LEAD ENCASED CONDUCTORS.

BY DAVID BROOKS.

In the first attempt in this country to work electric telegraphy, by Professor Morse, the wires were covered with cotton, soaked in a preparation of shellac, drawn into lead tubes four together, the intervening space being left empty.

This system was laid from Baltimore towards Washington, about five miles on the Baltimore and Ohio Railroad. I got this information from Tatham and Bros., who made most of the lead pipe purchased, although none of what they made was laid.

The experiment was a failure. About that time, or a little before, Professor Jacoby, of St. Petersburgh, undertook to lay cotton-covered copper conductors in lead pipe with the intervening space filled with rosin. There have been very many attempts of that kind which proved to be failures, until the year 1856, when the discovery of petroleum brought paraffine into the market as a cheap commercial product. This was brought to my notice, and I made many experiments to test its insulating properties, and as the result, it was taken to the patent office, and the patent awarded me, broadly, for its insulating properties.

It occurred to me that cotton-covered wires could be drawn into lead pipe, and a useful system for underground purposes accomplished, but before rushing to the patent office, specimens were buried in the yard of my factory directly under a body of water, or earth soaked with water from a hydrant. These experiments were repeated, and for a long time were attended with failure. In the journal of the *Society of Telegraph Engineers*, published in London, we find accounts of similar experiments made there with like results.

Sealing the ends of a portion of this leaded cable, coiling it up, immersing it in melted paraffine, and raising the heat to about the boiling point of water, we noticed bubbles coming out apparently from the lead. Continuing this heat until all bubbles ceased to rise and then testing the cable, we found the insulation restored. The inference was brought to my mind that the coiling and the uncoiling of lead produced such molecular changes in the metal as to make it sufficiently porous to admit moisture, and the many unsuccessful attempts to lay lead-covered cables, when the cables were insulated with paraffine, in deep water, have served to strengthen this impression.

It must be borne in mind that paraffine, rosin, asphalt and other similar substances, in their normal condition, are brittle and the coiling and uncoiling of the lead pipe breaks them into innumerable small particles, which would leave the cable full of cracks or crevices.

These circumstances suggested the use of oil, and that brought out my system of iron tubes on account of their cheapness.

Lead covered cables are now successfully made by having the insulating material either rosin, asphalt, or pitch, mixed with oil in sufficient quantity to make the material plastic and capable of being bent without fracture.

Some of the inventors of these mixtures have repeatedly stated that their insulating material is a secret. Other materials are the subjects of patents.

Asphalt, rosin, or pitch, when mixed with oil sufficient to make them plastic but not to crack, is heavier than water, and thereby a great advantage is gained. Paraffine, either solid or liquid, is lighter than water. If solid, it cracks—if liquid, a drop of water penetrates it by reason of greater specific gravity of water.

In pursuance of the foregoing remarks, we must now look at the advantages of lead-covered conductors for all kinds of indoor purposes, or what are commonly called distributing purposes for electric lighting, etc.

An ordinary cotton-covered paraffine conductor for inside work is a dangerous thing. There has been sufficient property destroyed by the use of these cheap articles to pay five-fold the substitution for them of lead-covered conductors.

A lead-covered conductor, No. 18 gauge, may show an insulation resistance of 10,000 megohms per mile. When used for inside telephone purposes, if the lead-covering is attached to a gas or water pipe, there is perfect safety from fire from the electric current, should the outside conductor come into contact with an arc light conductor.

A copper conductor, No. 00, for arc lighting can easily be insulated when lead encased to 500 megohms per mile, and when that is brought into a building for distribution purposes, and the lead covering connected with a water or gas pipe, there is perfect safety from fire from the electric current, such as occurred at the Temple theatre in Philadelphia. Again, we can scarcely see how persons could be injured by the electric current conveyed through an insulated conductor covered with lead pipe, as was one of the

employés of the Brush company in Philadelphia, who was killed not two weeks ago, and, since then, as another person was killed in the Adams Express building in New York.

Mr. I. N. Miller, of Cincinnati, has referred to several instances where people have been killed by taking hold of the electric light conductor covered with what is known as the underwriters' insulation, which is simply no insulation at all when exposed to dampness. As this insulation cannot be made to burn with a lighted match, it has been supposed to possess great elements of safety. But when it is encased in lead, and used for incandescent or arc lighting, a great portion of the current passes through the "insulation" to the lead covering.

Taking a piece of this underwriters' wire, covered with lead, and testing the insulation from conductor to covering with a current from a Holtz machine, you can produce no disruptive discharge, because the current passes through the "insulation" quickly, as fast as you can generate it by the machine. Take a similarly constructed lead-encased cable, properly insulated, immerse both ends of it in the insulating mixture and pass a current from the Holtz machine through naked conductors through the

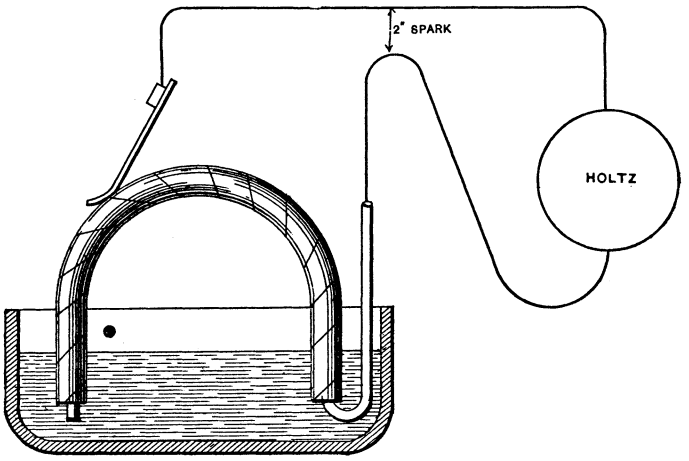

Figure 1.

air, one pole connecting with the encased conductor and the other with the lead covering, a spark two inches long will pass between the two conductors in the air before any passes between the cas-

ing and the conductor, although the distance through the insulation is only one-eighth of an inch. The object of immersing both ends of the encased cable in the insulating material is to prevent short circuiting through the air from copper conductor to lead covering at the terminals.

Much has been said of the incombustibility of the underwriters' insulation. But it is no more incombustible than the proper insulation, provided the spark is not exposed to the air. We can make a disruptive discharge through the insulation if it be too thin, but no combustion takes place, because the air is excluded.

We can now compare this insulation with gutta-percha, caoutchouc, and their compounds.

Exposed to the air, a lead-covered conductor will last ten times as long. Besides this, when running these seam-covered conductors around right angled corners, the insulating covering is apt to open upon the outside of the bend, while a lead-covered conductor will bear much rougher usage.

This quality has been demonstrated by a lead-covered cable for telephone and telegraph, armored with iron wire, and laid across the bottom of the river Delaware between Philadelphia and Camden seven years ago, where it has worked without interruption or deterioration for all that time, although occasionally hooked up by anchors and doubled upon itself.

Other cables laid in the same locality have had frequent interruptions; some have been entirely destroyed and replaced by similar ones, which have perished in their turn, and, for aught I know, the process is still going on. However, there is another class of electricians coming upon the stage who do a little of their own thinking, and they have found out that there is both economy and good service attained by more recent devices.

There has been one objection to these lead-encased conductors, that the space *at the terminals* between the casing and the conductor is so short that, when exposed to a damp atmosphere, moisture collects upon the surface of the unprotected insulating material, and thus the insulation of the conductor is impaired.

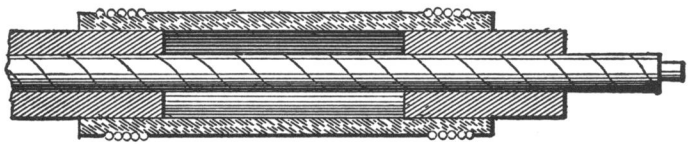

Figure 2.

Messrs. Tatham and Bros. have a simple device by which that difficulty is completely remedied. A short section of the lead casing is cut out some inches from the terminal and an India-rubber sleeve slipped over the gap, and over both parts of the lead pipe remaining. Both ends of the sleeve are then tightly bound to the lead pipe with twine, and the insulation of the cable is safe from moisture.

ADJOURNMENT OF THE GENERAL MEETING.

THE PRESIDENT:—I think we have all had a day of great pleasure and profit, and we shall go to our regular daily duties refreshed and benefited and better able to do the work that lies before us. There being no further business a motion to adjourn is in order.

On motion of Mr. Mailloux the meeting then adjourned.