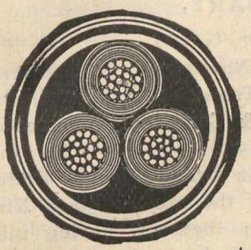
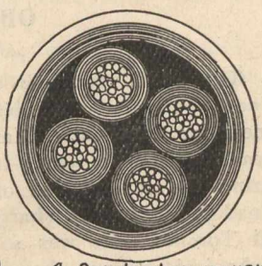
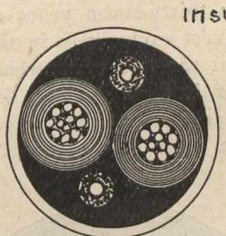
Disastrous burn-outs occur at times on high potential feeders, caused most often by the insulation between conductor and sheath breaking down at some point of severe mechanical injury to the lead. To decrease the charging current through a fault from conductor to sheath, and hence the destructive violence of the ensuing short between conductors, the plan of grounding the neutral point of the transmitting apparatus through a suitable resistance has been tried, and with success in some instances. These burn-outs seriously concern the underground distribution of the future, and this method of suppression has been the



3 Conductor, paper insulated leaded and armored Cable.



4 Conductor power cable with split insulation



Duplex Paper Insulated Cable with Pressure Wires.

subject of several A.I.E.E. papers and discussions recently.

As to the cost of an underground system, and in comparison with the cost of overhead construction, it is impossible to give any general statement that could be made use of in even the roughest estimate. The first cost of subway installations is admittedly high, especially as it is advisable to build most of the conduit in duplicate. However, it is reasonably urged that their maintenance cost is practically nil, and that all considerations of safety and sightliness demand that wires be placed underground.

REINFORCED CONCRETE AND ITS APPLICATIONS TO ENGINEERING CONSTRUCTION.

By J. S. de Vesian, M. Inst. C.E.

The object of the present paper is to present some notes upon the characteristics of reinforced concrete and its constituent parts, to describe briefly the principal systems employed in Great Britain, and to give particulars relative to applications of the material to various classes of engineering construction.

I.—Definition of Ferro-Concrete.

Ferro-concrete, or reinforced concrete, is a combination of concrete and steel, in which the steel takes the tension stresses and the concrete the compression. It may rightly be termed a new material, conforming to laws of its own.

For instance, if a beam of concrete alone will extend under tension for, say, 1-10th of an inch, a similar beam reinforced properly with steel will extend 1 in., or ten times as much, without showing signs of cracking or distress. The more the steel can be subdivided throughout the tension area of the concrete the better; or, in other words, small round bars are preferable to rolled sections of considerable area. By the suitable employment of such bars the designer is enabled to secure monolithic construction, in which all parts are connected absolutely without joints, and the reinforcement extends throughout the concrete, imparting the necessary resistance to tensile and other stresses to individual members, and by passing from one member to another the bars perform a most valuable duty by helping to distribute the forces over the different parts of the structure.

Extracts from a paper read recently before the Civil and Mechanical Engineers' Society.

II.—The Durability of Reinforced Concrete.

The durability of concrete need hardly be entered upon after the experience we have had from olden times. Many old works give us instances of the preserving effects that good concrete has on iron.

Sewer pipes with steel reinforcements have been lately replaced in Europe after forty years' use, and the steel was found to be in good condition. As an instance, coming under the author's personal notice of the preservation of steel when embedded in good concrete, the case of some piles at Southampton may usefully be mentioned. As these piles were originally made too long, the tops were cut off and thrown upon the foreshore, where they have remained for more than eight years, being covered and uncovered by the tides four times a day by the double tides prevailing in Southampton Water. Some of these stumps have been examined by various eminent engineers, as well as by the author, and in every case the steel was found to be perfect ¼-in. only below the surface, while the bars which had been protruding where they were cut off were, of course, completely rotted away. Another very common example of the preservation of steel and iron by Portland cement is furnished by old ships, whose bottoms have been coated inside with cement when built. In such cases the places have always been found in a state of perfect preservation under this coating when replaced in after years on account of corrosion from without.

III.—The Selection of Steel for Reinforcement.

It is very important that the steel used in ferro-concrete should be of suitable quality for its intended purpose. Most experts in this class of work are now agreed that mild steel produced by the basic open-hearth process, with a tensile strength of from 28 tons per square inch to 32 tons per square inch, and an elongation of 20 per cent. in a length of 8-in., is the best for general employment. High carbon steel is unsuitable, as is also any metal of variable quality, such as some kinds of Bessemer steel. Apart from the fact that high carbon steel is apt to break unless bent with great care after suitable heat treatment, there is no economy in such metal because, as its co-efficient of elasticity is not higher than the co-efficient for mild steel, the higher elastic limit cannot be utilized fully without causing excessive stresses in the surrounding concrete, resulting in the cracking of the material and the consequent corrosion of the metal. It is immaterial what form the steel takes, but, of course, the most economical form, and the easiest to arrange, is the round bar. This section can be obtained from many different works of the requisite quality, and at competitive prices. Some patentees advocate special bars squeezed into various forms, or twisted, with the idea of giving a greater hold on the concrete. Corrugated bars of several different shapes are sometimes recommended by makers in this and other countries, on the ground that the steps or indentations so formed give an absolute mechanical bond, in addition to the natural adhesion between the concrete and the metal. In the opinion of the author, all deformed bars necessitate a greater weight of steel being used for the same loads. The process of forming the bars injures the metal, and it may well be doubted whether such bars would pass the tests which must be rigorously enforced for any reinforcement in order to ensure the proper security of the structure when completed.

In the Hennebique system nothing but round bar is used for tension members. Flat steel is used for the stirrups to resist the shearing forces. The adhesion of concrete to steel, which is an undoubted factor, is ignored. The bars are always flattened and opened at the ends to form a secure anchorage. The adhesion varies from 200 pounds per square inch to 570 pounds per square inch of surface in contact, so that as long lengths of steel are buried in the material there would be, as a rule, more than ample adhesion even if the bars were perfectly straight and not anchored into the concrete at all. Moreover, in the Hennebique system, even in