Simplified Subscribers' Telephone Sets

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Editor's Note:

The designs described in the following article would appear to represent the first successful attempt at evolving a type of subscriber set in which the components are designed and coordinated logically and comprehensibly with a view to achieving simplified installation together with maximum reliability and economy in maintenance. The improvements embodied in the new sets, in fact, are of such significance as to influence the future general trend of subscriber set design. They resulted from lengthy and intensive study of subscriber set behavior in far-flung I. T. & T. Associate Telephone Companies operating under the most diverse conditions.

Introduction

Telephone set maintenance represents a large item of operating expense. Because of the distance of subscribers' premises from central offices, a considerable time interval necessarily elapses between a subscriber's report of trouble in his telephone and its elimination. Maintenance costs obviously could be lowered by decreasing the number of troubles and the time required to correct them. Further, if repairs were reduced to a simplified error-proof mechanical operation, less skillful help would be required and the training period curtailed.

Causes of Troubles and Their Remedies

To reduce the number of troubles, one must know their cause. An analysis of telephone set troubles under all kinds of climatic conditions, such as obtain in the far-flung I. T. & T. Associate Operating Telephone Companies, shows that the causes are due principally to (*a*) excess moisture, dirt, lint and insects and (*b*) open and high resistance circuits brought about by deteriorated soldered joints, broken conductors and poor contact between conductors and screw-heads.

(*a*) Excess Moisture, Dirt, etc.

Excess moisture holds top rank as a trouble maker. Telephone plants are low potential systems but, nevertheless, the stress imposed on dielectrics is considerable. The central office battery potential, which is usually 48 volts, is applied constantly on the telephone set terminals. Further, the line circuit is highly inductive and circuit interruptions which result from the making and breaking of the gravity switch contacts and the impulse contacts when dialing impose a stress known to reach 600 volts.

Fig. 1—Table Type Subscribers' Set for Automatic Operation. (FTR 803 SERIES)

Excess moisture results from high humidity at high temperature. It lowers insulation resistance between current carrying parts, causing leakage, deterioration of textile, paper and other types of insulating materials and electrolytic corrosion resulting in open windings.

Dirt, lint and insects cause both mechanical and electrical failures. They accentuate the effect of moisture by holding it like a wick. The free movement of ringer armature, switch-plunger, contact springs and contacts is impeded and, in dials, the gears and governor are clogged and the lubrication absorbed.

It would appear logical to exclude these deleterious minutiae from the set. However, limitations in first cost and design possibilities make it difficult to do other than strike a compromise. In other words, make the set reasonably proof

Fig. 2A—Table Type Subscribers' Set for Manual Operation.

Fig. 2A
(FTR 802 SERIES)

Fig. 2B—Interior of Table Set with Microtelephone in Place. Illustrates Method of Connecting Circuit Components without Employing Loose Wiring or a Cable Form (See Fig. 8).

Fig. 2B

against the entrance of dirt, lint and insects and, in addition, design the circuit elements, cording and wiring inside the set to resist the effects of moisture as well as of other unwanted substances that may accumulate.

(*b*) Open Circuits

Wiring, whether run loose in the set or formed into a cable, or whether soldered to terminals or clamped under screw heads, is a source of many cases of trouble. Wires frequently are nicked in skinning, eventually breaking, and soldered joints may become defective. Wires may interfere with moving parts, the insulation becoming defective. Moreover, during damp weather leakage occurs between wires in sewed cable and between wires and metal parts. While complete elimination of wiring and cabling is not feasible, the set components and the wiring can be so arranged as to almost completely remove wiring trouble.

Simplification of Repairs

When repairmen are required to solder and unsolder conductors, follow a color scheme and remove and replace wires under screw heads, they must be trained to know the telephone circuit and must exercise extreme care not to disturb other connections and adjustments when correcting a fault. In short, they must undergo a considerable introductory training period. If, on the other hand, the set components including the cords were made to plug-in, each in its correct position, with no regard to color schemes and with the wiring and cabling eliminated insofar as the repairman is concerned, chances for error would be completely removed, the time of repair would be shortened and the training period would shrink to a minimum. The grade of repairman needed would be lowered with equal or better results and the cost of making repairs would reach a new low.

Objectives Achieved

Companion table and wall telephones embodying a realization of the preceding objectives are pictured in Figs. 1, 2, and 3. The parts of the two telephones are the same except for the molded plastic covers so that stocking and repairs are simplified. Each set is arranged for individual and two-party selective service. In addition, two knock-outs are provided in the covers so that either set can be equipped with a push-button switch for PABX holding and transfer service and with an auxiliary receiver if needed.

General Plan of the New Sets

In all telephones the wiring interconnecting the several circuit components, gravity switch, dial and handset converge into a pair of line wires which run to the Central Office or PABX. They have heretofore been constructed on the plan of placing the various elements more or less haphazardly in the space available and interconnecting them by loose wires or cabling.

In these new telephones a completely reversed plan is followed. The interconnecting medium is a moulded plastic block into which is incorporated the bare copper bus wiring, the gravity switch complete with plunger, and all connecting terminals for the line, handset and dial cords and the several circuit elements. Every element connects directly to this block without the aid of supplementary wiring. The bus bar wiring is completely protected from dust and injury. Leakage paths between buses are great since each bus is placed in its own groove. The buses are short and heavy so that their resistance is almost nil. This combination connecting block and gravity switch is the heart of the new telephones.

The circuit components themselves are fitted with spring brass split (spade) lugs that slip directly under the screw heads of the connecting terminals. The lugs are so located and the method of mounting is such that considerable pressure is maintained between the lugs and their respective terminals in the connecting block even if the screws become loose.

Circuits

The basic circuit is shown in Fig. 4. It is the highly efficient three-winding induction coil, anti-sidetone type with maximum sidetone reduction on 600 ohm loops. Removable links are provided so that the circuit arrangements shown in Figs. 5, 6, and 7 can be obtained. For the arrange-

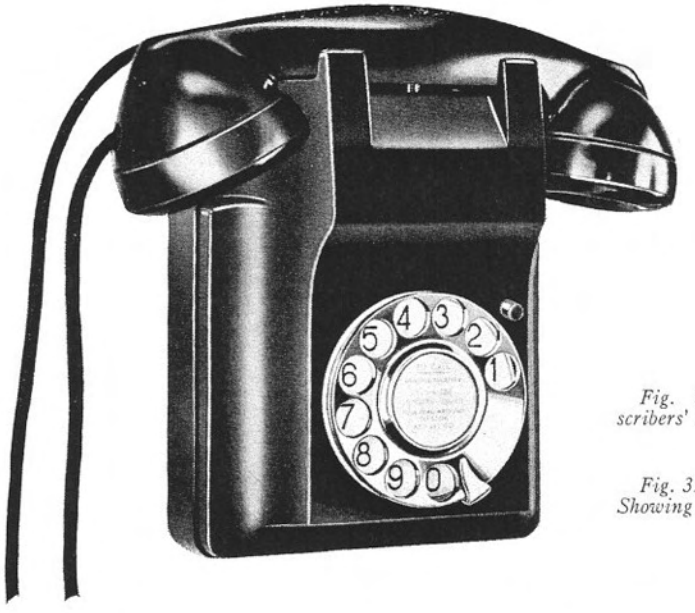
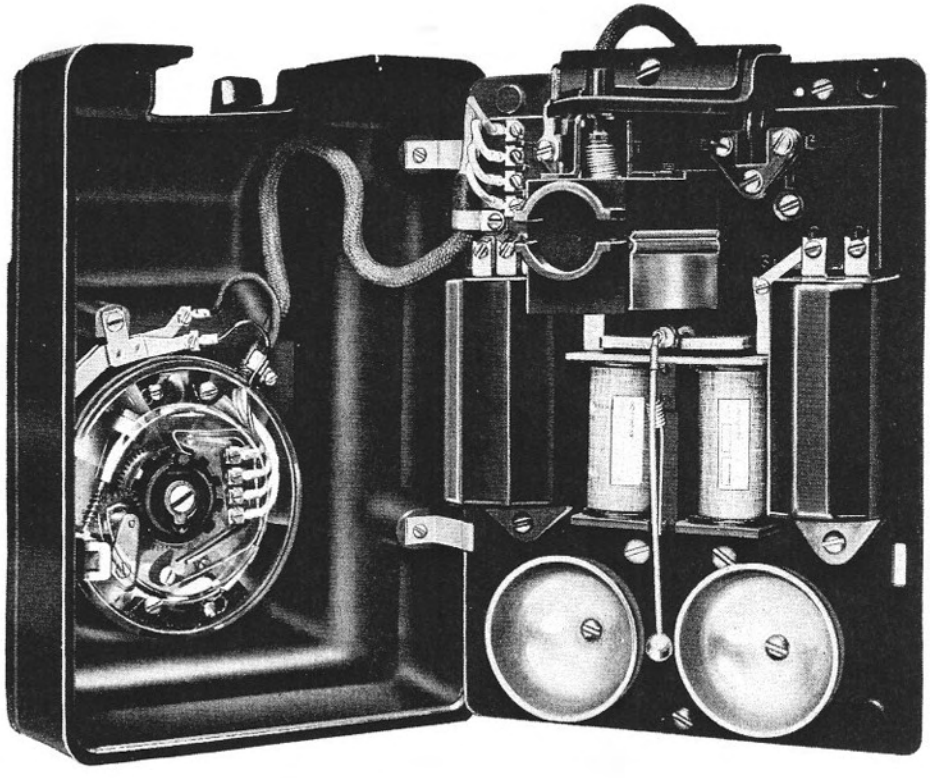


Fig. 3A (left)—Wall Type Subscribers' Set for Automatic Operation.

Fig. 3B (below)—Interior of Wall Set Showing Covered Dial Mechanism.



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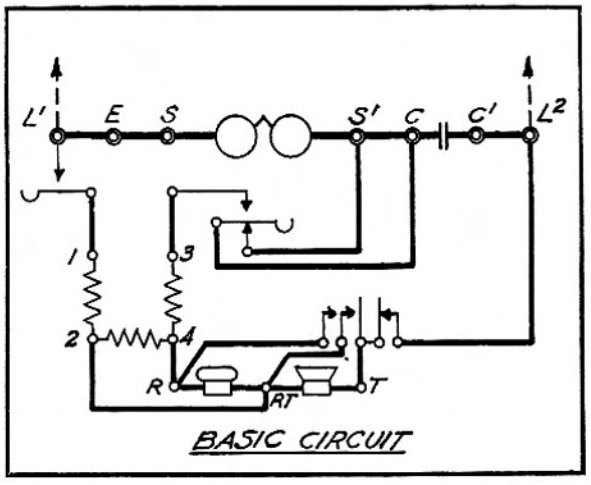

Fig. 4—Basic Circuit of a Modern, Anti-Sidetone Telephone Set as Used in the New Instruments.

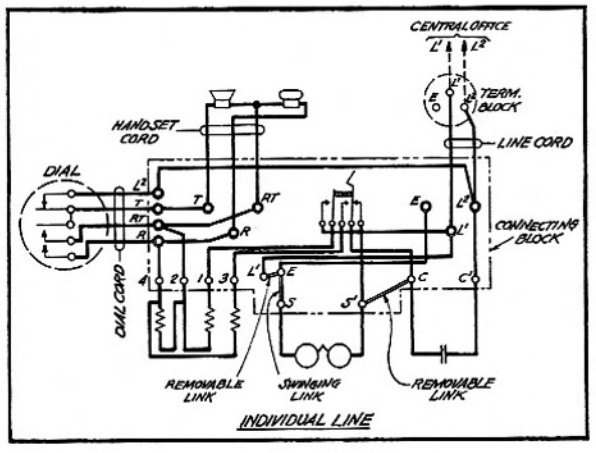

Fig. 5—Wiring Diagram of New Telephone Instrument Connected for Use on an Individual Line.

ment of Fig. 7, a push-button switch is mounted in the cover by means of an insert provided in both wall and desk set covers. The switch is wired in the circuit by using an extra conductor in the dial cord and by a short jumper from the switch to one of the dial terminals (see Fig. 3B).

Unit Components

The unit components are shown in the Frontispiece. These are alike in both table and wall sets with the exception of a difference of 90° in the position of the gravity switch plunger, as is evident by comparing Figs. 2B and 3B. It will be seen that each part fits in its own place and nowhere else, that wrong connections cannot be made except when conventional tipped telephone cords are used. Even this possibility of error has been eliminated by a new type of cordage developed for use with these telephones. A description of the new cordage is given hereinafter.

Detail descriptions of the various units making up the complete assembly follow.

Base Plate

This is a heavy flat steel plate, finished to prevent corrosion, on which all components except the dial are mounted. It is of ample thickness to ensure stability and to prevent the stripping of threads. The four corners are equipped with rubber feet which serve to prevent slipping and marring of highly finished table tops or to insulate the telephone from the wall.

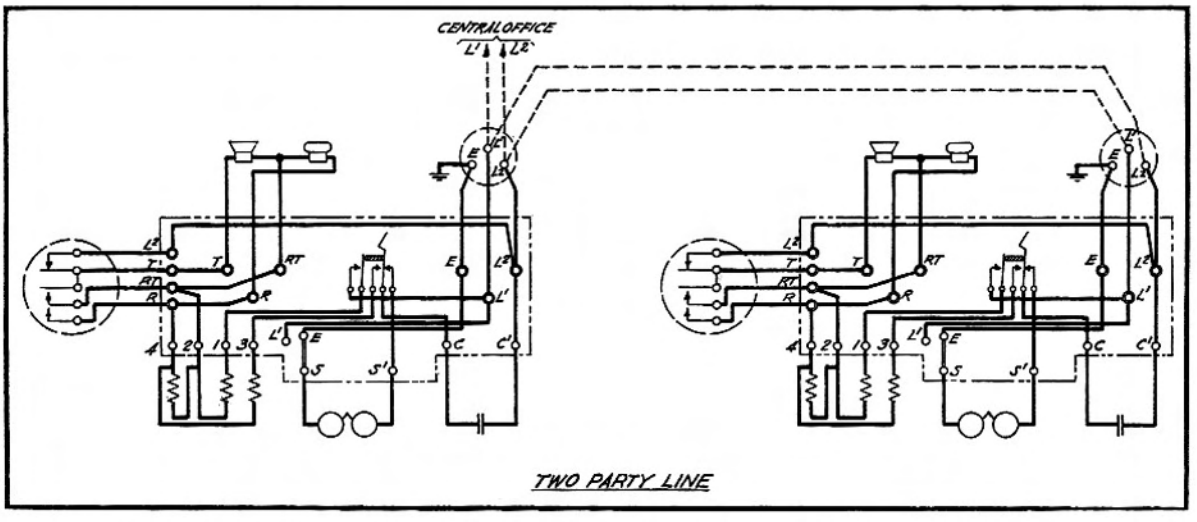

Fig. 6—Wiring Diagram of Two Subscribers' Instruments Connected for Use on a Two-Party Line.

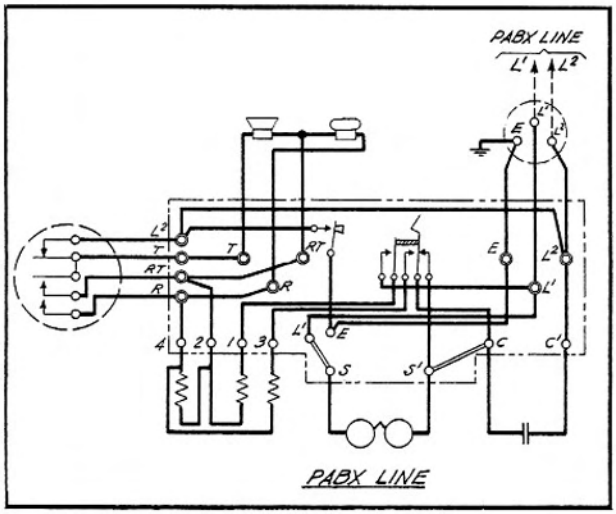

Fig. 7—Wiring Diagram of Connections to a PABX Line. A Knockout is Provided on Each Instrument to Permit Easy Installation of the Push-Button Switch.

Connecting Block

As shown in the Frontispiece, the connecting block is a heavy phenol plastic moulding of ample strength and insulating qualities. Threaded inserts to which the bus wiring is attached underneath are securely moulded into place. The threaded portions of the inserts accommodate the screws by which the circuit elements and cords are attached. The gravity switch housing, which is moulded integrally with the connecting block, is recessed at the front and right to give access to the switch for inspection and adjustment. A snap cover insures the exclusion of dust from the gravity switch housing.

Gravity Switch

The gravity switch springs are long and resilient and each is equipped with two precious metal contacts. Since alternating springs are bifurcated all contacts are made in parallel and, once properly adjusted, they are likely to remain so. (The chance of an open when two contacts are used in parallel is only a fraction of the chance when single contacts are used.) The spring nest is assembled as a unit which can easily be removed, if necessary. The main operating spring of the gravity switch is fitted with a bronze roller which registers with and is moved by the angular surface of the switch plunger of the table set, thus ensuring true rolling action between the two. The wall set plunger acts at right angles to the main

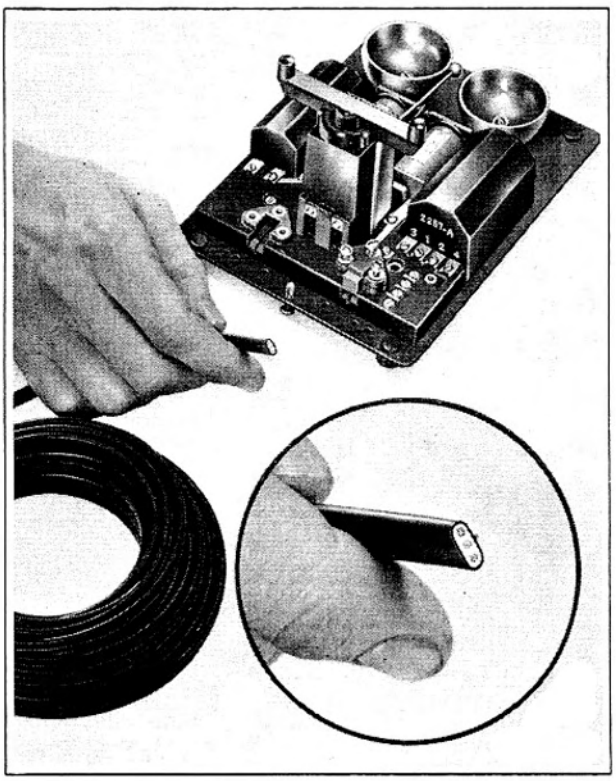

Fig. 8A

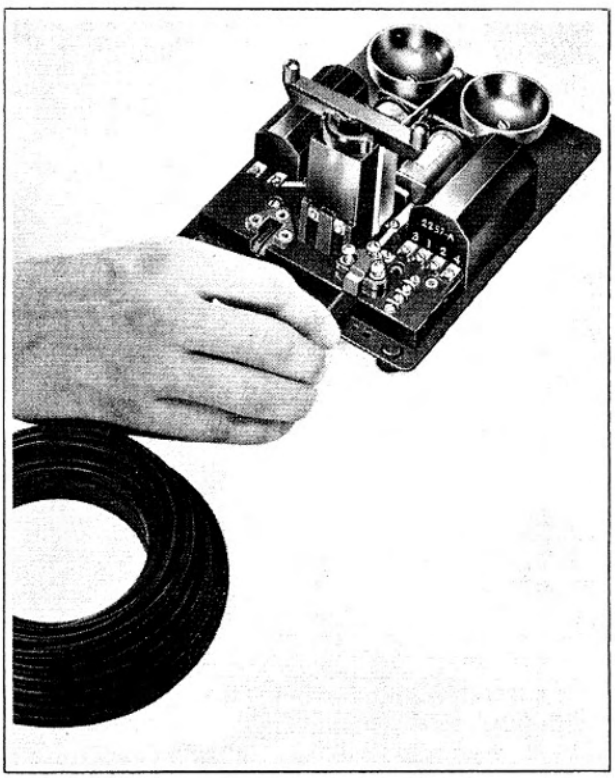

Fig. 8B

operating spring, producing movement of the latter by direct action rather than by camming action.

Plungers for both the table and wall sets are moulded in one piece with two widely separated bearing points; restoration by long resilient coil springs is positive. Further, the projecting knobs which register with the handset pass through holes in the cover which at all times completely clear the knobs, thus entirely avoiding friction with the cover. This construction ensures positive, unchanging adjustment of the gravity switch regardless of whether the set cover is off or on.

Induction Coil

The 3-winding induction coil is potted in a strong bakelite case which is filled with a high melting point compound. The bottom is sealed to prevent leakage at abnormally high temperatures. It is provided with a captive mounting screw at one end and four spade terminals at the other end. The spade terminals are clamped under their respective screws on the connecting block.

In addition to the protection from moisture provided by sealing, the windings are placed on a bakelite spool and the layers are insulated where necessary with cellulose acetate sheet. The use of insulating paper, which usually contains impurities that promote electrolytic corrosion, is avoided. Cellulose acetate sheet, on the other hand, contains no impurities; it is, therefore, much more satisfactory as a core covering and as an insulator between winding layers.

Condenser

The condenser is similar to the induction coil in appearance and sealing construction. The 2-μf condenser unit contained in the bakelite housing is capable of withstanding indefinitely the normal potential stresses to which it is subjected. It terminates in two spade tips which fit only under the proper screw heads in the connecting block.

Ringer

Simplification, as compared with past designs, has been extended to the new ringer. Adjustments are confined to the eccentric gongs and a simple

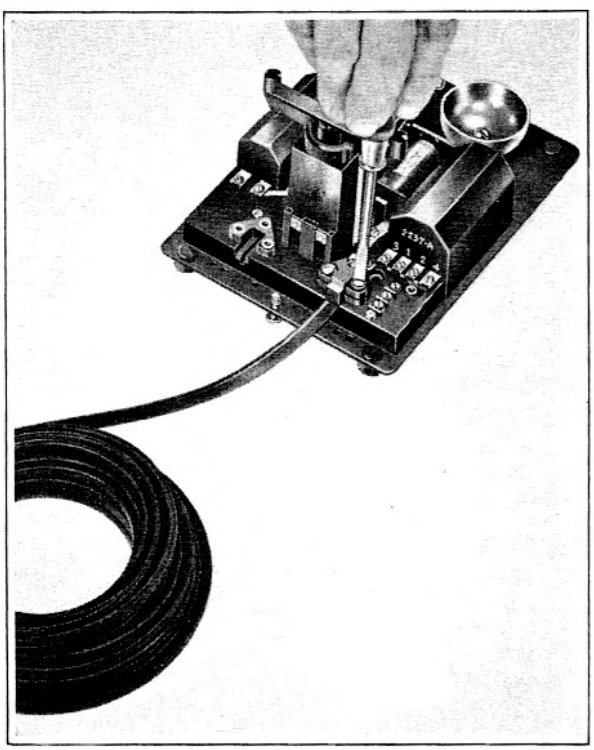

Fig. 8C

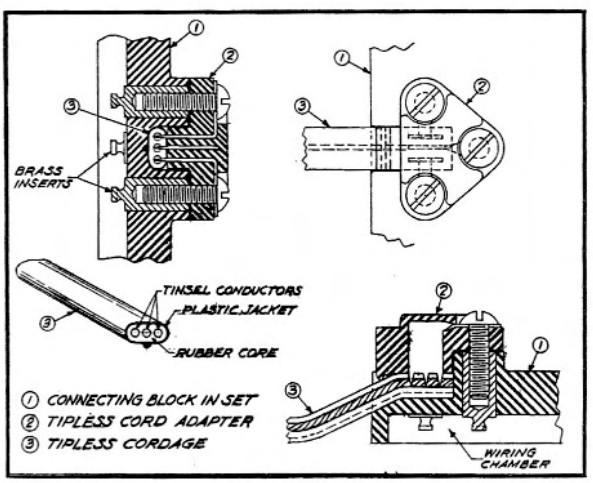

Fig. 8D

Fig. 8—Showing the New Plastic-Covered Tipless Cord and Method of Connection: (A) Cord as Cut from Bulk Stock Ready for Insertion into Special Cord Receptacle; (B) End of Cord Inserted into Receptacle, Rib Down; (C) Tightening Three Screws, thus Connecting and Fastening the Cord. Diagram (D) Illustrates the Mechanics of the Tipless Cord Connection.

Fig. 9A (left)—Showing the Conventional Textile-Covered Telephone Cord Bunched up by Twisting.

Fig. 9B (right)—Showing the Conventional Cord Pulled to Straighten it Out. Kinks and Knots Remain since Conductors Enclosed by the Outer Braiding Have Stretched Unevenly and Moved with Respect to Each Other.

Fig. 10A—Showing the New Plastic-Covered Tipless Cord Twisted and Bunched Up.

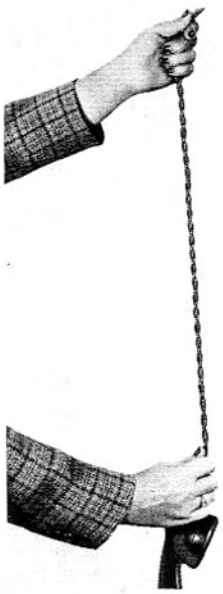

Fig. 10B—Showing the New Plastic-Covered Tipless Cord Drawn Out Straight. Kinks and Knots Do Not Develop.

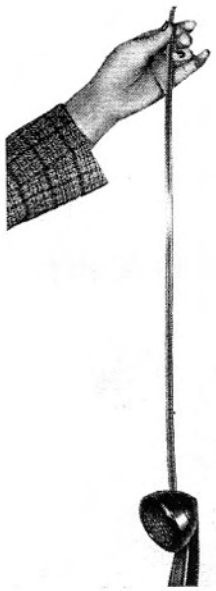

Fig. 10C—When Allowed to Unwind, the New Plastic-Covered Tipless Cord Returns to its Original Shape, Free from Any Kinks or Irregularities.

positive biasing arrangement that is completely dependable. After adjustment in the factory, adjustment in the field is unnecessary although it can be readjusted easily in case of necessity. Spade terminals again are employed for assembly to the connecting block, similar to the other components. The ringer frame is completely insulated from the metal base of the set; its coils are wound on bakelite spools with cellulose acetate insulation between the winding layers and as a covering for the coils. Since the ringer is in series with the condenser, no potential difference is maintained between winding terminals due to the central office battery. Electrolytic corrosion of windings, therefore, is amply guarded against by the precautions taken in insulating the windings, and potting of the coils is not necessary.

Dial

The dial used is basically the same as that used for some years past. It is of rugged construction and proved reliability. It has been improved, however, by the addition of a transparent cover which eliminates mechanical failures caused by dust and lint and causes the dial lubrication to be retained for longer periods. Further, the pulsing and off-normal springs are each fitted with two precious metal parallel contacts which, with alternate springs bifurcated, assure freedom from contact trouble.

Dial Cable

A short, flexible cable connects the dial to the connecting block. This cable is formed by a heavy outside braiding over four color-coded tinsel conductors each encased in rubber. Each separate conductor end is cut to exactly the correct length to fit its respective terminal and equipped with spade tips so that incorrect connection is impossible even if the color code is not known. Tinsel conductors are superior to either stranded or solid conductors for this purpose since the latter break or become noisy.

Handset and Line Cords

Cord maintenance is one of the largest items of telephone maintenance costs. This comes about from several factors such as rotted or discolored outside braiding, knots, twists and loops that made the cord unusable, open or noisy conductors, low insulation or conversely leakage between conductors, and loose cord tips. Moreover, since conventional telephone cords have loose ends equipped with tips, there is always the chance of a wrong connection. Repairmen should have some knowledge of the circuit functions to ensure proper installation of such cords.

An entirely new type of cord that minimizes or completely avoids these objections has been developed for the new telephones. It consists of three tinsel conductors laid in parallel in high grade insulating but low sulphur content rubber. The core so formed is then encased in a black plastic sheathing or jacket which resists sunlight, acids, alkalies and grease far better than either a textile braid or a rubber sheathing. The cordage comes in rolls and is cut to the lengths needed. No other preparation of the cord is required; it is installed in the telephone set, handset and line terminal block by exactly the same simple operation with no possibility of wrong connections. Actually, the cord conductors are poled correctly by providing the cord sheath with a rib fitting into a corresponding groove in the cord receptacle.

Thus, when a cord is inserted into the cord receptacle, its conductors are positioned practically automatically. To complete the connection, it is then only necessary to tighten the screws which cause metallic points to pierce the jacket and rubber insulation of the cord and to enter the tinsel. Inasmuch as the cords are securely snubbed ahead of the connecting points, all possibility of accidental loosening of the cords or of noisy connections is avoided.

Fig. 8 (A, B, C and D) shows a cross-section of the cordage and the simple mechanics of the connection. Cords remain clean and sanitary under all conditions throughout their life; they are truly waterproof and there is no braid to fray, fade and rot. In addition to an exceptionally long life, this type of cord has the virtue of resisting the effects of twisting, kinking and knotting. Figs. 9A and B show a conventional tipped cord which has been badly twisted and then straightened out by pulling. Some kinks and knots have not come out and the cord cannot be completely straightened because the three conductors enclosed by the outer braiding have stretched unevenly and moved with respect to each other. On the other hand, Figs. 10A, B and C show the new tipless cord which has been (*a*) badly

twisted, (*b*) straightened by pulling and (*c*) allowed to unwind by hanging free. It will be noted that the cord has completely recovered its original contour with no signs of uneveness.*

Summary

The improved features of the new telephone sets may be summarized as follows:

1. Complete unit mounting of components
2. No loose wiring.
3. Screw connections throughout—no soldering.
4. Gravity switch a single unit and integral with the base assembly—readily accessible for adjustment.
5. Dial mechanism and gravity switch springs protected from dust, lint, insects, etc.
6. All spring contacts double-connected in parallel.
7. Gravity switch springs operated by a bronze roller.
8. Simplified tamper-proof ringer.
9. Induction coil and condenser sealed in bakelite cases.
10. Cellulose acetate sheet and plastics used instead of paper, fiber and textile insulation.
11. New tipless cord—easier to connect, prevents error, more durable, snarl-resistant, cheaper to use.
12. Components of entire set replaceable with a screwdriver by unskilled repairmen—impossible to assemble incorrectly.
13. Rust-resisting steel base plate of sufficient thickness to prevent thread stripping.

* Restrictions in materials prevent the use of the new tipless cord for the time being. However, these new telephones are arranged to be corded with the conventional tipped cords as well as with tipless cords. The former have been used in some of the illustrations.

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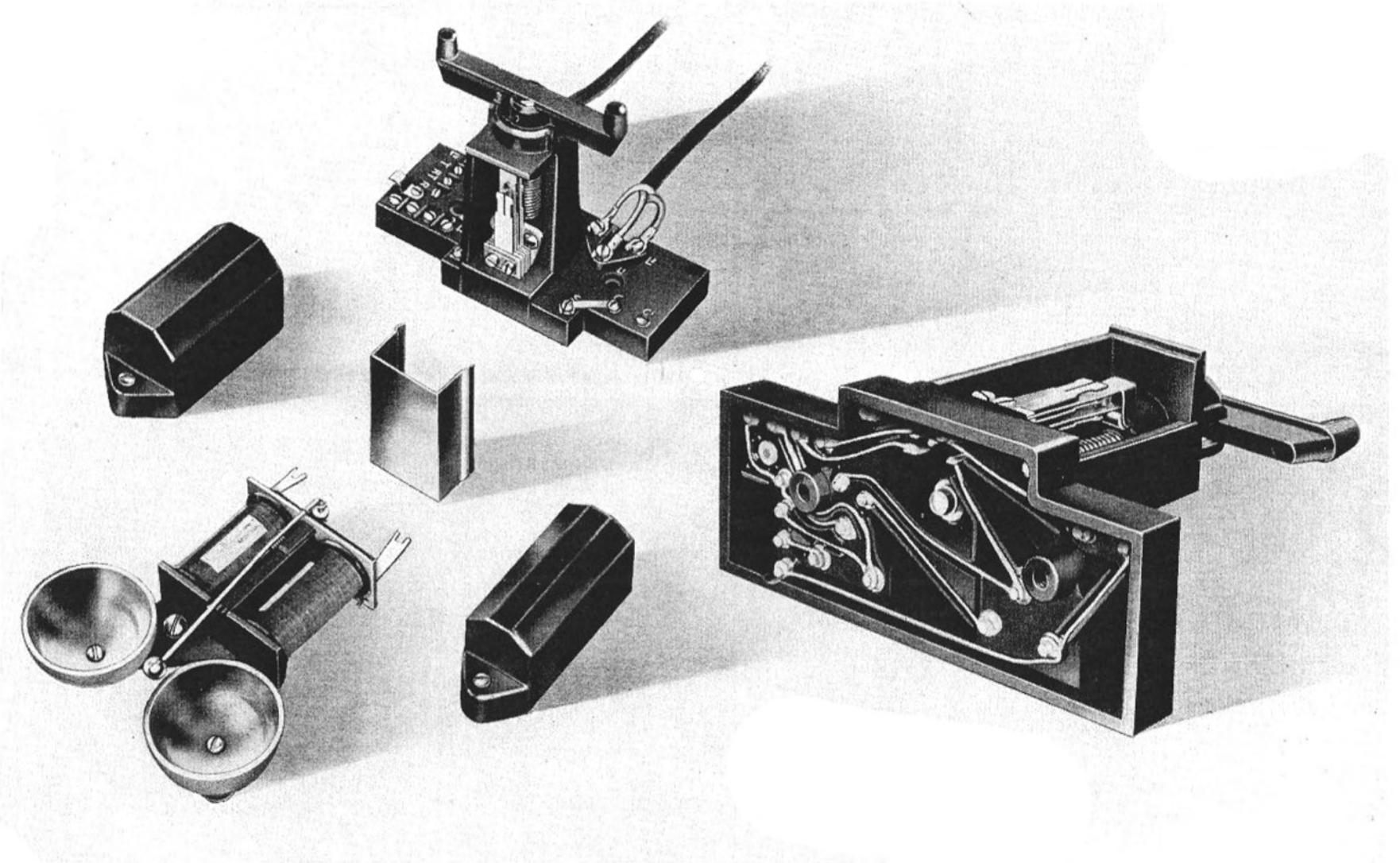

SHOWING SEPARATE COMPONENTS OF THE SIMPLIFIED SUBSCRIBERS' TELEPHONE SET AND METHOD OF CONNECTING THEM BY MEANS OF BUS-BAR WIRING ON THE UNDER SIDE OF THE CONNECTING BLOCK.