INSANE HOSPITALS.[1]

BY WALTER CHANNING, M. D.

THIS brief paper does not pretend to be an exhaustive one, but was written for the purpose of bringing the subject of which it treats especially to the attention of that portion of the profession not engaged in the treatment of the insane. Every one knows that certain forms of restraint are used in hospitals, but what they are, how applied, and why is not generally known. It is to just this lack of a mutual understanding between insane hospital authorities and the public that we owe the continued prejudice and want of confidence still felt to a certain extent in insane hospitals. There is and can be no disgrace in the principle of mechanical restraint, and no public sentiment should prevent the frank avowal of this fact.

Up to the beginning of the present century, though in some countries the treatment of insanity showed indications of improvement, it was still largely barbarous and unchristianlike. Insanity being a development of the brutal side of human nature, it was natural in the dark ages to resort to harsh and brutal measures in dealing with it. Hence were created relations between the sane and insane similar to those between man and beast. As civilization progressed, but little additional knowledge was gained of the disease of insanity. If any changes were made in its treatment they resulted in little more than better concealing it from the public gaze. There is always a natural tendency to cover up the weaknesses of mankind. We strive after the high and pure and virtuous in life, but detest and shun weakness and vice. So insanity was regarded as a sort of punishment for past sins. The lunatic was prematurely cast into hell, consigned by a just fate, and no helping hand was extended to save him. To this public sentiment is due the fact that the insane suffered in dungeons and chains so many years. It was not any enlightened public view which finally effected some amelioration in the condition of the insane, but a strong and determined stand taken by a few of the physicians engaged in their treatment.

Up to the advent of Pinel in France in 1792 every form of torture was used to subjugate unfortunate lunatics. Besides chains, shackles, handcuffs, and other means to confine the limbs, they were reduced to abject terror by revolving chairs, swings, shower-baths, traps in the floor, etc. Pinel was one of those geniuses or reformers who, as Maudsley says, can only be born once in a century. He, seeing far beyond any of the men of that day, recognized the fact that insanity was a disease, and the brutality of its past treatment could only develop and intensify its manifestations. Accordingly, on his entrance into the Bicêtre he removed the chains of over sixty of the patients and gave the first impetus to the use of non-restraint. Many years later Gardiner Hill and Charlesworth carried the work still further, entirely abolishing mechanical restraint. It remained, however, for Connolly to definitely systematize the work and gain an immortal reputation by his efforts. He went to the Hanwell asylum in 1838, and there began his remarkable career, which was to affect the question of restraint the world over, creating its (apparent) entire disuse in English asylums. Connolly was carried away by his theory, and has said and written much that to-day seems almost incredible. The cases illustrating the new system and the results obtained show that Connolly was possessed of the enthusiasm and extravagance characteristic of reformers in other fields. Viewed in the sober light of to-day we see that many of his ideas were impracticable. He imagined a state of affairs impossible anywhere except in the lunatic asylum of paradise. His theory, as you know, was to abolish mechanical restraints *in toto*. In the place of these restraints, however, he proposed to use the arms and hands of attendants; or, in other words, to replace mechanical or dispassionate by brute or passionate force. Lord Shaftesbury has said that "there is nothing on the face of the earth half so provoking as a madman when he chooses to be so." Insane patients will destroy glass, crockery, furniture, clothing; attack other patients, or attendants, and sometimes even injure themselves, and often with an apparent clear understanding of the nature of such acts, more frequently, of course, acting under the impulse of delusions. These acts may have been repeated twenty times, creating the most dire confusion among the other patients. All arguments, reasoning, or persuasion are absolutely useless. Now if the attendants who have charge of these patients were angels in disguise, we might well leave the patients to be for-

[1] Read before the Norfolk District Medical Society, October 1, 1879.

cibly controlled by them. The reality is, however, of necessity different. In New England we have attendants who are drawn from a good class of farmers' sons and daughters, and are above the average in both English and American asylums. Those of them gifted with amiable, equable dispositions may treat the insane with the necessary forbearance and tenderness, but the human temperament is fickle, under provocation passionate, and often irritable, and as far as my experience goes attendants become wonted and in many cases hardened to sights of suffering and outbreaks of violence which they constantly witness. It requires, in the first place, a very high order of intelligence to appreciate the complex nature of such a disease as insanity, and in the second place such virtues as patience, firmness, kindness of heart, tact, and perseverance to personally manage with success its subjects. Connolly pictures a state of affairs where the patients are so quiet and lamblike that they can be subdued by a few words; but in this country such cases are the exception and not the rule. Hand restraint means with us the use of force. To allow the ordinary attendant to use personal force to restrain the patient in an outburst of excitement and violence seems to me in most cases highly undesirable. One attendant cannot control the patient; it must take two or three, and a scuffle must frequently ensue, sometimes to be continued until the patient is exhausted, and often to be again renewed. Such hand-to-hand fights are demoralizing, both to patients and attendants. Connolly dwells on the fact that sufficient help should always be near at hand, thereby frightening the patient by superior force; but it must be remembered that many attacks of violence are paroxysmal, and may occur when help is not at hand.

As another means of non-restraint its advocates use seclusion. Seclusion means shutting a patient up in a room. Sometimes it will be his own room; in other cases a dark, gloomy room, devoid of furniture, and but little better than a prison-cell. Padded rooms are sometimes used for patients who are very violent and would be liable to injure themselves. The latter rooms are in certain cases useful, no doubt; but as the strongest padding I have heard of can be torn to pieces, and is also liable to become soiled and unfit for use, they cannot be generally of great utility. Seclusion may work well for short periods, but when it is to take the place of mechanical restraint it must often cut patients off from association with others, thereby defeating one of the main objects of treatment. Seclusion leaves a patient more liable to neglect, and affords him an opportunity to indulge his vicious propensities, as well as to brood over past misfortunes and present ill treatment. It is so much easier to keep a violent and dangerous patient under lock and key that attendants easily, almost imperceptibly, get into the habit of secluding them. Seclusion seems to me, in a word, the first step backward to the solitary confinement of past ages.

For years the ultra ideas of Connolly held sway in England, but the reaction has now set in, and restraint is again being used, though only in a limited number of cases. Dr. Lauder Lindsay says, in a recent article on Mechanical Restraint, that "we have the lunacy commissioners themselves, as impregnated as they have been with Connollyism for the last twenty-five years at least, proving officially that various forms of mechanical restraint are employed at the present day in those English asylums that bear the highest reputation, as by those physicians who are by habit and repute distinguished for their humane as well as successful management." Dr. Lindsay further says that in the last Blue Book, or thirty-second report of the English Commissioners in Lunacy, which bears the date of August, 1878, and which therefore records the incidents in English asylums in 1877, he "finds no less than one hundred and twenty-three cases of mechanical restraint reported as having occurred in a single year in a limited number of private asylums, under circumstances, that is, in which such restraint was least likely to be used." Dr. Lindsay's paper on The Theory and Practice of Non-Restraint is one of the ablest papers on the subject that I have seen. In this he shows the various make-shifts resorted to to take the place of restraint, such as dry and wet packing, tight wrapping in a sheet, etc. He says in another place that "in the course of five and twenty years I have heard only of three out-and-out supporters of Connollyism, two of whom are Connolly's sons-in-law. "Dr. Bodington, superintendent of an excellent private asylum in England, and author of a recent able article on restraint, writes me that "the non-restraint system, though a misnomer and a sham, so far as the name goes, has done much mischief in this country. I hope it will not be successfully set up in America. It is a system of pseudo-philanthropy, not true philanthropy."

American physicians visiting English asylums generally come home with the idea that English superintendents favor the use of restraint. Two of them have recently written as follows: Dr. Stearns, superintendent of the Hartford Retreat, says, in his last Annual Report, "In reference to . . . . non-restraint (so-called) I presume no one would admit any change of opinion during the last five years; but I noticed a great readiness on the part of every superintendent to say that he would use mechanical restraint in certain cases. And the opinion was advanced that Dr. Bucknill, in his recent letters on the subject, had been extreme in his view, at least so far as relates to Scotch asylums; that all or nearly all superintendents would not hesitate to use mechanical restraint in extreme cases; that the principal difference between the practice, in this respect, of Scotch and American superintendents is as to *frequency* of use. Americans use it in many cases where the Scotch would avoid it." Dr. Shew, superintendent of the Connecticut State Insane Hospital, said in his Annual Report for 1878, "In my recent brief visit to European institutions I saw in use the same mechanical appliances that are found in American hospitals, namely, camisole waists, leather wristbands, 'protection beds;' and in one asylum the shower-bath — a form of 'mechanical medication' which I have not found in any American asylum — was in daily use with good results, according to the testimony of the assistant physician. With one exception, the medical officers in charge of British asylums conversed with me freely respecting the moderate use of mechanical protection in preference to personal seclusion, or manual restraint by attendants. The impression gained by these interviews and personal inspection of institutions confirmed the statement already made, namely, that during the past few years a strong and general reaction in favor of the moderate use of mechanical protection in the treatment of the insane had taken place."

The abolishment of restraint in English asylums has produced a decided change of opinion as to its use in

other countries. No doubt it is much less frequently employed. Neither America, France, nor Germany, however, believes in its total discontinuance. Dr. Pliny Earle, one of the foremost thinkers and writers on insanity in America, very vividly defined the position of asylum superintendents in this country as many as thirty years ago in the following words:[1] "The authorities of this hospital (Bloomingdale) have gradually abandoned the most exceptional forms of restraint. They have never, however, become proselytized to the doctrine of the absolute, entire disuse of all restraining apparatus. There are exceptions to all rules, which are not governed by the invariable laws of mathematics or of moral right, and no argument . . . can overthrow our belief, founded upon the observation of several years, that there are cases in which the welfare of the patient and the dictates of true humanity require a resort to some restraining means . . . yet those who in their recession from left hand defections have in our judgment fallen into right hand errors, assert that, in the cases alluded to, whatever restraint is applied should be the hands of attendants. To this subterfuge we cannot resort, knowing, as we do, the greater irritation produced in a patient by being held by the hands of attendants than by having his limbs confined by mechanical contrivances. In the former mind struggles with mind; in the latter with matter alone."

To elicit definite information as to the amount of restraint at present employed in our American hospitals, I addressed a few inquiries to the superintendents of Massachusetts state hospitals. The answer of Dr. Earle, for many years superintendent of the Northampton hospital, I propose to give nearly in full, as being a very clear and frank statement as to the amount of restraint actually used. Writing under date of March 28, 1879, he says: "You ask first for the percentage of mechanical restraint used in this hospital. Preliminary to an answer to this question, it is but just to the institution and its officers to state that, from its origin to the time of the opening of the new Worcester Hospital, in the autumn of 1877, the Northampton Hospital was the receptacle for the overflow of the other two State hospitals for the insane. The consequence was, that we came to have an abnormally large proportion of excitable, refractory, destructive patients. The proportion of such patients now is from two to three times as large as it was when I took charge of the hospital in 1864. This is emphatically true as applied to our wards for females." He says that he cannot give the exact percentage, but, omitting one patient who wears it from choice, "the percentage of mechanical restraint in our men's department is not over *one*. In the female department the proportion is about six per cent., and in the two departments, as a whole, about three and four fifths per cent.

"Of the *forms* of restraint we use the camisole much more than any other. Next, the leathern wristbands and wristlets. Occasionally, but rarely, the leathern muff is used in combination with these. For strong, dangerous men, I have found the common iron handcuff not only the most effective, but in my opinion the most humane form, as not causing those abrasions of the skin which are a not infrequent product of the leathern wristlet.

"I think the crib, or covered bed, employed with proper discrimination and judgment, a great blessing to the insane. Our total use of it for one season probably does not exceed two hundred and fifty nights for one person in the course of a year. Within the last two years we have had two patients, both of them bright, intelligent young women, for whom it was used during the active stage of their disease, who became so attached to it that after convalescence they desired to continue to sleep in it so long as they remained in the hospital.

"You ask my opinion of the use of restraint in the treatment of insanity. My opinion of it is expressed in my practice. I have always believed that the so-called non-restraint method of the English was not a product of the highest wisdom, or the most genuine humanity; and consequently have always believed, as I still believe, that it is destined to lose its adherents and become, by and by, a thing of the past. Nevertheless, while so believing, I have always endeavored, since my first connection with an institution for the insane, to reduce the employment of mechanical restraint to the minimum of what I believed to be true humanity. In my history of the Bloomingdale Asylum, published more than thirty years ago, I stated in regard to that institution that during the last three years (1845 — 1848) the muffs have not been used in more than two or three cases annually, and in those for but a day or two, or at most but a few days each. There was one period of thirteen months, during which restraint was resorted to in but two cases in the men's department."

May 17th, Dr. Earle added a postscript to this letter, in which he said: "I have kept this letter ever since March 28th for the purpose of verifying, to some extent, my estimate of our use of restraint. I now think the estimate fully large enough, but it probably does not differ much from the truth."

Dr. J. B. Brown, superintendent of the Taunton Lunatic Hospital, wrote me on March 7th that at that time the amount of restraint in use was five per cent., a considerably higher rate than Dr. Earle's. Why so much was used Dr. Brown did not state, but he said that it had been lower and might have been higher. In choosing between restraint and seclusion he much preferred the former when it would prevent the latter. He uses wristlets, belt, and mittens made of leather or strong cloth, and the camisole also. The protection bed he has had no experience with. He closes his letter by saying: "With a sufficient number of attendants, I think restraint can be reduced almost to a minimum, but am not convinced of the assumed benefits of non-restraint, so-called."

Dr. Parks, of the Worcester Lunatic Hospital, used camisoles, muffs, wristers, and the protection bed in one case. He regards mechanical restraint as not only a necessary, but a humane appliance in the treatment of some cases of insanity.

Opinions and the practice of numerous other superintendents could be given, but as they all advocate very nearly the views given above it is unnecessary. The best and most humane men in the specialty, for instance such men as Dr. Kirkbride, superintendent of the Pennsylvania Hospital for the Insane, are unanimous in their opinion that restraint under certain circumstances is desirable. Such views have not, however, prevented its discontinuance, and many of our hospitals have for long periods gone without it. Dr. Kirkbride uses almost none, and both at Hartford and Middletown Drs. Stearns and Shew have gone without it for more than a year at a time. Of the Asylum for

[1] Part Second in the History, Description, and Statistics of Bloomingdale Hospital. 1848.

Insane Criminals at Auburn, N. Y., where in old times restraint was largely used, and in its most objectionable forms, Dr. C. F. MacDonald, who has recently resigned to take charge of another institution, writes me as follows: "The amount of restraint has been gradually reduced until none has been used for nearly a year, but this 'non-restraint' has been reached through an accidental state of affairs, namely, the absence of cases of violent mania and others requiring restraint. I am a believer in restraint, and would use it in certain cases. In fact, I think it a neglect of duty to omit its employment in certain cases to be found in general asylums. I think that we should endeavor to maintain the *principle* of restraint, but at the same time to demonstrate the fact that American superintendents are equally desirous with those of other countries to reduce its use to a minimum." That Dr. MacDonald should have been able to do away with restraint for so long a period in an asylum containing over one hundred persons of the worst character is a good illustration of what can be done.

No one can doubt, I think, who has visited and examined into the management of our lunatic hospitals, that our superintendents are many of them making earnest and persistent efforts to do away with restraint in any and all cases if possible. They have the immense advantage, however, over England of not having instituted the reform. This leaves them in a position to profit by the mistakes made by their English brethren, thereby avoiding extremes, separating the wheat from the chaff, and adopting principles that must be finally settled on by all.

In large general asylums there must almost always be cases requiring mechanical restraint, but very much depends on the hospital management. Patients who are well fed and clothed, provided with suitable work and recreation, and kindly treated; who are made to feel that their comfort and happiness are the chief end of the asylum officials, are infinitely less irritable and difficult to manage than where the opposite state of affairs prevails. The more we strive, therefore, to improve the surroundings of the insane the greater will be the diminution in the restraining apparatus required.

I shall bring this paper to a close with a reference to the forms of mechanical restraint used. The following kinds have been mentioned in the letters quoted above, namely: wristlets, with waistband, both of leather; muff added to these; camisoles; mittens; gloves; protection or covered beds, or cribs. The wristlets which I show here are made of leather, soft and well padded, and possess the advantages of being easily applied, of being soft and light, and therefore comparatively comfortable to wear; and also of allowing quite free motion of the arms and use of the hands. The muff is a leathern covering added to the wristlets, and used to cover the hands where a patient is inclined to be destructive with them. It is hot and uncomfortable, and should be very rarely employed. The camisole is generally made of stout canvas. It is a modification of the strait-jacket, though so much modified as to lose the objectionable features of this barbarous apparatus. It is a tight fitting waist, lacing behind, and with long sleeves, to the ends of which are attached long fastenings. The arms are crossed over the lower part of the chest and the fastenings carried to the back. By drawing these fastenings very tight or winding them about the elbows a greater amount of confinement for the arms can be secured. Patients soon become accustomed to the camisole, and have often told me that they did not mind it. It has the advantage of keeping the clothes on, but at the same time, whenever these are to be changed, must be removed and reapplied, all of which may make considerable trouble. For women it is a natural kind of garment, and therefore better adapted to them than to men. The strait-jacket of olden times was a long, sleeveless jacket, extending from the neck to the ankles. It laced behind and fitted close to the body, drawing in tight at the waist. In such an apparatus it was possible to make only the most limited motion of any portion of the body. The arms, being bound down to the side, suffered excruciatingly from the confinement. Patients with this apparatus on were formerly attached to a stake by a short rope, and kept thus tethered for hours daily. This instrument of torture has gone quite out of fashion, but has been replaced by a similar garment going only to the lower third of the thigh, but still possessing many of the bad features of the old-fashioned jacket. It is at best a brutal form of restraint and should be entirely abolished.

The "crib," as it is called by its enemies, or the covered or protection-bed, as its friends call it, is like a child's crib, with a cover similar to the sides, which shuts down and locks. The sides are from three to four feet in height, and it is wide enough to allow of free movements of the body. Opinions among superintendents are divided as to its use; for instance, out of eleven consulted seven were in favor of it. I think most of those who have tried it favor it, while those who have not shrunk from its use on moral grounds. In such a case as this the experience of Dr. Earle must have great weight, and he, as we have seen, "regards it as a great blessing to the insane" when properly used.

Various other easy forms of restraint are used, which, however, are not usually dignified with the name and need not necessarily be mentioned here.

My own opinion of restraint is that under some circumstances we cannot dispense with its use. This opinion I have only arrived at after living month in and month out with the insane. In large hospitals there will always be a certain proportion of very violent and dangerous patients who must be restrained. The question to study is, How best to apply such restraint? In the first place, hospital attendants should themselves be taught that restraint is no more to be prescribed by them than medicine, and they should feel that the less they use it the better their standing. The apparatus used should be kept in the physician's charge and dealt out like medicine. Records should be kept of the forms of restraint used, why applied, for what length of time, etc.; the object of such records being to limit the use of the restraint, as well as to make open and public the exact amount of its use.

It is better to err on the side of too little restraint than too much. Especially is this true as applied to personal freedom. The greatest possible freedom of personal action should be allowed to hospital patients. While they will permit the occasional use of mechanical protection when excited and violent, they are keenly alive to the injustice of locking them in wards like wild animals and debarring them from the independence of daily life.

In arguing for or against restraint we are apt to forget that any kind of confinement is restraint, and the employment of a certain form of apparatus for

confining the hands of violent and dangerous patients is only one of the smaller points appertaining to it. That many if not most insane persons must be restrained in hospitals is undoubted; a much more vital question than the abolishment of *mechanical* restraint is, How can we make the necessary *hospital restraint* bearable? A gratifying instance of the result which the consideration of this subject has produced is shown by the following quotation from the last report of the Government Hospital for the Insane at Washington. The new building was in January last "occupied by about fifty men, carefully selected from among those patients who had been employed in the various departments of work about the hospital. A liberal diet was furnished them, and since these patients were trusted every day about their work, it did not seem necessary to bolt and bar their rooms at night. Accordingly all window guards were omitted from the window and the key turned only in the outer door at night. The result has justified our expectations; the door being wide open there is no need to jump out of the window; there being every facility to run away nobody wants to go; they are content with and rather proud of their new home. Of course this arrangement will not apply to all classes of patients, but the experiment will bear extension. Congress thought so, making $30,000 immediately available for the present relief of our overcrowded wards. . . . We hope the buildings when occupied will help to demonstrate some things in relation to the care and cure of the insane that have, in this country at least, been either but imperfectly apprehended or wholly overlooked."

The Government Hospital is following the example set us by our English brethren, and by and by we may be as successful as they are at Cupar-Fife and Lenzie in Scotland. At the latter hospital there are five hundred patients, but no locked wards, and the officers carry no keys.

DEATH BY LIGHTNING.[1]

BY MEDICAL EXAMINER JOHN L. SULLIVAN, M. D.

The following pages are, in the strictest sense, a compilation. The writer's acquaintance with the subject being imperfect and theoretical only, the production of an original paper was not attempted. In pursuing the task assigned to him by the society's president he has striven simply to collect and arrange in a convenient form for reference such matters relating to death by lightning as were thought to possess medico-legal value, and to be sustained by good authority. Although "marks of quotation" seldom appear, as a rule the language employed by the writers drawn upon has been retained *literatim et verbatim*.

In lightning shock what are the effects caused, and what, if any, are the distinguishing marks of death by lightning?

The effects caused by the passage of lightning or a fatal current of electricity through the animal body differ in different cases. The following examples of some of the so-called vagaries of lightning, taken from sources believed to be trustworthy, may be cited in illustration.

[1] Read at the February meeting of the Massachusetts Medico-Legal Society, 1880.

Lightning may heal as well as harm; it may abolish sight, hearing, and the power of voluntary motion, or it may restore the lost senses and cure paralysis. It may strip the body naked, and consume the clothing, while the wearer escapes unhurt, or it may consume the individual and leave his garments untouched; one person who is fatally struck may be hurled violently to a distance, while another is left in the precise attitude and spot in which death surprised him. One case shall present extensive anatomical changes, such as amputation of limbs, rupture of the heart, comminution of the bones, while in another case no injury whatever will be detected. One autopsy may reveal softening of osseous structures, collapse of the lungs, fluidity of the blood, and in another exactly opposite pathological conditions will obtain, to wit, engorgement of the lungs, coagulation of the blood, and rigidity of the muscular system. One thunder-stricken corpse shall undergo rapid putrefaction, while another shall remain for days unchanged, as if in defiance of the laws of decomposition. There may be sudden incineration of the body, or it may be consumed slowly as if by spontaneous combustion, and only gradually be reduced to ashes, or we shall not perceive the man dead until we touch him, and then see him fall to dust; one subject will present all the signs of death by freezing, another those of instantaneous petrifaction. Lastly, the immediate disappearance of the thunder-stricken person may occur, without leaving a trace of his body or any of its parts, thus summarily relieving the medical examiner of responsibility in the case.

It has been proved by experiments, the details of which would be out of place here, that these diversities in the phenomena of lightning shock are due to differences in the *quality* and *intensity* of the electrical discharges concerned in their production. The natural electrical discharges included under the general term lightning are not all one and the same thing; in short, there are several kinds of lightning, and each kind deals, so to speak, with the living organism in its own way. Sheet lightning, zigzag lightning, ball lightning are terms used in scientific as well as popular language to designate as many distinct orders of lightning. These differ from each other in several respects, notably in the appearance of the flash as perceived by the eye, in the quality of the shock or blow given, and in the effects produced.

Sheet and zigzag lightning have each a counterpart on a small scale in discharges obtained from a powerful induction coil. One of these discharges is made without the other discharge with the vibrating or mechanical break attached. The former is the analogue of sheet, and the latter discharge that of zigzag lightning.

Sheet lightning is either a simple flaming flash or a compound flash made up of two distinct flashes, a thin, tense flash combined with a flaming flash. The tense flash is destructive to life. The flame flash causes general muscular contraction, singes, scorches, perhaps blinds, or it may induce a state of insensibility or anæsthesia which may last a considerable time, but it does not necessarily destroy life. In lightning shocks we may see in the effects caused the evidence of one or the other of these discharges, or of both in one and the same subject. Thus, two persons standing together are simultaneously struck; one will be dead instantly, and his body will be singed and burnt, the other will be much shaken, scorched, and burnt, but