

## The Subscriber's Telephone. Recent Improvements in Design.

IT may confidently be said that during the past few years the subscriber's instrument has been accorded more attention than at any other period in the history of telephony. This interest, moreover, has been sustained and despite the marked improvements in the design and efficiency of the modern set, research work in connection with this important unit has continued on an undiminished scale.

Before dealing with the results of this activity the factors previously outlined in this Journal as governing the development of the now familiar bakelite instrument may be recalled. In considering the improvement of the subscriber's telephone it was early evident that the greater appeal of the handcombination necessitated a change from the "candlestick" form. It was clear also that any proposed new instrument would have to embody such outstanding improvements as to make it worth while for Administrations to forsake existing standards. Briefly, the incorporation of new ideas in design, an improved standard of transmission efficiency and a longer service life were some of the essential requirements and the ends had to be achieved without sacrifice of simplicity or reliability.

The **GECOPHONE** handcombination telephone met all the requirements outlined and incorporated considerable improvements in every detail affecting performance and life. It formed a composite whole, constructed from a minimum number of parts and set a higher standard of transmission efficiency

than had been reached by any earlier type of instrument.

The improved performance was, of course, largely due to the successful development of a new transmitter. While the original solid back type had for many years given what was considered good service, its response to frequencies within the voice range varied considerably and fell away abruptly above 1900 cycles. Since good articulation depends so largely upon the reproduction of the higher frequencies the solid back transmitter imposed restrictions on the intelligibility of speech. The new immersed electrode transmitter effected a considerable improvement in response and quickly came to be acknowledged as the standard.

The greater sensitivity of the transmitter brought into prominence the effect of side tone—the reproduction in the receiver of speech and room noises affecting the transmitter of the same set. Side tone had been an inherent feature of earlier types of subscribers' instruments but had not been excessive, that is, it did not disturb the user, but with the development of an improved transmitter the level of side tone became so pronounced as to demand consideration.

The effect of excessive side tone is twofold, firstly the loud reproduction of his own speech in his receiver causes a subscriber to lower his voice until the reproduction in his receiver is about the level at which he hears his voice in ordinary conversation. This results in a considerable loss in volume of

speech at the receiving end. Secondly, under noisy conditions, side tone impairs intelligibility since the room noises reproduced in the receiver mask certain elements of the sound received. These considerations showed that in the design of the instrument measures should be taken to control side tone and with this in view it was decided that the volume level of side tone should be somewhat less than had been the case in earlier types of instruments. With the new transmitter and this control of side tone a very great improvement in articulation was achieved.

With the modern understanding of the importance of articulation the development was not allowed to rest at that stage and, after further research, The General Electric Company has produced an improved set, the principal feature of which is the further suppression of side tone. A number of minor, but valuable, improvements in construction are also included. The performance of the instrument is superior to that of any existing bakelite set whilst the constructional improvements ensure even more trouble-free service and are such as to be of special value when the set is employed under the adverse climatic conditions of tropical countries.

In view of the wide attention still being paid to the efficiency of subscribers' telephones, the unique qualities of the **GE@PHONE** set in respect of maximum side tone suppression are of special interest. The level to which side tone is suppressed depends upon the degree of balance between the line and a network in the instrument formed by the induction coil windings. Since this network cannot be balanced against all conditions of line, complete elimination of side tone is not possible, nor would such elimination be desirable as the instrument

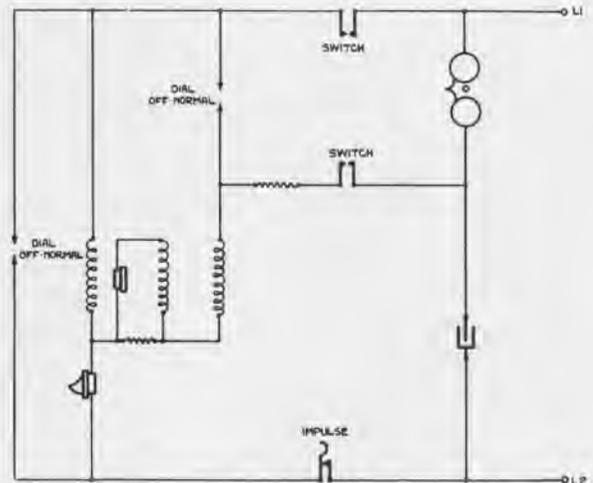


Fig. 1.

would sound "dead" By the introduction of a new induction coil, side tone is suppressed to what is perhaps the maximum possible extent. Furthermore, the level of side tone varies only slightly with the length of line. This is an outstanding feature of the instrument since in the light of modern experience the suppression of side tone for one particular condition of line presents little difficulty, but a high degree of suppression nearly constant for all conditions of line is not easily achieved.

In the early days of telephone communication the power efficiency was considered of prime importance as upon it depended the loudness of the received speech which was then the criterion of performance. At the receiving end, however, sounds may be audible without being intelligible, and under these circumstances repetition of words and phrases at the transmitting end becomes necessary. Avoidance of this repetition can be achieved only by improved intelligibility. A high standard of articulation has been a feature of the **GE@PHONE** instrument but with the attainment of a better transmitter response curve and the greater suppression of side tone, intelligibility is now still further



Fig. 2.

improved to such an extent as to permit of conversation over much longer lines in spite of the slightly lower power efficiency resulting from the use of a circuit giving this maximum side tone suppression. Actually the reduction in power efficiency results in a power loss of a maximum of 2db, when compared with the original model under like conditions, but for a given degree of intelligibility the improved set may be used on a line having an attenuation measured in tens of decibels above that permissible for earlier sets of the bakelite type. Since the purpose of a telephone system is the transfer from point to point, not of electrical energy, but of information, it follows that measures which further this end are of outstanding importance. No single factor so facilitates the exchange of information as the improved intelligibility which results from the maximum suppression of side tone.

The significance of the power efficiency, of course, lies in the fact that, given good transmission lines and a high grade of intelligibility the standard of transmission is dependent upon the power output of the set, which varies with the transmitter current. With

this in mind the use of barretters at the exchange has been considered, the object being to maintain the transmitter current at a more nearly constant level for all conditions of line. On long lines the transmitter current would then be greater than if barretters were not used and, correspondingly, an increase in the output of the subscriber's set would be obtained, permitting of the use of lines of greater length or lighter gauge for a given standard of transmission, or, alternatively, giving an improved standard of transmission on existing lines. The power efficiency of the **GE@PHONE** set has been arranged to be at a maximum on long lines and thus the reduced power output from the transmitter due to the decrease in battery feed current on long lines is partly offset by the increased efficiency under such conditions. It is seen then that the design of the instrument contributes to the end sought by the use of barretters.

Another point worthy of note is that steps have been taken to obtain full spark-quenching at the contacts of the impulsing springs. This has been achieved by the addition of a non-inductive winding on the



Fig. 3. Instrument open for inspection, giving direct access to every component.

coil, for the express purpose of spark-quenching, and a slight re-arrangement of the circuit which ensures that during impulsing the condenser and the non-inductive winding, in series, are connected directly across the impulsing contacts (Fig. 1).

Reference has been made to the better response curve of the transmitter, this has been achieved by a mechanical alteration which has resulted in an improvement in the response curve below 1000 cycles whilst maintaining the response to the higher frequencies so important for good articulation.

The improvements in construction make for easier installation and maintenance and a still greater freedom from breakages of component parts in service. The reduction in the number of breakages following the

development of the bakelite telephone was most marked, and a further advantage in this respect is now offered in the modified design of cradle for the handset. Of a more robust type and having forks with a minimum projection, this cradle minimises the risk of damage in service. Its adoption effects no appreciable change in the appearance of the set as will be seen from Fig. 2.

Easier installation and maintenance are made possible by the inclusion of two features shown in Fig. 3, where it will be seen, firstly, that the two cords, one to the handset and one to the external terminal strip, enter the set at different points, and secondly, that the terminal strip on the base is mounted in a horizontal position. The separation of the cords permits of the positioning of the cover and base as shown, thus promoting accessi-

bility The ringer occupies less space in the set and advantage has been taken of this to mount the terminal strip on the base in a horizontal position. The spacing between the terminals is increased and slots are cut in the strip to reduce the possibility of surface leakage. The cords are of the latest tropical type having no absorbent textile coverings at the ends.

In effecting modifications to simplify installation and maintenance of the set, attention became directed to the external terminal strip for the connection of the line wires. In existing types it was necessary to connect the line wires and cord conductors to the terminals before fixing the strip in position, also, the wires did not follow any prescribed path and the insulation was in indiscriminate contact with the terminals, thus giving rise to the possibility of leakage through moisture absorption by the insulation, particularly in tropical climates. Improvements in both respects were effected by the design of a new terminal strip seen in Figs.



Fig. 4. New type terminal strip (cover removed).

2 and 4. Two bakelite parts, a base and a cover, the latter held in position by a captive fixing screw, form the complete strip. The base may be fixed permanently in position, the wires then being run in channels to the terminals. The channels keep the insulation clear of the terminals, and separators, forming part of the base moulding, remove the possibility of short circuit or leakage between the terminal plates.

It will be appreciated that the improved terminal strip contributes in no small measure to the suitability of the **GEOPHONE** set for use in tropical climates.

