

# Why was the Western Electric 500D telephone set called that?

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## ABSTRACT AND INTRODUCTION

For many generations of telephone sets used in the Bell Telephone System, made by their internal manufacturer, Western Electric Company, had base apparatus codes (“model numbers” to lay people) that ended in “A” (*e.g.*, 302A) if the set had no dial and in “C” (*e.g.*, 302C) if it had a dial with what eventually was the most common of three arrangements of digits and letters.

In about 1950, the Bell Telephone System (and Western Electric) introduced a new family of general-purpose telephone sets, called the “500 type”. This became the mainstream type of Bell System telephone set for many years.

But for much of the life of this family, the base apparatus code for a set with no dial was 500C, and for ones with a dial (by then only one arrangement of digits and letters was common), 500D (not 500A and 500C, as we might have expected).

This unexpected situation came about through a fascinating story of the evolution of this telephone set family in its early years—a literal “war story”. This article tells that story.

### 1 DIAL ARRANGEMENTS

Because it is an important part of the story, I will first speak about different arrangements of digits and letters on a dial.

Note that all the dials I will speak of are rotary dials, with the familiar finger wheel with ten holes, behind which (or around which) is a plate (the *number plate*) with digits and maybe letters as well.

Over the years of evolution of the telephone network and its “numbering plan”, three number plate arrangements were most widely used. We see examples of them in figure 1.



**Figure 1. Dial number plate arrangements A, B, and E**

These all are from a certain series of number plates (the “150-type”) used on certain types of dial.

The letter part of a number plate’s apparatus code consistently describes the arrangement over different types of plate. (“C” and “D” referred to minor variations not of concern to us here.) But that letter does not match the letter used as part of the apparatus code for a telephone set having a dial with that arrangement. Great!

## **2 ON MANY TELEPHONE SET FAMILIES**

For many telephone set families introduced prior to 1950, the most common versions had base apparatus codes ending in a letter that told what kind of dial (if any) the set was equipped with, as follows:

A–No dial (used with manual switching service)

B–Dial, with arrangement A. Used in cities where the telephone numbers only had digits.

C– Dial, with arrangement B. Used in cities where the telephone numbers had “central office names” (according to the “Blauvelt plan”<sup>1</sup>). This eventually became the norm. (Small variations of the details occurred over the years.)

D– Dial, with arrangement E. Used in cities with “terminal per line” four-party line service, where the basic telephone number (all in digits) was followed by the letter J, M, R, or W to dictate the particular station on that line that would be “rung”. Note that these letters were assigned to the same actual digits as would carry those letters under arrangement B.

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<sup>1</sup> Named in honor of the AT&T engineer who first developed this scheme, used to provide for a seamless transition from manual to dial operation in large cities where the manual service telephone numbers began with a “central office name”. So “Westside 2368” became “WEstside 2368”, and would be dialed 932368.

### 3 THE 500-TYPE TELEPHONE SET

In about 1950, the Bell Telephone System introduced a new family of telephone sets, the "500" family. The new telephone sets included numerous innovations with regard to performance, durability, ease of use, ease of manufacture, and ease of installation. Many (including this author) consider it to be the finest family of non-electronic telephone sets ever designed. And it was essentially the last such family.

The basic members of the family were given apparatus codes in the 500 series. The basic version with no dial was the 500A, and the basic version with a dial was the 500B. Its dial in fact had arrangement "E", and thus under the earlier scheme its apparatus code would have ended with "C".

But by this time dial arrangement "E" was almost universally used, and so the 500-type sets with a dial, with that arrangement, got the next apparatus code letter, becoming the 500B. This was certainly logical, but it did not carry forward the historical tradition, which of course confused many of the workers at the time.

The pair together were spoken of as the "500A/B". In fact, one could easily be converted to the other in the field (by changing between the dial and an "apparatus blank", which filled the dial hole, and making a simple wiring change), and so the base unit was marked "500A/B". But this tidy situation did not last long.

### 4 THE TRANSMISSION EQUALIZER

An important innovation in the 500-type set was circuitry to automatically vary the transmitting and receiving "gains" of the set depending on the apparent length of the individual "loop" (subscriber line). This served to compensate for the varying loss of the loops with length, so as to provide a more uniform transmission experience for subscribers located at varying distances from the serving central office.

The apparent length of the loop was deduced from the level of the DC current flowing in the loop when the phone was active, as this principally depended on the resistance of the loop, which depended in a predictable way on its length, and was in turn predictably relatable to the line loss.

The implementation of this behavior was very ingenious. It revolved around a component called an *indirectly-heated thermistor*, which was housed in a small glass envelope reminiscent of a small vacuum tube. It included a filament-style heater, whose resistance **increased** as its temperature increased, and, thermally coupled to the filament, a

*thermistor*, a small bead of a special composition, whose resistance **decreased** as its temperature increased.

The DC current in the loop passed through the filament and heated it. The changes in the resistance of the filament itself and the thermistor it heated changed the gains of the transmitting and receiving branches of the telephone set, decreasing both gains as the current increased.

This composite component, in its little glass envelope, in turn inside a small metal housing with a terminal strip on top, was called an *equalizer* (because its task was to equalize the net transmission performance of the telephone set plus its associated loop over a range of loop lengths).<sup>2</sup>

This was an incredibly elegant implementation, and a gigantic effort went into its perfection (as for every aspect of the 500-type telephone set).

## 5 HEY—THERE'S A WAR ON

But shortly after the introduction of the 500-type telephone set, the US became embroiled in the Korean War, and various materials, critical to war production, were restricted in their availability for "civilian" projects. One of those restricted materials was critical to the manufacture of the temperature-sensitive "bead" in the equalizer. As a result the manufacture of the 500A/B telephone sets had to cease.

Thus, Bell Telephone Laboratories set out (rather frantically) to develop another implementation of the "automatic gain control" of the 500-type telephone set. Actually, there had already been concern that the cost of the equalizer was fairly high, so an alternative approach would be desirable, war restriction or not, and the development process was already underway. But it now had to accelerate.

The apparatus codes 500C and 500D (the next in the series) were pre-assigned to the manual and dial (arrangement "E" assumed) versions of the forthcoming new telephone sets (which, following the concept we saw above, would be spoken of as, and marked, "500C/D"). But the development was tedious, and it was clear that the 500C/D would not be available for a while.

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<sup>2</sup> This is of course a different use of the term "equalizer" than we find elsewhere in the field of audio engineering, where the term refers to a device whose response varies with frequency so as to compensate for variations of response with frequency elsewhere in the system.

## 6 IN THE MEANTIME

As an interim ploy, a new form of the 500 set was developed that just did not have the equalizer. It was replaced by a small terminal strip so the physical wiring arrangements could be unchanged. There was no longer any automatic control of the transmission gains. That meant that on "short" loops its transmission would be "too hot" in both directions (which can be problematical in various regards), so this type of set was limited in application to loops having a certain minimum length (actually, a certain minimum resistance, as that was how the loops were administered).

These telephone sets were given the apparatus codes 500J and 500K (collectively, "500J/K"<sup>3</sup>). (That stayed clear of the codes 500C and 500D, already assigned to the anticipated "new equalizer" design, and some codes in the range 500E through 500H, already allocated to sets with special features.)

### THE NEW DESIGN

The final design of the new transmission circuit of the family involved the use of nonlinear resistances ("varistors") to change the transmitting and receiving gains as the loop current varied. These were actually incorporated into a new version of the block that held all the transmission circuitry (the "network"), not placed in a separate "equalizer" module.

As had been earlier planned, the basic models with this new transmission circuit were designated the 500C (no dial) and 500D (dial), the next letters in the apparatus code letter series. And again, owing to the ease of conversion between non-dial and dial versions, the marking on the base of this "model pair" was "500C/D".

Once the production of the 500C/D design had "ramped up", the manufacture of the 500J/K sets was discontinued, and that design was consigned to the ash heap of history.

And that, my dear readers, is why the most familiar type of the "500-type" telephone set (the kind with a dial) was designated 500D and not 500C, as we might have expected.

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<sup>3</sup> Actually, initially, telephone sets of this design were spoken of as, and marked on the base, "500T", that not indicating whether there was a dial or not, since that could be so easily changed in the field. It has been suggested by some historians that the "T" was mnemonic for "terminal strip", which this pair of sets had where the equalizer went in the 500A/B. The odd "T" notation recognized the "ethereal" nature of this design.