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INVESTIGATION OF CARTRIDGE-INCLOSED FUSES

REPORT OF THE BUREAU OF STANDARDS IN THE CASE OF ECONOMY FUSE & MANUFACTURING CO. *v.* UNDERWRITERS' LABORATORIES (INC.), CONCERNING THE FIRE AND ACCIDENT HAZARD OF THE ECONOMY REFILLABLE FUSE AS COMPARED WITH APPROVED FUSES

BY BOARD OF REFEREES:

E. B. ROSA, Chief Physicist
H. B. BROOKS, Associate Physicist
BURTON McCOLLUM, Electrical Engineer
W. J. CANADA, Electrical Engineer
and
F. W. GLADING, Associate Electrical Engineer
Bureau of Standards

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STATEMENT OF LOUIS W. DOWNES, GENERAL MANAGER D. & W. FUSE CO., PROVIDENCE, R. I.

Mr. DOWNES. I regret the confusion that has arisen on this question of whether the subject covered the entire field of inclosed fuses or not, because we certainly were under the impression that it involved the 600-volt fuses as well as the 250-volt; and I am still further confused by the statement that no report has been made by the Laboratories on the 600-volt Economy fuse, because I have in my hand two photographic copies of the report issued by them on those points. Mr. Cunningham referred to one of them. The fact that the Economy people, in the face of the report, which criticized their operation on 600 volts, continued to market and advertise them as broadly as they do as the par excellence of fuse design, would seem at least to be a questionable attitude on their part, in view of the argument presented to-day.

One of the greatest difficulties which the manufacturer of inclosed fuses has experienced—and I speak from a very long experience in this particular line of work—has been the continued demand by the user for an increase in capacity of a given size of cartridge fuse. He might have installed a 60-ampere fuse, the limit of that particular size under the present rating. He would come back to the factory with an insistent demand that he must have a 65 or a 70 ampere fuse to go in the same cartridge, or it might be even worse than that. He might have a 200-ampere fuse and insist that he must have a 300-ampere link to put into the 200-ampere case. That is something we have all had to contend against, and the Underwriters will bear me out that it has been the subject of discussion between us on numerous occasions, and it shows the

general tendency of the public to ignore, first, the danger, of which they are wholly ignorant, of overfusing a given size of case, and disinclination to take out the cut-out which is already installed, if they find the fuse is of too low capacity, and install the next largest size. That sort of thing necessarily is a factor which has to be taken into serious consideration on the question of this refillable fuse, because of the facility which presents itself for an increased capacity by multiplying the number of links; that is, by the use of two or three links, which can be readily done in a given cartridge, and that is something that will inevitably result from the use of that type of fuse.

Speaking of that, as I do, from a great many years' experience, and knowing this pronounced tendency, it is something I believe this Bureau should take under careful consideration.

Another point that I wish to emphasize which has not been touched upon directly. Mr. Merrill in his talk spoke of the appointment of additional members to the existing switch and cut-out committee of the National Fire Protection Association, for the specific purpose of investigating the use of these fuses. They made a careful study of the problem for two years, and unanimously reported against any change in the Code, which permitted the use of that type of fuse The chairman of that committee, a man of the widest experience in insurance, was directly connected with the inspection department of the Factory Mutuals, and that department had the best opportunity in the world of observing these fuses in field service, and for some time the Factory Mutuals, insuring property of over two and one-half billions of dollars, have refused to permit the general use of those fuses in the large plants that they cover. They must have had some reasonable grounds for that attitude. It is undoubtedly true that in certain cases where they knew that the work of refilling would be done by a skilled man and one who could be relied upon to do the work properly, they would permit its use, if requests were made; but I am speaking of the cases which have come under my own observation, where they knew that the Economy and other types possibly of refillable fuses were installed and they have actually ordered them out of the plants.

It seems to me right there is a subject for a good deal of thought, because they are not the kind of people to take a radical step of that kind unless they believed it was a hazard to the property which they insured.

Mr. Foote in his argument gave some figures as to the total number of fuses which they have sold in the last two or three years, amounting to about a million, and it has occurred to me to suggest that investigation of the total number of fuses in use in this country at the present time, as a manufacturer knowing approximately the productive capacity of my competitors has yielded some figures which may be of interest. I find, on a conservative basis, that there are about 6 000 000 fuses produced each year; in other words, in 10 years we would have 60 000 000 fuses turned out. Taking a little higher average of renewals than that used by Mr. Sargent, 20 per cent, let us say 30 per cent, which would mean that at the present time there are approximately 40 000 000 fuses installed. If we admit that 4000 fuses a year are improperly renewed in the manner indicated in those exhibits, we would have 0.4 of 1 per cent of improper refilling of the fuses installed. Now, as a matter of experience, I know that the total number of improper renewals coming back to our factory—and we get them sooner or later, as they are returned for renewing in the sizes in which we do that work—is insignificantly small. I could say that 25 to 30 fuses a year would be a maximum that we have ever received in our history of fuses returned to us which had any indication of improper renewal. So that by conceding 4000 as a maximum I am giving a very wide margin of safety.

This problem is one that we have considered for a great many years. We have one of the earliest patents on the renewable type of fuse, but for the reasons that have been well expressed here to-day we have never put that type of fuse on the market, although we knew that a possible demand existed.

At a time slightly before the standardization of the inclosed fuse this whole matter was under very lengthy discussion by the insurance interests of the country, represented in the biennial meeting held in New York, and that particular feature of making a fuse as difficult to renew by the user as possible was one which underwent lengthy argument and discussion, and it was practically the unanimous opinion of the insurance interests represented at that meeting that there was necessity for the wording that is in the Code to-day. They had serious grounds for taking that position. Accepting that principle, and converted to it as it were at the time by the arguments presented, we have always abided by it, and at the same time we want to make it clear that the construction of a refillable type of fuse is not and can not be confined in any way. At the present time we have a type of refillable fuse completed and designed and tested, which can be put on the market, if that situation is forced on us; but we would do so against our better judgment, for the reason that our long experience has shown us that too great care in the construction of the inclosed fuse can not be taken.

To indicate something of the care which is taken in my own factory, I would say that there are continuous tests going on in that plant 300 days in the year to check our product, to see that it comes up to the standard. At intervals we take fuses and subject them to the short-circuit tests under the conditions outlined by the Underwriters as to ampere capacity, and the tests which Mr. Cunningham submits in his report were an indication of the class of work that we are doing in order to keep our product up to the highest possible grade to fulfill the conditions which the Underwriters have imposed in their wisdom. And now to eliminate that care, that study to which we have given our entire time for 15 or 20 years and going right back and putting the construction of the renewal of the fuse into the hands of the ignorant public, who know nothing about what takes place in the fuse, seems to me a very unwise step. Examine, yourself, some of those fuses that are exhibited, as an indication of what we are liable to run into. There are fuses which are being sold to-day, put on the market and advertised as high-grade articles, high-class material, that I know from my positive knowledge of fuse design as applied to those particular types, can not operate satisfactorily under short circuit, and constitute a desperate fire hazard and life hazard in themselves.

I have with me a fuse which has recently come out [illustrating] under the name of "Hickman," of Harrison, N. J., which gives an indication of the class of people who are getting into the development of inclosed fuses. Here is a glass tube onto the ends of which copper has been apparently electroplated or sprayed, a fuse wire of considerable size being passed through the center, now being made in the dimension of the 30-ampere, 250-volt class. That man evidently is perfectly honest, because he sent that fuse to us for our examination and test, with the idea of disposing of his patent if he could. That sort of thing has been on the increase within the past two years, during this period of field trial, and all sorts and conditions of people are getting into the construction of inclosed fuses and the designing of inclosed fuses.

As a matter of interest I had two of those short circuited under only moderately severe conditions yesterday morning before I took the train, and the result to a man examining a panel board equipped with that is something you do not want to think of. If the short circuit occurred when a man was examining that panel board, he would lose his eyesight with a chance of a thousand to one.

During the past two years of this period of field trial upward of 22 to 24 manufacturers have started into the inclosed-fuse business. Several of them are represented in the exhibits shown there to-day. A great many of them are marketing their goods extensively to-day which have never been submitted to the Underwriters for consideration or approval, so far as we are able to learn; or certainly, they have never passed any test of the owners, and that is just an indication of what will take place if this field is opened and everybody could make his own fuse. We are going to have hundreds instead of as at present 28 or 30 manufacturers of inclosed fuses, because it

requires a comparatively small plant to assemble some caps on a fiber tube, without any experimental equipment or testing equipment, and we know positively of one case where a man has been manufacturing inclosed fuses in his cellar and back room for the last two or three years, and marketing them quite extensively. He has two or three operatives there; no facilities or equipment. He just takes a piece of lead wire of any convenient size which he may have on hand and drills a hole through the cap and solders it in, and that fuse goes out. If his customer wants a 50-ampere fuse, he marks it "50 ampere;" if he wants 75 amperes, he marks it "75 amperes." We have tested a number of them, so that I can speak positively as to the varying capacity of the same sizes of wire used in the different tubes.

Dr. ROSA. I would like to ask Mr. Downes if he understands that the proposal under consideration is to relax all requirements on fuses if refillable fuses were to be approved? Did you understand that any kind of fuse could be used at liberty, in case refillable fuses could be utilized?

Mr. DOWNES. I do not.

Dr. ROSA. I do not quite understand the last statement made.

Mr. DOWNES. Possibly I can make myself a little clearer in this way. At the present time the manufacturers of fuses have definite arrangements with the Laboratories by which frequent tests are made of their product. The representatives of the laboratory come into the factory, take goods at random and test them out, and at intervals short-circuit tests are arranged for—at less frequent intervals on account of less opportunity—so that every possible effort is being made, not only by the Underwriters' Bureau, but the Laboratories, to keep the standard up to a high level. It is perfectly obvious that the manufacturer, if he is making refillable type of fuse, can have no further interest in the Underwriters' Laboratories inspection, for the very simple reason that the only thing they can do is to make measurements of the visible dimensions of that fuse and see whether it conforms with the Code dimensions, or to test out the fuse as it goes from the factory. After it gets into the hands of the consumer and is refilled, the manufacturer certainly will not take the responsibility of the operation of the device, so that the influence of the laboratory toward maintaining a high standard of manufacture is necessarily bound to end right there. They can only say that a fuse as it comes from the factory is a good fuse, or, if it happens to be defective, they will call the manufacturer's attention to it. After it gets into the hands of the consumer, they can not tell, unless they take that fuse out and take it back to the laboratory and make a test of it, and I know from my general knowledge of the subject of inspection that they could never hope to do that. I think Mr. Merrill will bear me out in saying that that would be an utter impossibility. They can pick out one here and one there, and send it back and see, but the interest of the manufacturer ends—and I believe that I can speak for a group of manufacturers, although I am not authorized so to do—and any laboratory inspection of the renewable type of fuse will cease to exist as soon as the Code is changed permitting those to come out, because the test does not amount to anything.

So far as the test arrangements exist, we are doing and will continue to do everything in our power to keep the standard up to the highest possible level. That has been our aim for years. We are under constant and very heavy expense. Take my own concern alone, which is not a large concern. Our laboratory is spending $10,000 a year in maintaining our quality. There are other manufacturers that I know spend an equal amount. We can not continue to do that as long as the construction of that device may be wholly and entirely changed, due to the ignorance, carelessness, or indifference of the man who is using it, and, as I pointed out, the general tendency is, if your fuse blows, to put in a bigger one. Protection they do not consider, but simply put in a bigger one. I can give you an instance which will illustrate that rather clearly, of a building in New England which was using a refillable type of fuse.

Mr. FOOTE. May we have the name of the place and the name of the man?

Mr. DOWNES. I can not give you the name of the man, but it occurred anyway.

Mr. FOOTE. Then we can not check it up?

Mr. DOWNES. I can have it checked up, yes. His renewable type of fuse blew, and he was criticized by the management. It was a factory building. He said the lights were going out. "Can you stop that?" He said, "I will fix it." So the next time he put in either two or three links, so that the capacity of the fuse was immensely increased, and when the overload came on he blew his primary fuses, and then with a great deal of glee he said, "It is not up to me; it is with the lighting company. When trouble comes it is not up to me. My fuse did not blow. Theirs was the fuse that blew." That tendency you can not eradicate from the using public, and I speak from a great many years' experience in contact with those people freely, and I know they will proceed if a fuse blows to increase its capacity, no matter what happens.

Dr. ROSA. Is that also true of the nonfillable fuse?

Mr. DOWNES. It is the difficulty which they experience in increasing the capacity, that is the safeguard. As I have already stated, they finally write and want a 65-ampere fuse in the 60-ampere cartridge; but we positively refuse to do that.

Dr. ROSA. Is the general tendency of the users of fuses to put in a bigger fuse when the 50-ampere cartridge fuse blows, for example, so that the next time it will not blow? The users do not carefully regard protection, and the tendency is to use a bigger and bigger fuse until it ceases to blow. Is that your understanding?

Mr. DOWNES. There is this tendency, to slightly increase, not to go to the next size. As I say, it was difficult to induce them to take out the 60-ampere block and get them to put in a 100-ampere block, so they could very properly use 60, 75, and on to a 100-ampere fuse. They will not do that. They will ask a manufacturer to give them 65-ampere fuse links in a 60-ampere cartridge, or if it happens to be a 100-ampere cartridge they will ask him to give them 110, 115, 120 ampere links for that 100-ampere cartridge. In other words, that is the tendency. When a fuse blows, they do not reason "Now, let us go and look up the trouble and see why that fuse blows. Was it a defect in that motor? Was there a short circuit on the lighting line, or was the load up to the limit, or something of that kind?" But they promptly put in a bigger fuse.

That has been the tendency, and it has been my experience for 25 years. I was formerly, before I started the D. & W. Fuse Co., in the employ of the Narragansett Lighting Co., of Providence, and had a splendid opportunity of examining that trait, because we were continually getting complaints, where customers had refilled their own open blocks when they were in use. And I would find 60 and 70 ampere open fuses installed on a cut-out whose normal capacity would not exceed 100r 15 amperes, because they would have trouble in the line and the only idea was to keep increasing the capacity of the fuse until it stopped blowing.

Mr. CUNNINGHAM. I have been asked by the Chase-Shawmut Co. to state—and I think the Johns-Pratt Co. also said—that if their fuse was to be regarded as a standard after it was filled by the janitor or porter or anybody of that kind they would regard the approval of the Underwriters as a trivial absurdity and not feel justified in going to any trouble to have it done.

Mr. FOOTE. If refilled by the factory, are they approved by the Laboratory or submitted there for tests?

Mr. CUNNINGHAM. I do not know whether they are tested.

Mr. DOWNES. They are tested and approved. I think Mr. Merrill will bear me out that the arrangement with the Underwriters is that when we refill a fuse that is returned to us for that purpose we put our label on it, and we stand back of it, and that is made in accordance with the standard construction employed by us and used on the types of fuses which they test from time to time. They are at liberty to test those whenever they see fit.

Mr. FOOTE. You do not submit to tests each new job?

Mr. DOWNES. They do not ask us to.

Dr. ROSA. I would like to ask a question about the renewing of fuses. It is the practice in some places for local concerns to renew the so-called nonrefillable fuses. Is there any connection between the manufacturers of renewable fuses and these local concerns; any guaranty that the refilling by the loc al concerns is done properly

Mr. DOWNES. None whatsoever. We have taken every step we can to eliminate that sort of thing, because we find the work done by these people, who may be said to be specializing on refilling fuses, is very indifferent in character—the capacity of the fuse, its rating may be anything at all—and we have no connection with them, and in several instances we have brought suit against them for infringement of various detail apparatus and stopped them from doing that kind of work. But that is no indication of the carelessness with which the public is liable or likely to do refilling, if it can be judged at all by the work done by these people who are making a specialty of doing it. We have never yet found a fuse that was anywhere near its proper rating when refilled by one of these specialists, so called, the general tendency being to make them very much heavier; in other words, to increase the volume of metal in the link, and on that point we run into the very serious hazard, because, as you have probably determined, a variation of less than 1 per cent in the link means the difference between the fuse operating properly and an explosive fuse when it comes to short-circuit conditions, and we find that they will go so far as to increase the metal volume by from 50, 75, to 100 per cent.

Dr. ROSA. We were very much interested to know what the facts were, and we have some information on that subject which seems as though the protection for making the fuse is lost to some extent, if local concerns are going to make it a business to renew them instead of sending them to the manufacturer. Mr. Downes states it is rather usual when they are so reloaded that the capacity is increased. As a matter of fact we have a specimen taken in actual use which had been reloaded in that way by a local concern, in which the cartridge was filled up—three heavy conductors of fusible wire, practically filling the cartridge—and while that is only one case and may not be typical, it confirms his statement that the tendency is to renew them improperly. I think that is rather an important phase of the question that ought to be kept in mind and upon which we need to have further information. If we could be assured the nonrefillable fuses would only be refilled by manufacturers, obviously that would be a very important fact and a very important protection.

Does anyone else wish to address the conference? Mr. Skinner, representing the Westinghouse Electric Co., is here. I will ask if he cares to make a statement.

Mr. SKINNER. I do not believe I have anything to say at this time.

Mr. FOOTE. I understood all the matters would be laid before this meeting, so that we might have an opportunity to examine them. We are here against a lot of interests to prove our case by facts. Whatever they have to submit should be submitted here, so that we may answer, and that is our understanding of the agreement.

Dr. ROSA. I think Mr. Skinner should have the privilege of preparing a statement of whatever he may have to say and give Mr. Foote a copy of it.

Mr. SKINNER. I would be pleased to do so.

Dr. ROSA. May we hear from Mr. Bates, of the Bryant Co.?

Mr. BATES. I do not believe I care to say anything.

Dr. ROSA. Is there any other person who wishes to make any statement or suggestion before we close? Mr. Merrill and Mr. Foote will close, and either one may speak first.

Mr. MERRILL. I have nothing to add, Mr. Director, except to express the thanks of my people for the very great patience you have shown in this hearing, and the admirable way in which it has been conducted, and the painstaking research on the facts presented. We wish to offer the thanks of the Underwriters' Laboratories and that of our associates for our reception, and particularly for the hospitality shown us.

Mr. FOOTE. I shall not have very much to say, because, as I view it, what has been said requires very little answer, in view of the question submitted here, being one of proved fact and not voluntary statement. There have been two examples of fact suggested, one of which was given some importance, identifiable by the case of the Sullivan Machinery Co., and I will ask Mr. Eustice to explain that situation.