



US006163721A

United States Patent [19] Thompson

[11] Patent Number: **6,163,721**
[45] Date of Patent: **Dec. 19, 2000**

- [54] **POWER CONSUMPTION REDUCTION IN MEDICAL DEVICES BY EMPLOYING PIPELINE ARCHITECTURE**
- [75] Inventor: **David L. Thompson**, Fridley, Minn.
- [73] Assignee: **Medtronic, Inc.**, Minneapolis, Minn.
- [21] Appl. No.: **09/289,502**
- [22] Filed: **Apr. 9, 1999**

- 5,292,343 3/1994 Blanchette et al. .
- 5,330,513 7/1994 Nichols et al. .
- 5,388,578 2/1995 Yomtov et al. .
- 5,447,519 9/1995 Peterson .
- 5,464,435 11/1995 Neumann .
- 5,496,351 3/1996 Plicchi et al. .
- 5,562,711 10/1996 Yerich et al. .
- 5,610,083 3/1997 Chan et al. .
- 5,683,432 11/1997 Goedeke et al. .
- 5,730,142 3/1998 Sun et al. .
- 5,778,881 7/1998 Sun et al. .
- 5,782,888 7/1998 Sun et al. .

Related U.S. Application Data

- [63] Continuation-in-part of application No. 09/067,881, Apr. 29, 1998, abandoned, and a continuation-in-part of application No. 09/181,460, Oct. 28, 1998, and a continuation-in-part of application No. 09/181,459, Oct. 28, 1998, and a continuation-in-part of application No. 09/181,517, Oct. 28, 1998, and a continuation-in-part of application No. 09/181,523, Oct. 28, 1998.
- [51] **Int. Cl.⁷** **A61N 1/36**
- [52] **U.S. Cl.** **607/2**
- [58] **Field of Search** 607/2, 9, 5; 395/750.03, 395/750.04, 750.07, 800.32, 800.33, 800.34, 556, 555, 557

References Cited

U.S. PATENT DOCUMENTS

- 4,031,899 6/1977 Renirie .
- 4,428,378 1/1984 Anderson et al. .
- 4,460,835 7/1984 Masuoka .
- 4,561,442 12/1985 Vollmann et al. .
- 4,663,701 5/1987 Stotts .
- 4,791,318 12/1988 Lewis et al. .
- 4,791,935 12/1988 Baudino et al. .
- 5,022,395 6/1991 Russie .
- 5,052,388 10/1991 Sivula et al. .
- 5,154,170 10/1992 Bennett et al. .
- 5,185,535 2/1993 Farb et al. .
- 5,187,796 2/1993 Wang et al. .

OTHER PUBLICATIONS

Jan Mulder et al., "Application of the Back Gate in MOS Weak Inversion Translinear Circuits," IEEE Transactions on Circuits and Systems—I: Fundamental Theory and Applications, vol. 42, No. 11, Nov. 1995.

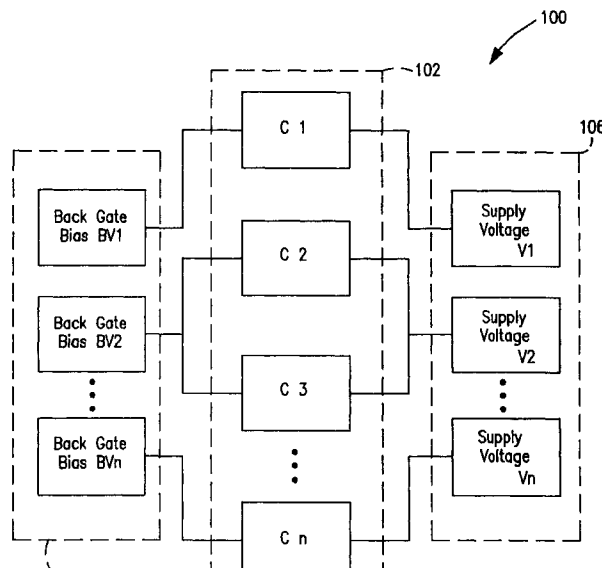
Primary Examiner—Scott M. Getzow

Attorney, Agent, or Firm—Thomas F. Woods; Harold R. Patton; Girma Wolde-Michael

[57] ABSTRACT

Power consumption in medical and battery powered devices is reduced through the use and operation of pipeline architecture in a digital signal processor, microcontroller or microprocessor by operating such devices at clock frequencies tailored to conserve power while preserving computational and executional performance. The digital signal processor, microcontroller or microprocessor can be operated at lower clock frequencies relative to those that would be required by one of such processors to complete the multiple functions within a predetermined time period but having no pipeline architecture. With reduced clock frequency, power consumption is reduced. Further, with reduced clock speed, supply voltages applied to such processors may also be reduced.

63 Claims, 20 Drawing Sheets



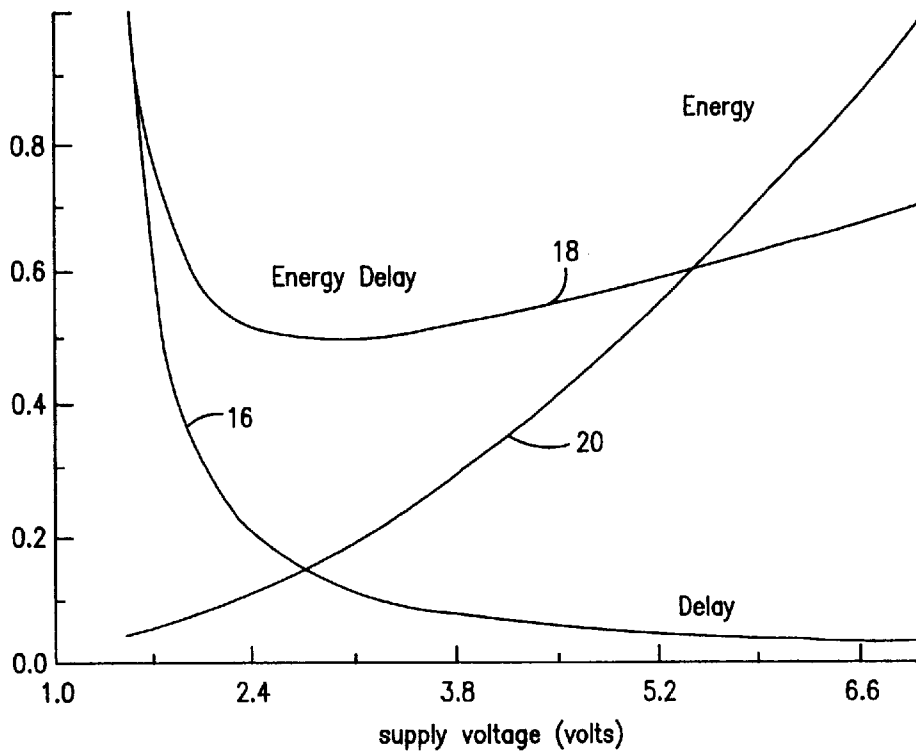


FIG. 1

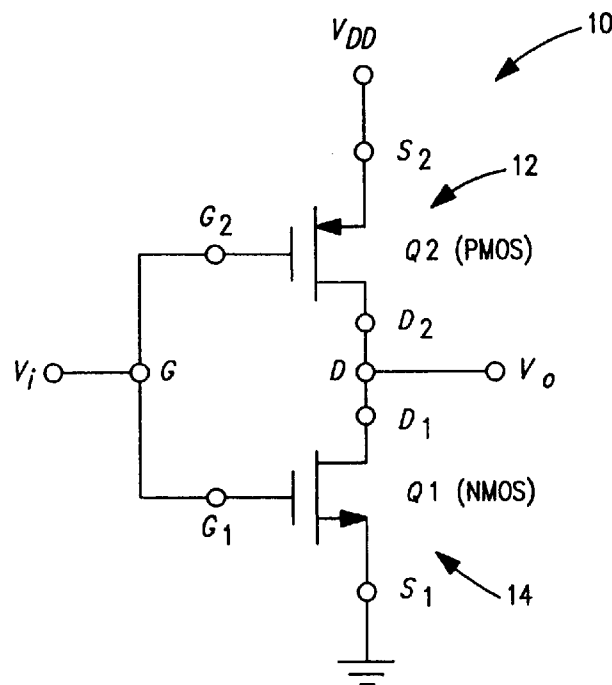


FIG. 2

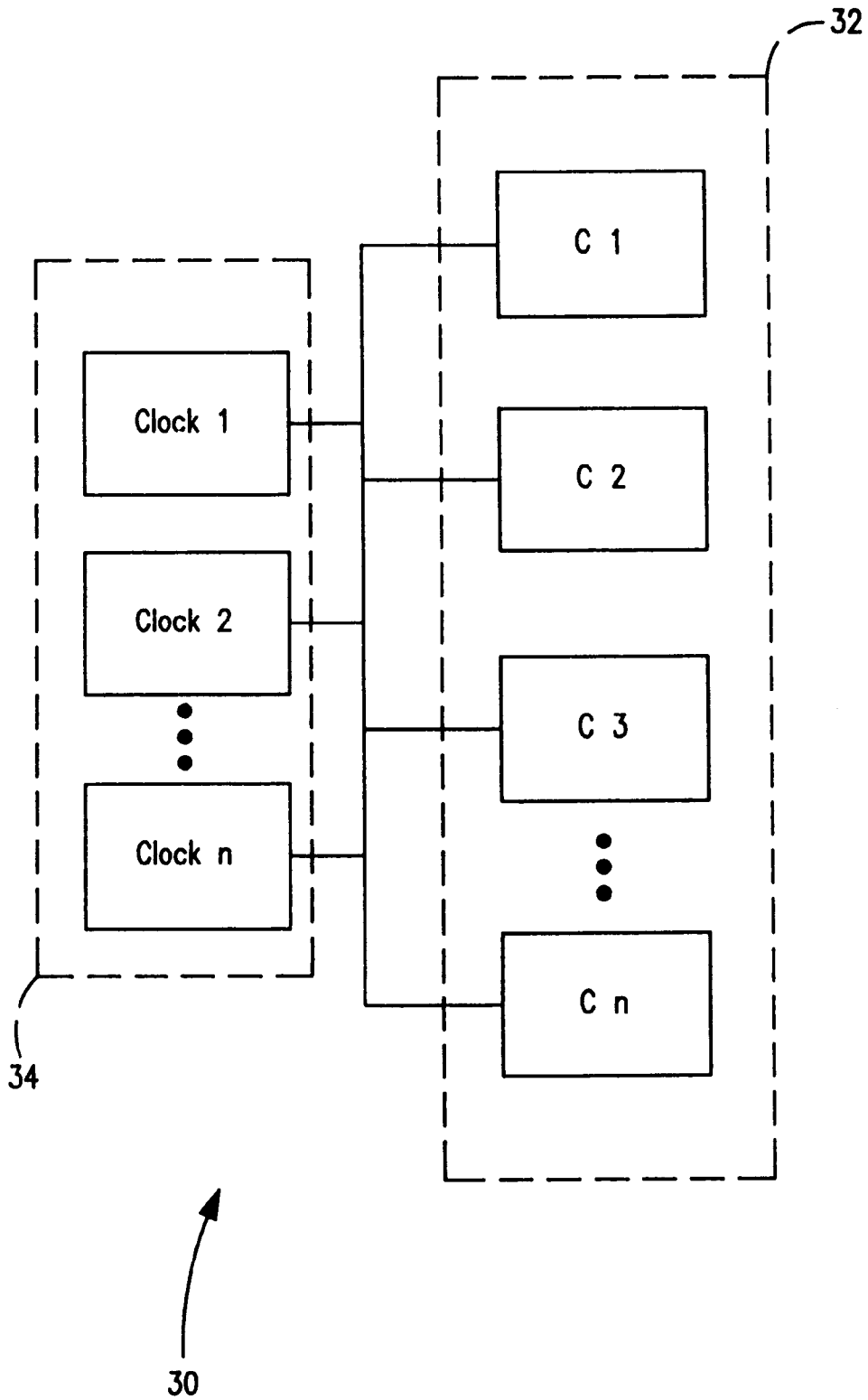


FIG. 3

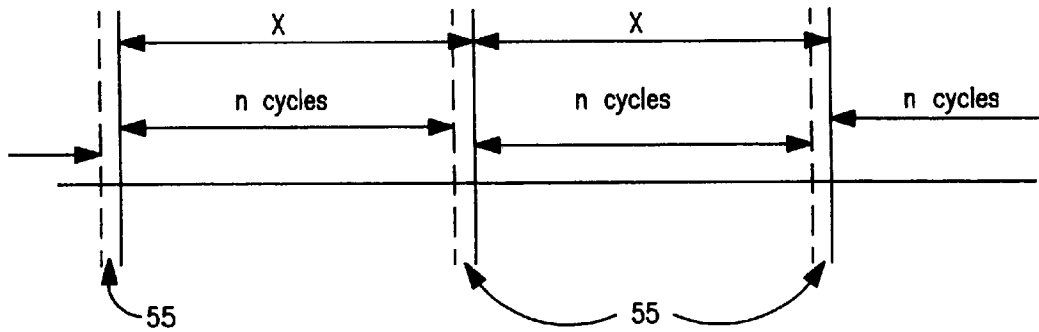


FIG. 4A

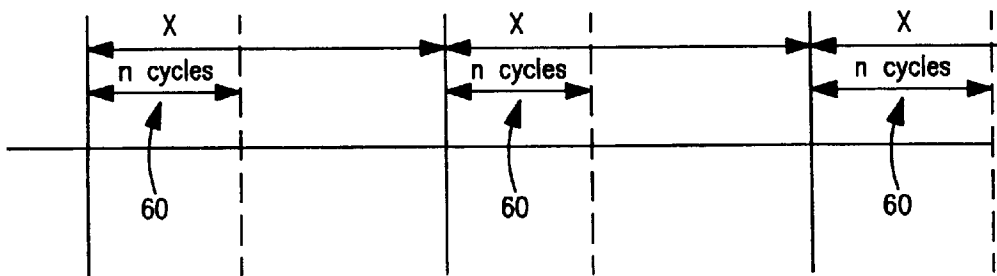


FIG. 4B

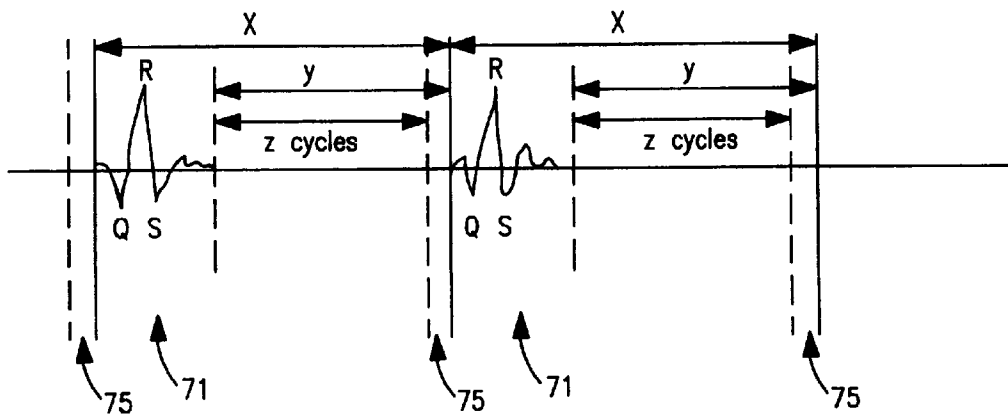


FIG. 4C

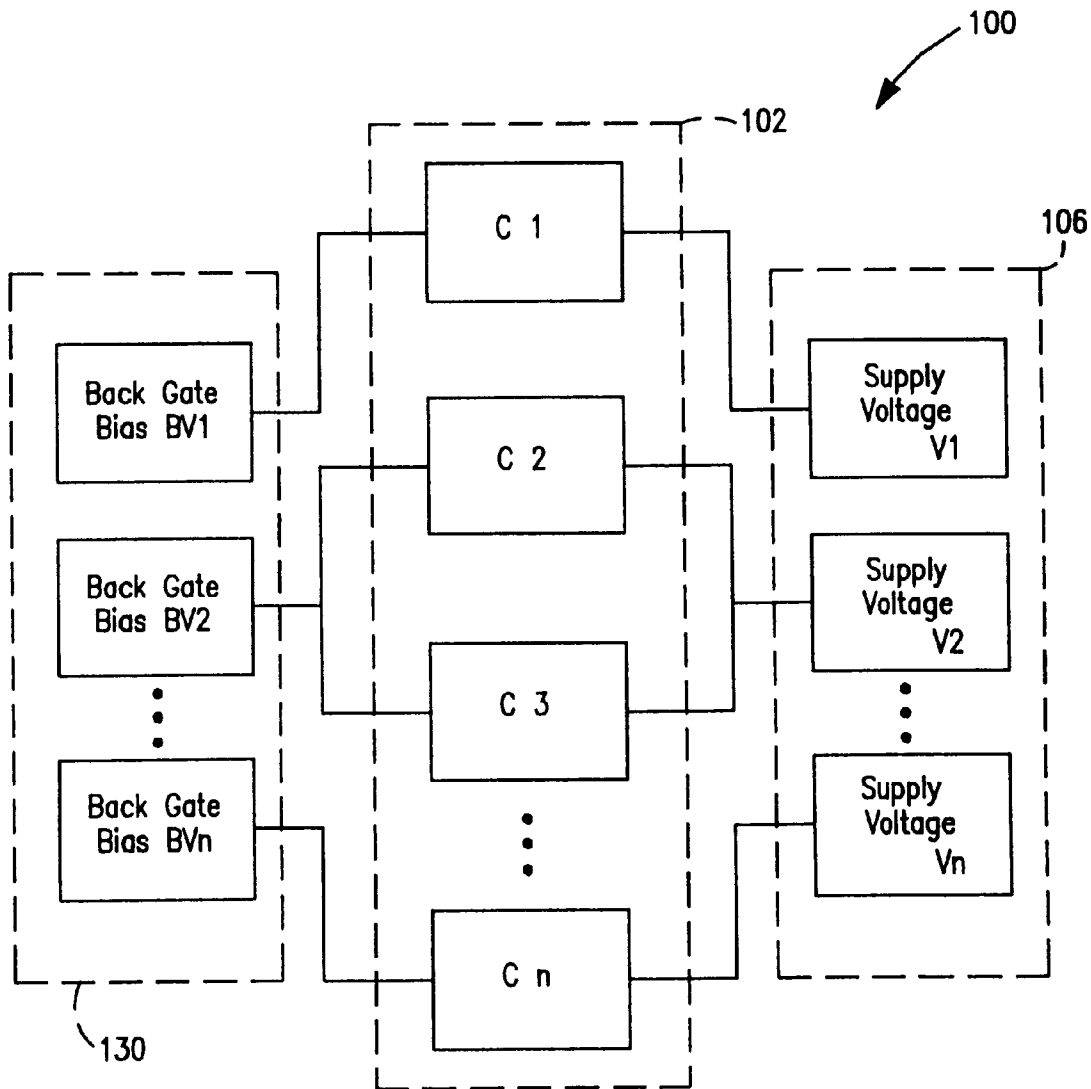


FIG. 5

Explore Litigation Insights

Docket Alarm provides insights to develop a more informed litigation strategy and the peace of mind of knowing you're on top of things.

Real-Time Litigation Alerts



Keep your litigation team up-to-date with **real-time alerts** and advanced team management tools built for the enterprise, all while greatly reducing PACER spend.

Our comprehensive service means we can handle Federal, State, and Administrative courts across the country.

Advanced Docket Research



With over 230 million records, Docket Alarm's cloud-native docket research platform finds what other services can't. Coverage includes Federal, State, plus PTAB, TTAB, ITC and NLRB decisions, all in one place.

Identify arguments that have been successful in the past with full text, pinpoint searching. Link to case law cited within any court document via Fastcase.

Analytics At Your Fingertips



Learn what happened the last time a particular judge, opposing counsel or company faced cases similar to yours.

Advanced out-of-the-box PTAB and TTAB analytics are always at your fingertips.

API

Docket Alarm offers a powerful API (application programming interface) to developers that want to integrate case filings into their apps.

LAW FIRMS

Build custom dashboards for your attorneys and clients with live data direct from the court.

Automate many repetitive legal tasks like conflict checks, document management, and marketing.

FINANCIAL INSTITUTIONS

Litigation and bankruptcy checks for companies and debtors.

E-DISCOVERY AND LEGAL VENDORS

Sync your system to PACER to automate legal marketing.