THE OLD PALINDROMICAL EQUATIONS TRICK

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Actually, this magician’s trick is “old” only in the sense that I worked it out some three decades ago; to my knowledge, it has never been used or published by anyone before now. This is a puzzle with no linguistic elements, but it may nonetheless be of some interest to palindrome-aware Word Ways readers.

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After entertaining her audience with some standard sleight-of-hand and equipment illusions, the magician announces that she will now demonstrate magic of a more cerebral kind, involving palindromes and math. Amid scattered groans, she chalks the equation $A + B = C + D$ on a blackboard and informs her audience that, given a seven-digit number to substitute for any one of these letters, she will immediately, and with no electronic assistance of any kind, replace the other three letters with other seven-digit numbers such that the resulting equation will be both numerically correct and end-to-end palindromical (disregarding commas).

Before beginning the demonstration, the magician selects a young volunteer from the audience to come on stage and operate an electronic calculator to verify the mathematical correctness of her equations. Now ready to begin, she solicits a seven-digit number (“a well-mixed one, please—and to assure that each term in the equation has exactly seven digits and that none begins with a zero, I’ll need a number whose first digit is between 1 and 8”) and a letter position from an audience member, and is given the number 7,832,465 and position D. After first chalking this number in place on the blackboard, the tuxedoed thaumaturge at once fills in the rest of the equation as follows:

$$5,642,387 + 4,334,412 = 2,144,334 + 7,832,465$$

“Please note,” she remarks, “that this equation is both numerically correct—as confirmed by our checker—and end-to-end palindromical. Sheer luck? Well, let’s try another one—who’d like to give me a new seven-digit number and letter position?” Provided these, the magician repeats her previous performance, quickly producing this equation, which is also soon confirmed to be both numerically correct and end-to-end palindromical:

$$8,904,615 + 1,072,184 = 4,812,701 + 5,164,098$$

“Now that my powers of prestidigitation have warmed up,” resumes the magician, “I think I may be ready to undertake a much greater challenge, namely, correctly completing the same palindromical equation with all eight-digit addends this time—an order of magnitude increase in difficulty! Would someone kindly think of a well-mixed eight-digit number for me to start from, and also specify a letter position for it in the equation?” Soon, the following two equations, both of them
arithmetically correct and end-to-end palindromical, enjoy their fifteen seconds of fame on the blackboard:

\[
36,270,452 + 12,429,232 = 23,292,421 + 25,407,263 \\
77,214,806 + 21,735,192 = 29,153,712 + 60,841,277
\]

By now, the spectators’ applause after each demonstration is increasingly accompanied by perplexed sideward glances at one another, as the realization sinks in that what the magician seems to be doing ought not to be humanly possible. Getting the sums on each side of the equation to be the same seems no great feat, but how in the world does she get the whole equation to be palindromical as well at the same time? That’s the head-scratcher. It seems an assignment fit to faze a supercomputer, yet the magician serenely proceeds with nary a hesitation.

“For my final demonstration,” she announces, I will attempt a mental palindromathematical calculation feat of such prodigious difficulty that it will severely strain even so potent a faculty of prestigiation as my own: I will attempt to formulate, in my mind, another impromptu palindromical equation of this kind, only this time the equation will have six terms, not four, and this time each term will be not seven, not eight, but nine digits long! Impossible, you say? Perhaps, but there’s only one way to find out! Now, can someone think of a well-mixed nine-digit number to seed our six-term equation? With six terms in the equation, I’ll need a number whose first digit is between 1 and 7 this time.”

Now the magician works a bit more slowly, hesitating a bit over one of the terms and even going back twice to change digits previously written. But after a tense minute or so she at last steps aside, having somehow conjured up five other nine-digit terms for the mammoth equation to go with the one she received from the audience. But is it... Yes! The checker’s thumb is up, the equation is numerically correct! But is it also... Yes!! Unbelievably, it is indeed an end-to-end palindrome as well!! Incredible! The hall erupts in applause as the audience realizes that it has just witnessed the unveiling of what is patently one of nature’s great palindromical truths, namely, that

\[
405,237,022 + 321,520,134 + 250,141,523 = 325,141,052 + 431,025,123 + 220,732,504
\]

The simple methodology of this trick is left for the interested reader to elucidate. A hint: think palindromically.