500 type telephone set

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Station Apparatus Development

In comparison with earlier telephone sets, whose components were designed at different times, the new 500 type telephone set has the distinction of being the first complete station set to be designed as an integrated unit. With all its components designed to work with each other and embodying the latest technology, the new set is superior to its predecessors.

For many years, the standard telephone set (Figure 1) was of the desk stand type with the transmitter in a fixed position on a stand and the receiver suspended on a side switchhook, while the ringer, induction coil and condensers were separately housed in a bell box on a nearby wall. Later the transmitter was detached from the stand and combined with the receiver to form a handset which was more convenient to use and also provided better transmission. During the thirties, improvements in apparatus design made it feasible to take the further step of combining all of the elements in a single package of agreeable size which resulted in the familiar combined telephone set as illustrated by the 302 type (see Figure 1) which came out in 1937.

The combined set was an immediate success. Some indication of its merits may be had from the realization that there are now some 25,000,000 of this type of set in the telephone plant. It became apparent at the close of the war that if a completely new set could be developed as an integrated unit, taking full advantage of improvements in structures, materials and design techniques, as related to service requirements, it would be possible to provide a new telephone set that would be still better than the 302. The development was started; the new set was ready for its first field trials by 1948, was placed in limited production in 1949, and production has been steadily increasing since then.

A primary objective of the new set was to raise the level of transmission over long loops. Such an improvement in transmission would make it possible to take further advantage of smaller gauge cables and also to extend the loop range. It was recognized, however, that an increase in level of transmission on short loop connections would be undesirable since the level for the existing 302 type set on short loops was already as high as could be used. The objective, therefore, was to secure transmission levels on the short loops no greater than with the existing 302 type set but to improve transmission on limiting loops by approximately 10 db, equally divided between transmitting and receiving. Other objectives were: a smaller handset of lighter weight; a dial with better pulse regulation and easier to see and operate; a ringer with higher acoustic output,

more pleasing sound, and facilities for subscriber control of its loudness.

In order to achieve the objective of increased transmission levels on the long loops without a similar increase on short loops, two important changes in the circuit of the new set were required. First, it was necessary to provide some means for limiting the volume level on short loops. Also, in order to avoid zoning on the basis of loop length it was desirable that level-limiting be accomplished automatically. Second, improved sidetone balance was necessary to offset the increased volume levels of the new transmitter and receiver.

The schematic circuit of the new telephone set and the manner in which these changes in the station circuit were carried out are shown in Figure 2. Control of level with change in loop length is obtained by the use of an element entirely new in station circuits —the 311A equalizer. The loss characteristic of the equalizer is controlled by the magnitude of the dc line current through the set. Essentially, the equalizer consists of a tungsten filament connected in series with the station transmitter and a thermistor located nearby in the same glass envelope and electrically bridged across the receiver. The resistance of the thermistor is controlled by heat from the nearby filament. On short loops where the dc line current through the set is high, the tungsten filament introduces a combined battery supply and ac circuit loss of about 5 db. On long loops where the line current through the set is low, the effect of

Fig. 1—Left to right, the deskstand of 1919, *the handset of* 1927, *the combined set of* 1937, *and the* 500*-type set of* 1950.

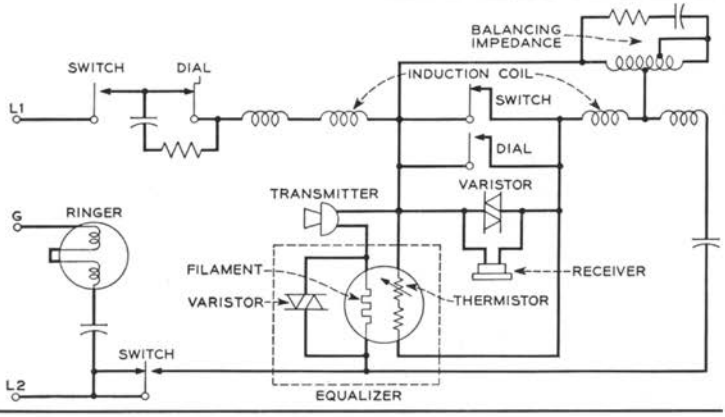


Fig. 2—Schematic of 500 *type telephone set.*

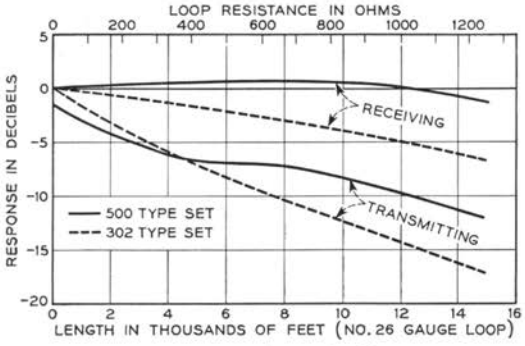


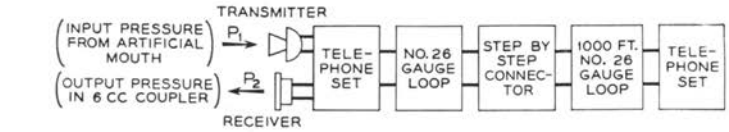
Fig. 3—Relative volume levels.

the filament resistance is negligible. Because of the negative coefficient of resistance of the thermistor a corresponding graduated receiving loss with change in loop is obtained. Thus, the higher gains of the new transmitter and receiver are permitted to work to full advantage on long loops but are reduced on short loops to keep the over-all level approximately equal to that of the 302 set.

The improved sidetone balance necessary with the higher efficiency instruments was secured with a new three-element balancing impedance. Radio interference in dialing is suppressed by a .1 mf condenser associated with a resistive element and the induction coil line winding.

As may be seen from the headpiece, the design of the 500 set is characterized by a low silhouette with the dial face set at a lower angle than formerly. The numbers and letters are arranged outside the dial fingerwheel, thus permitting a greater angle of vision for dialing than in the previous design where the characters could be seen only by looking through the holes of the fingerwheel. Also, with the characters outside the fingerwheel, there is less tendency to scratch or mar them when dialing.

The handset is shorter and weighs only 12 ounces—4.5 ounces less than the previous design. Because of its size and shape, the new handset provides a better average fit for the distribution of head sizes. This results in a higher acoustic input to the transmitter which, in turn, steps up the modulation of the carbon and so increases the transmitter output. Additional increase in transmission is obtained by an inherently more efficient transmitter. The life of the neoprene jacketed handset cord is much increased by reinforcing it with a grommet where it enters the handle. The grommet also provides an acoustic seal for the cavity leading through the



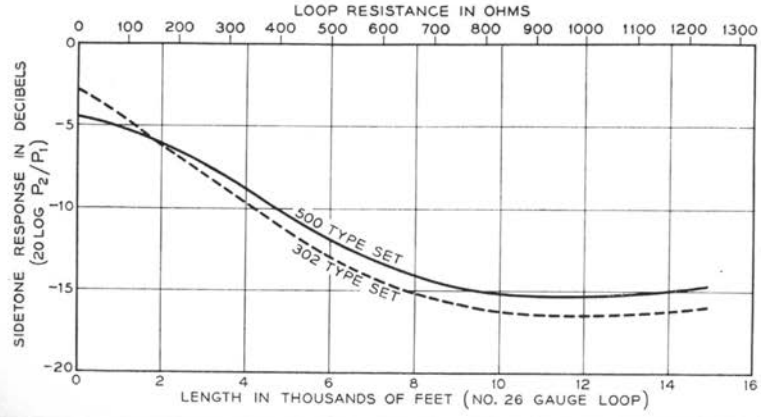


Fig. 4—Comparative sidetone levels. Sidetone level is a function of the instrument efficiencies and of the balance between a balancing impedance in the set and the line impedance which in turn varies with circuit length. Superior balance of the 500 set counteracts effect of higher instrument efficiencies on sidetone.

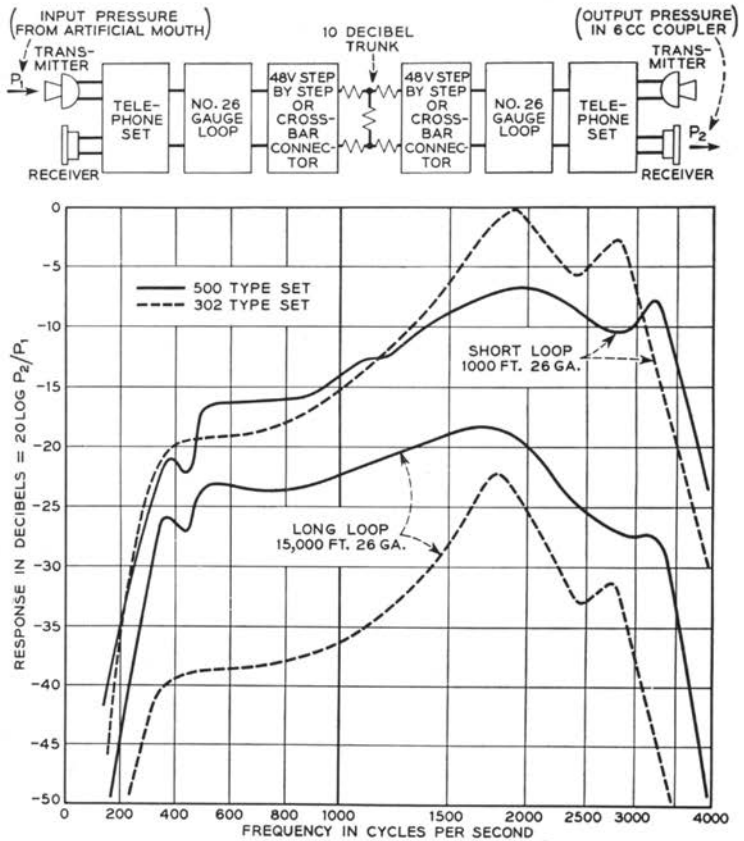


Fig. 5—The over-all frequency response characteristics of the new and old sets on short and long loop circuits.

handset handle to the back of the receiver. The grommet is notched to fit a projection in the handle so that the cord is anchored in a simple and positive manner.

The comparative transmission characteristics as a function of loop length of the new and old sets are shown in Figure 3. There is approximately 5 db gain in both transmitting and receiving under long loop conditions while on zero loop the levels for transmitting and receiving are essentially the same as for the 302 set as indicated above. The curves shown in Figure 3 represent loudness comparisons only and do not include the additional transmission improvement achieved through broader frequency range in the receiver and more nearly orthotelephonic quality in transmitting. The curves for sidetone, Figure 4, indicate how effectively the new circuit achieves the objective of keeping the sidetone level on short loops at or below the level of the 302 set. The over-all frequency response characteristics of the new and old sets on short and long loop circuits are shown in Figure 5.

The fundamental ringer tones have been made considerably stronger by mounting formed aluminum resonators under the gongs. In previous ringers, resonators have been added in the field only when required. Figure 6 shows the sound output spectrum of the new ringer as compared to that of its predecessor. It should be noted that the fundamental frequencies of the two gongs of the new ringer are lower, which results in a more pleasing and effective tone. To produce a harmonious sound, the two gongs were made to differ in their fundamental fre-

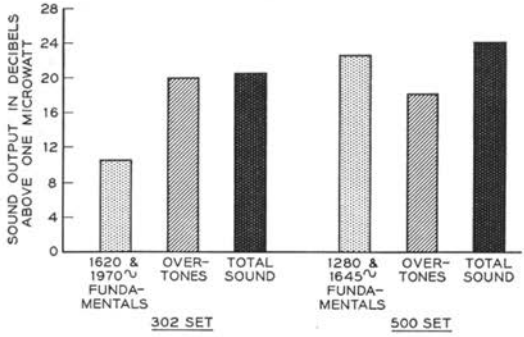


Fig. 6—Ringer sound output spectrum.

quencies by a major third. An outstanding feature of the new set is the provision for ringer sound level control by the subscriber. A notched wheel that projects through the base of the set can be shifted to four different positions for four levels of ringer output.

In the design of the new telephone set, full advantage was taken of the fact that all the components were being developed simultaneously. Thus, for example, the ringer and network have been designed to nest together to save space. The switch bracket has been designed to accommodate a flexible support for mounting one end of the ringer. The switch has been laid out to require as little space as possible at the base where space is at a premium and spreads out at the top where more space is available. All the components of the set are directly mounted on a metal base (Fig. 7) with the plastic housing serving only as a cover. This facilitates assembly, wiring and testing of the set in production and greatly facilitates maintenance in the field.

Early preproduction models of the 500 set and later several thousand sets of the first run of production were installed for comprehensive service trials in various areas selected on a basis of range of service and climatic conditions and have since been carefully observed for performance in relation to that of an equal number of 302 sets installed in comparable locations in the same areas. Trials to date have fully confirmed expectations as to improved performance in transmission, dialing and ringing, and public reaction has been universally favorable.

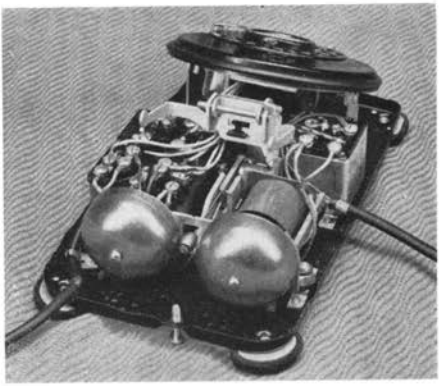


Fig. 7—Internal view of 500 set.

THE AUTHOR: W. L. TUFFNELL joined the Engineering Department of the Western Electric Company in 1922 and took the three-year student assistant course. For two years of this period he took part in the design of transmitters and receivers with the Research Department. After the Laboratories were organized in 1925, he worked on the development of carbon transmitters and electromagnetic recorders. In 1927 he left to study at the University of Wisconsin, where he received the B.S. degree in 1930. He then returned to the Laboratories, where for many years he was concerned with the development of transmitters for handsets and deskstands, and with the development and commercialization of the transmitter and amplifier of the orthotechnic audiphone. Since 1949 he has assisted in the development of station apparatus such as telephone sets, dials, ringers, coin collectors, cords, and telephone booths.