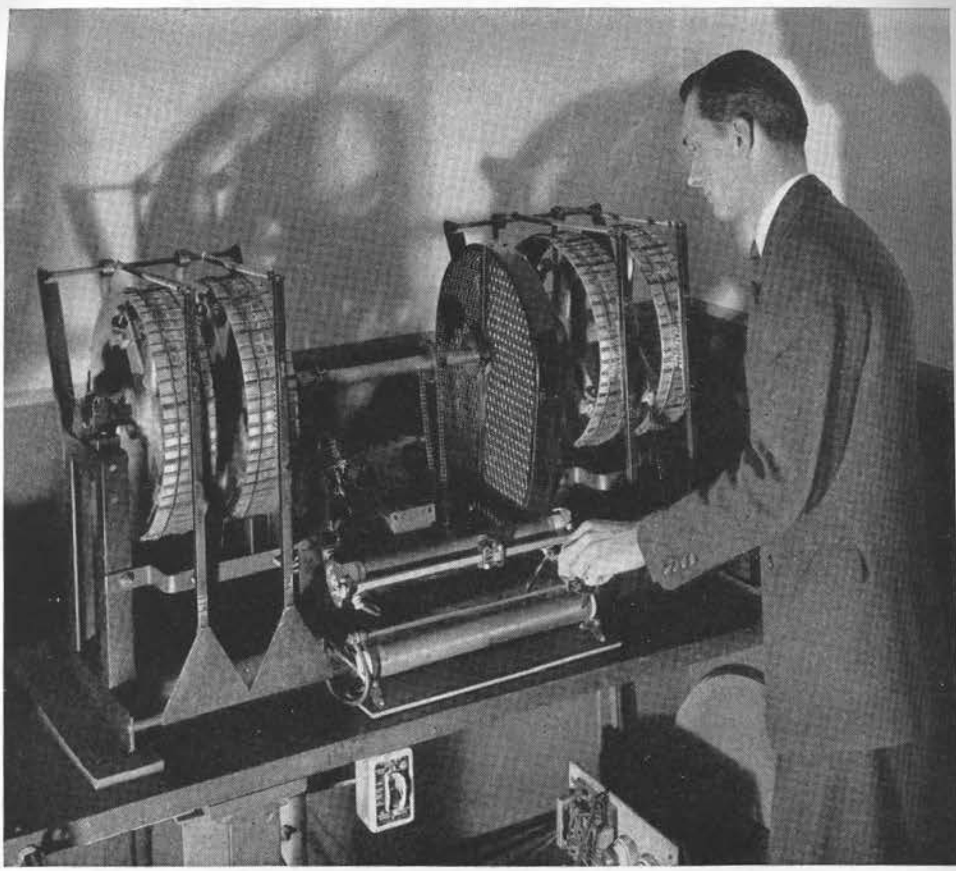

Improvements in Drop Wire

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Outside Plant Development

DROP wire is usually the last connecting link to be installed between the central office and the subscriber. The more permanent parts of the distribution system, such as underground and aerial cable or possibly open wire, have all been placed before the familiar "drop" is run from pole to house. Where possible, the drop is installed in the clear but contacts with trees or other objects are not always avoided, particularly when the wire sways in the wind. The drop is exposed at all times directly to the weather and to mechanical damage of widely varying nature. There are over eleven million such drops now in use in the Bell System, and their average overall length is about 190 feet.

The service life of a station drop is considerably shorter than that of the permanent distribution plant because of continuing migration of subscribers and service changes. Approximately 300 million feet of drop wire are added each year as new wire. Drop wire must, therefore, remain a relatively low-cost item, in spite of the severe service conditions to which it is subjected. It must also be strong and rugged while kept down in size and weight to facilitate installation.

The first drop wire supplied as a single unit to replace open-wire drops was a 14-gauge twisted pair of hard drawn copper conductors to provide the mechanical strength for installation in spans. Each conductor was separately insulated with a heavy wall (.040 inch) of rubber compound braided and weatherproofed. This large and relatively expensive wire was used exclusively for drops until 1910 and is still in considerable demand for special purposes such as for storm repairs, very long drops, and emergency circuits for toll open-wire lines. From 1910 to 1931, drop wire evolved through several stages and emerged finally as a duplex-extruded type with two parallel wires of 17-gauge, 1¾ per cent tin-bronze under a common braid. During this period a much smaller, better appearing drop wire which had mechanical strength equal to that of its bulkier predecessors was developed by using small high-strength conductors, first of copper-clad steel and later of tin-bronze, with thinner walled (.028 inch) and greatly improved rubber insulating compounds. The substitution of more durable weatherproofing compounds for the waxy materials formerly employed also added greatly to the weather resistance of the new wire. For nine years this parallel type 17-gauge "BP" drop wire has remained the Bell System's standard except for severe tree conditions where specially designed wires with greater resistance to abrasion are required.

As field reports become available relating to failures which can be traced to certain features of wire design, the emphasis on development effort is shifted to correct these faults. Several years ago, the crushing strength and stability of the insulating compounds required major attention to minimize insulation failures at points where the wire was tightly squeezed in clamps or at other attachments. Such failures have now been largely eliminated but three types of drop wire service failures still result in annual maintenance charges which bulk uncomfortably large. Tree abrasion failures account for more than one-third of all maintenance expense, while loss of adhesion between insulation and the conductor and the cracking of insulation by sunlight penetrating through openings in the braid also contribute to a lesser extent.

Development work directed toward minimizing drop wire failures from these three sources has made possible the introduction of a new standard drop wire. Fortunately, since first cost must continue to play a part in determining the suitability of the product, advances in the technique of non-ferrous metal casting and wire drawing made available a three per cent tin-bronze conductor as strong in 18-gauge size as was the previously used 1¾ per cent bronze in 17-gauge, and with electrical conductivity adequate for its use in drop wire. The cost advantages which result from this saving in metal have played a large part in building into this newcomer its greater durability at no increase in price.

In the new drop wire, designated TP, to differentiate it from the former standard BP wire, the hot dip tin coating usually applied to the conductor has been replaced by a new composite

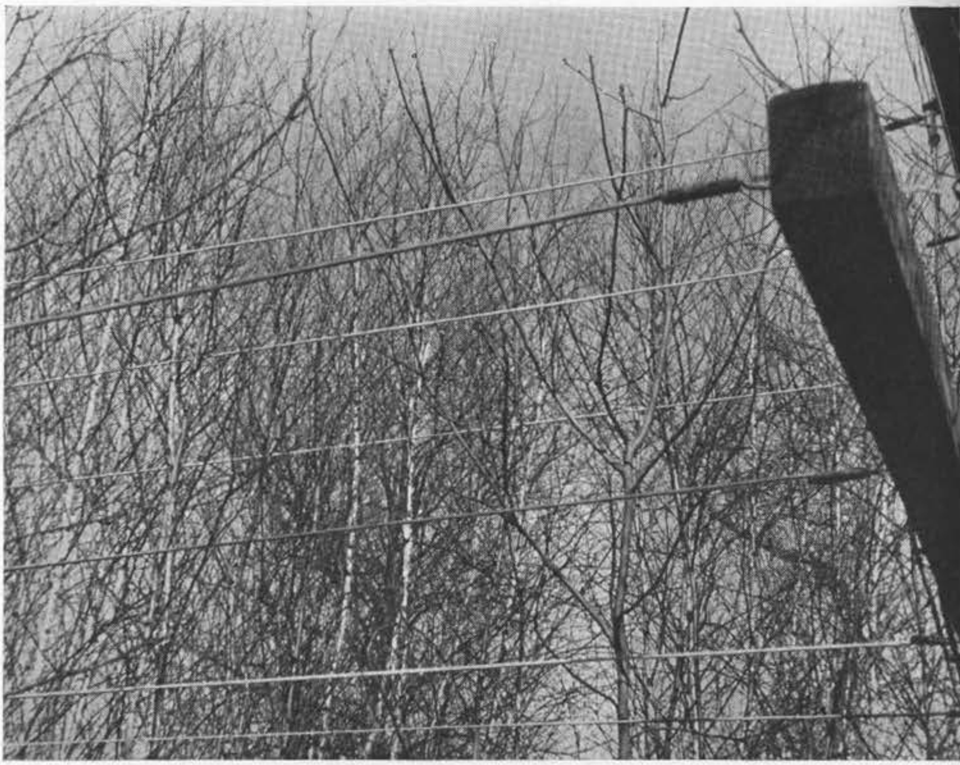

Fig. 1—Drop wire is tested for resistance to abrasion by running it through birch thickets at the Chester Field Laboratory

coating. This new conductor coating was developed to serve the double purpose of providing an inert barrier between the conductor and the rubber compounds and of presenting to the insulation a surface to which rubber will adhere firmly over long periods of time. Experience with the tin coatings showed them to give satisfactorily high initial adhesion but this dropped to unsatisfactorily low levels, particularly in warm humid weather. In marked contrast, the composite coatings now standard have exhibited steadily increasing adhesion over a considerable period of time. This enduring adhesion adds to the performance of the completed drop wire at clamps and other attachments, improves the crushing strength of the insulation, facilitates precise skinning at terminations and permits the re-use of wire which otherwise might have become unsuitable because of loss of adhesion.

Compressive strength and aging characteristics of the rubber insulation have been improved so that a somewhat thinner insulating wall than that standard for BP could be employed on the new TP wire with no sacrifice in those properties. The reduction in size of conductor from 17 to 18 gauge and the slight reduction in insulation thickness permitted the use of a cotton braid almost twice as heavy as was previously employed without increasing the size of the finished wire. The introduction of a new wire of overall size or shape different from the old standard would have complicated field installation practices, particularly so long as much of the older design remains in service in the plant.

Resistance to cracking of the insulation when exposed to sunlight has been greatly increased. The insulation of BP drop wire will crack through to the conductor in a relatively short time if the braid is removed and the insulated conductor wound about itself into a small helix, or otherwise sharply bent, and exposed to summer sunlight, but the new insulation under similar severe exposures exhibits only slight surface attack over long periods. Field experience to date, particularly in coastal areas, has shown the greater ability of the insulation to withstand sunlight without cracking to be particularly helpful in minimizing drop wire failures which result from electrolytic corrosion of the conductors at points where cracks in the insulation have occurred.

Another important improvement incorporated in the new drop wire is the cotton covering and weatherproofing applied over the insulated wire to provide protection from sun and rain and tree abrasion. The new cotton braid is nearly twice as heavy, in pounds of cotton per thousand feet of finished wire, as the braid of the 17-gauge drop wire and the amounts of asphalt saturant and stearine pitch finish taken up by the heavier braid are increased. The savings realized from the use of the smaller conductor have permitted these important steps to be taken without any price increase.

The performance characteristics of the new wire have been determined in the laboratory, checked under severe tree conditions at the Chester Field Laboratory, and checked further by general service trials. In the laboratory, the resistance to abrasion of short samples of the finished wire is determined by the abrasion machine shown in the headpiece. Here the wires are mounted in slots on the periphery of the rotating drums and rubbed against slotted hardened steel abraders until braid failures occur. A large number of wires of both types were also installed in birch thickets on the grounds of the Chester Field Laboratory under exposure conditions as severe as are likely to be encountered in service. The multitude of

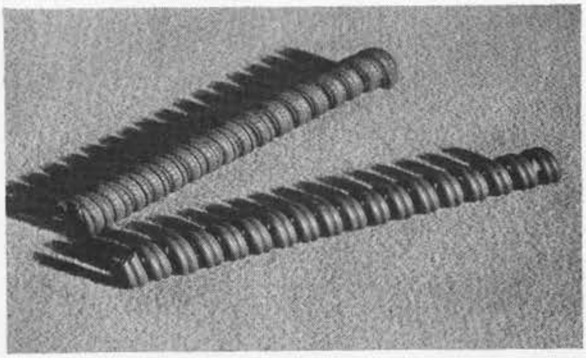

Fig. 2—The new TP drop wire is much more resistant to cracking, due to sunlight, than the BP type formerly used

tree contacts provided by these thickets and the severe wind conditions in this area made possible quite satisfactory confirmation of laboratory results. These tests demonstrated that the new TP drop wire was roughly two and a half times more resistant to tree abrasion than its predecessor.

Apart from their greater abrasion resistance, the heavier braid and the greater quantities of weatherproofing materials taken up by it have increased the weather protection offered to the underlying insulation in approximately direct proportion. Where wires are sharply bent, the heavy braid shows less tendency to open and expose the insulation to sunlight. It has been anticipated that this latter improvement, together with the more light-stable insulation, will be reflected in improved performance of drop wire in coastal areas to a degree comparable to that already discussed for areas where tree abrasion constitutes the major hazard.

Recent rapid strides in the development of knitted cotton covers as replacements for braid and of a wide variety of new and promising synthetic insulating and weatherproofing materials point toward drop wire designs which promise to achieve even more in resistance to abrasion and to weathering than has been realized in the new TP drop wire.

Television for National Republican Convention

THE National Broadcasting Company broadcast television scenes from the National Republican Convention in Philadelphia beginning June 24. The television signals from the pickup apparatus in Convention Hall in Philadelphia were transmitted over cable circuits to the NBC television studio in Radio City, New York. The Bell System provided facilities for this cable transmission.

For the major part of the distance, from the Long Lines testroom in the Bourse Building in Philadelphia to Bell Telephone Laboratories in New York City, the coaxial cable was used. This cable was equipped by the Laboratories for transmitting television signals, including those used by the National Broadcasting Company. This required the provision of amplifiers at five-mile intervals that transmit frequencies up to about three million cycles, and equalizers that maintain proper strength of all the frequencies within this very wide band as well as equal times of arrival within a small fraction of a millionth of a second.

Besides equipping the coaxial cable, it was necessary to arrange for transmission between Convention Hall and the Bourse Building in Philadelphia, and between the Laboratories and Radio City in New York. For these shorter distances regular cable pairs were used, as was done for recent television transmission from Madison Square Garden to Radio City. Such circuits do not transmit television signals as readily as does the coaxial cable, and amplifiers are needed at approximately one-mile intervals. In New York City a new type of cable was installed to link the Laboratories with Radio City. This new cable has the advantage of requiring no intermediate amplifiers for the distance involved.

For the two cable runs at each end of the coaxial cable, it was simplest to transmit the signals just as received from the television camera, the so-called video signals, extending from a few cycles per second up to several million. For most satisfactory transmission over the long length of coaxial cable, however, it was desirable to eliminate the lower range of frequencies, and to accomplish this, special equipment was provided at Philadelphia to raise the frequency band by about 300,000 cycles. Corresponding equipment was provided at the Laboratories to bring the signals back to the video range.