



US006882993B1

(12) **United States Patent**
Lawande et al.

(10) **Patent No.:** **US 6,882,993 B1**
(45) **Date of Patent:** **Apr. 19, 2005**

(54) **INCREMENTAL REFRESH OF
MATERIALIZED VIEWS WITH JOINS AND
AGGREGATES AFTER ARBITRARY DML
OPERATIONS TO MULTIPLE TABLES**

Satyanarayana R. Valluri et al., View relevance driven materialized view selection in data warehousing environment, 2002, Australian Computer Society, Inc. Darlinghurst, Australia, pp. 187-196.*

(75) Inventors: **Shilpa Lawande**, Nashua, NH (US);
Abhinav Gupta, Palo Alto, CA (US);
Benoit Dageville, Foster City, CA (US)

Oracle Corporation, "Create Materialized View" copyright 1996-2001, Oracle 9i Reference Release 1(9.0.1) Part #A90125-01, pp. 1-22.*

(73) Assignee: **Oracle International Corporation**,
Redwood Shores, CA (US)

* cited by examiner

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 453 days.

Primary Examiner—Diane D. Mizrahi
(74) *Attorney, Agent, or Firm*—Hickman Palermo Truong & Becker LLP; John D. Henkhaus

(21) Appl. No.: **10/059,616**

(57) **ABSTRACT**

(22) Filed: **Jan. 28, 2002**

(51) **Int. Cl.**⁷ **G06F 17/30**

(52) **U.S. Cl.** **707/2; 707/102**

(58) **Field of Search** 707/1-10, 100-104.1,
707/200-205

A method is provided for incrementally refreshing a materialized view after multiple operations on a row of a base table of the materialized view, by determining an equivalent operation for the multiple operations and refreshing the materialized view according to the equivalent operation. The method is applicable to a materialized view based on multiple base tables on which multiple operations have been performed. The step of determining the equivalent operation can include identifying rows for which an earliest operation is a DELETE operation, or rows for which a latest operation is an INSERT operation, or a combination of the two. The step of refreshing the materialized view includes performing an inverse operation of the equivalent operation to determine a pre-update state of the row, and refreshing the materialized view based on the pre-update state. Additional embodiments are provided which enhance the performance of materialized view refresh queries.

(56) **References Cited**

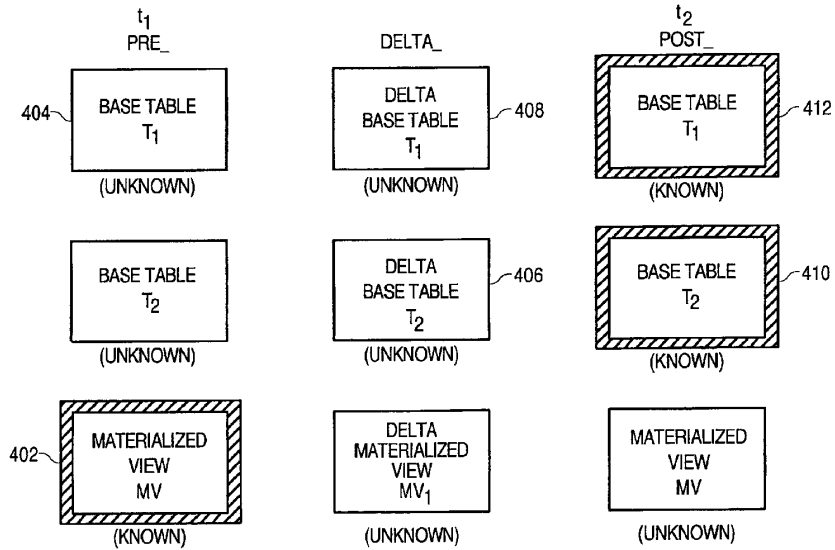
U.S. PATENT DOCUMENTS

5,963,959 A	*	10/1999	Sun et al.	707/200
6,496,819 B1	*	12/2002	Bello et al.	707/3
6,546,402 B1	*	4/2003	Beyer et al.	707/201
6,708,179 B1	*	3/2004	Arora	707/102
6,763,352 B1		7/2004	Cochrane et al.	707/4

OTHER PUBLICATIONS

Jonathan Goldstein et al., Optimizing queries using materialized views: a practical solution, 2001, ACM Press Special Interest Group on Management of Data, pp. 331-342.*

33 Claims, 12 Drawing Sheets



(t1) TIME TABLE 102

TIME_ID	DAY	HOUR	MONTH
1	1	01	JAN 1980
2	1	23	JAN 1980
3	5	02	JAN 1980
4	5	08	JAN 1980
5	6	06	FEB 1980
⋮	⋮	⋮	⋮
50	3	13	JUL 1985

(t2) LOCATION TABLE 104

LOC_ID	STREET	CITY	STATE
1	1st	Santa Clara	CA
2	Main	Los Angeles	CA
3	Peachtree	Atlanta	GA
4	Main	Atlanta	GA
5	Howard	Santa Clara	CA
⋮	⋮	⋮	⋮
12	Kifer	Ogden	UT

(t3) PRODUCT_SALES 106

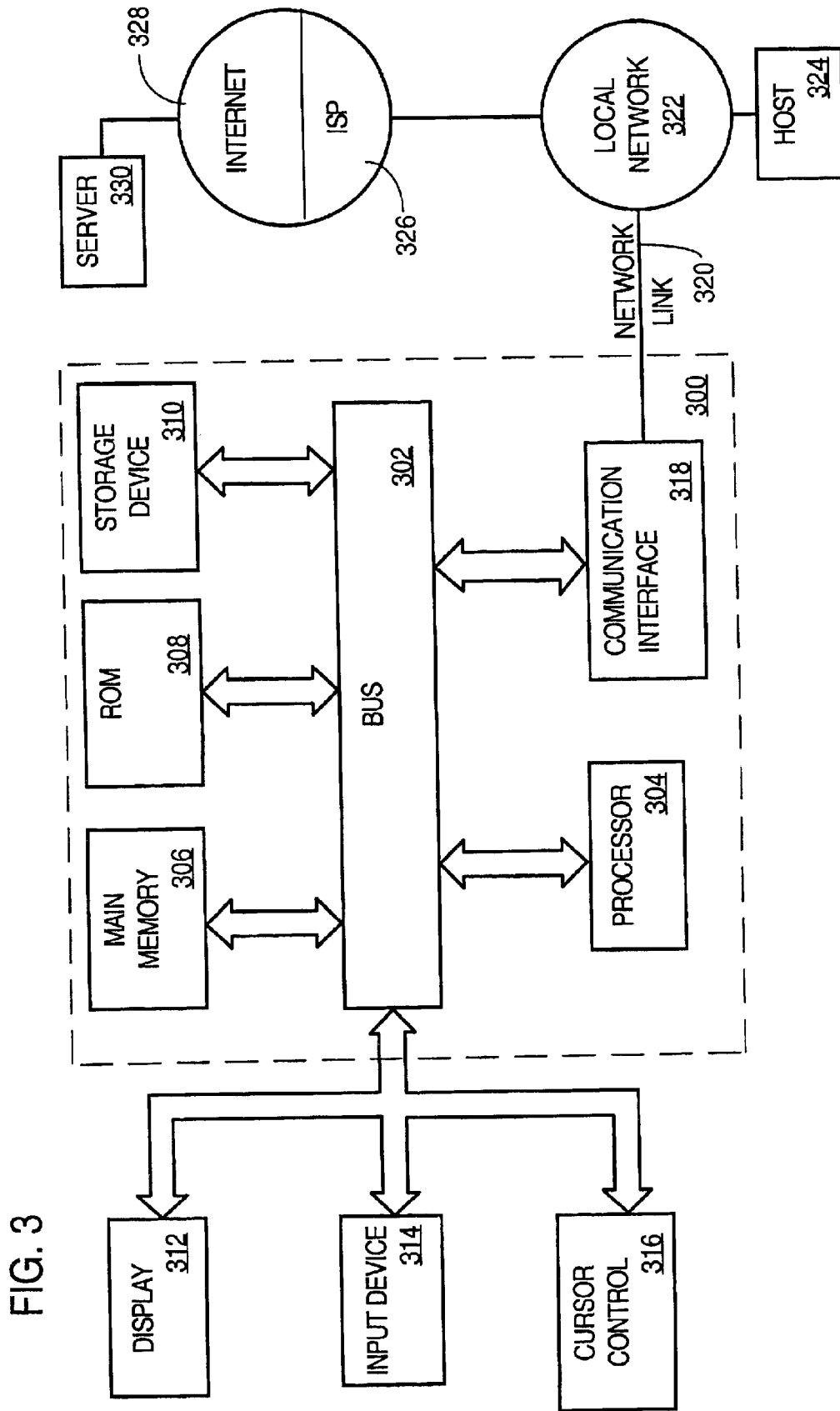
SALE_ID	LOC_ID	TIME_ID	TOTAL
1	1	4	\$500
2	11	3	\$300
3	10	1	\$20
4	3	3	\$10
5	9	70	\$400
⋮	⋮	⋮	⋮
5,000	5	20	\$60

FIG. 1

SALESREPORT TABLE 202

MONTH	CITY	SUMSALES
JAN 1980	Santa Clara	\$50,000
JAN 1980	Los Angeles	\$90,000
JAN 1980	Atlanta	\$30,000
JAN 1980	Tustin	\$15,000
JAN 1980	Seattle	\$70,000
⋮	⋮	⋮
JUL 1985	Ogden	\$35,000

FIG. 2



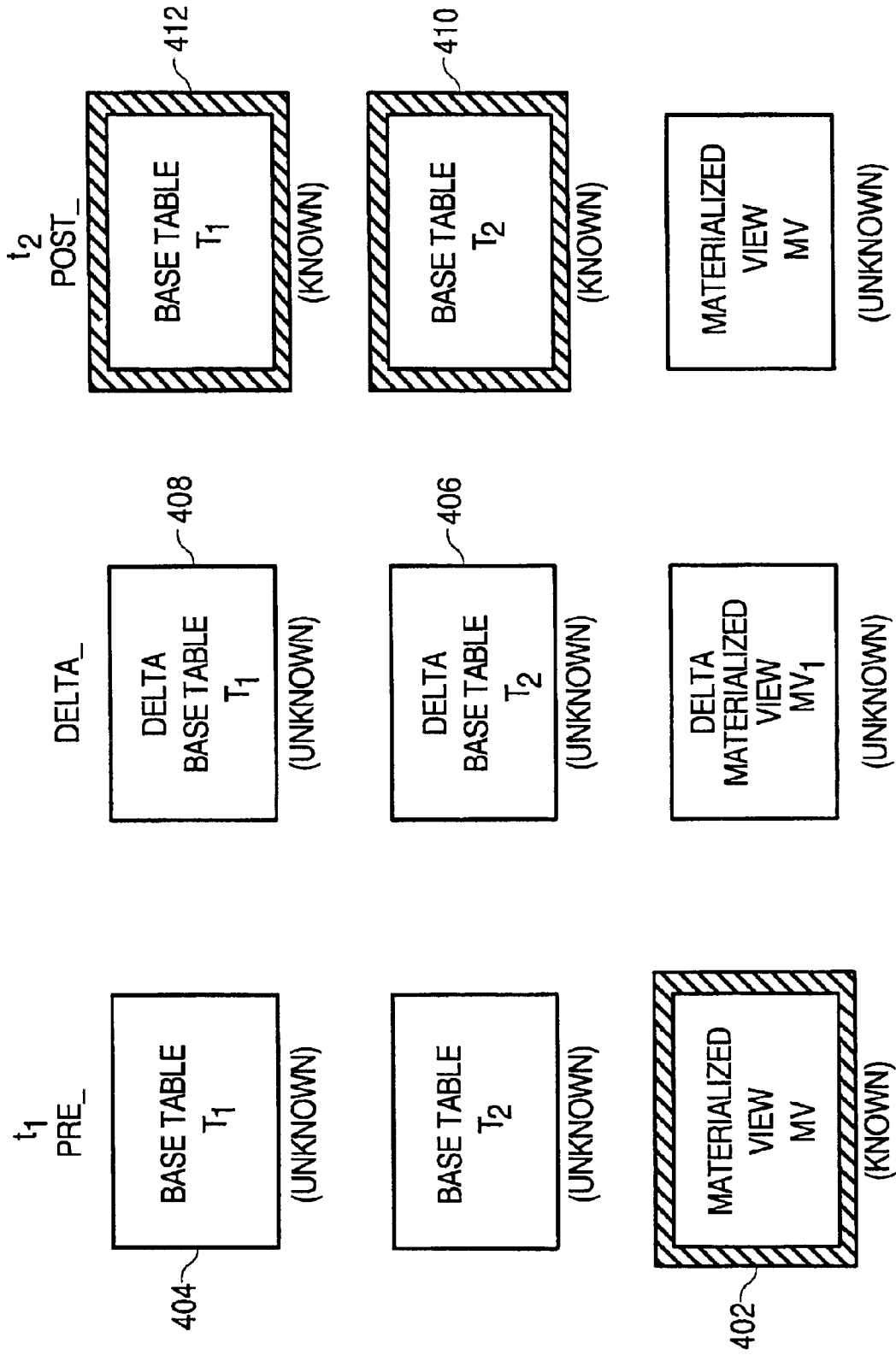


FIG. 4

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.