



US008140786B2

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

(10) **Patent No.:** **US 8,140,786 B2**
(45) **Date of Patent:** **Mar. 20, 2012**

- (54) **SYSTEMS AND METHODS FOR CREATING COPIES OF DATA, SUCH AS ARCHIVE COPIES**
- (75) Inventors: **Alan Bunte**, Monmouth Beach, NJ (US); **Anand Prahlad**, East Brunswick, NJ (US); **Brian Brockway**, Shrewsbury, NJ (US)
- (73) Assignee: **CommVault Systems, Inc.**, Oceanport, NJ (US)
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 1003 days.

5,093,912 A	3/1992	Dong et al.
5,133,065 A	7/1992	Cheffetz et al.
5,193,154 A	3/1993	Kitajima et al.
5,212,772 A	5/1993	Masters
5,226,157 A	7/1993	Nakano et al.
5,239,647 A	8/1993	Anglin et al.
5,241,668 A	8/1993	Eastridge et al.
5,241,670 A	8/1993	Eastridge et al.
5,276,860 A	1/1994	Fortier et al.
5,276,867 A	1/1994	Kenley et al.
5,287,500 A	2/1994	Stoppani, Jr.
5,321,816 A	6/1994	Rogan et al.
5,333,315 A	7/1994	Saether et al.
5,347,653 A	9/1994	Flynn et al.

(Continued)

FOREIGN PATENT DOCUMENTS

EP 0259912 3/1988

(Continued)

OTHER PUBLICATIONS

Webopedia, "Data Duplication", Aug. 31, 2006, pp. 1-2, http://web.archive.org/web/20060913030559/http://www.webopedia.com/TERM/D/data_deduplication.html.*

(Continued)

Primary Examiner — Edward Dudek, Jr.

Assistant Examiner — Christopher Birkhimer

(74) *Attorney, Agent, or Firm* — Perkins Coie LLP

(21) Appl. No.: **11/950,376**

(22) Filed: **Dec. 4, 2007**

Prior Publication Data

US 2008/0229037 A1 Sep. 18, 2008

Related U.S. Application Data

- (60) Provisional application No. 60/882,884, filed on Dec. 29, 2006, provisional application No. 60/871,737, filed on Dec. 22, 2006, provisional application No. 60/882,883, filed on Dec. 29, 2006, provisional application No. 61/001,485, filed on Oct. 31, 2007, provisional application No. 60/868,518, filed on Dec. 4, 2006.

(51) **Int. Cl.**
G06F 12/00 (2006.01)

(52) **U.S. Cl.** **711/161; 711/E12.06; 711/E12.103**

(58) **Field of Classification Search** None
See application file for complete search history.

References Cited

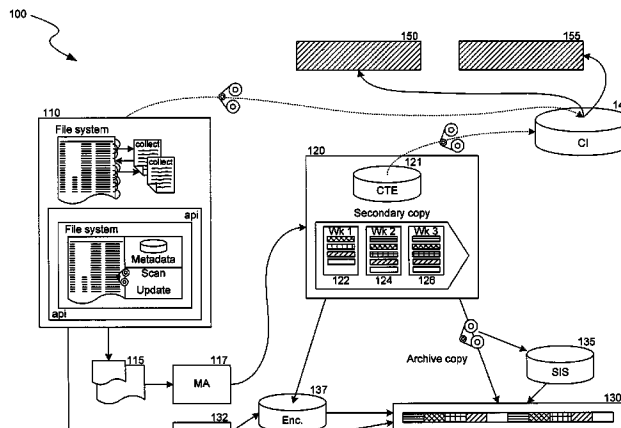
U.S. PATENT DOCUMENTS

4,686,620 A	8/1987	Ng
4,995,035 A	2/1991	Cole et al.
5,005,122 A	4/1991	Griffin et al.

(57) **ABSTRACT**

A system and method of creating archive copies of data sets is described. In some examples, the system creates an archive copy from an original data set. In some examples, the system creates an archive copy when creating a recovery copy for a data set. In some examples, the system creates a copy without redundant data, and then encrypts the data set.

13 Claims, 20 Drawing Sheets



U.S. PATENT DOCUMENTS

5,410,700	A	4/1995	Fecteau et al.		6,976,039	B2 *	12/2005	Chefalas et al.	1/1
5,437,012	A *	7/1995	Mahajan	711/111	6,993,162	B2 *	1/2006	Stephany et al.	382/118
5,448,724	A	9/1995	Hayashi		7,017,113	B2	3/2006	Bourbakis et al.	
5,491,810	A	2/1996	Allen		7,035,943	B2	4/2006	Yamane et al.	
5,495,607	A	2/1996	Pisello et al.		7,089,395	B2 *	8/2006	Jacobson et al.	711/202
5,504,873	A	4/1996	Martin et al.		7,111,173	B1 *	9/2006	Scheidt	713/186
5,544,345	A	8/1996	Carpenter et al.		7,117,246	B2	10/2006	Christenson et al.	
5,544,347	A	8/1996	Yanai et al.		7,143,091	B2	11/2006	Charnock et al.	
5,559,957	A	9/1996	Balk		7,191,290	B1	3/2007	Ackaouy et al.	
5,619,644	A	4/1997	Crockett et al.		7,246,272	B2	7/2007	Cabezas et al.	
5,638,509	A	6/1997	Dunphy et al.		7,272,606	B2	9/2007	Borthakur et al.	
5,673,381	A	9/1997	Huai et al.		7,287,252	B2	10/2007	Bussiere et al.	
5,699,361	A	12/1997	Ding et al.		7,320,059	B1	1/2008	Armangau et al.	
5,729,743	A	3/1998	Squibb		7,325,110	B2	1/2008	Kubo et al.	
5,742,792	A *	4/1998	Yanai et al.	711/162	7,395,282	B1	7/2008	Crescenti et al.	
5,751,997	A	5/1998	Kullick et al.		7,444,382	B2	10/2008	Malik	
5,758,359	A	5/1998	Saxon		7,444,387	B2	10/2008	Douceur et al.	
5,761,677	A	6/1998	Senator et al.		7,478,113	B1	1/2009	De Spiegeleer et al.	
5,764,972	A	6/1998	Crouse et al.		7,487,245	B2	2/2009	Douceur et al.	
5,778,395	A	7/1998	Whiting et al.		7,496,604	B2	2/2009	Sutton, Jr. et al.	
5,812,398	A	9/1998	Nielsen		7,647,462	B2	1/2010	Wolfgang et al.	
5,813,008	A	9/1998	Benson et al.		7,661,028	B2	2/2010	Erofeev	
5,813,009	A	9/1998	Johnson et al.		7,685,177	B1	3/2010	Hagerstrom et al.	
5,813,017	A	9/1998	Morris		7,685,459	B1	3/2010	De Spiegeleer et al.	
5,822,780	A *	10/1998	Schutzman	711/165	7,698,699	B2	4/2010	Rogers et al.	
5,875,478	A	2/1999	Blumenau		7,870,486	B2	1/2011	Wang et al.	
5,887,134	A	3/1999	Ebrahim		2001/0037323	A1 *	11/2001	Moulton et al.	707/1
5,901,327	A	5/1999	Ofek		2002/0099806	A1	7/2002	Balsamo et al.	
5,924,102	A	7/1999	Perks		2002/0107877	A1	8/2002	Whiting et al.	
5,940,833	A	8/1999	Benson		2003/0033308	A1	2/2003	Patel et al.	
5,950,205	A	9/1999	Aviani, Jr.		2003/0110190	A1	6/2003	Achiwa et al.	
5,974,563	A	10/1999	Beeler, Jr.		2003/0182310	A1 *	9/2003	Charnock et al.	707/104.1
5,990,810	A	11/1999	Williams		2004/0148306	A1 *	7/2004	Moulton et al.	707/101
6,021,415	A	2/2000	Cannon et al.		2004/0230817	A1	11/2004	Ma	
6,026,414	A	2/2000	Anglin		2004/0250033	A1	12/2004	Prahlad et al.	
6,052,735	A	4/2000	Ulrich et al.		2005/0033756	A1	2/2005	Kottomtharayil et al.	
6,076,148	A	6/2000	Kedem		2005/0066190	A1 *	3/2005	Martin	713/200
6,094,416	A	7/2000	Ying		2005/0086443	A1	4/2005	Mizuno et al.	
6,131,095	A	10/2000	Low et al.		2005/0114406	A1	5/2005	Borthakur et al.	
6,131,190	A	10/2000	Sidwell		2005/0131900	A1	6/2005	Palliyil et al.	
6,148,412	A	11/2000	Cannon et al.		2005/0182780	A1 *	8/2005	Forman et al.	707/101
6,154,787	A	11/2000	Urevig et al.		2005/0203864	A1	9/2005	Schmidt et al.	
6,161,111	A	12/2000	Mutalik et al.		2005/0234823	A1 *	10/2005	Schimpf	705/50
6,167,402	A	12/2000	Yeager		2005/0262194	A1 *	11/2005	Mamou et al.	709/203
6,212,512	B1	4/2001	Barney et al.		2006/0005048	A1	1/2006	Osaki et al.	
6,260,069	B1	7/2001	Anglin		2006/0010227	A1	1/2006	Atluri	
6,269,431	B1	7/2001	Dunham		2006/0047894	A1 *	3/2006	Okumura	711/111
6,275,953	B1	8/2001	Vahalia et al.		2006/0053305	A1	3/2006	Wahlert et al.	
6,301,592	B1	10/2001	Aoyama et al.		2006/0056623	A1 *	3/2006	Gligor et al.	380/28
6,311,252	B1 *	10/2001	Raz	711/117	2006/0174112	A1 *	8/2006	Wray	713/168
6,324,581	B1	11/2001	Xu et al.		2006/0224846	A1	10/2006	Amarendran et al.	
6,328,766	B1	12/2001	Long		2006/0230244	A1	10/2006	Amarendran et al.	
6,330,570	B1	12/2001	Crighton		2006/0242489	A1	10/2006	Brockway et al.	
6,330,642	B1	12/2001	Carteau		2007/0022145	A1	1/2007	Kavuri	
6,343,324	B1	1/2002	Hubis et al.		2007/0118705	A1	5/2007	Arakawa et al.	
RE37,601	E	3/2002	Eastridge et al.		2007/0179995	A1	8/2007	Prahlad et al.	
6,356,801	B1	3/2002	Goodman et al.		2007/0198613	A1	8/2007	Prahlad et al.	
6,389,432	B1	5/2002	Pothapragada et al.		2007/0203937	A1	8/2007	Prahlad et al.	
6,421,711	B1	7/2002	Blumenau et al.		2007/0255758	A1	11/2007	Zheng et al.	
6,487,561	B1	11/2002	Ofek et al.		2008/0028007	A1	1/2008	Ishii et al.	
6,513,051	B1	1/2003	Bolosky et al.		2008/0098083	A1	4/2008	Shergill et al.	
6,519,679	B2	2/2003	Devireddy et al.		2008/0162320	A1	7/2008	Mueller et al.	
6,538,669	B1	3/2003	Lagueux, Jr. et al.		2008/0162518	A1	7/2008	Bollinger et al.	
6,564,228	B1	5/2003	O'Connor		2009/0106480	A1	4/2009	Chung	
6,609,183	B2 *	8/2003	Ohran	711/161	2009/0112870	A1	4/2009	Ozzie et al.	
6,609,187	B1 *	8/2003	Merrell et al.	711/173	2009/0132619	A1	5/2009	Arakawa et al.	
6,658,526	B2	12/2003	Nguyen et al.		2009/0144285	A1	6/2009	Chatley et al.	
6,704,730	B2	3/2004	Moulton et al.		2009/0177719	A1	7/2009	Kavuri	
6,745,304	B2 *	6/2004	Playe	711/161	2009/0204649	A1	8/2009	Wong et al.	
6,757,699	B2 *	6/2004	Lowry	1/1	2010/0094817	A1	4/2010	Ben-Shaul et al.	
6,757,794	B2	6/2004	Cabrera et al.		2010/0161554	A1	6/2010	Datuashvili et al.	
6,795,903	B2 *	9/2004	Schultz et al.	711/154					
6,810,398	B2	10/2004	Moulton						
6,868,417	B2	3/2005	Kazar et al.						
6,901,493	B1 *	5/2005	Maffezzoni	711/162					
6,928,459	B1	8/2005	Sawdon et al.						

FOREIGN PATENT DOCUMENTS

EP	0405926	1/1991
EP	0467546	1/1992
EP	0774715	5/1997

EP	0981090	2/2000
WO	WO-95/13580	5/1995
WO	WO-99/12098	3/1999

OTHER PUBLICATIONS

Federal Information Processing Standards Publication 180-2, "Secure Hash Standard", Aug. 1, 2002, pp. 1-83 <http://csrc.nist.gov/publications/fips/fips180-2/fips180-2withchangenotice.pdf>.*

Menezes et al., "Handbook of Applied Cryptography", CRC Press, 1996, pp. 321-383 <http://www.cacr.math.uwaterloo.ca/hac/about/chap9.pdf>.*

Microsoft, "Computer Dictionary", Fifth Edition, 2002, p. 249.*

SearchStorage, "File System", Nov. 1998, pp. 1-10, <http://searchstorage.techtarget.com/definition/file-system>.*

CommVault Systems, Inc., "Deduplication," http://documentation.commvault.com/commvault/release_8_0_0/books_online_1/english_US/features/single_instance/single_instance.htm>, internet accessed on May 21, 2009, 9 pages.

CommVault Systems, Inc., "Deduplication—How to," http://documentation.commvault.com/commvault/release_8_0_0/books_online_1/english_US/features/single_instance/single_instance_how_to.htm>, internet accessed on May 21, 2009, 7 pages.

U.S. Appl. No. 12/626,839, filed Nov. 27, 2009, Klose, Michael F. Diligent Technologies "HyperFactor," <http://www.diligent.com/products/protectTIER-1:HyperFactor-1>>, Internet accessed on Dec. 5, 2008, 2 pages.

Overland Storage, "Data Deduplication," http://www.overlandstorage.com/topics/data_deduplication.html>, Internet accessed on Dec. 5, 2008, 2 pages.

Lortu Software Development, "Kondar Technology-Deduplication," <http://www.lortu.com/en/deduplication.asp>>, Internet accessed on Dec. 5, 2008, 3 pages.

Quantum Corporation, "Data De-Duplication Background: A Technical White Paper," May 2008, 13 pages.

Kornblum, Jesse, "Identifying Almost Identical Files Using Context Triggered Piecewise Hashing," www.sciencedirect.com, Digital Investigation 3S (2006), pp. S91-S97.

International Search Report and Written Opinion, International Application No. PCT/US2009/58137, Mail Date Dec. 23, 2009, 14 pages.

U.S. Appl. No. 11/963,623, Gokhale.

U.S. Appl. No. 12/058,178, Kottomtharayil.

U.S. Appl. No. 12/058,317, Kottomtharayil.

U.S. Appl. No. 12/058,367, Kottomtharayil.

Armstead et al., "Implementation of a Campus-wide Distributed Mass Storage Service: The Dream vs. Reality," *IEEE*, 1995, pp. 190-199.

Arneson, "Mass Storage Archiving in Network Environments," Digest of Papers, Ninth IEEE Symposium on Mass Storage Systems, Oct. 31, 1988-Nov. 3, 1988, pp. 45-50, Monterey, CA.

Cabrera et al., "ADSM: A Multi-Platform, Scalable, Backup and Archive Mass Storage System," Digest of Papers, Compton '95, Proceedings of the 40th IEEE Computer Society International Conference, Mar. 5, 1995-Mar. 9, 1995, pp. 420-427, San Francisco, CA.

Eitel, "Backup and Storage Management in Distributed Heterogeneous Environments," *IEEE*, 1994, pp. 124-126.

Jander, M., "Launching Storage-Area Net," *Data Communications*, US, McGraw Hill, NY, vol. 27, No. 4 (Mar. 21, 1998), pp. 64-72.

Jason Gait, "The Optical File Cabinet: A Random-Access File System for Write-Once Optical Disks," *IEEE Computer*, vol. 21, No. 6, pp. 11-22 (1988).

Rosenblum et al., "The Design and Implementation of a Log-Structured File System," *Operating Systems Review SIGOPS*, vol. 25, No. 5, New York, US, pp. 1-15 (May 1991).

U.S. Appl. No. 12/145,342, filed Jun. 24, 2008, Gokhale.

U.S. Appl. No. 12/145,347, filed Jun. 24, 2008, Gokhale.

U.S. Appl. No. 12/647,933, filed Jul. 3, 2008.

U.S. Appl. No. 12/647,906, filed Dec. 28, 2009, Attarde et al.

U.S. Appl. No. 12/649,454, filed Dec. 30, 2009, Muller et al.

Commvault Systems, Inc., "Continuous Data Replicator 7.0," Product Data Sheet, 2007.

U.S. Appl. No. 12/565,576, filed Sep. 23, 2009, Kottomtharayil et al.

U.S. Appl. No. 13/251,022, filed Sep. 30, 2011, Gokhale.

* cited by examiner

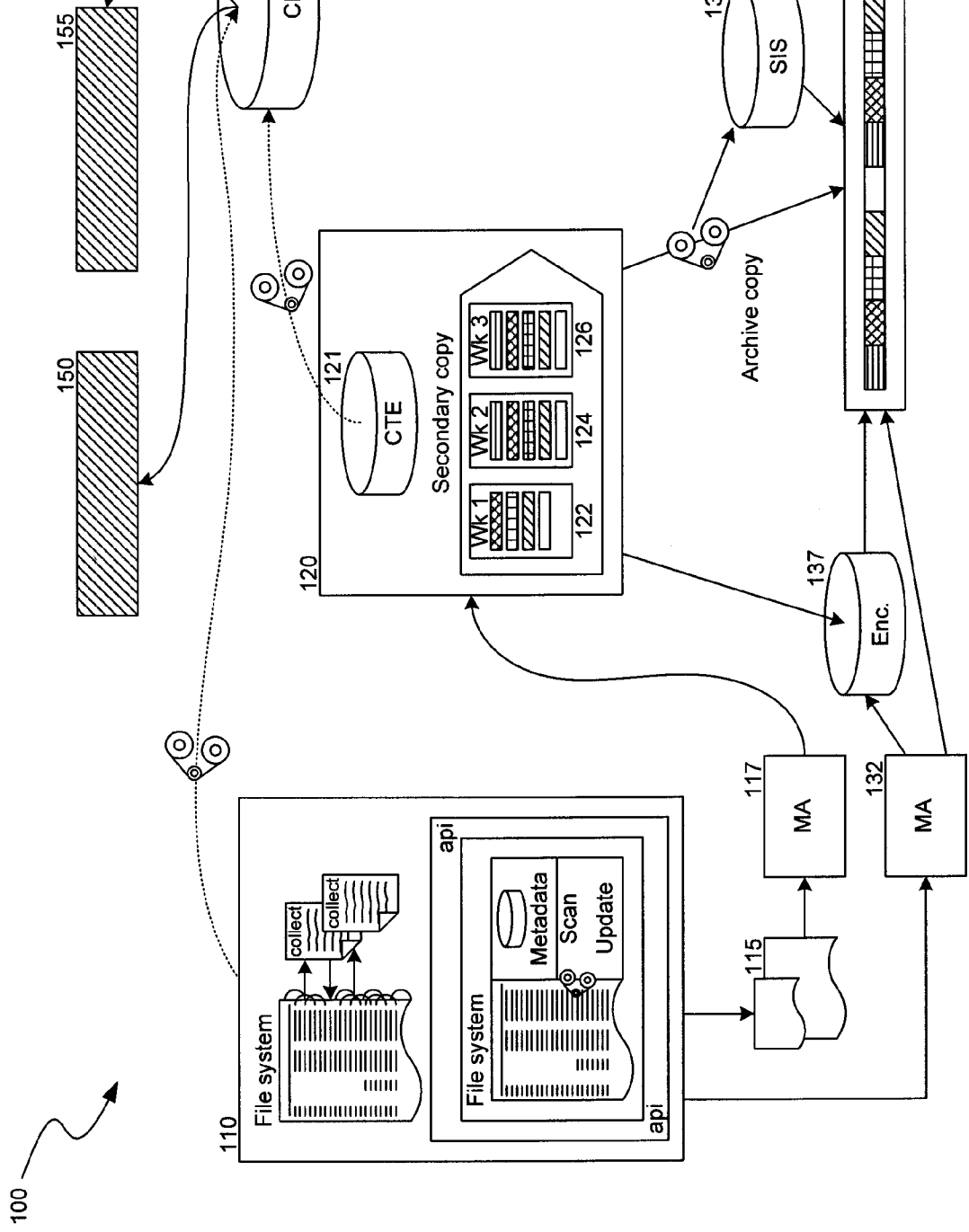


FIG. 1A

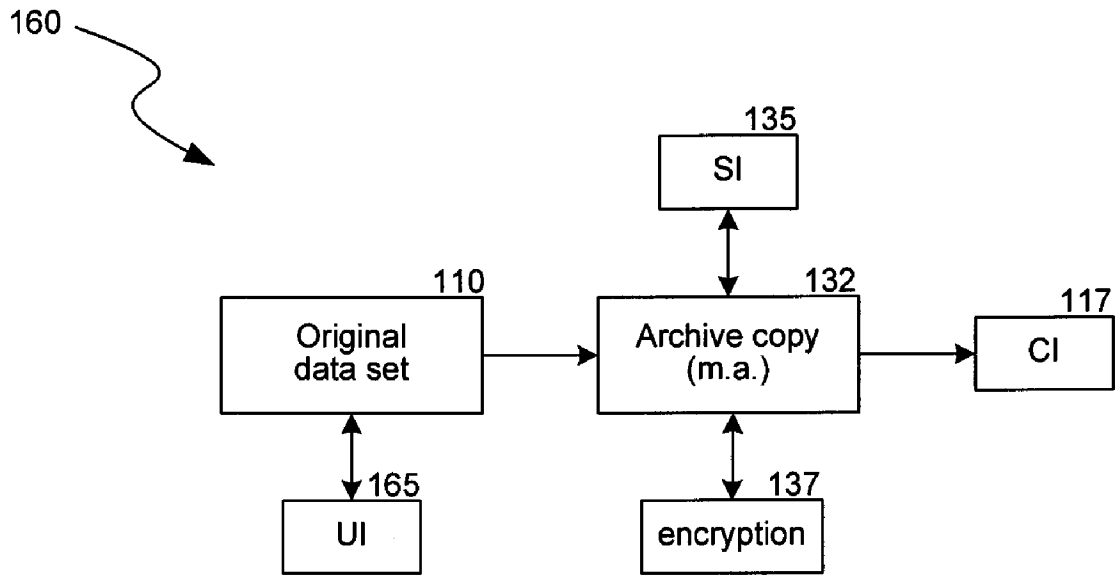


FIG. 1B

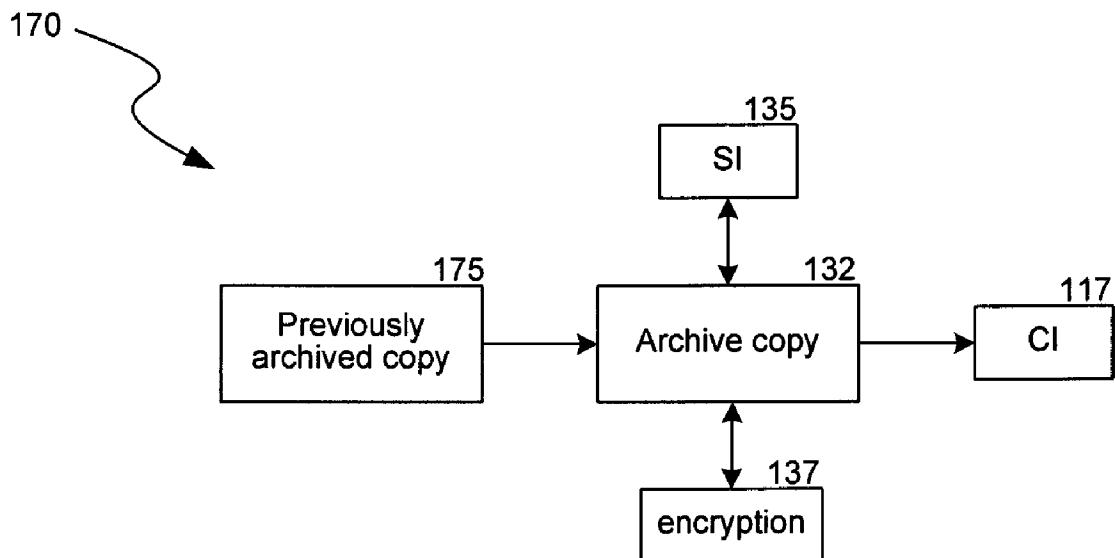


FIG. 1C

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.