

# Exhibit D



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**Leather et al.**

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(45) **Date of Patent:** **Jan. 13, 2015**

(54) **DIVIDING WORK AMONG MULTIPLE GRAPHICS PIPELINES USING A SUPER-TILING TECHNIQUE**

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(51) **Int. Cl.**

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**G06F 13/14** (2006.01)  
**G06F 12/02** (2006.01)  
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**G09G 5/36** (2006.01)

(52) **U.S. Cl.**

CPC . **G06T 11/40** (2013.01); **G06T 1/20** (2013.01);  
**G06T 15/005** (2013.01); **G09G 5/363** (2013.01)  
USPC ..... **345/506**; **345/519**; **345/544**

(58) **Field of Classification Search**

USPC ..... **345/506**, **530**, **505**, **588**, **544**, **545**, **532**,  
**345/501**, **502**, **531**, **519**

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,885,703 A	12/1989	Deering	
5,179,640 A *	1/1993	Duffy .....	345/596
5,550,962 A	8/1996	Nakamura et al.	
5,745,118 A *	4/1998	Alcorn et al. ....	345/587
5,794,016 A *	8/1998	Kelleher .....	345/505
5,818,469 A	10/1998	Lawless et al.	
5,905,506 A *	5/1999	Hamburg .....	345/672
5,977,997 A	11/1999	Vainsencher	
5,999,196 A	12/1999	Storm et al.	
6,118,452 A	9/2000	Gannett	

(Continued)

OTHER PUBLICATIONS

Elias, Hugo. "Polygon Scan Converting." [http://freespace.virgin.net/hugo.elias/graphics/x\\_polysc.htm](http://freespace.virgin.net/hugo.elias/graphics/x_polysc.htm).\*

(Continued)

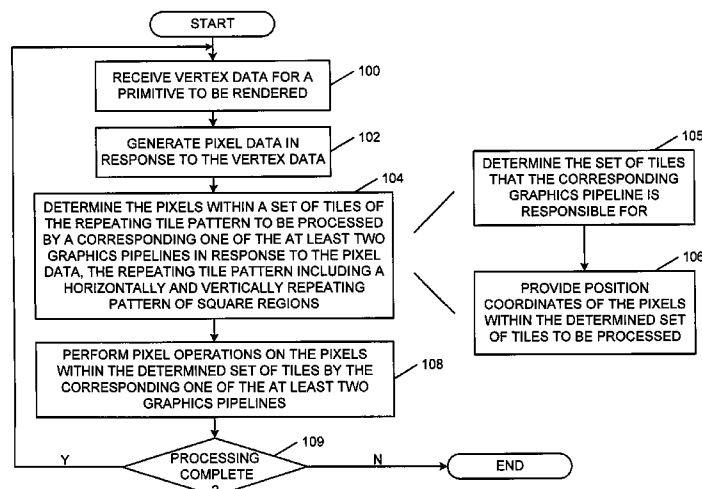
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(57) **ABSTRACT**

A graphics processing circuit includes at least two pipelines operative to process data in a corresponding set of tiles of a repeating tile pattern, a respective one of the at least two pipelines operative to process data in a dedicated tile, wherein the repeating tile pattern includes a horizontally and vertically repeating pattern of square regions. A graphics processing method includes receiving vertex data for a primitive to be rendered; generating pixel data in response to the vertex data; determining the pixels within a set of tiles of a repeating tile pattern to be processed by a corresponding one of at least two graphics pipelines in response to the pixel data, the repeating tile pattern including a horizontally and vertically repeating pattern of square regions; and performing pixel operations on the pixels within the determined set of tiles by the corresponding one of the at least two graphics pipelines.

**21 Claims, 5 Drawing Sheets**



## US 8,933,945 B2

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(56)

## References Cited

## U.S. PATENT DOCUMENTS

6,184,906 B1 *	2/2001	Wang et al. ....	345/532	7,015,913 B1	3/2006	Lindholm et al.	
6,219,062 B1	4/2001	Matsuo et al.		7,061,495 B1	6/2006	Leather	
6,222,550 B1	4/2001	Rosman et al.		7,170,515 B1	1/2007	Zhu	
6,292,200 B1	9/2001	Bowen et al.		2002/0145612 A1	10/2002	Blythe et al.	
6,323,860 B1	11/2001	Zhu et al.		2003/0076320 A1	4/2003	Collodi	
6,344,852 B1	2/2002	Zhu et al.		2003/0164830 A1 *	9/2003	Kent .....	345/505
6,353,439 B1	3/2002	Lindholm et al.		2004/0041814 A1	3/2004	Wyatt et al.	
6,380,935 B1	4/2002	Heeschen et al.		2004/0164987 A1	8/2004	Aronson et al.	
6,384,824 B1	5/2002	Morgan et al.		2005/0068325 A1	3/2005	Lefebvre et al.	
6,407,736 B1	6/2002	Regan		2005/0200629 A1	9/2005	Morein et al.	
6,417,858 B1	7/2002	Bosch et al.		2006/0170690 A1	8/2006	Leather	
6,424,345 B1	7/2002	Smith et al.					
6,557,083 B1	4/2003	Sperber et al.					
6,570,579 B1 *	5/2003	MacInnis et al. ....	345/629				
6,573,893 B1	6/2003	Naqvi et al.					
6,636,232 B2	10/2003	Larson					
6,650,327 B1	11/2003	Airey et al.					
6,650,330 B2	11/2003	Lindholm et al.					
6,697,063 B1	2/2004	Zhu					
6,714,203 B1 *	3/2004	Morgan et al. ....	345/506				
6,724,394 B1	4/2004	Zatz et al.					
6,731,289 B1	5/2004	Peercy et al.					
6,750,867 B1	6/2004	Gibson					
6,753,878 B1 *	6/2004	Heirich et al. ....	345/629				
6,762,763 B1 *	7/2004	Migdal et al. ....	345/506				
6,778,177 B1 *	8/2004	Furtner .....	345/544				
6,791,559 B2	9/2004	Baldwin					
6,801,203 B1	10/2004	Hussain					
6,809,732 B2	10/2004	Zatz et al.					
6,864,893 B2	3/2005	Zatz					
6,864,896 B2 *	3/2005	Perego .....	345/542				
6,897,871 B1	5/2005	Morein et al.					
6,980,209 B1	12/2005	Donham et al.					

## OTHER PUBLICATIONS

European Search Report from European Patent Office; European Application No. 03257464.2; dated Apr. 4, 2006.

Foley, James et al.; Computer Graphics, Principles and Practice; Addison-Wesley Publishing Company; 1990; pp. 873-899.

Crockett, Thomas W.; An introduction to parallel rendering; Elsevier Science B.V.; 1997; pp. 819-843.

Montrym, John S. et al.; InfiniteReality: A Real-Time Graphics System; Silicon Graphics Computer Systems; 1997; pp. 293-302.

Humphreys, Greg et al.; WireGL: A Scalable Graphics System for Clusters; ACM Siggraph; 2001; pp. 129-140.

Akeley, K. et al.; High-Performance Polygon Rendering; ACM Computer Graphics; vol. 22, No. 4; 1988; pp. 239-246.

Breternitz, Jr., Mauricio et al.; Compilation, Architectural Support, and Evaluation of SIMD Graphics Pipeline Programs on a General-Purpose CPU; IEEE; 2003; pp. 1-11.

International Search Report for PCT Patent Application PCT/IB2004/003821 dated Mar. 22, 2005.

Fuchs, Henry et al.; Pixel-Planes 5: A Heterogeneous Multiprocessor Graphics System Using Processor-Enhanced Memories; Computer Graphics; vol. 23, No. 3; Jul. 1989; pp. 79-88.

\* cited by examiner

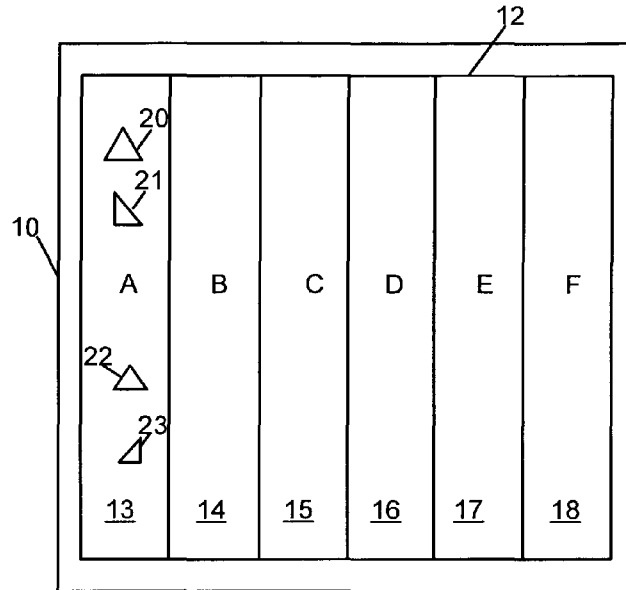


FIG. 1  
PRIOR ART

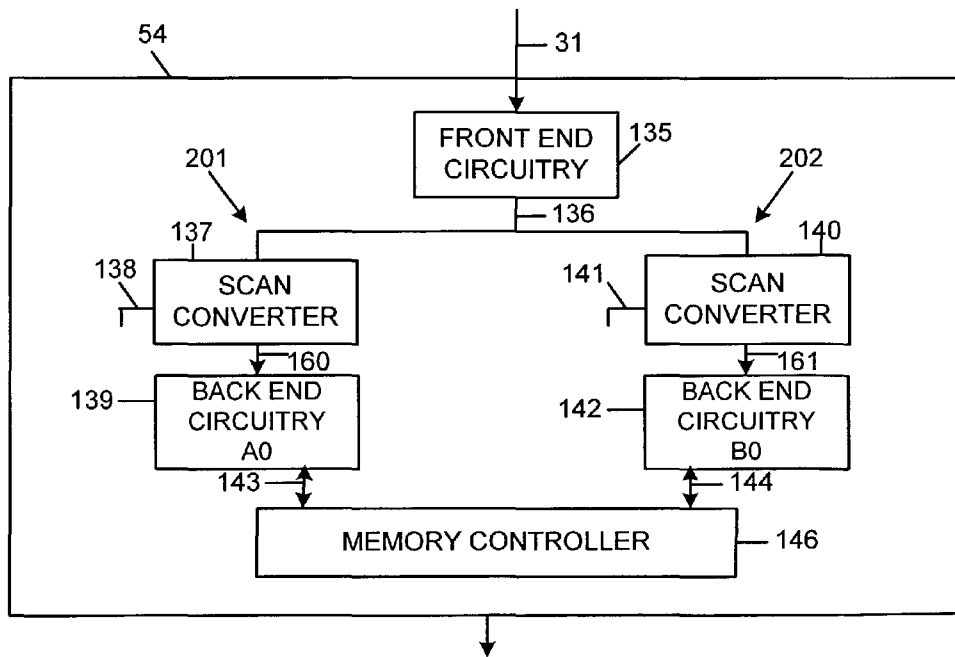


FIG. 5

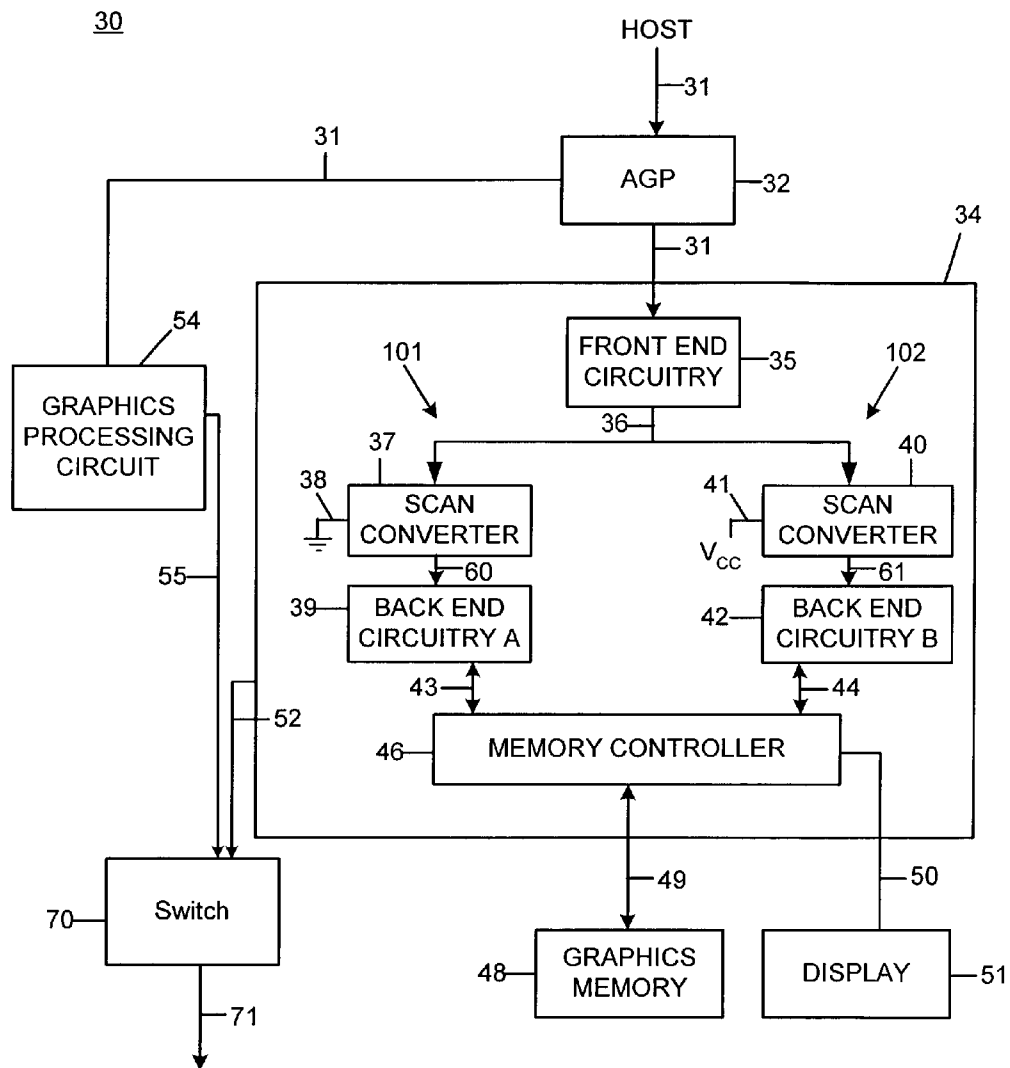


FIG. 2

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