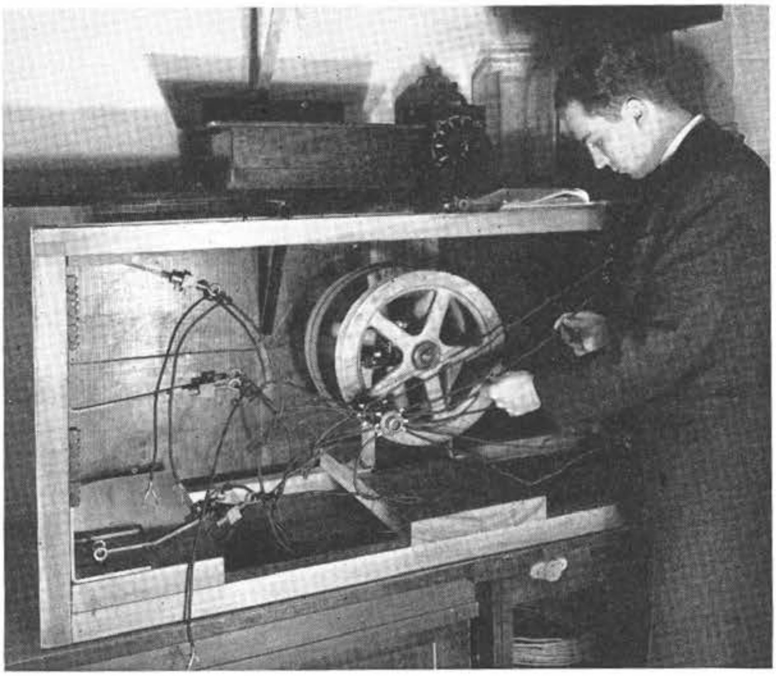

Rubber-Insulated Station Cords

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FROM the moment of its installation a telephone station cord is subject to a variety of forces tending to shorten or terminate its useful life. It is bent, twisted, kinked, rubbed, and strained day in and day out, and yet under these diverse destructive influences the conductors should not break, the insulation should not fail, and the outer braid should not fray. Besides these mechanical hazards, it must withstand contact with water, or excessive dampness, as well as perspiration from the hands. Rain may blow on it from an open window, wet umbrellas may be leaned against it, or in a large variety of ways water may gain access to the wires to cause leakage of current and in this manner accelerate corrosion, or to rot the textile coverings.

For many years the insulation and outer covering of Bell System textile-insulated cords have been given a water repellent treatment similar in effect to that used in water-proofing woolen topcoats. While this treatment has been very effective in preventing trouble from casual wettings, field experience has shown that it does not afford complete protection under unusual conditions of wetting or under continued exposure to dampness. Under such conditions nothing less than a rubber insulation will serve, and because of this, for a number of years the Bell System has provided rubber-insulated cords that are available for use under these exceptional situations.

Although rubber-insulated cords

have been used in very damp locations, rubber of the kind commercially available has never been as satisfactory for general use in telephone cord insulation as the very carefully prepared textiles that have been usually employed. The rubber-insulated cords were necessarily larger and stiffer than the textile-insulated cords, and the rubber tended to deteriorate with time at a greater rate than the textile materials. Cords of this type were used, therefore, only under service conditions of exceptional severity; as a result the number made each year was comparatively small, and the cost correspondingly high.

In recent years a large amount of research has been conducted on rubber compounding,* and much better rubber compounds are now available than could be obtained some years ago. In these Laboratories, work has been carried on with the particular objective of obtaining compounds suited for use in the telephone plant, as recounted in a past issue of the Record.† With these compounds, it seemed possible, therefore, to develop a more satisfactory type of rubber-insulated station cord that would be adaptable to large-scale production methods, and comparable in cost with the textile-insulated type. The preliminary results were so satisfactory that it seemed desirable to extend the initial objective, and to develop a rubber-insulated station cord for universal use. This has been done, and rubber-insulated station cords are now available for general use.

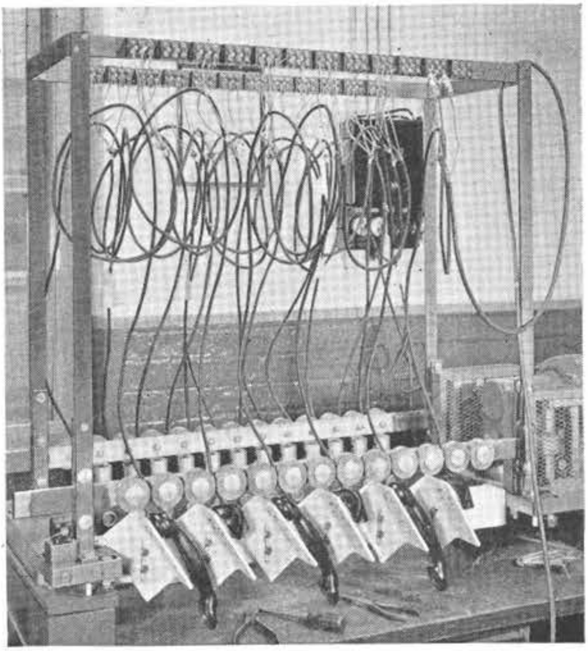

Fig. 2—A machine to study the effect of bending the cord back and forth over the entrance of the handset

To the layman a station cord probably seems a commonplace thing, but as a matter of fact it is a complex structure, every part of which must be carefully chosen to secure a satisfactory service performance. In developing a new type of cord, therefore, every structural element must be duly considered, and every change must be justified by an adequate determination of its probable effect on the service that the product will give. The construction of the textile-insulated

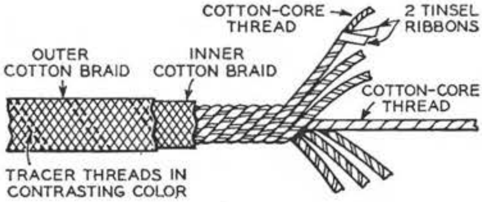

Fig. 1—Construction of the present textile-insulated cord conductor

*Record, *October*, 1936, *p.* 34.

†Record, *November*, 1937, *p.* 85.

cord conductor that was previously standard is shown in Figure 1. It consists of six conducting elements, or tinsel threads, each made up of two tinsel ribbons wound around a cotton thread. These six tinsel threads are then in turn stranded around a core of cotton thread to form the complete conductor. A cotton braid is woven over this conductor, and then an outer braid. The outer braid carries the colored tracer threads used to identify the various conductors of the cord. A number of such conductors laid together in parallel and enclosed with a braided outer covering form the completed cord.

The former rubber cords used the same tinsel conductor structure as the textile cords, but over the conductors were placed two servings, or wrappings of cotton yarn, then the rubber insulation, and then an outer cotton braid carrying the tracer threads. As these insulated and braided conductors were larger and less flexible than the textile-insulated conductors they were generally twisted together, rather than laid parallel before the covering braid was put on, in order to provide cords of sufficient flexibility.

After an improved rubber compound had been developed, there remained the task of designing a cord structure. The individual conductors had to be small and flexible enough to allow them to be laid parallel in the cord and thus permit the use of the recently developed automatic braiding machines. To obtain estimates of the relative qualities of various cord constructions, a variety of testing machines have been developed and built which subjected the cords to the sort of wear they would receive in service, but at a greatly accelerated rate. In the machine shown in the photograph at the head of this article, for example, the cords are placed in position in an initially twisted condition which causes kinks to form near the middle of the cord. In the operation of the machine the cords are repeatedly pulled out from this twisted and kinked condition. At frequent intervals the cords are inspected for fraying of the braids and are tested electrically for breaks in the conductor. The cords are tested in pairs—each pair consisting of a standard and an experimental cord—and the results are obtained in terms of this com-

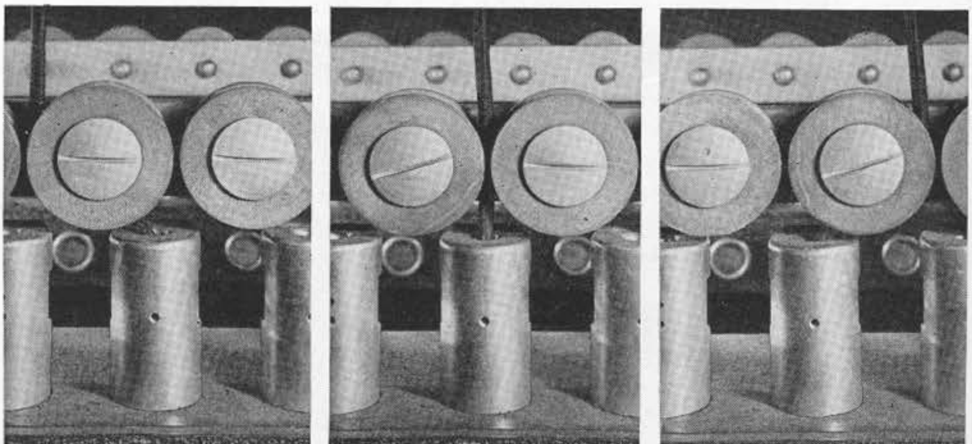

Fig. 3—The cord is bent over the rounded edges of the cord holders between two rollers which are moved back and forth by a reciprocating bar

parison rather than on an absolute measurement of cord durability.

In another machine, shown in Figure 2, the cords are bent back and forth across the entry hole of the handset handle, or across the top of cord holders shaped to simulate handset handles. This machine also is motor driven, and tests for conductor continuity are made periodically. The motion of the machine in bending the cord is shown in detail in Figure 3, which gives the two extreme positions and the mid-position as the crossbar carrying the rollers that flex the cords is moved back and forth by the motor drive. These two tests indicate the sort of treatment to which the experimental cords are subjected in the laboratory. They are supplemented by field trials of cords incorporating structural features of various materials which appear to be quite promising.

The conductor construction that has proven satisfactory, and is being used in the new rubber-insulated cords, consists of the standard tinsel conductor, covered first with a single fine cotton braid. Over this is placed the rubber insulation in colors corresponding to the tracer colors used in the textile braided conductors. These insulated conductors, placed parallel, are then covered with an outer braided covering of cotton.

One feature of this new type of cord that required consideration was the design of a satisfactory cord tip for use with the rubber-insulated tinsel conductor. For the textile cords these have been of the solderless type already described.* Such tips could not be used with the previous rubber cords because connections sufficiently stable in resistance could not be secured. However, the new type of tip that was developed has tangs so formed as to readily penetrate the rubber-insulated conductor and produce permanent low-resistance connections with the tinsel core. The penetration of the tangs was also aided materially by careful proportioning of the U-shaped portion of the tip relative to the diameter of the rubber-insulated conductor. In this way the conductor is held in position at the start of the closing operation until the tangs have made their initial penetration of the rubber insulation.

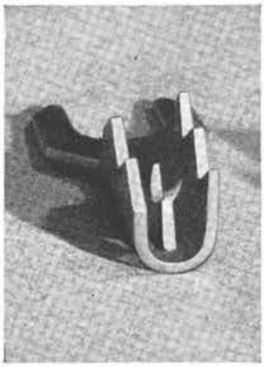

Fig. 4—Conductor tip used for the new rubber-insulated cords

The completion of the development work has made available an improved rubber-insulated cord, comparable both in manufacturing cost and service life to the textile-insulated cord, and having the additional advantage of being water-proof. Practically all of the station cords now being manufactured are rubber insulated, and are being used for most of the new stations and to replace the textile-insulated cords that become defective. Ultimately the new rubber-insulated cords will come into general use.

*Record, *July*, 1926, *p.* 196.