POWER

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Fictitious Price Bait

Being in the market for the equipment of an extraordinarily important power house, a reputable public utility engaged a professional purchasing agent of wide local reputation to do the buying.

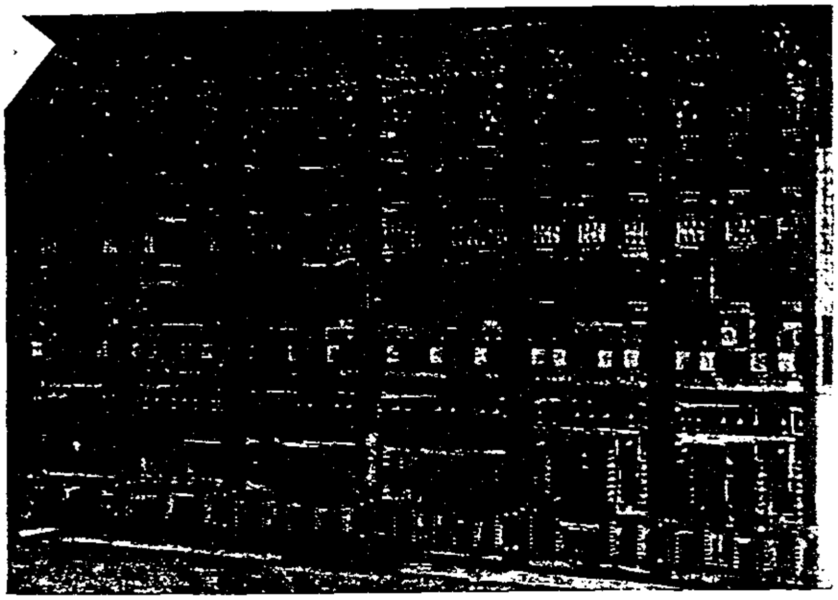
Competition was desperately keen, so here was the opportunity, thought the machinery men, to cash in on their assiduously-developed friendship with the purchasing Pooh-Bah.

The buyer's representative, sensing the situation, was also anxious to prove to his employer the wisdom of selecting him for such an important work.

So, choosing two competitors for each principal division of the job, the agent told each confidentially of the purity of his desire to befriend him. But, since his price was high, the best that could be done was to offer half the units at the other fellow's lower figure, which he then pretended to name. Thus each of the selected bidders was used in an attempt to force a competitor to accept a fictitious price for his product.

When the scheme was discovered the purchasing agent blandly called off the deal and announced he was ready to receive "final" prices from all.

And that purchasing agent occupies an important place in the business of his community today.



Rear of steel-panel switchboard wired with asbestos and varnished-cambric insulated wire designed for this purpose

New Control Cables Have Improved Characteristics

By H. M. FRIEND

Developments made in insulated wire and cable based on recent discoveries by rubber chemists and physicists and the experimental research work of the cable manufacturers in applying these discoveries

WITHIN the last two years important improvements have been made in control cable. These may be classified as improvements in insulating materials; improvements in protective coverings; and new specifications. Insulating materials used for control cable are rubber, asbestos, and combinations of varnished cambric and asbestos. Of these rubber is the most generally used.

Rubber-Insulated Control Cable

When conditions are not severe, such as when high temperatures, chemical fumes, or fire hazards are not present and when the control cable is installed in a conduit system, rubber-insulated cable is satisfactory. When moisture is a serious factor in a conduit system, rubber is the most suitable insulating material.

Before discussing the improvements that have been made recently in rubber insulating compounds it is necessary to mention the two most important discoveries in rubber chemistry made in recent years. One of these is the use of organic accelerators in place of those of the inorganic types, such as litharge and magnesia, which had been universally employed since the days of Goodyear. By the aid of these new organic accelerators vulcanization may be accomplished at a lower temperature and in a shorter time. Besides lowering the cost of manufacture the resulting product has better physical and aging properties.

The other discovery is the use of anti-oxidants that greatly improve the aging qualities of the rubber compound. These antioxidants were developed by the rubber chemists working on the accepted theory that the deterioration of rubber with time is due chiefly to oxidation.

While there have been numerous other developments in rubber chemistry in recent years, these two great discoveries are recognized as the most important since the work of Goodyear. They are now in general use in the rubber industry and have added materially to the life of rubber products.

Recently cable manufacturers have devoted a considerable amount of work to adapting these discoveries in rubber chemistry to their rubber insulating compounds for cable. On account of the many characteristics of the compound which can be changed by varying the ingredients added to the rubber, more interest has been aroused in rubber-insulated cable during the last two years than in any recent period of equal length.

This research work by the cable manufacturers has produced rubber insulating compounds in which the inherent weaknesses of rubber, such as, aging with time; rapid aging with heat; deterioration by oils, acids and alkalies; and injury by ozone, which is formed when corona is present, have been largely overcome. As control systems operate at voltages of 250 or less, corona-resisting compounds need not be discussed here.

The problem of reducing the inherent tendency of rubber to deteriorate with age has been studied for a long time. As applied to rubber-insulated cable this subject was attacked by one cable manufacturer some years ago before the recent discoveries in rubber chemistry by developing an insulating material that has the characteristics of a rubber compound but is softer and of lower mechanical strength than the standard rubber compounds. The composition of this insulation has been kept secret, but it is understood to consist of an oil-base compound with only a small amount of rubber added for mechanical strength. Therefore the properties of the compound do not depend on the characteristics of rubber, and it has superior aging qualities, resistance to the deteriorating effects of heat, oils, acids and alkilies as well as being less affected by corona. However, the physical properties and insulation resistance are lower than those of the standard 30 per cent rubber insulations, or the recent improved types.

In two articles on control cable in *Power*, Nov. 19, 1929, page 796, and Dec. 3, 1929, page 881, the writer

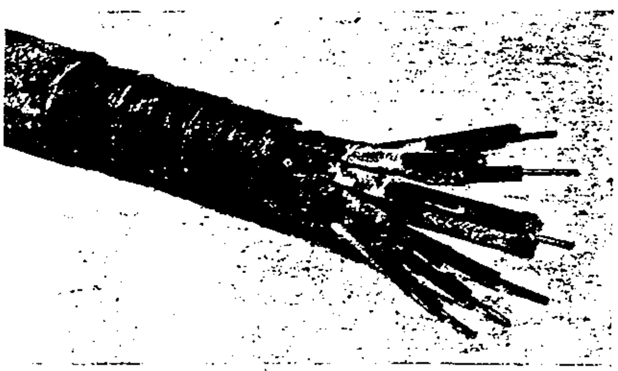


Fig. 1—Section of multi-conductor rubber-insulated control cable that may be laid directly in the ground

stated "At the present time the question of the most suitable rubber compound for insulated wire has not been settled. The fact that leading cable companies have recently developed new compounds possessing resistance qualities to ozone, heat and aging superior to the 30 and 40 per cent rubber compounds shows that there is a trend away from the old standard."

This development work on the part of the cable manufacturers and their application of the discoveries in rubber chemistry have resulted in great improvements in rubber insulation for cables. Some of these earlier developments gave compounds which, though possessing superior aging qualities and resistance to corona, were as inferior in physical properties as they were soft and mushy. Further research work, however, has improved these properties, with the result that rubber insulation is now available which has superior aging qualities, does not deteriorate rapidly with heat, is less affected by oils, acids and alkalies and has great resistance to the effects of corona; as well as possessing high tensile strength, elasticity, toughness, density (impervious to moisture) and the electrical characteristics required of the standard high-grade rubber compounds.

These new insulating compounds consist, in general, of various percentages of rubber with the new organic accelerators and anti-oxidants added to give superior qualities. In physical and electrical characteristics they meet the requirements of the standard specifications for 30 per cent rubber insulation with the exception of the chemical analysis, which they will not pass because of the presence of the organic accelerators and anti-oxidants.

To check the improvements in the aging characteristics of rubber compounds the rubber chemists have developed new tests for measuring the aging under accelerated conditions. This is necessary because to do so under service conditions would require too long. These tests depend on exposure to oxygen, usually at temperature and pressure higher than normal atmospheric.

Two of these tests are rapidly coming into general use, the Bierer-Davis oxygen bomb test and the Geer test. In the Bierer-Davis test the samples are heated to 70 deg. C. in oxygen under a pressure of 300 lb. per square inch. This test is quicker and more nearly duplicates natural aging than the other. In the Geer test the samples are heated in a current of air maintained at 70 deg. C. for 96 hr. After the samples have been subjected to these tests their physical properties are measured. The depreciation in tensile strength and elongation must not exceed certain limits. Leading specifications now include or are being revised to include accelerated aging tests made by the Geer dry-heat and the Bierer-Davis oxygen-bomb methods.

As an illustration of the improvement in the aging properties of these new rubber compounds data are given from an address delivered by Charles R. Boggs, May 13, 1931, before the Signal Section of the American Railway Association. A rubber compound conforming to the specifications of this section is given in Table I.

Table II and Fig. 2 give the results of tests made on shelf-aged rubber insulation and Table III and Fig. 3 give the results of Bierer-Davis bomb tests made to determine the effects of aging on bare-rubber-insulated wire at room temperature in the diffused light in Mr. Boggs'

TABLE I—RUBBER COMPOUND CONFORMING TO THE SPECIFICATIONS OF THE AMERICAN RAILWAY ASSOCIATION'S SIGNAL SECTION

	Percentage by Weight
Up-river, fine, dry Para rubber	32
Whiting	23
Zinc oxide	36
Litharge	5
Paraffin and ozokerite	2
Sulphur	2
Total	100

TABLE II—TEST RESULTS OBTAINED WITH SHELF-AGED RUBBER INSULATION

Age in Years	Compound A[1] Tensile Strength, Lb. per Sq.In.	Compound A[1] Elongation, Inches; 2-In. Sample to Break	Compound B[2] Tensile Strength, Lb. per Sq.In.	Compound B[2] Elongation, Inches; 2-In. Sample to Break
1	1,312	11.00	1,770	11.51
1	890	9.62	1,788	11.10
2	847	7.96	1,682	10.59
3	789	6.55	1,641	10.49
4	702	5.37	.....	.....

[1]Compound A conforms to the specifications of the signal section of the American Railway Association, Table I.
[2]Compound B same as A plus organic accelerator and anti-oxidant.

TABLE III—TEST RESULTS OBTAINED ON RUBBER INSULATION AFTER ACCELERATED AGING IN OXYGEN AT 300 LB. PER SQ.IN. PRESSURE AND 70 DEG. C.

Hours Heated	Compound A[1] Tensile Strength, Lb. per Sq.In.	Compound A[1] Elongation, Inches; 2-In. Sample to Break	Compound B[1] Tensile Strength, Lb. per Sq.In.	Compound B[1] Elongation, Inches; 2-In. Sample to Break
48	464	6.41	1,430	10.44
96	Brittle	....	1,204	10.29

[1]Compounds A and B are the same as in Table II.

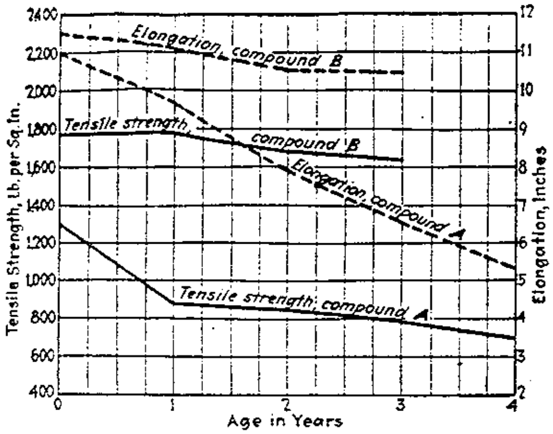


Fig. 2—Results of test obtained with shelf-aged rubber insulation

Compounds A and B are the same as in Tables II and III

testing laboratory. The physical results reported are average figures for a number of samples.

Mr. Boggs, commenting on the tests, said that comparison of the physical properties of compounds *A* and *B*, whether judged by shelf aging or by accelerated aging, shows the wonderful improvement obtained by the addition of an anti-oxidant and accelerator to the compound that the manufacturer is now required to use.

Asbestos-Insulated Control Cable

For severe operating conditions where high temperatures, acid fumes and vapors, oil, grease, or fire hazards are present asbestos insulation is superior to rubber. A standard type of this cable, consisting of a felted asbestos insulation impregnated with special compounds and covered with an asbestos outer braid, also specially impregnated, can be operated under constant exposure to temperatures up to 400 deg. F. For services such as rheostat-grid connections, open wiring in boiler rooms, wiring around chemical soaking pits, and for back-of-switchboard wiring exposed to high temperatures this type of cable is the most serviceable. The all-asbestos insulated type is made only in single-conductor cable; for multi-conductor control cable a combination of varnished cambric and asbestos is used.

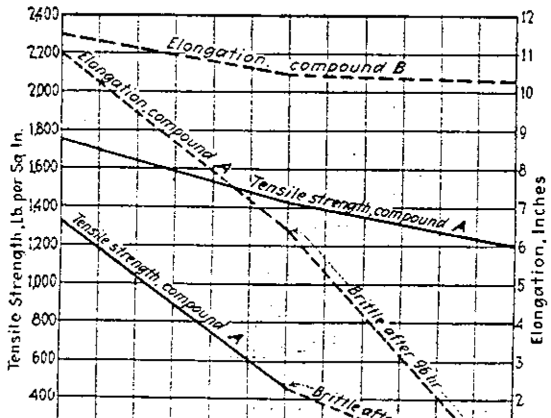


Fig. 3—Test results on rubber insulation obtained after accelerated aging in oxygen at 300 lb. per sq.in. pressure and 70 deg. C.

Compounds A and B are the same as in Tables II and III

In general all-asbestos insulated cable should be confined to open work. It may be used in conduit systems where moisture conditions are not severe, but either the combination varnished-cambric-asbestos type or rubber-insulated cable is better suited to conduit systems.

Recent improvements in all-asbestos insulated cable have been mainly in the impregnating compounds. A compound is now available that greatly improves the moisture-resisting properties of the felted asbestos and the outer asbestos braided covering. This is a black compound which is both flame- and moisture-proof. Where white braids are required the finishing compounds are flame-proof only. Research is being conducted on these impregnating compounds and improvements are soon expected to be available.

Multi-Conductor Asbestos-Insulated Control Cable

Combination asbestos and varnished-cambric insulation multi-conductor control cable is a recent improved type. For conduit installation this cable possesses the desirable qualities of asbestos for certain operating conditions and will withstand constant temperatures up to 250 deg. F. It is suitable for conduit installations, as the varnished cambric gives protection from moisture. Where severe

Fig. 4—Multi-conductor type control cable with asbestos and varnished-cambric insulation

moisture conditions are present, such as when the cable is submerged, rubber-insulated cable is better.

In the construction of this cable the conductors are stranded tinned copper insulated with a felted-asbestos wall especially impregnated. Three varnished cambric tapes are applied over the asbestos. A second layer of felted asbestos specially impregnated is then applied. Colored-cotton marker braids are woven over each insulated single conductor. The conductors are cabled with a lay and are then wrapped with a special moisture-proof tape which also prevents the outer black finishing compound from soiling the identifying braids. The outer covering consists of a heavy woven-asbestos braid impregnated with special black moisture-resisting and flame-proof compound which finishes smooth. Another manufacturer makes this type of cable with a varnished-cambric jacket replacing the special moisture-proof tape.

Improvements in Protective Coverings

In addition to the improvements in rubber insulation the cable manufacturers have done considerable work to develop better protective coverings for cable and have recently put on the market cables with non-metallic sheaths suitable for laying directly in the ground. These cables were developed mainly to replace the parkway type that was laid in the ground without conduit and which depended for its protection on a lead sheath with galvanized-steel-armor tapes and impregnated jute coverings.

Several manufacturers have modified this type of cable for control service. These new types are so recent that they have not yet been extensively used in control systems, but they possess characteristics which make them superior for certain services and they allow the design of a control system where the control cable is laid directly in the ground without conduit. This type also offers another choice for use in a conduit system in place of the conventional types of lead-sheathed or weather-proof-braided cable. Difference of opinion among engineers regarding the relative advantages of lead-sheathed and weather-proof-braided cable in conduit systems may lead many installations to adopt the new type with non-metallic sheath as it offers better protection than the weather-proof-braided type without the disadvantages of lead.

Several manufacturers have put on the market cables of this type. While differing in construction details, they all depend on moisture-resistant rubber compounds and non-metallic protective coverings. The conductors for this new type of cable made by one manufacturer

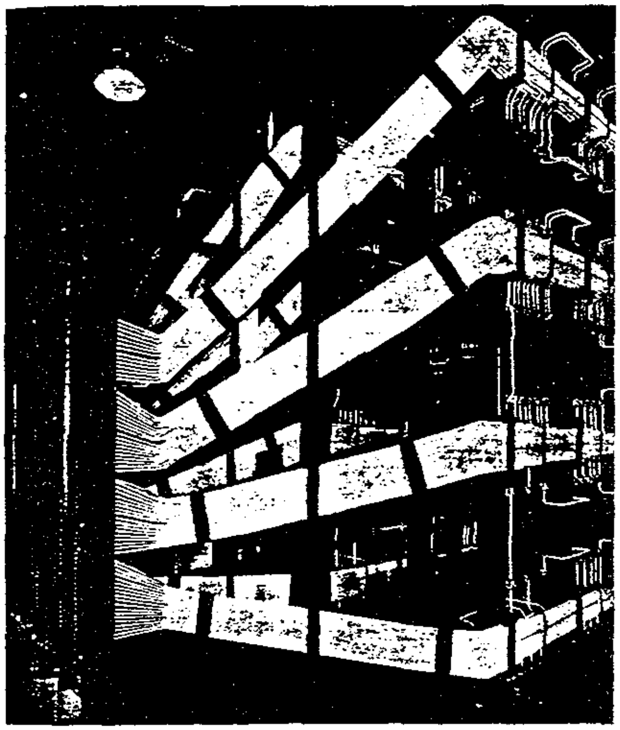


Fig. 5—Over 12,000 ft. of asbestos insulated wire was used to connect the control of this rheostat to the resistance grids

are soft tinned copper. The insulation consists of intermediate-grade rubber that has good aging qualities and a thickness in accordance with A.I.E.E. specifications. A colored cotton braid for identification is placed over each insulated single conductor and coated with a clear moisture-proof finish. The individual conductors are cabled with a lay, and paraffined jute is used to round out the cable. Where conductors are numerous and consist of a core and outer layers a single-faced rubberized-cloth tape is applied over the core portion and over each subsequent layer. To protect the colors in the outer layer of conductors a single-faced rubberized-cloth tape is wrapped over each of these conductors. The valleys between individual conductors of the outer layer are filled with an asbestos-base calk that provides a seal over the entire surface of the assembly. An asbestos-braid sheath $\frac{1}{16}$ to $\frac{3}{32}$ in., depending on the diameter of the cable thoroughly impregnated with a saturant and covered with a seal of the asbestos base calking material is next applied. Two wraps of kraft armor tape are wrapped in opposite directions, making a wall at least 0.060 in. thick. A layer of the asbestos-base calk is placed over this armor to provide a moisture-proof seal. An outer covering consists of pre-saturated asphaltum-filled jute finished with special impregnating compounds and dusted with soapstone. When this cable is to be used in conduit, where it is unnecessary to provide so much mechanical protection, the outer covering is simplified.

The protective properties of this cable depend mainly on the calking material, the asbestos braided covering, and the protecting kraft armor tapes. The calking material was developed by research. It is claimed that it is impervious to moisture and the attack of earth acids and earth alkalies, and that it is practically inert and remains in a plastic state even at freezing temperatures. The asbestos sheath filled with the calking material takes the place of the usual lead sheath. It is claimed to be unaffected by electrolysis and is not subject to induced-current sheath losses, is not subject to crystallization and other defects inherent in lead. The kraft armor tapes which are saturated are claimed to be impervious to decay or oxidation.

This article has not attempted to cover all the improvements in rubber insulating compounds which have been made, but has merely touched on the most important ones. The next few years will undoubtedly show additional improvements in control cable insulation and construction.

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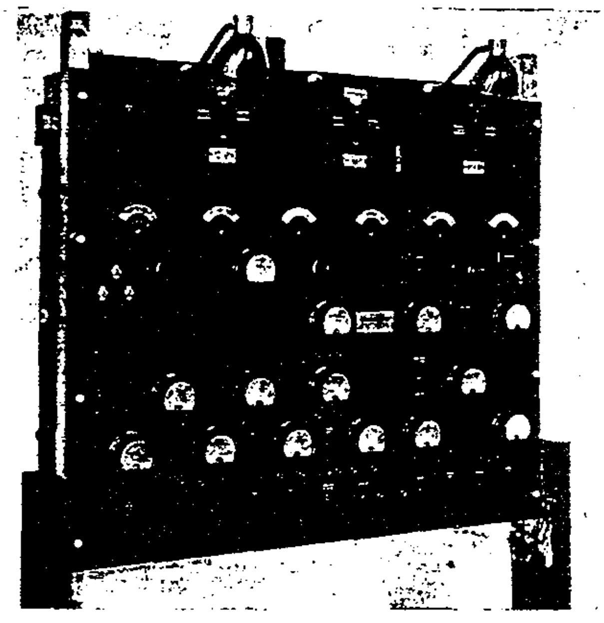
Controlling the Akron



This diminutive Westinghouse switchboard on the navy airship Akron, 42 in. wide, 35 in. high and 12 in. deep, with its 2,170 ft. of wire, controls all the power and lighting circuits of the ship. It weighs only 200 pounds