had been held responsible for the failure of the insulation of an underground alternating current circuit in a neighboring city, which was proven by the fact that, upon changing the route of the circuit, the cable in question no longer broke down.

As my experience of over six years with more than fifty such alternating circuits, representing a total length of about 300 miles of underground cable, had not disclosed any similar case, I was considerably nonplussed. It is therefore reassuring to learn from Messrs. Houston and Kennelly's calculations, that the maximum increase of voltage due to resonance on a circuit such as the one I refer to would be, under the most favorable conditions, about one volt.

The paper further shows that even on the very longest aerial circuits the devices which may be provided to protect the insulation from the effects of lightning discharges may safely be left to deal with the increased voltage due to resonance.

THE PRESIDENT:—We will now have the second paper, by Professor Anthony, on Underwriters' Rules.

[The following paper was then read by the author.]

A paper presented at the Ninty-sixth Meeting of the American Institute of Electrical Engineers, New York President Houston in the Chair. and Chicago, Manager A. S Hibbard in the Chair, April 17th, 1895.

UNDERWRITERS' RULES.

BY WILLIAM A. ANTHONY.

A recent controversy, in relation to inside wiring for incandescent lighting, has suggested to me the importance of bringing out a full and free expression upon the subject, from those whose experience gives them the best right to speak, and I venture to bring the matter before the INSTITUTE in the hope that it may provoke such an expression as may have some influence in determining the character of any changes in the rules for construction that may be proposed, or in fixing the interpretation to the rules now in force. The present rules are, of course, the result of a process of evolution, and I think every one will admit that the process has been one of progress. In early days of electric lighting, the desire to conceal the wires led to fishing them in between floor and ceiling and between plastered walls, as had been done with electric bell and burglar alarm wires. Fires occurred, and were ascribed to the electric wires, sometimes rightfully, but no doubt sometimes wrongfully.

Insurance companies took up the matter, passed rules and appointed inspectors. Many of the rules were good, some were only an annoyance to the construction companies. Different boards adopted different rules, and often the inspector was a law unto himself.

Wishing to assist in securing uniformity, and feeling that electrical engineers, who have to do with the practical work of electrical installation, are best qualified to frame rules for electrical construction, the National Electric Light Association, in 1890, appointed a committee to take the matter in hand, and upon the report of this committee, in 1891, adopted a series of rules, which,

with some amendments adopted at later meetings, may be assumed to represent fairly well the consensus of opinions among the electrical fraternity, as to what constitutes a safe electrical installation.

Rules, substantially the same as those, have been adopted by the National Board, and various local boards of fire underwriters, and are the recognized rules in force at the present time.

The object of all rules is first, to secure a safe and permanent installation; second, to provide for the repair or renewal of conductors in case of failure. It may be said that from the standpoint of the insurance companies, the first is the only object, but surely, conductors so installed that they can be easily overhauled and replaced in case leakage is discovered, are safer for the very reason that a fault is likely to be repaired before any serious damage has occurred.

When highly insulated wires, whose insulation resistance was measured in megohms per mile after immersion in water for weeks, came into use for electric lighting plants, it was natural to suppose that they could be put anywhere, and would last indefinitely. They were put in all sorts of inaccessible places; on the beams before floors were laid, in partitions before plastering, on the lath with iron staples, to be covered with mortar. Some such circuits are no doubt in existence to-day, as perfect in insulation as when first put up; but numberless cases of failures of insulation occurred, and experience shows that such a construction is entirely unreliable. Then came the interior conduit, which it was assumed would serve both as a mechanical protection and an insulator, but it was found not to be entirely reliable in either capacity. It was not impervious to moisture, it was subject to damage by nails, saws and chisels. It was found necessary to prescribe that wire of the highest insulation should be used in it, and that it should not be drawn in until all danger from mechanical injury was passed. Then came the brass armored conduit; but that was not nail proof. Now we have the iron armored conduit, and it remains to be seen whether this will fulfil all requirements.

It has come to be pretty well recognized that no mode of electrical construction is absolutely proof against failure at some point, and that form of construction is best which affords the smallest chance for injury or depreciation, and offers the greatest facilities for repair or renewal in case of failure.

There has been a uniform progress in the direction of greater

safety and better facilities for repair, from the time when wires were put anywhere, to be covered by floors, or mortar, or built into brick walls, to the iron armored conduit which is offered to-day. To be sure, the cost of the installation has advanced, and the iron armored conduit presents difficulties when alternating currents are employed. To me it seems that the advantages gained are worth the cost, and the difficulty with alternating currents disappears, if the two conductors are placed in one conduit. To this I can see no possible objection when the conduit is iron armored.

In view of the fact that we cannot be absolutely certain that failures in insulation will not occur in any given installation, it seems to me that the foundation principle of all rules for the placing of conductors should be accessibility. Further, no conductor should be placed where its position or its relation to other conductors in any part of its length is unknown. This means that raceways must be provided, into which conductors may be drawn and from which they may be removed at pleasure, such raceways to serve as adequate protection from mechanical injury; or the conductors must be placed in mouldings which are themselves accessible, or they must be supported by cleats or insulators in plain sight.

I believe that past experience would warrant the adoption of a rule that would require the use, for concealed work in buildings of fire-proof construction, where conductors must be carried up steel columns, over steel floor beams, in brick partitions, or in plastered walls, of a raceway or conduit, equal in its ability to afford mechanical protection to that known as iron armored conduit, so installed that conductors could be drawn in or out at any time.

And now a word as to the controversy that suggested this paper:

A conductor has been put upon the market, which consists of a standard Habirshaw wire with its covering of rubber and braid, having woven upon it two additional coverings of extra heavy braid. This additional covering, which is tightly woven on, and from which the wire can no more be removed than from its original covering of rubber and braid, the maker, by an extraordinary stretch of language, calls a tube, and claims for it the advantages of the conduit tube prescribed in the insurance rules. It goes without saying that this wire affords no means of re-

placing a damaged conductor, and, therefore, has not that advantage of the conduit. As to mechanical protection, it certainly is not superior to the unarmored conduit, and it has not the advantage that the conductor can be left out until the danger of injury is passed. As to insulation against moisture, the added coverings do not improve it, the insulation being entirely due to the rubber covering which is inside of all the braids.

And yet I have just learned that the New York Board of Fire Underwriters, on March 20th, passed the following resolution:

Resolved, "That the Superintendent be authorized, until further notice, to approve the use of the Attix tube and wire, when equal in quality and insulation to the samples submitted to this Board and tested, under the same conditions where tubing would be permitted; provided that there is no splicing or tapping of the wire, but that its introduction shall be in all cases by the loop system; that in new buildings, when necessary to carry it between floors and plastering, it shall be through holes bored in the beams, not less than two inches apart, a single conductor in each hole, out of the reach of nails; and in old buildings, where necessary to carry it within the reach of nails, it shall be protected by some device from perforation; and provided further that the wire and tube be carried intact into the cut-out boxes, and that in no case shall the outer covering be removed before introducing the core wire into the cut-out box."

It will be noticed that the wire is called a "tube and wire," when it is no more a tube and wire than the Habirshaw which forms its basis. The tests referred to, show that, after immersion in water or being imbedded in plaster, the insulation resistance was 20 megohms per mile. But the Habirshaw wire, without the Attix covering, would have shown the same. What then is the propriety of confining the operation of this resolution to the Attix wire? Why not permit the use of any good highly insulated wire under the same conditions?

It seems to me that this resolution is one of those reversions to an ancestral type which we find in all evolutionary development, which is off the general line of progress, and which is destined soon to become extinct.

Discussion.

The President:—Professor Anthony's paper is now open for discussion.

Mr. C. O. Mailloux:—This paper, with its unimposing title and modest dimensions, is I think one of the greatest importance to electrical engineers. I do not wish to disparage the preceding paper, and it ought not to be any disparagement to say that the paper we have just heard is at least of equal merit, great as is the value of the preceding paper; because although the question of electric wiring is one which seems a relatively simple matter in these days of sines and sinusoidal functions, yet it is one which, when we come to the practical and commercial side of our profession, we have at one time or other to deal with; and there are those of us who have extensively to do with it. I think that we should be very watchful of the construction which is placed upon the rules formulated by the different insurance companies. They may be working for the purpose of making the electrical business better, but that is with them only an incidental consideration; they have not the interest in so doing that we should have. Their interest is primarily to see to it that the installation is made safe from fire. We have a further interest. We have some interest in seeing that the installation is perfect, not only electrically but practically, and that it is a credit to the profession which it represents. I am very sorry to call the attention of this body, (or at least some of the members of it who may not be familiar with it), to the fact, though many of you are familiar with it, that in the matter of insurance rules electrical construction has been handled with a spirit of inconsistency and partiality and with a want of that broad liberal treatment that characterizes other lines of fire inspection. This case, of the Attix wire, is perhaps as good an instance as any, and it ought to be one sufficient in importance to call the attention of electrical engineers to the necessity of our acting, either singly or jointly, in such a manner and with sufficient emphasis, as to let our voices be heard and prevent the continuance of such inconsistencies.

As the paper very clearly puts it, it strikes one as almost absurd to characterize or define as a *tube* a piece of wire which has a solid wrapping of some material supposedly fireproof, applied to it. It is no more a tube than would be any other wire on which might be put a covering braid or some other material than the insulation. I do not see why a simple braid or a simple tape really is not as much a tube; yet we have found ourselves tied hand and foot in many cases by such rulings as that, on the part of insurance inspection authorities. I might mention a dozen cases in my own practice which are equally incongruous, equally absurd, and which have caused needless delay, needless expense, trouble and annoyance. I think it is time that the

INSTITUTE as a body should protest against a continuance of such rules and such measures on the part of insurance companies. I may state with pleasure that I have heard several representatives of distinguished and prominent insurance companies express themselves in no uncertain terms in regard to the manner in which this work has been done by those who were supposed to represent them and do their best for their business. I have stated to some of them that it has an evil influence on their business. I know of cases where the insured has preferred to do his own insuring rather than submit to the arbitrary dictation of the insurance inspectors. Some of the insurance companies themselves have expressed their dissatisfaction; and they feel, in some quarters at least, that there ought to be a change in policy; that insurance rules ought to be compatible with, and favorable to progress in electrical installations, rather than obstructing it.

MR. WILLIAM J. HAMMER:—I am heartily in sympathy with the gentleman who presented this paper and the gentleman who has just spoken. I think that subjects of this character are of the utmost importance to the AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. At the last annual meeting I had the honor as the Chairman of the National Electric Light Association's Committee on Standard Rules for Electrical Construction and Operation to present their last report to the INSTITUTE with the request that a committee be appointed to examine and endorse it on behalf of the INSTITUTE in order to secure fuller cooperation and a better enforcement of these rules. Two gentlemen appointed on the committee of the INSTITUTE and who are among the most honored members of this body, made the statement to me at the time that they thought it was inadvisable for the INSTITUTE to take up a matter of this kind, because it was purely a commercial one, and the INSTITUTE was a scientific body. In this connection I wish to say that I heard some one make the remark recently that many members in the INSTITUTE thought it was hard to get papers before this body which were within five miles of the earth. I think we have had admirable papers of the character that have been read to-night by our worthy President and Mr. Kennelly, but there are also other papers which reach a very large percentage of the members, are of vital interest to the professional work that a good many of us are engaged in; and I am particularly interested in this class of work, having been identified for a number of years with the work of the committee of the National Electric Light Association which promulgated the rules now practically used all over this country by the insurance people generally, and I might add, without any credit to the organization that brought them out. I think severe criticism can justly be made upon the underwriters for allowing their inspectors or their experts to bring out rules of this character and pass them, and foist them upon electrical engineers and the public at large. I think many of these things have not been

treated in as conservative a manner as they might have been. Last year a very earnest effort was made to secure the cooperation of all the electrical interests, including the insurance inspectors, etc., with a view to having one single set of rules go out, having them more rigidly enforced, and having them kept up to date—those efforts, although very earnest, were not brought to a conclusion. Since that time the committee has continued its efforts, and before very long, the committee of the National Electric Light Association, who are recognized as the ones who have brought this subject to the front for years past, will extend a formal invitation to the representatives of the telephone interests, the street railway interests, the Fire Chiefs' Association, the AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS and perhaps some other association or two which will be interested in seeing that proper rules which are conservative in their character and which do not benefit any particular class of manufacturers or any particular industries to the exclusion of others, are adopted; and it is hoped that before this year is out some uniform action will be taken by these organizations which will look to just the step that Prof. Anthony and others have recommended, and which is certainly highly advisable. I merely refer to this now, because very earnest efforts have been made during the past year and they are being pushed very actively by a committee of the National Electric Light Association acting in conjunction with some of these other gentlemen, and the matter will be brought before the INSTITUTE as well as these other bodies within a short time and in a manner which I trust will appeal to them and be treated as being of such decided importance to the electrical interests for the INSTITUTE OF ELECTRICAL ENGINEERS as well as other bodies to cooperate with the National Electric Light Association in its important work.

MR. H. WARD LEONARD:—This subject is one that has interested me for a good many years and I am familiar with the difficulties that have always been met with by contractors in dealing with the rules set forth by the underwriters and the requirements that they lay down. Having installed a good many hundred thousand lamps on different styles of wiring in the past ten or twelve years, I feel that the use of anything such as has been described in this paper as the Attix "tube and wire" is certainly a distinct reversion to the conditions that applied to electric light wiring in about 1885 or 1886. I personally installed work at that time which was done with practically identical materials, and which I think were as good as the Attix tube and wire can be to-day, and it seems to me that the conduit is an essential condition for thoroughly first-class work to-day, and that a conduit to be of any service whatever must be a permanent, reliable, strong tube which will be always there, enabling you to pull the wire out and in, in case of any failure of the wire. I personally am very strongly a believer and always

have been, at least for a great many years, in placing the opposite poles of a circuit, whether it be a two-wire circuit or a three-wire circuit all inside of a single iron pipe, and I have put in some thousands of lamps in this city in which both poles of the circuit are inside the single plain iron pipe, with quite satisfactory results; and I wish to call attention to a point which may not have impressed itself on all the members, and that is, that in case you do have both poles of the circuit inside of the iron pipe and the system of iron pipe be grounded, it is almost inconceivable that any condition of leakage or trouble in the electric circuit should occasion a fire. In other words, it is my belief that the rules of the underwriters which they have so strenuously urged for the last few years, that when conduits are used that only one wire be placed in each conduit, is merely aggravating the possibilities of fires which could be eliminated by using first class insulated wires inside of a single, metallic conduit. The underwriters apparently have been convinced of this point comparatively recently and have waived that requirement where the wires are placed in an armored conduit. As an indication of the difficulty of securing attention on the part of the underwriters to those whose voices ought to be heard in practical matters relating to electric work, I will say that there exists in this city an association of nearly all of the representative concerns of electrical contractors, and feeling that the underwriters had imposed very arduous and unreasonable rules and in fact conditions which made it more expensive, more difficult and more dangerous to do electric wiring work, the contractors in question appointed a committee when they learned that the underwriters were likely to issue a new set of rules in the then immediate future. They appointed this committee to wait upon the underwriters for the purpose of aiding them in drawing the rules and in arriving at rules which would be mutually satisfactory, and I happened to be chairman of that committee and so can speak about it from my own knowledge. A letter was sent to the underwriters by me as chairman of this committee, expressing a desire to participate in their discussions in regard to this matter, or at least to be given an audience to express our views in regard to some of the points which we hoped would not be inserted in the new rules and which we had considered arduous in the old rules, and the letter was acknowledged with the statement that in case they cared to have any conference with us or to hear any expression of opinion from us, they would let us hear from them, which we never did. I am heartily in sympathy with the general tenor and purpose of this paper and believe that this INSTITUTE is by all means a proper body to express its opinion in regard to matters having so practical a bearing on the work of electrical engineers.

MR. FRANKLIN S. HOLMES:—I am in hearty sympathy with the paper, and am also disposed to criticise the position occupied by the Board of Fire Underwriters.

I understand the Board to be an organization of business men formed to protect its business interests by issuing and enforcing such rules as will reduce fire risk. Its field is commercial, not technical, and when it deals with technical matters it is liable to act foolishly. As an instance in point, compare the three tables, showing the safe carrying capacities of copper wire, which have been published by it within two or three years. We find that the carrying capacity of a given wire varies nearly a hundred per cent in these different tables. See also the unreasonableness of the Board's rulings in the matter of pipe conduits. It prescribes that iron pipe carrying duplex conductors must be lined. And yet if we ground or short-circuit a service, carried in a plain iron pipe and protected by a 25-ampère fuse, by no possibility can we heat the pipe dangerously hot, at any point in its length. The lining of a pipe, for small conductors at least, does not affect the fire risk one way or the other, and, therefore, the Board should make no such sweeping rules on the matter. Similarly, in this question concerning Attix wire, its ruling is partial. Any continuous duct into which wires are, or may be drawn after a building is completed, whether it be paper tube, brass covered conduit, canvas jacket, or iron conduit, are each and all better than plain wire protected however thickly by a pervious insulation. The insulation of the Attix wire is pervious, and in no sense can such protection be considered as the equivalent of a duct, however fragile or strong. I repeat, I think the Board of Fire Underwriters has limited duty to perform and should confine its action to impartial rules in matters involving fire risk only. It should leave devices and methods which pertain to excellence of construction to others whose business it is.

I am very glad to hear that there is a movement on foot which will effect a conference of all parties interested in raising the standard of electric light installations. I hope the result will be first, a more rational set of general rules, and second, a strict definition of the functions of the Board of Fire Underwriters with reference thereto.

Mr. James Hamblet:—It came to my notice a short time ago that certain buildings in the city of Brooklyn were wired for electric lights and inspected by the inspectors of the Board of Fire Underwriters and approved. The lights were used for a time, and then a certain time after that inspection, they were again inspected and condemned, and the owners were compelled to re-wire their buildings or improve them according to the new rules adopted by the same Board of Fire Underwriters. I also know a similar instance in Brooklyn where a contractor made an estimate for the work and the inspectors were watching him, and the inspector told him that by the new rules a certain new kind of tube was to be used and he must put in that kind of tube. That destroyed his profits on that little job.

MR. W. J. JENKS:—I feel a great deal of interest in this paper which Prof. Anthony has read, not alone because I am thoroughly in sympathy with the views which he expresses, but also because I think the discussion of the general subject of the relations between the electrical engineering profession and the fire insurance underwriters may, if now taken up by the INSTITUTE, become very profitable. I have had some little experience in representing the incandescent electric lighting industry in discussions with the insurance people during the past twelve years. In 1883, representatives of the underwriters came to study the arrangement and operation of the first three-wire underground system in the world, at Brockton, Mass., of which I then had charge. In 1884 the first schedule of insurance rules adapted to the necessities of incandescent electric light construction of central station systems and isolated plants, was issued by the New England Insurance Exchange, as the result of a careful study of actual conditions by Capt. William Brophy, who was then their inspector, and Mr. S. E. Barton, who was then chairman of their electric light committee. In formulating these rules the New England people followed the example which had been set for them in 1881 by Mr. W. H. Anderson and his associates in New York, in their issue of the first rules adapted to series systems of arc lighting, in that they sought information of those who engaged in the practical work of installing electric lamps, and encouraged suggestions from such people as to revisions which the rules might require. This policy of mutual consultation and cooperation was explicitly adopted by Mr. Edward Atkinson in 1882 when he was president of the Boston Manufacturers' Mutual Fire Insurance Company. Cooperative efforts of this sort have been the rule during all the subsequent history of the art, and in proportion to the cordiality of the relations between the insurance companies and the electric lighting and power people, has been the correctness of the form into which insurance opinions have been moulded. There are a great many examples in the rules, of the truth of this statement, and while I fully appreciate the differences which now exist as set forth in Prof. Anthony's paper, I think the instances thus afforded and the remarks which have been made to-night, should be considered as local rather than as general in their application. The cordiality which has, as a rule, existed for many years, was well illustrated when in August, 1890 at Cape May, two or three days in advance of the meeting of the National Electric Light Association, a committee from that Association met representatives from some of the individual electric light companies and a number of executive men representing the underwriters' boards of different parts of the country, and chose a sub-committee to collate all the available information as to requirements of the underwriters throughout the United States and formulate a revised code. I happened to be one of the members of that sub-

committee, and the results of our work appeared in the arrangement of what is now the National Code, first adopted by the Western Union Fire Underwriters' Association, then by the National Electric Light Association, and finally (with some modifications) pretty generally by the different boards of underwriters throughout the United States. I believe this code did not appeal to the necessities of the New York Board of Fire Underwriters, or perhaps it might be more correct to say that it is the record of the growth of the business, that the New York Board has desired to have rules which were unique, differing essentially from those which other people were satisfied with. There are several evidences of the correctness of such a theory in the rulings which have from time to time vexed the souls of electrical engineers who have been unfortunate enough to find themselves under the surveillance of some of the inspectors in the Metropolitan district. Other members of the INSTITUTE can, and I have no doubt will, give detailed testimony upon these points. But I believe it will be found that looking the country over, the insurance people are disposed to maintain a feeling of hearty accord with all electrical engineers who are worthy of the name, and in addition to this, to boil down their rules so that they will come to be short schedules of methods which are dangerous and therefore are prohibited, rather than manuals of instruction for the guidance of constructors who know a great deal more about the business than the underwriters ever expect to learn. I remember that as early as 1887 Mr. Barton, to whom I have just referred, who was at that time more intelligently informed in these matters than almost any other active insurance man in the country, by reason of his close contact with electrical central station men, said in an official report.

"Were we again to begin at the beginning, with our present "knowledge, we think we would be inclined, in justice to all "concerned, to issue rules setting forth those practices that we "would *not* permit, rather than stating in such complete detail "what should be done."

My own feeling has been for several years that the underwriters would ultimately come to the point of issuing a list of commandments as to what the electrical constructors should avoid, leaving us to elaborate a set of rules such as have been spoken of to-night, to teach young engineers in detail what they should do in order to secure the best practical results, and I think that list of commandments should begin, as do the most of those delivered to Moses in the olden times.—"Thou shalt not."

MR. MAILLOUX:—I do not think that this subject can be disposed of in the time that remains for this discussion, and for one I feel that I would like to have an opportunity to collect my ideas. I am under the weather this evening, with a cold, and can scarcely formulate my ideas as I would like to. There are one or two facts in connection with the matter which I think

it might be well to bring to the attention of the meeting and which may serve to stimulate discussion. In the first place I would like to call attention to the fact that the insurance companies themselves are not entirely satisfied with the way the matter has been arranged, and at present out of some forty or fifty insurance companies represented in New York City, there are nearly one-half who have formed a little insurance inspection association of their own; they are no longer satisfied with the inspection made by the official underwriters, but have an inspector of their own. I am very sorry that their inspector is not here this evening, as he is a member of the INSTITUTE and could give us some very interesting information. I trust that he may have an opportunity at another meeting to give us his experience which is, I assure you, quite interesting.

Gentlemen, I feel quite strongly in this matter, because I have had a great deal of experience with the insurance inspectors, not only in this but in various districts, and as Mr. Jenks has very well observed, I found a noticeable difference, of which I will give you one instance. The iron conduit tube was adopted by the New England Insurance Exchange in June last. I had occasion to communicate with them with reference to a large installation at Newport which was in their district. I had found that their rules would not allow me to use an iron conduit, although there were certain electrical and other objections to any other forms of conduit which might be allowed under the rules. I stated the case, urging the electrical objections and the mechanical ones as well, and received a reply the next day stating that the objections were well taken, that they had been submitted shortly before by others, and that it had been decided to allow the iron conduit tube to be used with twin conductors for such cases. Some four or five months afterwards, I had occasion, in connection with several installations contemplated in New York City, to go over the same matter. A question came up almost similarly. I went in person to consult with the officials of the inspection department in New York and was informed by them that they had as yet taken no action in regard to the iron conduit tube; expressing at the same time grave doubts as to the propriety of their taking any action whatever. It seemed to them to be something that was of very doubtful, if any, utility, if not absolutely bad. However, in the same breath almost, I learned that the Attix tube, so called, was then allowed. This was several months before any official promulgation of this "Attix rule" was made, as this conference took place some time in October or November. You can scarcely imagine the feeling with which I heard this announcement. I could scarcely believe that we were in a metropolis and in a progressive age when I heard that we were going to be relegated by official direction back to methods which I, for one, should not sanction. I will state, that as a member of the examining board of this

INSTITUTE, I would not want to acknowledge or accept as a member, a man who was capable of admitting Attix wire as the rule prescribes. I would consider that he was doing something derogatory to the profession. Although we are still far away from the ideal and the perfect, we who have had practical experience with the different ways of interior wiring, consider the iron conduit tube such a great step in advance that we hailed it with a certain degree of delight, but we were literally told that we must not touch that. Now I submit that when we reach such a point, that the progress of our profession is retarded by arbitrary methods such as these, it is time for us to act. I will give you another case which is quite interesting. I have now in hand a case where the insurance inspectors inspected a large dry goods establishment in Brooklyn. I was called in by the proprietors of the establishment after they had made efforts during several months to adjust the matter with the insurance companies—I was called in by them to see what could be done in the matter. It took me three months to bring about a conference between the various insurance inspectors interested in it. There were some twenty odd companies who carried partial risks on the establishment, it being a very large one. I discovered very quickly that some of these inspectors wanted certain things done and other inspectors wanted that very thing not done, and so on, for a long list of requirements; yet they were all working from the same rules. Some of them told me that I must not allow any moulding to be capped. Others said that that was very wrong;—the rules required it to be capped; and so on through a long list of inconsistencies. I began in June. In October I succeeded in bringing about a conference between the different insurance companies at which I appeared as representative of my clients. I took delight in calling the attention of the seven or eight inspectors present to the fact that they were extremely inconsistent and arbitrary. I put it in those words and stated my reasons clearly, and this particular case furnished me ample reasons. I think it had a salutary effect; a certain agreement was drawn which stated what these inspectors would all agree to agree or disagree about. I had made so many efforts to satisfy them all that I had given up hope of doing so, and I thought all other efforts useless until I had their signatures as evidence to what they would or would not allow. It was no longer a question of rules. It was a question of what their individual preferences or whims might dictate. Now, gentlemen, I think that the electrical profession needs some attention, when it is placed in such a position as that. I think that not only looking at it from a scientific standpoint, but also from the standpoint of dollars and cents, it will pay us to go to the bottom of this thing. I believe that with the proper amount of suasion we ought to be able to place ourselves in a position where instead of being dictated to we may ourselves dictate to some extent what is proper. I do

not think there is a more competent body in the United States to formulate rules and restrictions, to prescribe what is a proper thing to do in connection with electric wiring, or what is proper and desirable from the engineering standpoint. I submit that men who are business men merely, though they may have experience, are not so well fitted as those who have had the training and the experience of years, to do this. I think that with all the scientific men and all the practical men that this INSTITUTE contains, it is more competent than any other body to dispose of this question. I am in a position to assure this body that it has sympathy from the outside, that it has sympathy from the very ranks of the insurance companies, which is saying a great deal; because I have already called to your attention the fact that they have dissenters, men who are dissatisfied with the way their business is transacted, and they are only waiting for a word of sympathy or encouragement, or some little energy on our part and on the part of all the other associations interested in the electrical industries in order to give us a helping hand and bring about the desired change.

MR. JAMES I. AYER:—It is very gratifying to me, having worked with the Electric Light Association in relation to these rules for some years, to see the interest taken by the INSTITUTE in this matter. I think that if any additional arguments were needed I can cite a case which perhaps touches the engineer a little more directly and forcibly than some of the points made to-night; that is the tendency of the inspection department of the Board of Fire Underwriters to usurp the prerogatives of the electrical engineer; in other words to issue certificates to contractors which pass as current coin, as evidence that they have got what they paid for—a first-class electrical installation. There is not an engineer here engaged in practical work who has not run against it, who has not seen passed what should not have been passed, and the investors, the men who are paying for the installations, would have been very glad to pay the engineer's fees if they did not feel that they were getting something for nothing from the Board of Underwriters. A case of that kind came up only a few months ago where a very large installation was being made. The specifications were made partly by the manufacturing company and by the architect who had a little assistance in getting them out. But after the contract was awarded, while there were unusual electrical problems involved in the construction work, the parties paying for the installation declined the services of an engineer because they thought they did not need one. They had a competent contractor and realized that it was all right. Later on, when the installation was about to be completed, some comments were made by engineers who observed the work and said it was bad and all that. The question was raised in the Board of Directors—it was a very large corporation—as to whether it was all right or not. Some thought it

was; they advocated the acceptance of the contract as tendered by the contractor, but the point was raised that there was a lack of thorough workmanship. Immediately, the contractor brought in the argument that the insurance certificate that he possessed was an evidence of what they had got; that they had everything that they could demand or desire under the contract. The work was accepted. A month later they paid a considerable fee to an engineer to tell them what the matter was—why they could not successfully operate the plant. It took about $20,000 to correct the evil, and they paid an engineer to tell them of how little value an insurance inspector's certificate is. It is not often they come out that way—that the engineer profits in the end by it. But it is a fact that the fire underwriters are stepping into the shoes of the electrical engineer; they are interfering with his profession, his businesss, and I know, as Mr. Hammer has well said here, some of the members are anxious to have papers read here that would "get within five miles of the earth occasionally." We all know that this question of insurance rules was regarded by many as something beneath the dignity of the INSTITUTE. It has been so expressed; it has been so treated. But I think that as the thing has taken shape, it is clear to all the members that it is essential that this INSTITUTE take some definite action.

MR. W. J. JENKS:—I want to suggest that we have with us to-night a gentleman who, though not a member of the INSTITUTE, is well-known to almost all of us, at least by his reputation, as one of the most experienced insurance men in the United States, in those relations with the electrical people which we are now discussing. I refer to Mr. C. J. H. Woodbury of Boston, for many years Vice-President of the Boston Manufacturers' Mutual Fire Insurance Company, and now connected with the American Bell Telephone Company. Mr. Woodbury now stands in a position where he can without prejudice give us accurate information in regard to the actual feeling of the underwriters toward the electrical business, and the steps that are now being taken toward the end which has been considered in this discussion so desirable of attainment.

THE PRESIDENT:—We should be pleased to hear from Mr. Woodbury. I trust Mr. Woodbury and the members of the INSTITUTE will excuse the President who has to go to Philadelphia to-night and must leave now in order to catch his train. I will ask Vice-President Hamblet to take the chair.

The President then withdrew and Mr. Hamblet took the chair.

MR. C. J. H. WOODBURY:—I came here this evening as a guest and to listen, not expecting to take any part in debate. My former position for a number of years was in technical relation to underwriters of manufacturing property, and I had occasion to have an intimate knowledge of the policy of the insurance companies in regard to electric light and power installation, and as that is now with me something of the past, I can perhaps look

at the subject from a disinterested standpoint. There were a great many electric lighting rules, so called, made by local bodies of underwriters, at times conflicting bodies. In 1893, shortly after the last issuance of the rules of the National Electric Light Association, there was formed in Chicago what was known as the Underwriters International Electric Association, the name of which has since been modified by the change of International to National. Suffice it to say that they adopted a set of rules which were in most respects along the lines of those of the National Electric Light Association. There were, however, some points of difference, and these rules have had several amendments which have been prepared and promulgated from time to time. Two months ago I had occasion to make definite inquiries throughout this country in regard to these electric lighting rules. I found that while the rules of the Underwriters National Electric Association are at the present time very generally adopted, yet there is a great difference in their promulgation and enforcement, and that is a difficulty which seemed to be an inevitable one in the early stages of the work, but will grow less and less pronounced as time goes on, because the insurance companies will have a better trained set of men. At the meeting of the National Electric Light Association I had some unofficial assurances which I was able to present to the committee, and they made a report which has been received with a great deal of favor in insurance circles. At the present time the affairs of the National Electric Underwriter's Association on the subject of these rules are in exceedingly good and competent hands. The chairman of the Electrical Committee is a member of this INSTITUTE, an electrician of accomplishments and standing, and one who in addition to his technical education has had a very extended practical experience in electric lighting and in telephony and telegraphy. All of these parties perceived the necessity of certain amendments and also the necessity of a unification of the whole set of rules, because this question of the function of these rules is not one which can be sub-divided and separated one part from another by any line of demarcation. It begins with the design and extends to the construction, the installation and the maintenance of all electrical apparatus of whatsoever kind or nature, whether it produces quantities of energy which can be converted into heat sufficient to cause a fire, or whether it pertains to the inherently harmless instruments, from battery circuits, but which may be, and are in certain conditions, a possible source of danger by reason of their exposure to the heavier currents used in lighting and in power. These questions are fully recognized and can be treated in only one way, and that is by a conference representing all of the various tributary interests. I am sure that the underwriters are alive to it and that they aim towards that end, because I judge from their representations to me to the extent to which I represent one of these interests of

electricity in this matter. I am looking forward to a conference which will occur in the immediate future representing, I do not care under what head, all of these various electrical interests and which will result in the unification of the electric lighting rules, and it is through that means and through that means alone, that such a result can be obtained. It should be conceded that it will take time for the training and development and selection of persons competent to enforce these rules adequately and justly.

THE CHAIRMAN:—The importance of this subject seems to demand that it be referred to a committee. We have a letter here received from one of our members who is ill. The Secretary will please read it.

THE SECRETARY:—This letter is from Mr. Fremont Wilson, a gentleman who I think has been referred to this evening. I will read an extract referring to the subject:

"If Prof. Anthony's paper is discussed, I hope it will be deemed of enough importance to have a committee of five appointed and a resolution passed, and a letter sent to the New York Board of Fire Underwriters, requesting the privilege of the audience of our committee to appear before the New York Board in relation to the non-observance of standard rules, etc., and to prove to the representatives of the New York Board the injury they are doing to the electric light and power interests throughout the country, by the peculiar methods that have been in vogue for the last two or three years.

THE CHAIRMAN:—What action will the INSTITUTE take upon this letter of Mr. Wilson?

MR. HOLMES:—If this committee, which it is recommended be appointed, is to simply consider what is advisable and appear before the Board of Fire Underwriters, I am in favor of its appointment. But I am not altogether clear, as the resolution is phrased, that the committee will not be formed with instructions. I am in favor of such a committee.

THE CHAIRMAN:—It is proposed to refer the whole subject to this committee for action and report to the INSTITUTE.

MR. HAMMER:—I would like to suggest as it has been stated here to-night, that the matter is already in the hands of the National Electric Light Association and that their committee will extend an invitation to the INSTITUTE OF ELECTRICAL ENGINEERS, as well as representatives of the other interests, and that the matter will then be taken up, not dealing with specific cases but with the whole thing in a broad gauge way. While we may move a little bit more slowly in that way, I think perhaps by joint action going about it thoroughly, we will accomplish more than by having the INSTITUTE refer the matter to a committee in the way proposed.

MR. MAILLOUX:—I agree with Mr. Hammer that the matter ought to receive more deliberation before we act. At the same time, I feel that there ought to be a committee representing the

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS on the subject. I also feel that further discussion ought to be had on the subject, I think that there are others, who would be present at another meeting perhaps, who would be able to contribute to the discussion. This subject is too important and it is of too much interest not only for the welfare of the society but for the individual welfare of its members, to be passed over lightly. So far as the appointment of a committee is concerned I would be willing to leave that to the Council. I think the Council is competent to appoint such a committee and to give it proper constitution, but I think the whole matter might be well laid over to the next meeting. I would make a motion to that effect. (Seconded).

THE CHAIRMAN:—If it be your minds that this discussion and the appointment of the committee be laid over till the next meeting of the INSTITUTE, please manifest it by saying aye—contrary no.

(The motion was carried and the meeting adjourned.)

DISCUSSION IN CHICAGO.

A meeting of the Western members of the AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS was held in the Electricity Lecture Room of Armour Institute, on Wednesday, April 17, 1895. The meeting was called to order by the Local Secretary, Mr. B. J. Arnold, with about sixty members and visitors present. Mr. A. S. Hibbard was elected Chairman for the evening.

The paper, on "Underwriters' Rules," by Professor William A. Anthony, was read in detail by Mr. Arnold.

MR. CLARK C. HASKINS:—The subject matter of the paper of Professor Anthony is one of very proper interest to all who are desirous of advancing the art of electrical construction. I trust that every member of this association feels similarly in that regard, and is ready to further the good cause in every reasonable manner.

I note what the Professor says about the object of all rules, as he states it:—

"1st—To secure a safe and permanent installation.

"2nd—To provide for the repair or renewal of conductors in case of failure."

I agree perfectly with the gentleman. The three R's of electrical line maintenance are removal, repair and renewal, and the more readily these functions can be performed, the better for the plant, the constructor and the owner. Time is the only test of electrical appliances, and especially is this true of insulation. The conduit system is comparatively new. The electrical fraternity has carried it through several stages or moltings, as has been suggested in the paper under discussion. In its first embryotic condition, it was assumed to be a perfect insulator, and capable of

thoroughly protecting a couple of dry cotton-covered conductors —ordinary magnet wires. It didn't do it. There were several serious faults found in it, both electrical and mechanical. A second molting, and it still failed to fill the requirements, and again there was a change. We are now experimenting with the latest, and let us hope, the perfect conduit.

The public is complaining at the advanced cost of proper installation. It is extremely difficult to make an ordinary consumer understand the hazard of a poorly constructed plant. "He knows," he says, "plenty of plants that have been running right along for years, not built any better than" the cheap one he is running, or the cheap one he wants to build, "and they have never felt the need of better construction." I have occasionally seen such an individual converted in an hour by an object lesson, when months of argument would have been lost on him. The teaching of the public in any new branch of practical education is difficult and slow. The reason for this is that it costs money if one listens to reason and adopts the best systems and methods—and when one individual is convinced, his lasting wants are at once supplied; but his next door neighbor has to be labored with equally patiently, and long. In this system of education the class consists of single individuals—there is but one scholar in the school, and he is as often at the foot as at the head of his class. Now, between experimenting for inventors and making converts of purchasers, the constructors and engineers will have their hands and heads busily employed for some years to come.

My idea of a conduit is simply a something in which electrical conductors can be run for:

1st—Mechanical protection against injury.

2nd—Ease of removal and replacement for any cause or purpose.

But, in considering the insulation of a wire to be placed in a conduit, the insulation of the latter must not be considered, while at the same time if the latter is lined with a good insulating material, the conduit is that much better, and the installation that much improved.

I think the case before us a plain one. If a solid covering tightly woven outside a conductor will permit of the removal of that conductor, and its replacement by another, then the covering becomes a conduit. Whether a wire which already shows 20 megohms insulation resistance is any the less a good wire for being mechanically covered by extra braiding is scarcely a debatable question; but it does look unreasonable for any Board of Underwriters to accept one such wire for any purpose, and deny the same endorsement for similarly constructed conductors which will bear up under the same tests.

I think the day will come sooner or later when this whole matter will be solved by either conduits everywhere through

buildings, or raceways constructed in the walls and ceilings, or even better, open work everywhere. I look upon the last as the acme of good construction, if it can be reasonably accomplished.

THE CHAIRMAN:—It will be of great interest to hear discussions on the various points which the paper brings out, and we should like to hear from as many on the subject as possible. We are fortunate in having with us to-night a representative of our own Underwriters' Board, whose work is directly in this line, and I would ask Mr. Merrill to enlighten us on this paper from his point of view.

MR. W. H. MERRILL, JR.:—I thank you, Mr. Chairman, for extending to me the privilege of speaking at this meeting.

I regret that the paper by Prof. Anthony does not bring out the useful criticisms and suggestions which I had hoped from its title that it might contain. I had expected to speak on behalf of the underwriters in answer to criticisms which might be made of the National Code of Rules, which we have worked on from year to year for such a length of time, and which is now almost uniformly adopted by underwriters' organizations and municipal departments throughout the country. Instead, I find the paper starts with a brief sketch of the history of rule-making which I cannot agree is correct in the share of this work it attributes to the insurance interests, and devotes the remainder of its discussion to a certain resolution adopted by the electrical committee of one local board of fire underwriters. Discussion of either of these points will be of little benefit to either the electrical or the insurance interests of the country as a whole. Much good would result from an intelligent discussion of the National Code as promulgated by the National Board. If there is any organization outside of their own employees that the insurance interests should look to for technical information which would lead to the promulgation of more specific, comprehensive and equitable rules, that organization is certainly the AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

I do not think I am exceeding my authority, in stating on behalf of the electrical committee of the Underwriters' National Electric Association, that that body would welcome any suggestions or criticisms, members of your INSTITUTE can give us either collectively or individually.

Fair and disinterested intelligent discussion of the many technical points to be considered in framing any set of rules is the only way to arrive at the best results. You have men among you, splendidly trained specialists, who are undoubtedly more competent to deal with many of the problems presented than are our inspectors. No one man can master the wide field covered by the science. Yet the insurance inspector is sometimes criticised for not having performed this feat.

Underwriters, as a body, are too closely cognizant of the part electricity is playing in their loss reports, not to welcome any aid

that can be given them by the men who are responsible for the service electricity has rendered, and perhaps for some of the pranks it has played. Whenever any man among you judges it would be for his or your interests to help us in our endeavor to properly regulate practice within safe channels, I promise you that the national body will not refuse to cooperate with him as far as lies in its power through the promulgation of sensible amendments and extensions to, as well as interpretations of the National Code of Rules.

THE CHAIRMAN:—I am sure we are very much obliged to Mr. Merrill for his very interesting talk, coming from a point on which we are not generally posted. There is another view of which we have heard nothing as yet, which is very important, and that is the view of the wireman. It would be well for us in bringing all the light possible to bear on this paper, if we could hear something from one who is in the wiring business. We have with us this evening Mr. Arthur Frantzen, who is actively engaged in the wiring business, and I know that he can give us something that will be interesting as well as instructive to us.

MR. ARTHUR FRANTZEN:—My discussion on the Underwriters' Rules will bear more on a contractor's view of the rules rather than a technical one. Mr. Merrill, I believe, has cited very clearly what good construction embodies; yet there are many things contractors must contend with, that underwriters seem to overlook: one being that all the most of our customers care for is the result at the cheapest figure possible, and the unscrupulous contractor gets the job every time, installing his work according to his interpretation of the rules, which differ according to the standard of education of the reader. Should his conscience be too elastic, the next thing is to conceal the defective work, or subsidize the inspector (were such a thing possible), in order to have the work passed. It is not the rules that prevent poor construction, but rather the practical supervision and enforcement of the rules by the inspectors. A case in view, that I know of, will show what I mean by practical, and showing the necessity of having inspectors experienced wiremen.

A contractor installed open wiring for a motor on knobs, and as the proprietor was in a hurry for power, the contractor connected his meter loops together temporarily and left joints unsoldered or taped until the meter was installed. In the mean time, during the contractor's absence, the inspector calls and examines the work, when, Lo, behold! he finds a most flagrant violation of the rules, and proceeds to cut off the two joints for exhibit "A" and "B," and the poor contractor became 10 inches short on his meter loops. Now, had the inspector been a practical or experienced wireman, he could readily have understood the case without any explanation.

In conduit work we have various experiences, and find that the only case when it is used as a complete system of raceways is

in large office buildings or fine residences. The general public as a rule will not pay for so expensive an installation if they can possibly avoid it. As regards the various conduits in the market, I find that where the lights are all in a small district; circular loom or canvasite makes the best work on account of its flexibility, but for office building work, with long runs, brass armored conduit is preferable; but the conduit to install is the single tube system of iron armored conduit. It is the only conduit you can install, and go on a vacation and return to find everything perfectly intact. The only drawback is its cost, and yet the single tube iron armored system is practically as cheap as the double conduit system of brass armored.

Nevertheless, conduit at its best has many drawbacks, such as breakage, inflexibility and liability to injury, which requires constant watching. The class of construction that gives the best satisfaction at all times, if done well, is open knob or cleat wiring. Here you have something neat to inspect, if well done. It is always accessible, and therefore changes are easily made. Of course, this would never apply to residences or office buildings; but in such cases a combination of special ornamental picture moulding and direct and short runs of conduit from same to outlets makes without a doubt the cheapest and most satisfactory wiring installation.

Trusting I have not wearied you with a rather irrelevant discussion of rules which prove too much for us, if interpreted differently from our worthy inspectors, I will close with the hope that our cause may be appreciated more fully by underwriters and the public in the near future.

MR. L. GUTMANN:—I am not a wireman. However, in regard to installation work, would say, that I divide up partly with Prof. Anthony and partly with Mr. Haskins. I do not think that it is a good practice to have a wire tightly located in tubes. On the contrary there should be plenty of air space between the conductor and the tubes, which by preference should be iron gas pipes. The conductors should lie centrally and be held away from the armor tubes by non-combustible insulators.

We cannot make iron rules and predict a given style of installation work to be the best. While conduit wiring in many cases is the more substantial, the open wiring will have its advocates in many places; the main reason being that with the same security of insulation we have cheapness and accessibility.

For a general plan of wiring I would use one or two inch pipes for all conductors to be placed in a vertical position and going from floor to floor, while all horizontally placed conductors, including fuse blocks, etc., may be placed in brick channels with removable fronts, which channels may be easily concealed if placed in the cove of the cornices, or else form part of the cornice of a room or hall. I do not think it worth while to dwell on the point, that a braid should be an insulated tube, as we all

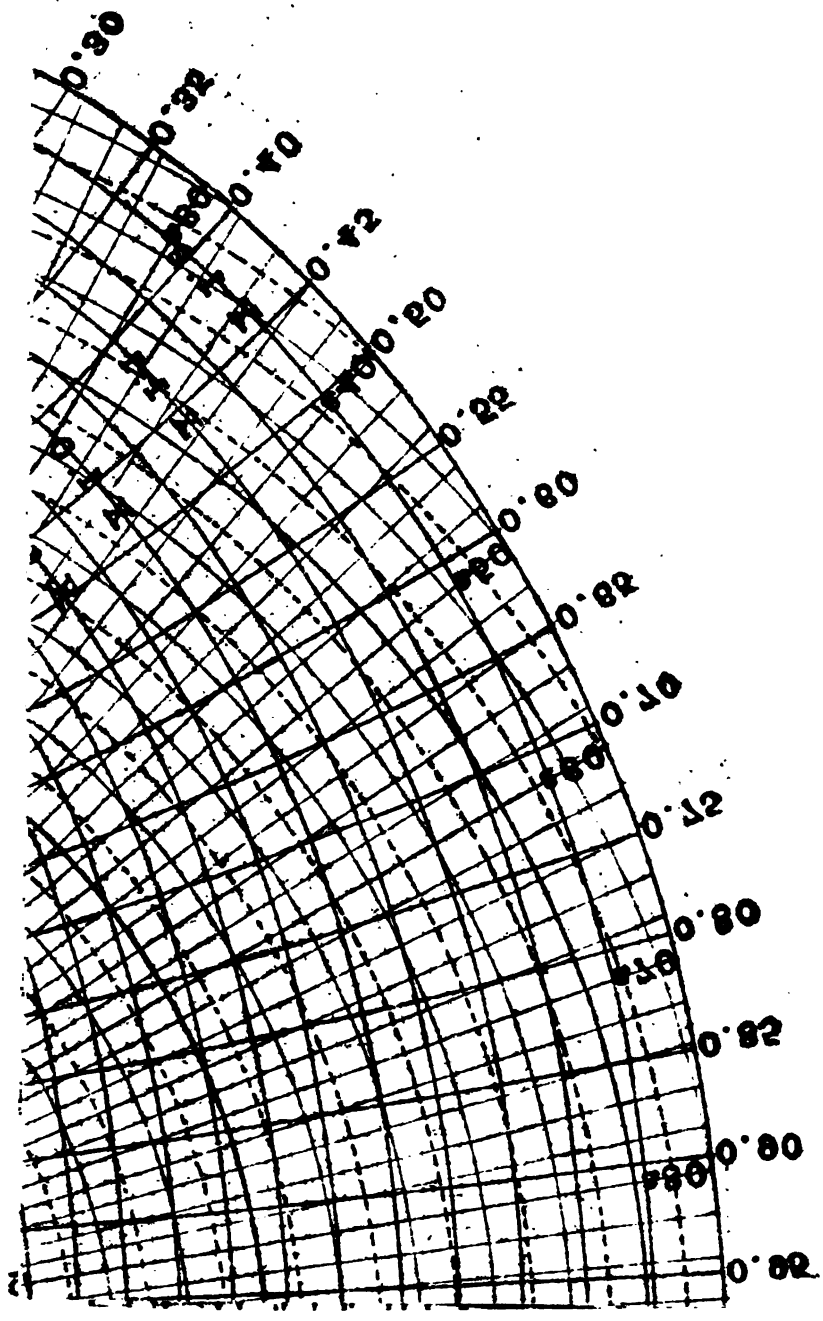
know that this is a fallacy on the surface of it; besides a braid cannot be a substitute for an armor, nor does it provide for the air space considered desirable between shell and conductor.

THE CHAIRMAN:—The paper itself is, of course, an immediate reference to what has been called an Attix wire or tube. If there is anyone here who has had experience with Attix wire and who can speak in its behalf, we should be pleased to hear from him.

A late ruling has passed on this form of wire against others, which might be readily made. It is interesting at this time, when we have presented to us this paper on underwriters' rules, to bring out the fact that the representatives of the Underwriters' Board and the various lines of business are coming closer together in their views. I realize it very much in my business, and I have no doubt that you gentlemen, who are putting in electric light wires, also find it so. We are finding that the representatives of the underwriters are going at the questions involved in better fashion, and I am sure that we shall soon find a better ground plan on which to meet underwriters.

In our telephone installations we are using greater care than ever before, and the work is in many ways getting to be more satisfactory. The use of trolley and power wires has brought up a condition of things in which overhead wires are often made to carry extraordinary currents. This has only been touched upon in this paper, but I think that, in closing our meeting, we may add what may be but an expression of opinion, though I think you will all endorse it, that the subject of underwriters' rules and the subject of what we may do with our wires influenced by currents which they are not supposed to carry, is one of much importance and is worthy of a great deal of thought and a great deal of work. It is to be hoped that the work, as it goes on, may be brought out, not only at these meetings, but especially at meetings of our representatives with the underwriters' representatives, so that we may not be working in the dark and doing our work over, or doubling it.

MR. B. J. ARNOLD:—In 1889, while in charge of the St. Louis office of the Thomson-Houston company, I was called upon to reconstruct the lighting plant of the Southern Hotel, which consisted of a 50-light T.-H. dynamo with fifty 2,000 C. P. lamps running in different parts of the building. The plant was originally installed by the T.-H. company, with underwriters' wire. This wire was run under the floors and fished through from one hole to another. The result was that it came in contact with the iron beams of the building in many places. These iron beams consisted of old railroad rails, out of which the hotel is built, as the proprietor was largely interested in a railroad which had recently relaid its tracks with heavier rails, and the old rails were utilized in the construction of his building. The wires were supposed not to touch the iron, but as the lights for some inexplainable reason would suddenly go out at times, and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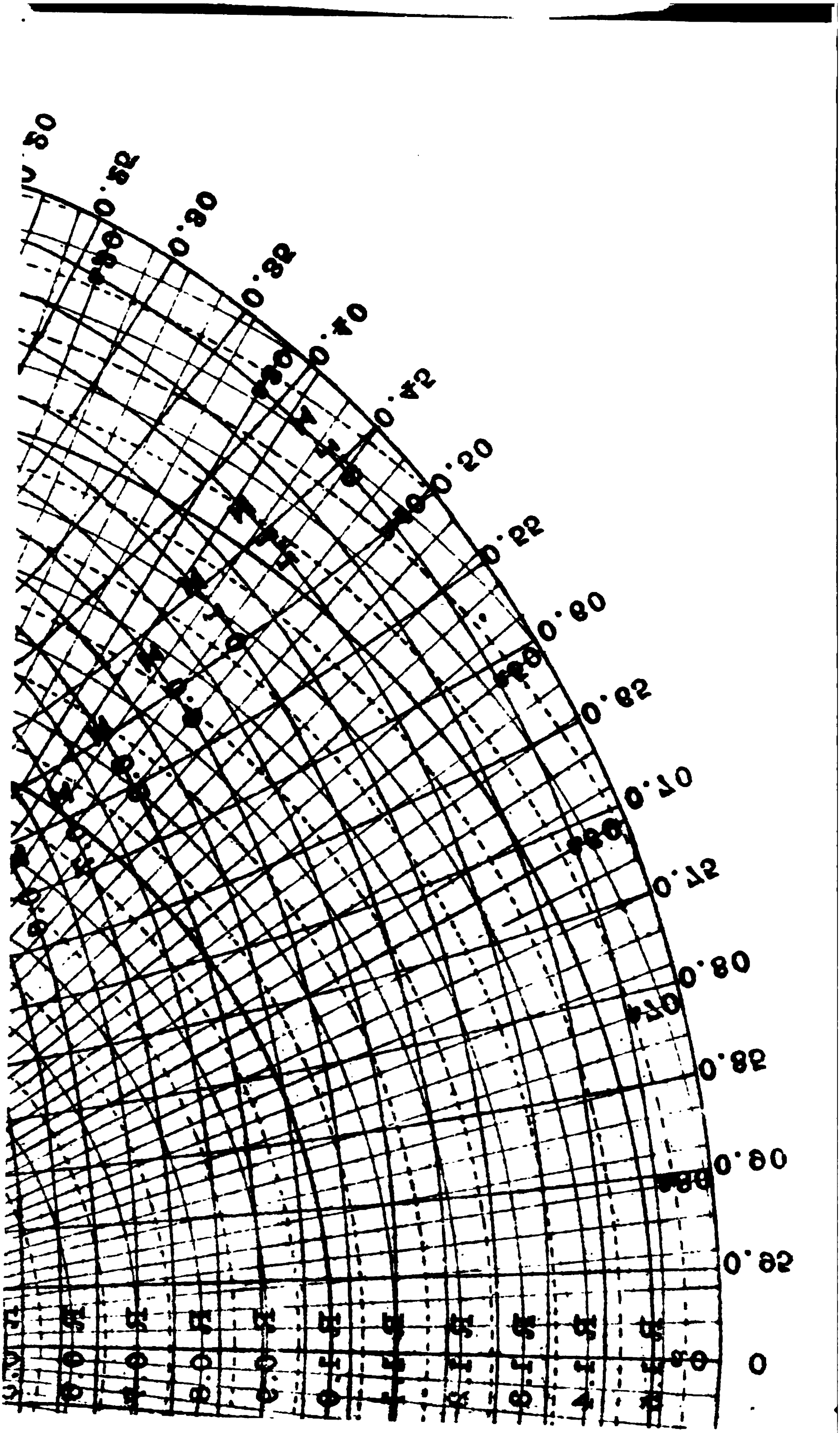


start up again as suddenly as they went out, without the defect appearing to be in the dynamo, the conclusion seemed to be that as the building was infested with rats, they occasionally stepped on the wires and brought them in contact with the iron of the building, causing a momentary short-circuit. It was not only severe upon the rat, but upon the lighting service, and caused great dissatisfaction. The management of the building had become thoroughly disgusted and threatened to throw the plant out, as they had fooled with it for about three years. They sent our company word, that unless the thing was fixed, they would abandon the plant. After looking it over, I decided that the best was none too good in this case, and as I feared that with even the best insulation available, the rats might chew it off and bring the wire in contact with the iron beams again, I adopted the only conduit system that occurred to me, as follows:

We secured bamboo fish poles, cut them in lengths of about six feet each, bored out the pith and threaded them upon okonite wire, and wired the building throughout in this manner, started up the plant, and so far as I know there has never been the least difficulty with it from that time to this. The management were to have 60 days to test the plant in before paying for it, but they sent me a check in thirty days with a letter, saying they were satisfied.

I believe this is the first case of interior conduit on record, but as I was more interested in getting the plant to work satisfactorily than in any personal compensation, I did not think of patenting it or attempting to protect it, and relate the instance here as it seems applicable.

THE CHAIRMAN:—The paper and discussions have been of more than usual interest to us, as they seem to be so much in line with our daily work. I am sure that we are all very much obliged to the gentlemen who have kindly spoken to us this evening, and have given us their ideas on this subject. If there are no further remarks, a motion for adjournment is in order.

[Adjourned.]

DISCUSSION CONTINUED, NEW YORK, MAY 21, 1895.

THE PRESIDENT:—It was decided at our last meeting that Prof. Anthony's interesting paper on "Underwriters' Rules," which for lack of time could not receive the full discussion that its merits and importance demanded, should come up for discussion this evening. I will therefore ask that the discussion be opened by Prof. William L. Puffer of the Massachusetts Institute of Technology, and the subject will then be open for discussion by any member who wishes to take part.

Discussion.

Prof. Wm. L. Puffer:—I must confess that I was somewhat surprised when I read the notice announcing to the members that I was to open the discussion on this paper, especially as it was a paper that I did not hear in the first place, and the discussion of which, taking place either here or at Chicago, I have not very carefully read. I looked over the proofs this morning but somewhat hastily. I have been very much interested in this general matter of insurance rules for quite a number of years, and especially the last year or so. I think I may say that I fully agree with Prof. Anthony in nearly all the remarks that he made about the subject of his paper, which branched off, I think, towards the close, on to a particular form of insulation of wire, which was termed, I believe, a tube. I agree with him most decidedly that the mere fact of putting a braid, no matter how good it may be, over a wire good or bad, does not in any sense constitute a tube from which the wire may be removed. I take the ground that the presence of a mechanical covering on the outside of a wire is a very desirable thing as increasing the life of the insulation, and in that way to be encouraged; but not in the sense of a tube, and it should not be used as in ordinary work. In my own mind I have had the notion for quite a while that any electric wire ought to be mechanically protected if that wire was in a position where there was the most remote possibility that there could be any interference with it; and I remember the first occasion when I had to consider the matter seriously was in the laying out of a lighting system in the iron stack of a large library, in which case it seemed desirable, after looking the ground over, to recommend—and this, if I remember correctly was just before the days of the first tube—to recommend that in that library, rubber covered wires should be used, and that two wires should be put together and pulled into common iron gas pipe which should be cut with due care in removing the fins which are left by the cutter. I believe to-day that really is the best position for wires subject to mechanical injury, for you cannot easily hurt anything inside of an iron pipe unless you have an enormous amount of power at command which is not likely in the average place. Of course when we come to consider the iron pipe we must draw a distinction, I think, between the use of alternating currents and direct currents, for I know that if we have alternating current work, and if we attempt to put a single conductor in an iron pipe there will be difficulty. It will cost too much copper on account of the false drop we get due to the presence of iron. Also there is the liability of trouble due to the mere hysteresis loss of iron undergoing the various cycles of magnetization. So that it would seem desirable, to me at least, to twist the wires rather than to lay them parallel in the same pipe. As even a twisted pair of wires in an iron pipe will have a false drop, it is much better, in my mind, to put those wires

in the form of concentric cables. But I do not believe in the usual statement that those two wires should be insulated by something that practically is no insulation at all, that is, a layer of ordinary cotton threads. For I believe if insulation is worth having at all, we ought to insulate between the wires, aiming to keep the wires apart rather than afford an opportunity for the wires to come together and break down the system. With the wires in pairs in an iron tube, if the fuses are properly proportioned, there will be no trouble from burning holes in the pipe itself, except in the case of very large conductors. Under those conditions there is, of course, the possibility of melting tube, wire and everything else.

In the discussion of this paper there was what I might call a general uprising, in which the insurance rules and insurance people and things of that sort were treated rather harshly. But you must consider that the insurance people have a very wide field. They have to meet many considerations on every side, the consideration of the various contractors, the cheap Johns, and the man who is paying the bill, and taking it all together it is not an easy row to hoe. I do not agree with them in all points. I think there have been mistakes in the insurance rules and that there are mistakes in them to-day—such, for instance, as to what a safety fuse is. The statement, as it rests now, I think is something like this: "The safety fuse shall be stamped with the number of amperes it will carry indefinitely without heating," or something to that effect. Well, we know that a good sized piece of copper might be stamped 2 amperes, and we could safely guarantee it against heating with that current. That is one of the little loop-holes which are in the rules. Of course it should read "That it should just melt, etc." The Associated Factory Mutual Insurance Companies of New England have seen fit in their Inspection Department to take up the general question of inspecting electric risks, because they have had trouble; there have been fires started under conditions where they should not; it is true they have not cost very much money up to the present time, but they may cost a great deal. Upon looking over the style of risks of these companies and seeing that they really were selected risks, or mills generally—no stores, no show-windows, no houses, no fire-traps, but mills in which the æsthetic side of wiring plays no part at all, it seemed best to me and to the department at that time to modify the rules, which we took in the main from the pamphlet issued by the Underwriters' National Electric Association, and giving due credit in our books for what we took, then modifying, changing and leaving out a great many rules which in our judgment did not apply to the mutual risks. It seems to me that the National rules as they stand are not really what we might call up to date. They take no account of some of the newer forms of transmission, the newer dangers and the newer precautions which should be taken. While in

general I believe in sticking to one set of rules throughout the whole country, it seemed best to make certain variations. I may say that the Inspection Department is a department maintained by, I believe, twenty insurance companies—mutuals—for mutual aid in preparation of drawings for their plans, sprinkler layouts and general engineering questions, and also to lay out and maintain a very carefully planned set of inspection routes, keeping men travelling around the different mills all the time, each mill being visited, I believe, about four times a year. The work of the department is in general advisory, and it aims to meet the mill men in a friendly manner, to meet the contractors in a friendly manner, and to do all possible good without stirring up any bad feelings. The scheme of rules as we got them out is arranged in some such way as this: In our introduction we admit the uniformity of standards as a desirable thing, and then we have to depart from it on account of inability to agree, which is the general reason for want of uniformity. The general plan of our rules is something like this: We have divided them into classes, the first class being generators as a whole; the second class being electric motors as a whole, and then comes arc lighting as a whole; then low potential systems; then high potential systems for power transmission in general, and there is where the danger lies now, I think, mainly. Then there is the electric railway class, the storage battery, the welding, and the foreign or private wires as we call them. We have taken great care to give due credit in our book to all the rules which we have taken bodily from the Underwriters' rules as issued previous to the 1st of January. Any changes which we have made, even to changes of grammatical expression, and any new rules, have been marked very carefully with a large block letter to distinguish them from the rules which they may have replaced. We then say in large print on the page opposite the first page of rules, that these rules are to be considered as carefully drawn specifications indicating what we believe at the present time to be the best form of construction for mill work, and advising that all contracts for new work have a copy of the rules bound in as a part of the contract, and then we go on and give our rules. Under each rule we have written very carefully a description or explanation of what is meant by that rule, for in our work we find that we can very often convince a man and lead him to our belief by telling him the reason why, when we cannot do it by telling him that he must. Under the head of grounding lightning arresters, for instance, we describe how to do it and why certain things are bad. And so under everything. We explain as well as we possibly can and get out what seems to be to us a good set of rules. The only objection which we have met with up to the present time—I expect to hear a number before the evening is over, however—has been due to only one rule which we have modified, and that rule which we have modified is the rule about sockets and lamps.

Now the regulation rule says, that the shell of the lamp socket shall be insulated from the circuit. In addition to that we say "nor should any exposed part of the lamp base be a part of the circuit," for you know well enough that every portable lamp and every drop-lamp cord is handled by everybody—Tom, Dick and Harry, in the basement, in the attic, in the cotton room where there is loose stuff, down in the well or where it is wet, and there is no reason, in my mind, why the exposed part of the lamp base should not be insulated from the circuit; for there is no use in carefully insulating the holder and the socket and the guard ring for holding the shades, and then put in a 50 C. P. lamp or even a 16 C. P. with a great shell outside and leaving that in connection with the circuit with all the dangers that abound when there are portable exposed parts of the circuit, or exposed parts of the circuit in such places as to be within reach of everybody.

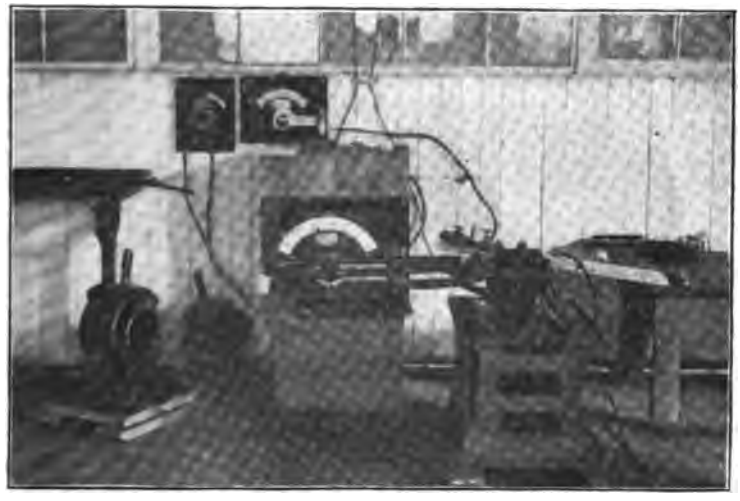
There is another matter too, in which we have departed, and it is the subject that I wanted to bring up, especially as my share of the discussion of this general paper on insurance rules, and that is the question of the carrying capacity of wires. Under that head there is a great deal that can be said. You remember that in the old insurance rules previous to the 10th of January, when the changes were made, the carrying capacity table was based on the experiments of Mr. Kennelly some years ago, which experiments, we must all admit, were very carefully carried out, having a scientific basis and depending on practical measurements.—just what we want when we fall back on any particular thing as a standard—something that we can back up and defend. Now about the last part of December, I believe, and in the official papers which came out about the 10th of January, the Underwriters National Electric Association issued a set of ratings—two of them, in fact, one for concealed and one for open work. The concealed work table has been increased 25 per cent. over the old table, which was based on Mr. Kennelly's figures, and the open work, meaning cleated work overhead, has been increased 75 per cent. Now, at that time, we could not see our way clear to adopting all those changes, for it was quite plain to my mind at that time, that we were running altogether too close to the point where the insulation of the wire would be very seriously injured, and perhaps in this connection I ought to say what the table used by us at that time was based upon. It was based on a recommendation make by a large and thoroughly scientific committee of the English Institution of Electrical Engineers, who reported that in their opinion no wire should ever be heated to a point higher than 150° F. In their experience they had learned that rubber and rubber compounds on an average began to disintegrate at 150° F. We have taken some trouble to find out whether or not the average American wire would come under this same classification, and we find that the average statement is about the same. That means that the average rubber wire can

be trusted only up to 150° F., or a rise of 75° over the average temperature of the atmosphere. Then, taking that point as the ultimate limit, the English engineers recommended that the wire should not carry over one-half that current which will heat the wire up to 150° F., thus providing for a safety factor of two; this one-half current will produce a rise of about 19° F., which of course is very low. Now, with respect to these new ratings the increase of 25 per cent. and the increase of 75 per cent., there is in the official announcement which I have here, no authority for the increase, no excuse, no reason, no scientific basis for the table. It is simply given as an arbitrary table, and therefore just as good or just as bad as any other arbitrary table.

At that time I had some experiments carried on simply to test the correctness of my opinion that it was not desirable to heat wires so much as permitted by the new table. We keep the old rating for the present, but I do not say that we shall not change that rating. I do not say that if the proposed conference between the various interests sees fit to recommend, after due deliberation, one of the ratings, we should not adopt it. But at present we do not want to do so, for we think that that rating may possibly be changed when the danger of it is properly brought out. I then went to work looking up as many data as I could find and I plotted them on a sheet of paper which I have here. I have Prof. Forbes' tables for bare wire and for covered wire. They do not agree with anything else that I have been able to get. I had also plotted Mr. Kennelly's work for bare wire, black wire and concealed wire; also some experiments of our own, and from them reached the general conclusion that Professor Forbes' tables, which are based on scientific experiments, not made on wires, but on something else; are not correct. They do not give the proper carrying capacity for the wire at that particular temperature.

Now, as to the methods which I took to find out certain results, I suggested to one of our young men at the Institute, for a thesis, that it would be advisable to carry on some very interesting experiments from this point of view; we obtained seventy-five samples of wire, which we put through a careful test. The object of the test was to find out what strength of current passing through those wires for, say ten or fifteen minutes, would raise the temperature of the wire up to some definite point which we would readily recognize without measurement of the resistance or any guess-work. The first end point that was used was when a very small drop of water, inserted through a small hole in the insulation and put in contact with the copper would just boil; that was the first point. The next point was, when the slightest trace of visible smoke appeared. There were those two points. The seventy-five samples of wire were put through that particular test in this way; we took a 500-volt alternating circuit, connected it through a reactive coil to a welding coil. In the

welding coil secondary we put the wire under test in series with a suitable ammeter and very slowly increased the current until the points were found. If the boiling point, which generally came first was reached too quickly, the current was reduced. The aim was to find the current which would just be sufficient when long continued, to give the indication. The wire was used in five foot lengths, and bent into a horizontal loop nearly circular. The room was as free from drafts as could be, and such care was taken that the results are as close as the rather uncertain end point will allow. Now, before showing you the curves, I want to refer to one thing which I have never seen pointed out:—it seems to me that in wiring, as in all engineering work, we ought to allow a safety factor. A bridge builder who in his calculations only allowed for the amount of weight he was



FIG, 1.—Arrangement of Apparatus for Heating Tests of Insulation.

going to carry over a bridge, would not be the man we would trust to build the Brooklyn bridge. We would want a man who would build a bridge that would stand not only the weight of the bridge cars but of the people in them, not only that of the people in them in ordinary times, but of the crowds who would be there in the case of a blockade, and we would want a margin beyond that. So in wires we want a margin—a margin over something—the only question that can be asked is over what? The reason for this margin is due to the fact that we cannot trust our fuses. Suppose we could trust to a fuse—we know that if we have a shunt motor, and start one of these great ventilating fans, that we have to use for a short time a great deal more current than the rated current for that motor, before we get the fan up to speed. We know too, that if our main line voltage is

fluctuating, we have to put in a big fuse to take care of the fluctuations of the current. That means that the wire which presumably has been put in on the rating of the motor, has got to stand whatever can pass through the fuse that is used in practice. I say if that is the case, the rating table of the wires should have a safety factor, or else there should be some other way of getting the larger wire, as for example by specifying that the wire used should carry twice as much as the motors are rated for, or better still, carry the amount that the fuse will carry that we have to use in commercial operation. The curves I have are in rather a small shape for a room as large as this. Here (Fig. 2) is a sheet of paper. On it I have plotted the curves of Mr. Kennelly; one curve being the experimental curve, the double of which currents heat the wire up to 150° F. Along with that I have plotted the mathematical curve which Mr. Kennelly finds fits the experimental quite closely, and from which he calculated the safe carrying capacity of wire which has been taken as a basis for insurance work. The insurance table is rather inaccurate however, the values being given only to the nearest five amperes. In the table I have given the proper value as taken from the experimental curve and also the rating as adopted until January 10. Then I have plotted the double of that curve which is, of course, for a total rise of 75° F. These plots are for paneled wires. In order to show the difference between paneled wires and wires in the air, I am obliged to go to Mr. Kennelly's results and take from them his experiments on bright copper and black copper; then plotting them, in order to avoid confusion, at 80° C., I have plotted 80° C. rise with bright copper, black copper and paneled wire; the lower curve representing bright copper, the upper bare copper, the middle, paneled wire. The three curves keep together fairly well, showing that if we should take the panel wire curve as a basis for the rating in general we would not do any very great injustice to either the black copper or the bright copper. So I have simply taken it for granted that the paneled wire curve is correct enough for a basis.

The seventy-five samples which we tested up to the smoking point and the boiling point are plotted on this paper, and they give us this top curve. That curve represents the average of the smoking points of all sorts of wires that you can think of. There is thin underwriters', there is thick underwriters,' there is black line wire, thick and thin, there is rubber covered, thick and thin—all sorts. They all smoke just about at the same point. It does not make any difference whether you have the white underwriters' or the very heavy covered wire; if you watch carefully you will see smoke at just about the same current for the same sized wire. So you will agree with me, I think, that we may speak of the smoking point as a definite thing. The smoking point and the boiling point correspond at the smaller values and differ slightly at the upper values—5 or 10 per cent.

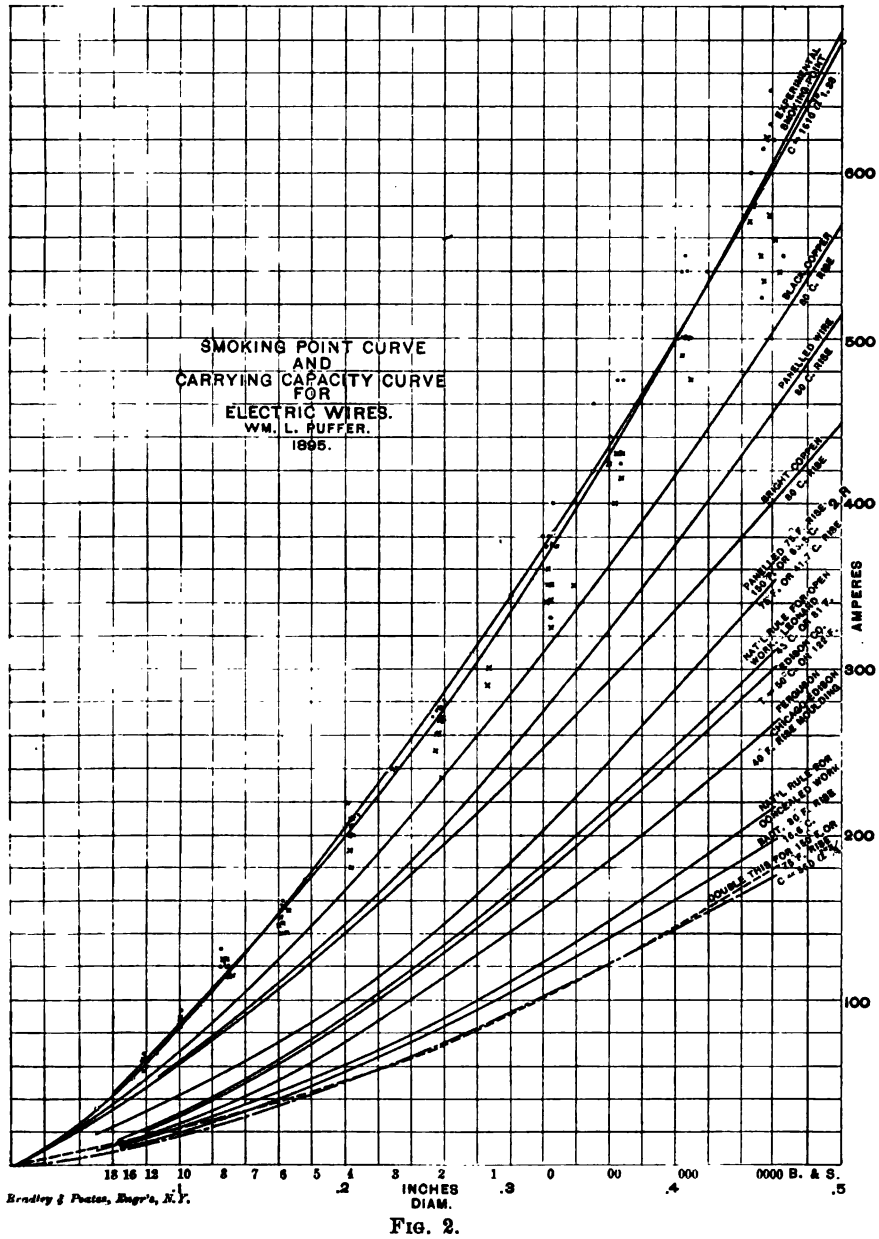

SMOKING POINT CURVE
AND
CARRYING CAPACITY CURVE
FOR
ELECTRIC WIRES.
WM. L. RUFFER.
1895.
AMPERES
600
500
400
300
200
100
18 16 12 10 8 7 6 5 4 3 2 1 0 00 000 0000 B. & S.
.2 .3 .4 .5
INCHES DIAM.
Bradley & Pentes, Engr's, N.Y.

FIG. 2.

Now as regards the safety factor—if we think of the injury to the insulating cover of our wire—and there is nothing else provided in the rules but rubber covered wire—our safety limit must be less than the point 150° F. where that rubber begins to spoil. Its safety point must not be over the 75° F. or 40° C. rise curve which I will call the safety valve curve, as it were, for rubber covered wire.

The open work rating of the present insurance rules—I mean the National, is a curve immediately under this 75° F. and almost up to it, no safety factor worth considering. I will admit that it would be all right possibly, provided it was for a constant current circuit and that the current could not increase over that particular value; but if we are obliged to use rubber wire for the sake of its insulating features we might as well save it, and if we do not want to save the rubber covering of the wire, let us put on something else. I have advised a factor of safety of 2 in our rating table of wires which is nothing else than Mr. Kennelly's original table which the insurance people have used up to the first of this year. And by the way, I should show you the 25 per cent. increase of the present rule which really rests on nothing whatever except arbitrariness. It is in here—here being the 150° F. point and this being the 25 per cent. increase. I have no objection to that rule except that if I double the current I heat the wire too much, and if that rule rested on some experimental data equally good, I should not object to it at all, and even now I do not object, except that it does not rest on anything particularly. We have nothing to go back to.

Professor Holman, of the Institute, to whom I showed this plot as I was leaving to take the train for New York, has sent me a letter which I received this morning in which he has given me a mathematical expression for this smoking point curve—he says is very close to it. The smoking current is 1,610 times the diameter of the wire to the 1.28 power, the diameter being in inches. The current then in amperes which will make any kind of insulated wire smoke can be calculated by taking 1,610 times the diameter in inches raised to the 1.28 power. Now the limiting rise of temperature of these observations made in ordinary air at a temperature of about 20 to 25° C. in about 80° C., and if we look at Mr. Kennelly's eighty degrees rise curves there is a discrepancy. Mr. Kennelly measured resistance and from that calculated the temperature. I am not prepared so say whether I believe that the resistance measurement actually expresses the true temperature of the wire itself. May it not be that the middle of the wire is much hotter than the outside, and consequently Mr. Kennelly's error be in one direction while our experiments must necessarily rest on an end point which is a little bit hotter and therefore giving an error in the opposite direction. Probably this is the reason for the discrepancy. If you will notice again you will see that, practically speaking, the original

rating multiplied by 2 is the danger point of rubber. Twice that again is the point at which the rubber or any other insulation begins to smoke. Now it seems to me that a factor of safety of 4 is not too great; nor a factor of safety of 2 up to the point where you know you are going to spoil your wire insulation altogether.

It might not be uninteresting to read the table. I will read first the size of wire, Brown & Sharpe, then the ratings according to the experimental determination, then the ordinary insurance rule, then the 150 degrees, and then the smoke.

TABLE OF LIMITING CURRENTS FOR B. & S. GAUGE.

B. & S.	1	2	3	4
oooo	180	175	360	630
ooo	149	145	298	519
oo	123	120	246	438
o	103	100	206	372
1	86	85	172	319
2	72	70	144	273
3	60	60	120	237
4	52	50	104	207
5	45	45	90	178
6	39	35	78	155
7	34	30	68	134
8	29	25	58	127
10	23	20	46	87
12	17	15	33	65
14	13	10	25	48

No. 1. This column is taken from the published curves of Mr. Kennelly's experiments and expresses as nearly as could be taken from his curves those currents whose double would heat the wire up to the 150° F. point or 75° F. rise.

No. 2. This is the usual rating given in insurance tables before January 10th and is a rough approximation to the mathematical curve of Mr. Kennelly's.

No. 3. Taken also from Mr. Kennelly's curves and is a table of currents producing 75° F. rise or the danger point of rubber coverings.

No. 4. This is the table of smoking points of all kinds of insulations.

There is another point I want to bring up in connection with the general matter of insurance rules, and that is a question which I think is becoming quite important—and please understand that I do not stand as an alarmist in any way. I believe that electric lighting is a pretty safe thing. In connection with this insurance work I have seen some plants so bad that I do not see how they could run them at all. I have seen a plant so bad, and so fuseless in the proper places that when the engineer was asked if there was any trouble about running the dynamos, he said that sometimes the belts got to slipping a good deal, but if they got very bad he would hold them on with a stick for a little while, and then it would be all right again. The great spread of alternating current work is introducing danger, especially in mill work, where there are very high potential systems in use. The high potential is coming in the shape of transmitted current from a long distance, for use in the mill for light and power. For power work, of course, we can easily make it as safe as any power. But for lighting work, I think that the ordinary installation is a source of consid-

erable danger which can be entirely removed by a device which I am a little afraid to suggest, although I believe in it thoroughly. I believe that where a transformer is used, receiving energy, say at three, four or five thousand volts, and transmitting the energy over a mill for lighting circuits at comparatively low voltages, that it is introducing a serious danger. Of course I admit, with everybody else, that converter insulation never breaks down. Nevertheless, suppose it did happen, and there are those who say it does now and then, we have the high voltages distributed over a hundred different circuits containing lamps and sockets designed for only the small voltage. Of course we know that any employee giving the system the slightest touch would have a shock even if the insulation was perfect, due to the electro-static capacity. I think the insurance rules ought to introduce another factor, and that is safety to life as well as safety from fire. I think there is something of an insurance nature in the demoralization of a fireman when he realizes that if he touches a wire he is likely to get an unpleasant sort of shock. Such a fireman is not half as good in putting out a fire as a man who will wade right in. Now, here is my suggestion: thoroughly ground the middle of your secondary wire. If you do that, your trouble all disappears. I look on it as the choice of two evils; I will take the lesser evil, and that lesser evil is grounding the middle of the secondary, putting a lesser strain on the insulation than by a ground either side, rendering it impossible for the high voltage to go over your mill, and then no one can get a greater shock from any part of the service than the voltage of the plant itself between the wire and ground. Suppose you have a 100-volt plant; if you ground in the middle, there is 50 volts alternating which is not a very serious matter. If you have a 3-wire transformer, it is nothing but 110 volts. If this is done, the electro-static charge element entirely disappears. You have no fear whatever of grasping your secondary wire at any particular point, and I must admit that I always take hold of a wire that I know to come from a transformer with very considerable dread; and that element would then disappear. The fire danger, I think, is comparatively small, and the fear of shocks in the minds of the firemen will instantly disappear. For in mill work, you know, the firemen are right around the premises at work, and they know just what is going to happen when they touch those wires, and from experience they will learn that there is nothing going to happen.

I think, gentlemen, I have taken altogether too much time under the pretense of opening the discussion on another man's paper by almost introducing one of my own. But I should be very glad to add anything that I can which I may have left out, or supply any information that I possess in this general matter that I have brought out and which I wish to have fully discussed, and especially the grounding of the secondary of transformers, which I believe most decidedly to be the proper thing.

MR. A. E. KENNELLY:—Mr. President and gentlemen, I did not intend to say anything so early in the proceedings; but as there seems to be an unwillingness on the part of many present to bring forward their own remarks, I want to fill in the opportunity at least.

The broad question as to the desirability of having insurance rules revised, is, I think, very evident, since there seem to be so many different sets of rules in existence, and these not only differ in detail, but also radically, so that the rules by which a particular installation shall pass in one case or by one company, will not permit that same installation to pass or be admitted under the regulations of another company. The question as to how far this INSTITUTE ought to enter into an arrangement whereby such conformity of action can be obtained, is a little more difficult to determine. On the one hand it seems clear that from all commercial questions at least, the INSTITUTE should be careful to keep aloof, because a danger we all know exists that if the INSTITUTE enters into a question of endorsing a particular wire of Mr. A—. or the particular way of putting in a wire of Mr. B—. that there would be a continual demand that the INSTITUTE shall endorse the particular wires of Mr. X., Mr. Y. and Mr. Z. But in a case of this kind where injustice appears to be possible to a number of manufacturers, and to a number of persons who desire to make and install good work, it seems desirable that the INSTITUTE should at least lend a hand in settling a very difficult and very important matter. While of course, it is easy to put one's finger upon the weak points in various rules as we see them, yet I think we may perhaps be doing scant justice to bodies that have been doing a great deal of good work in the past; I mean these different insurance boards and the work that has been done by their advisers. I think there can be no doubt that if these insurance bodies with their rules and their inspectors had not been at work in the past, that electric lighting would have fallen into a great deal more discredit, and the art would have been much less advanced than it is at present. I think we owe therefore, a great deal of good to their efforts, even although their rules may be capable of improvement in detailed particulars. I think it is very important that any such system of rules should not state anywhere what good manufacturing should be. I maintain that every man should keep to his own business, and it is not the business of the fire inspectors or the fire insurance board to say what good electrical engineering, or good electrical manufacturing, or good electrical installation may be. The business of that board or those inspectors is to say what dangerous or false installation and work may be; and any system of rules, therefore, which should be arranged as a uniform system throughout the country should be careful to state what should not be done and not to try to define what should be done. If they do that, there will be far less

danger of having to modify their rules every few months, as electrical methods multiply and change. The electrical manufacturer, contractor or engineer does not desire to state what fire hazard is, or its limitations, or its commercial capabilities. His duty is to endeavor to make the plant he has in hand as good as it can be made under the circumstances. Insurance rules would go beyond their natural limits altogether should they attempt to say what ought to be used, instead of simply saying what ought not to be used.

In regard to the detail question of the safe carrying capacity of wires, I think it is only fair to mention that Professor Forbes, when he tabulated such results as he possessed a good many years ago—I think it was about 1885—merely took such information, such experimental data as existed at that time, and put them into tabular form. He did not in any way declare that such data were reliable, but simply assuming them to be reliable gave the results to which those data pointed; and consequently the fact that in conformity with more recent developments, the tables that he prepared are not perfectly accurate, does not in any way detract from the merit of Professor Forbes' work. In fact he pointed out a great many things at that time which were and still are valuable, and which were new and important.

The question of how much margin should be left in different wires is an important one, because it always raises a question of economy; that is to say, the man who wants to put in a wire as cheaply as possible, wants naturally to put in as small a wire as shall be permitted to him under the rules; whereas, the man who has to take the fire risk wants to have that wire as large as possible, so that under no conceivable conditions the wire may become too hot. Therefore there must always be a conflict and a clash of opinion between those two representatives. When a large wire is put in, I mean a main or a sub-main, that large wire does not, it would seem, require to carry such a large excess of current as a small wire. That is to say, some accident may happen on a small wire by which an unduly large current may pass through it, or a motor may be on that wire which may require an unduly large current; whereas, all over a building a number of such accidents will not conspire, and therefore, a large main does not, I think, require so large a margin of safety as a small wire. But I agree with Professor Puffer that a margin of safety is desirable, and that we should not work up to the safety limit in putting in wire, particularly a small wire. The safety limit of a wire is, I think we will all agree, a wire which you can hold in the hand without discomfort. When a wire is so hot that you cannot hold it without either having a very thick epidermis or else a remarkable degree of Spartan equanimity, that wire is at the limit of safety. I think this temperature is reached by about 50 per cent. excess of currents over those given in the original table of Insurance Rules.

I think then that a committee might be formed by the INSTITUTE, which should have the power to arrange some plan by which a general conformity of rules should be met all over the North American continent, to specify what bad practice should be, and what should be avoided, and that by such a plan we shall gain not only in simplicity but in security, and at the same time the manufacturer and the man who is putting in a plant shall not be harassed and hampered by needless complications.

THE PRESIDENT:—I see Mr. Woodbury is here. We would be pleased to hear from him upon this subject.

MR. C. J. H. WOODBURY:—Mr. President: The treatment by the speaker of the evening of the carrying capacity of wires is one which has a great deal of interest, and the ratio used in his factor of safety is one which I think deserves very careful attention. A factor of safety is an empirical multiplier, whose necessity in the mechanics of engineering is for the most part due to the variation between the hypothesis upon which the modulus of rupture is based, and the results of the precedents furnished by experience. Now, if a similar method of procedure will furnish a short cut to correct results in the treatment of the problems of the safe conductivity of wires, it will furnish a desirable innovation in many instances.

The suggestion of the last speaker is one which is somewhat attractive, and yet I believe that there is on the part of others something under way in that line in which when the details are presented, I think it will be found that arrangements have already been made for affiliating with the INSTITUTE OF ELECTRICAL ENGINEERS for the advice, cooperation and skill which they will be enabled to give.

The question is sometimes asked as to how far the underwriters should go as a matter of business policy on the promulgation of these insurance rules, which apply to the hazard of electricity, which is one of many hazards. An insurance policy is a contract of indemnity under conditions which are stated on that policy, and which must be construed according to the laws and decisions of the various states having jurisdiction. It may be considered that if a body of underwriters go beyond a certain point in the specifications of electric wiring or any one thing, they also assume responsibilities which may not have been contemplated in the original policy, and therefore there is a phase to this question outside or beyond that which is purely electrical or purely commercial, and that is the insurance side. I believe that it is through the insurance companies that the questions pertaining to the hazards of the transmission of large quantities of electrical energy, and their abatement, has been brought before the manufacturers and operators of electric plants, and that with the various opinions on the subject there is no doubt but that in the immediate future the results will be codified in rules which will be equitable and satisfactory to all of the various elements of the community which are interested in this subject.

PROF. W. A. ANTHONY:—As I stated at the last meeting it was my object in reading that paper to provoke a discussion upon this matter and not so much to bring any particular aspect of it before the meeting. I felt that it was important that the electrical engineers should consider in some way the question of the insurance rules. I had no particular plan in mind. I did not suppose that the electrical engineers would go to work to frame rules for installations, but I wished to provoke a discussion which should show just where the engineering fraternity stood in this matter, and I am glad that so much has been done. This matter that has been brought before us to-night on the safe carrying capacity of wires alone, shows the importance of having this work done by engineers who understand the subject and who know just what the work means. Professor Puffer has brought together all the various experiments on the subject, has given us a number of new experiments of his own, and given us something on the safe carrying capacity of wires that we never had before. The fact that the insurance rules have been changed in this respect, without any warrant, without referring to any authority, seemingly entirely arbitrarily, enforces exactly the idea that I had in mind that it is the engineers who should decide upon such matters as these, and not the insurance companies. It seems to me that when such changes as these are made, the engineer should be consulted upon those changes, and I hope that some plan will be devised by which the engineers may have a voice in the matter.

The points that have been brought up here to-night are exceedingly important ones. The margin that should be allowed is a very important consideration, because safety fuses are uncertain in their action. The blowing of a safety fuse always takes time, and if a very large current is at once thrown upon a wire, a safety fuse may last long enough, before it blows, to allow the wire to become very highly heated, and this is especially the case where large wires are concerned, and where we are depending upon large safety fuses. I do not know that I quite clearly see the force of the remark of Mr. Kennelly on that point, that a large wire does not need the same margin of safety as a small one, because if we depend on safety fuses to protect a large wire, a large safety fuse takes so very much longer time to blow than a smaller one. If a current appears that is sufficient to injure the larger wire it is apt to remain upon that wire just so much longer time, unless an automatic magnetic break is used for cutting the current off. I can see, of course, that the large wire may not be as liable to be subject to a large current, because we may not have the combination of circumstances to occasion the great excess of current on the large wire. But that other point, that when we attempt to protect a large wire by a large fuse, that safety fuse may fail to blow and may carry the current for a long time over the wire, it seems to me makes it just as im-

portant that the large wire should have as large a factor of safety as the small one.

MR. W. J. HAMMER:—At the last meeting I referred to the proposed call by the National Electrical Light Association for a joint meeting of the different organizations. I have here a list of those to whom it is proposed by that committee to extend the invitation. Although the formal invitation has not yet been extended, it will be very shortly, and assurances have already been given informally by a number of those parties that they will cooperate. It is proposed that this meeting should probably be held towards the latter part of September.

DR. C. T. HUTCHINSON:—I suggest that this discussion be ended. This is an entirely foreign matter.

THE PRESIDENT:—I think this has a bearing on the subject. The question under discussion was Professor Anthony's paper and also to see what action the INSTITUTE would take in pursuance thereof.

MR. W. J. HAMMER:—The organizations to whom it has been suggested that invitations be sent are, THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, The Underwriter's Association, the American Street Railway Association, the American Bell Telephone Company, the National Fire Chief's Association, the Western Union and Postal Telegraph Companies, the American Institute of Architects, the Inspection Department of the Associated Mutual Insurance Companies of Boston, and there are also several others which are under the consideration of the committee. It is also proposed to extend at that time a general invitation to any one interested either in insurance matters or in electrical installation throughout the country to send in to that meeting any objections or suggestions which they might have with respect to any of the rules which are at present being promulgated throughout the country. It is proposed that meeting should be held toward the latter part of September. It is hoped that such questions as Professor Puffer has brought up here tonight as to the carrying capacity of wires will receive very careful consideration.

Since the last meeting a prominent officer in the insurance interests sent me a letter in answer to some correspondence in which he said he was afraid there was considerable feeling among the insurance interests as to the attitude of the INSTITUTE as shown by our last meeting, and I think that if the gentleman had been present at the last meeting he would probably have felt differently about it. I do not think the position taken then by the members of the INSTITUTE was for anything but the general advancement of the subject and securing of the very best methods in construction and operation of electric work.

MR. J. I. AYER:—The relations of the insurance interests to the electrical interests in regard to wiring rules have been more or less strained for a number of years, in fact ever since the insurance people organized a department of electrical inspection,

and it has been difficult to reconcile the differences and get harmonious action between the bodies representing the two interests —the insurance and the electric. That most of the trouble has been brought about by misapprehension there is no doubt, and by the lack of concerted action on the part of the electrical people. The National Electric Light Association representing the central station interests of the country has endeavored to effect harmonious relations and bring about the object which is now being sought, not only by the electrical people but I think, to some extent by the insurance people; that is a general code of rules which will suit all interests and which will perhaps be the result of the work of all interests; and I think it is only proper to emphasize the remarks made by Mr. Kennelly and Mr. Hammer in expressing the sentiments of the INSTITUTE so that there may not be a misconstruction put on this discussion by the insurance people of the country, but that they may understand the desire of the INSTITUTE is to harmonize with them—is not to oppose them but to work in harmony with them, and produce a universal set of rules. The insurance people in protecting their interests have apparently trodden on our toes, perhaps usurped our prerogatives as engineers, and this has been brought about wholly by the neglect of engineers to take care of their own interests.

In relation to the suggestion of Professor Puffer to ground the middle of the secondary coil of the transformer where high potential alternating currents are transformed and used for lighting and other purposes in mills—several years ago when our transformers at the ordinary pressures (1,000 volts alternating) were not as good as they are now, and would break down, some of us were much worried and had to suffer a great deal of anxiety by reason of the dangers people were subjected to by using these inferior devices which happily have disappeared. At that time I had occasion to design a protecting device, which, I think, would cover the difficulties he meets with, and that was an automatic switch which was operated by two solenoids, or either one of two, to open the main line of the secondary at the entrance of the building whenever a high potential current might get on the secondary wire. The solenoids were of sufficiently high resistance to prevent the leakage of but very few watts—they were connected directly across the mains, and the wire between was grounded—but with any excessive potential difference sufficient current would flow to actuate the magnets and open the circuit. The switch in opening could easily be arranged to permanently ground the secondary leads from the transformer, and leave the building cut out. These meet the difficulty without grounding the middle wire of the transformer, to which there are objections.

MR. FREMONT WILSON:—Professor Puffer's paper has interested me greatly. In regard to his criticism as to the factor of safety on motor wires differing from the factor of safety on

electric light wires, my experience has been that there should be a great difference in the factor of safety. I would suggest that as we have a guest here this evening, a gentleman who has probably had more experience with motor service in this city at least, than any of the other members, that he be invited to give us his experience in regard to the factor of safety of motor lines, as compared to the factor of safety on electric light lines. I refer to Mr. Arthur Williams of the Edison company.

THE PRESIDENT:—The INSTITUTE will be pleased to hear from Mr. Williams.

MR. ARTHUR WILLIAMS:—After listening with much pleasure to the paper of Professor Puffer and the remarks which have been made, I really think that to present what I have learned in my own experience in a comprehensible form would require more time than it would be proper for me to take. I am hardly prepared to make any remarks that would interest the INSTITUTE, and therefore ask to be excused.

THE PRESIDENT:—I believe, gentlemen, that there is no other matter on our programme. I will encourage you by informing you of the fact that the envelopes are almost opened.

MR. C. O. MAILLOUX:—Some of the delay has been due to the fact that I have been feeling rather restive as the result of trying to follow the interesting discussion and do my work as teller at the same time. My excuse is that I am perhaps as much interested in this discussion as any member of the INSTITUTE, because my practice as an engineer brings me into as intimate contact with these rules as perhaps any other member of the INSTITUTE in this section and in various other parts of the country. Although I was unable to follow the whole discourse this evening because of my duties here as one of the tellers of this election, yet I followed it with as much as I could lend of attention. I am very glad that there has been the amount of expression of opinion that we have received this evening. I am glad to see that we are apparently aroused to the necessity of some action. I spoke with considerable feeling on the matter at the last meeting, and I perhaps could not do more at this session. I do feel, however, that I must reiterate the sentiment which I expressed, which is, that we ought not to be placed in the position of being dictated to in this matter in regard to what is proper, furthermore the rules of insurance inspection ought not to be such as to hamper progress in electrical installation. I know that in many instances in my experience I have found it impossible to introduce the reforms and improvements which were calculated to greatly enhance the character and value of the installation, and therefore, I feel strongly that there should be an end to all such methods that tend to retard the progress of electrical work, and make us go back to prehistoric systems.

DR. C. T. HUTCHINSON:—It occurs to me that there would be a good deal of difficulty in telling just what margin of safety

About the margin of safety of big wires I agree with the speaker—I think it was Professor Anthony—that larger wires ought to have the same margin as smaller ones, for the danger comes when there is trouble in the system. For example, with a great dynamo in a plant distributing through great feeders, the danger comes when there is a short-circuit on the mains, of such a resistance due to the length of the arc that the current which may not be sufficient to blow the main fuses, will be sufficient to greatly overheat the insulation of the wires or even soften it.

About grounding the secondary—the reasons I believe in it are, first, to get rid of electro-static troubles; of course, that would be admitted, I think, anyway. Secondly, I have made a great many experiments on grounded transformers, and I have read with a great deal of attention the accounts of accidents that have happened through breaking down of transformers. I remember one where a transformer broke down during a sleet storm in the winter, simply due to the leakage of water into the case, and it was discovered accidentally and I immediately went there. I succeeded in burning 16 50-volt lamps in series between any lamp cord and the tin gutter of the green-house. At night, when it got cold, the ground entirely disappeared, and there was no inconvenience experienced. In the morning when the thaw came on again, we had the same trouble. These things could not positively happen with the middle of the secondary dead grounded, which fact in itself, is almost reason enough for the grounding. The worst thing that can happen is to blow a primary fuse.

In regard to the carrying capacity of the wire on motor load, I think personally that the carrying capacity on the motor load ought to have a greater margin if anything than on a lamp load, for the man that runs the motor is going to put in a fuse big enough not to trouble him under running conditions. I can, perhaps, best illustrate by a particular example, where a very big motor, several hundred horse power, was put in, supposed to take 60 amperes under full load. The wiring was figured on insurance rules for 60 amperes. It was found necessary on account of the starting current to use 180-ampere fuses. Now that wire calculated for 60 amperes was evidently protected, if such we can call it, by 180-ampere fuses. So that you will see that in that case there is quite a large demand on the safety factor of the rating of that particular wire. I know of a great many cases where motors at times are so heavily overloaded that they take in current three times their rating; that is, being rated for one, the current is often as great as 3. If the wire is selected for the rated current of the motor on the insurance rating of the wire, it is evidently carrying about 200 per cent. more than it ought to carry, and the protecting fuse is one that will allow at least 200 per cent. increase of current over the wire previous to the melting of the fuse itself.