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**Ghia et al.**

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(54) **CIRCUIT FOR PRODUCING LOW-VOLTAGE DIFFERENTIAL SIGNALS**

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(51) **Int. Cl.**<sup>7</sup> ..... **H03K 19/094**; H03K 19/173

(52) **U.S. Cl.** ..... **326/83**; 326/44; 326/40; 326/49

(58) **Field of Search** ..... 326/83, 86, 87, 326/38, 40, 44, 45, 46, 49, 30

(56) **References Cited**

**U.S. PATENT DOCUMENTS**

5,355,035 A \* 10/1994 Vora et al. .... 327/433  
5,812,461 A \* 9/1998 Komarek et al. .... 365/189.05  
5,958,026 A 9/1999 Goetting et al.

**FOREIGN PATENT DOCUMENTS**

JP 60260254 \* 6/1987 ..... 326/30

**OTHER PUBLICATIONS**

Electrical Characteristics of Low Voltage Differential Signaling (LVDS) Interface Circuits, TIA/EIA-644, Mar. 1996. Jon Brunetti and Brian Von Herzen, "Multi-Drop LVDS with Virtex-E FPGAs," XAPP231 (Version 1.0) Sep. 23, 1999. Application Report "LVDS Multidrop Connections" published by Texas Instruments, Jul. 1999.

\* cited by examiner

*Primary Examiner*—Michael Tokar

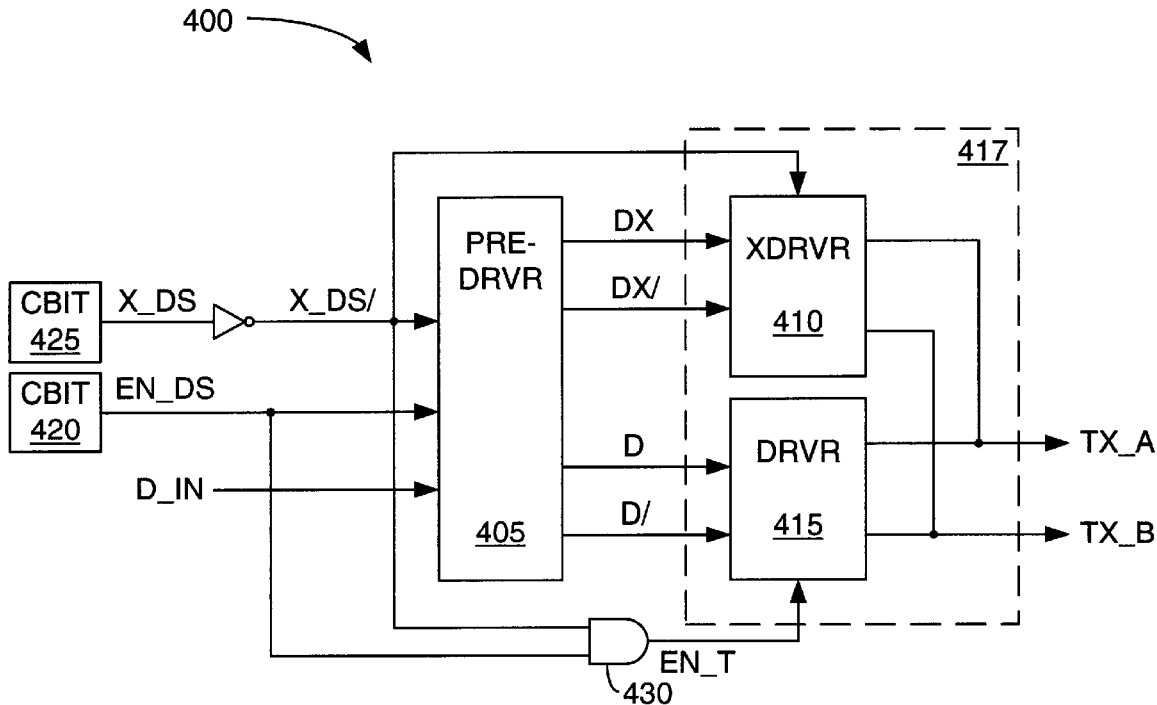
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(57) **ABSTRACT**

Described are systems for producing differential logic signals. These systems can be adapted for use with different loads by programming one or more programmable elements. One embodiment includes a series of driver stages, the outputs of which are connected to one another. The driver stages turn on successively to provide increasingly powerful differential amplification. This progressive increase in amplification produces a corresponding progressive decrease in output resistance, which reduces the noise associated with signal reflection. The systems can be incorporated into programmable IOBs to enable PLDs to provide differential output signals.

**23 Claims, 10 Drawing Sheets**



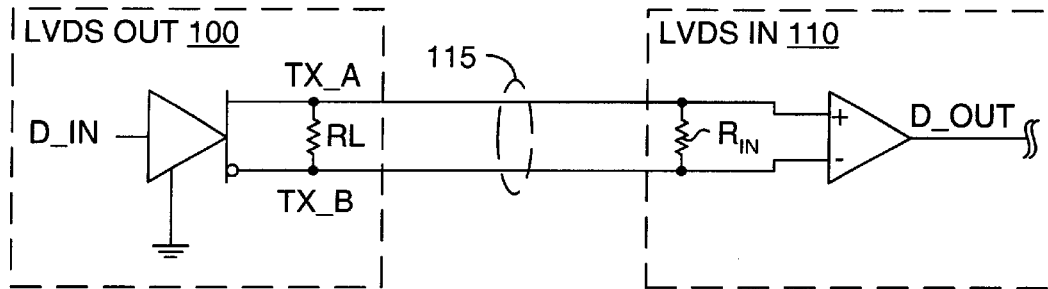


FIG. 1  
(PRIOR ART)

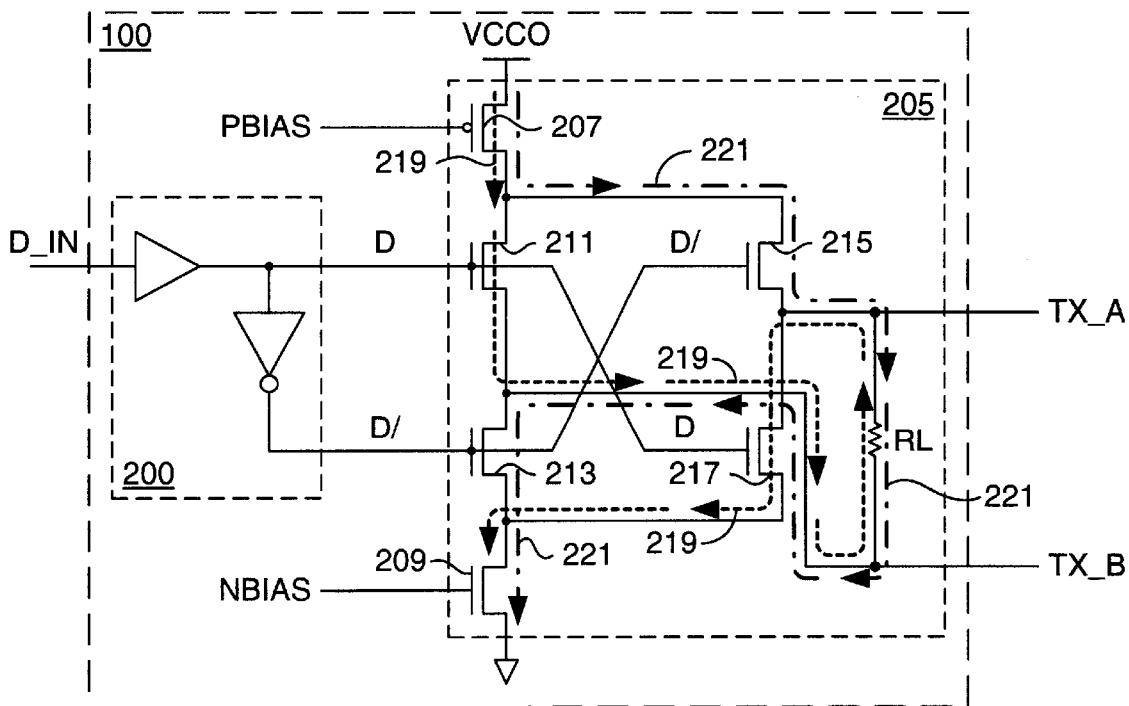


FIG. 2  
(PRIOR ART)

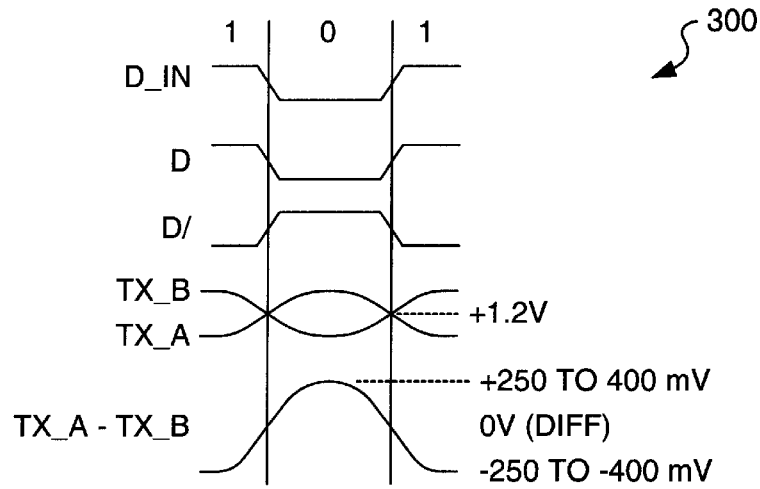


FIG. 3  
(PRIOR ART)

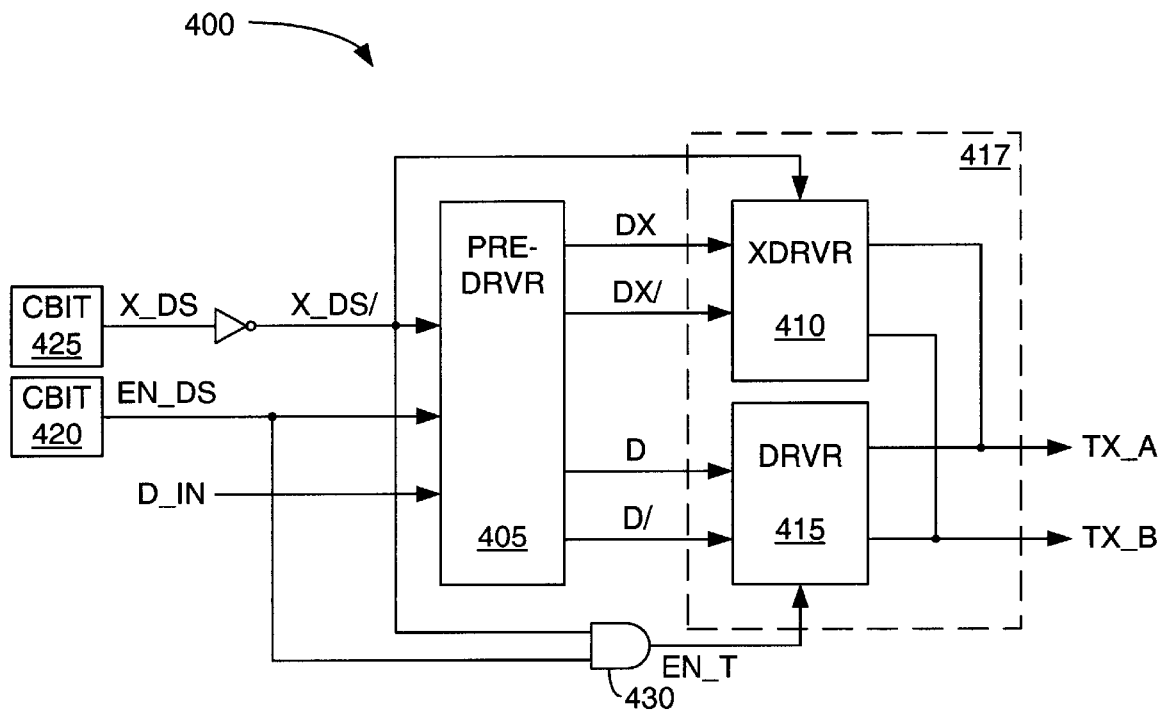


FIG. 4

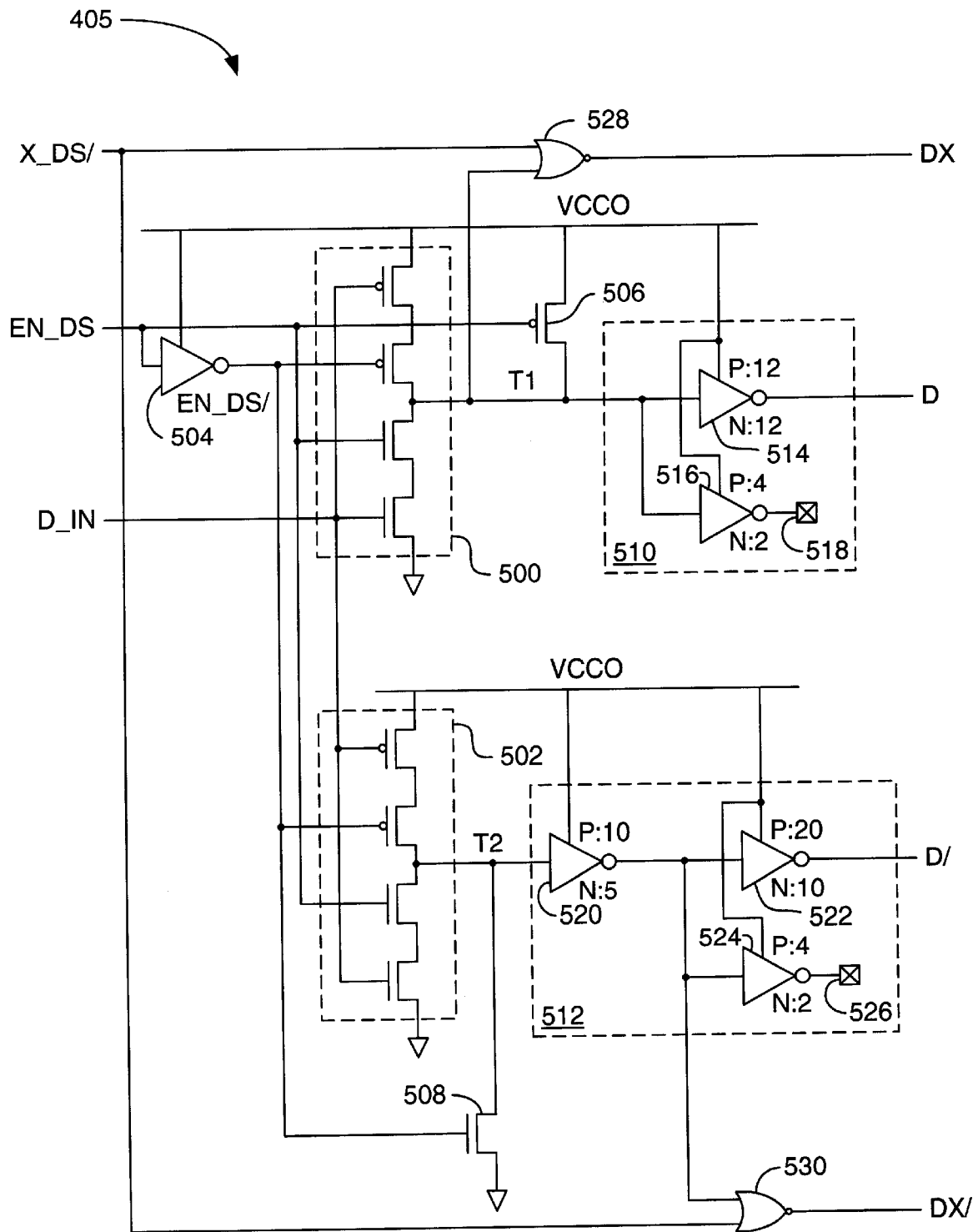


FIG. 5A

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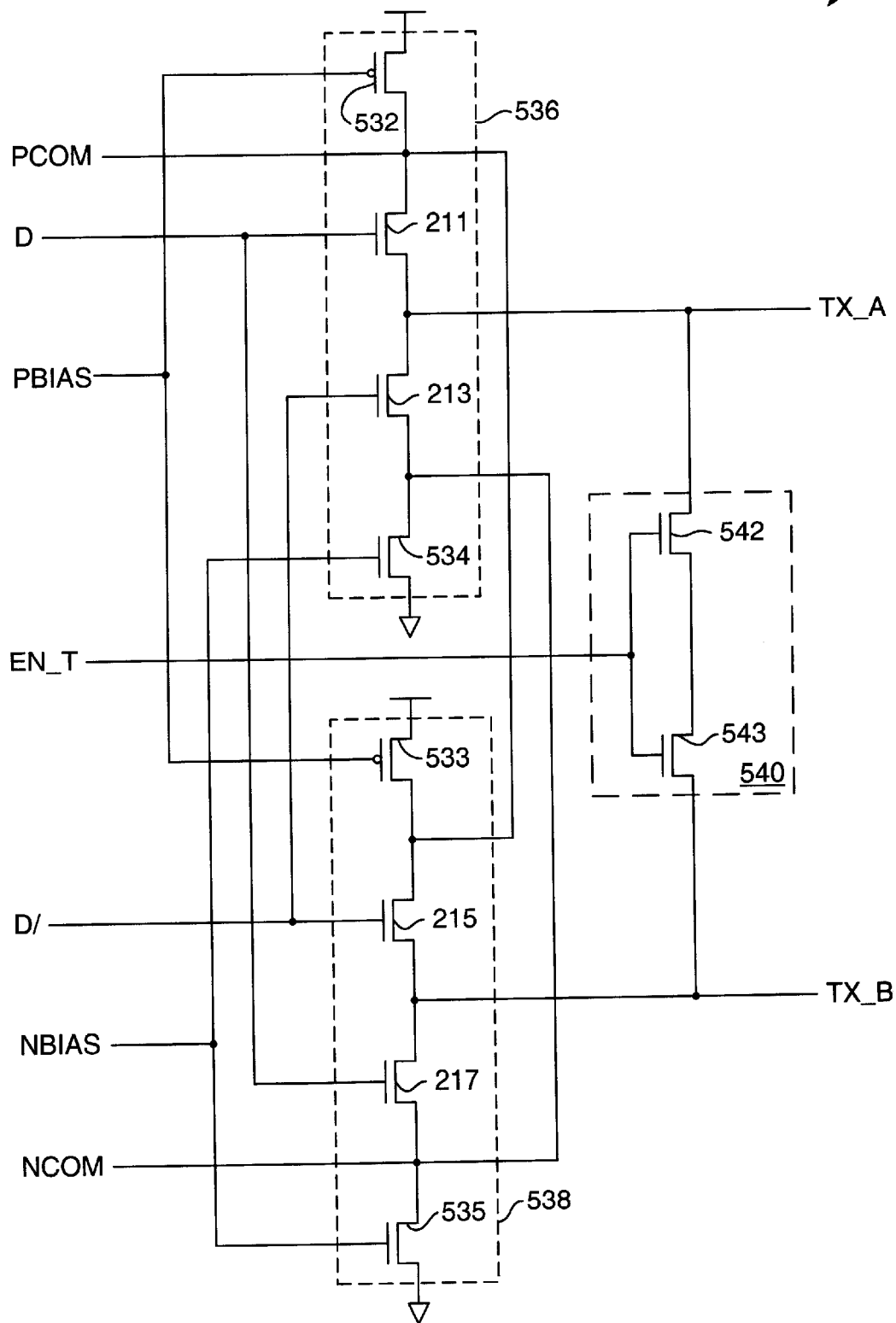


FIG. 5B

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