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PROTECTION OF CABLES FROM ARCS DUE TO THE FAILURE OF ADJACENT CABLES.

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The matter of the protection of cables depends largely on the number of cables and amount of room available. This protection is needed in stations and sub-stations, also in manholes on underground work; on inside work there is generally available room for separating the cables, and for this reason it is easier to take care of them than in underground work. In general, similar protection can be used in either place, except that in underground work material must be used which will not be affected by water, as manholes are liable to be flooded. Protection of cables in manholes will be considered particularly.

In old conduit systems where a large number of ducts have been installed and no attempt made at separating them as they enter manholes, it is a difficult matter to protect cables. If, however, the work has been carefully laid out, plenty of room taken in manholes and the ducts spread so that there is a vertical space of from 8 to 12 inches between the two halves of the conduit line, it is much easier to ensure satisfactory protection. It should be borne in mind that a conduit line of a large number of ducts is not a desirable thing. Two independent lines will cost considerably more than a single line of the same capacity, but this extra cost is an insurance against future trouble.

On account of the large amount of energy carried by high-pressure cables their protection is of the utmost importance. High-pressure transmission cables operate usually at from 5000 to 15 000 volts and are nearly always three-conductor cables. It is to the protection of such cables that this paper refers particularly, although it will generally be found that protection

is needed more from burn-outs on low-pressure cables than from those on high-pressure ones. High-pressure cables are usually protected by automatic overload devices and, if these are satisfactory they will disconnect the cable before any large amount of damage is done. On the other hand, low-pressure cables may continue to burn without drawing enough current to cause them to be cut off. Cables generally break down in manholes due to poor work in jointing or to careless handling during installation. Various methods are in use for fireproofing and isolating them from one another.

A method employed in a number of places is to wrap the cables with asbestos paper or tape about 1/8 in. thick, using two layers and binding the asbestos on by means of steel or brass tape. The metal tape is wrapped either in an open spiral leaving an inch or more between turns, or with the edges touching leaving no open space. With the metal tape wrapped close there is less danger of the asbestos disintegrating on account of water in manholes or of other causes. The asbestos wrapping should be carried well into the duct. This protection has been found adequate by several large companies. Its life, however, is uncertain, particularly on underground work. One disadvantage is that in the case of loaded cables the heat is less easily radiated on account of the asbestos covering. Asbestos paper soaked in silicate of soda has been used for wrapping cables; this has the advantage of not requiring any metal tape for a binder, as the paper treated in this manner is cemented to the cable. It is doubtful if the silicate of soda treatment will be satisfactory for use in manholes that are likely to be flooded, although it should be in dry places.

A second method of isolating and protecting cables consists in providing separate chases or runways for them. Sometimes this is done by building special long and thin bricks into the wall of the manhole leaving them projecting so as to form a shelf. Soapstone slabs are also laid in the wall forming shelves or boxes for the cables. The cables may be further protected with asbestos if desired. It is difficult with this method of protection to make a satisfactory job where the cables enter the ducts unless there has been a very elaborate spreading of the ducts.

The third method of protection, which is very satisfactory when the cables run fairly straight through the manholes, consists of a covering of vitrified-clay tile. Ordinary single-duct

clay tile in 18 in. lengths is used, the tile being cut nearly through before baking so that it is easily broken in halves. The tile on the lower layer of cables is supported by means of light galvanized angle-irons run longitudinally through the manholes. The upper layers are supported on the lower ones. For the bends in the cables 45 degree curves with a 12 in. radius are used. These curves being laid in reverse similar to the letter " S " near the end of the manholes where the cable enters the duct. The tiles are laid in cement mortar forming a good mechanical piece of work and giving practically a conduit line through the manhole. One or two of the lower ducts should be left open at each end of the manhole for a space of about one-half inch so that water will drain from the conduit line. The principal objection to the use of tiling is, that in the case of trouble, making it necessary to remove a cable, the tiling must be broken out. Iron brackets are avoided by the use of tiling and there is no chance for current to flow from the lead sheath of one cable to that of another except such leakage as may occur due to moisture in the ducts. Personally, the writer is in favor of using the split-clay tile covering where possible, and asbestos paper and brass tape in other places.

High-pressure cables should be covered, not only to protect them from the failure of adjacent cables but also on account of the dangers which may arise from an unconfined arc. Oscillations may be set up which will produce pressures many times in excess of that at which the cable is working, and these high-pressures are liable to break down the insulation on the cables or on the switchboard apparatus, transformers, or generators, which may be connected to the cables. For this reason one large company in New York has installed on all cables within a mile of the power-house, in addition to the regular asbestos covering, a sheet-iron armor 1/16 in. thick. This armor being rolled and especially prepared to meet curves or bends in the cable, each section lapping the next one. This sheet-iron is clamped together so as to make a strong mechanical covering.

A manhole fire causes more trouble at the top of the hole than lower down, and for this reason the most important cables should be kept towards the bottom of the manhole. In the case of large manholes it will often be found desirable to build a partition wall longitudinally through the hole, making practically two manholes.

While burn-outs in cables are bound to occur—and for this

reason, fireproofing cables, particularly important ones, is necessary—at the same time, the number of burn-outs can be kept to a minimum by careful work. Only experienced and careful men should be allowed to train cables. The manhole should be built so that it is not necessary, or even possible, to make a short bend in the cable in taking it from the duct to the side of the hole. The jointing should be done by thoroughly reliable men and they should be given to understand that it is not speed which is wanted but first-class work. If it is not desirable to do the jointing as soon as the cables are pulled in, the ends should be sealed, first cutting them back far enough to be positive that there is no moisture present. Tests for moisture should be made if there is any reason to suspect its presence.

The experience of one company in Chicago has been that nearly all trouble that has occurred on three-conductor high-pressure cables has been due to defective joints, to moisture in the cables near the joints, or to sharp bends in the cable. Some burn-outs have occurred due to the lead sheathing of the cables being damaged by electrolysis. This can be prevented by grounding the lead of the cables at suitable intervals or by insulating them if possible. Frequent inspection should be made to determine whether the lead sheaths of the cables are carrying current, a recording voltmeter having a total range of from three to five volts will be found convenient for this work and a chart covering the entire day will be found much more valuable than a few single readings.