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(21) International Application Number: PCT/US93/03239 (22) International Filing Date: 7 April 1993 (07.04.93) (30) Priority data: 07/866,848 10 April 1992 (10.04.92) US (71) Applicant: AVID TECHNOLOGY, INC. [US/US]; Metropolitan Technology Park, One Park West, Tewksbury, MA 01876 (US). (72) Inventors: FASCIANO, Peter, J. ; 30 Coachman Lane, Natick, MA 01760 (US). GARMON, Paul, D. ; 11 Lloyd Street, Winchester, MA 01890 (US). PETERS, Eric, C. ; 80 Carleton Road, Carlisle, MA 01741 (US). (74) Agent: GORDON, Peter, J.; Wolf, Greenfield & Sacks, Federal Reserve Plaza, 600 Atlantic Avenue, Boston, MA 02210 (US).		(81) Designated States: AU, BB, BG, BR, CA, CZ, FI, HU, JP, KP, KR, LK, MG, MN, MW, NO, NZ, PL, RO, RU, SD, SK, UA, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE). Published <i>With international search report.</i> <i>Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i>
(54) Title: DIGITAL AUDIO/VIDEO INSERTION SYSTEM (57) Abstract <p>A digital audio/video insertion and broadcast system takes audio/video source information and digitizes, compresses and stores the information. The storage is in a random access medium such as magnetic or optical disks. Playing apparatus decompresses the information and regenerates an analog signal. Patching apparatus inserts the regenerated analog signal into a broadcast or cable channel at preselectable times. Editing apparatus may be provided for editing a stored video file prior to playing.</p>		

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DIGITAL AUDIO/VIDEO INSERTION SYSTEM

Background of the Invention

This invention relates to audio/video advertisement insertion and broadcast systems.

Automated advertisement insertion systems have been developed to insert audio/video advertisements into interruptions in broadcast or cable programming. Examples of prior art advertisement insertion systems are disclosed in United States Patent 4,724,491 to Lambert and United States Patent 5,029,014 to Lindstrom. Lambert employs multiple video tape recorders for advertisement insertion and Lindstrom teaches a system employing laser disks for inserting messages in an order different from the order in which they are recorded in the laser disk. Neither system digitizes, compresses and stores the original analog source material nor do the prior art systems permit editing of a particular commercial segment as part of the audio/video advertisement insertion or broadcast process. Nor can they control a broadcast system.

Summary of the Invention

The digital audio/video advertisement insertion and broadcast system of the invention includes analog audio/video source information and apparatus adapted for digitizing, compressing and storing the information. Playback apparatus is provided to

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decompress the information and regenerate an analog signal. Patching apparatus controls the broadcast and inserts the regenerated analog signal into a broadcast or cable channel at preselectable times. A preferred embodiment further includes editing apparatus interconnected with the digitizing, compressing and storing apparatus for editing the digitized information before it is played and inserted into a communications channel. In this specification the term "advertisement insertion" is meant to include any material regardless of length, inserted or broadcast in a communication channel.

Brief Description of the Drawing

Fig. 1 is a schematic illustration of a digital audio/video advertisement insertion and broadcast system at a main business location;

Fig. 2 is a schematic illustration of a digital audio/video advertisement insertion and broadcast system at a headend site or local broadcast site.

Description of the Preferred Embodiment

The digital audio/video advertisement insertion and broadcast system of the invention will be described with reference to a paradigm cable television system, typical of a present day installation, having 20 channels. The system of the invention, nevertheless, is applicable to any broadcast system. The cable system's headend, main office and studios may or may not be located at a

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common site. In the present invention, video and audio source material is digitized. The video portion of the information is compressed via JPEG technology to a user selected degree of image resolution. JPEG chips are available from C-Cube of Milpitas, California. The stored digital audio/video (DAV) files are 60 fields per second, full motion, full resolution video and stereo audio files. Suitable JPEG compression technology is disclosed in copending United States Patent Application of Paul D. Garmon, Robert A. Gonsalves, Patrick D. O'Connor and Stephen J. Reber entitled Improved Media Composer filed April 10, 1992, and assigned to the assignee of the present application. The DAV files may be stored on suitable magnetic media or optical disks. The DAV files containing the digitized audio and video information of differing resolutions may be stored, sequenced and replicated in any order at any time. Because the information is stored as files, the files can be readily edited to accommodate last minute changes before advertisement insertion. Stereo audio signals are digitized in any number of standard digital audio formats, e.g., 44.1 KHz, 44 KHz, 48 KHz, etc. as an integral part of each DAV file. Optionally, stereo audio signals may be stored at "left-plus-right" and "left-minus-right" channels so as to freely integrate DAV program files into both stereo and monaural channels. The DAV files also contain file identification and tracking data for verification of air play.

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With reference to Fig. 1, the hardware at a cable operator's main business location includes a video cassette player 10 which includes the analog video and audio information. This information is received by processing equipment 12 interconnected with a file server 14. The processor 12 (referred to as a Capture Mate) includes a general purpose computer to support the digital audio/video insertion system operating software, a robust, high-speed magnetic hard drive or drives, support for a digital audio/video network, telephone and other analog signal interconnects, techniques for digitizing audio/video program signals into DAV files, apparatus for regenerating analog signals from DAV files, and apparatus for remotely controlling analog VCRs for digitizing incoming material or sending analog or digital feed for insertion into the cable system or broadcast systems. The file server 14 is typically a free standing extensive mass storage device employing either magnetic or optical storage media. The processor 12 normally supports and operates the office manager 16 portion of the insertion or broadcast system software. The office manager 16 software is typically responsible for digitizing, using conventional techniques, new program material from analog sources, handling associated traffic instructions, and generating channel insertion logs, performance affidavits, invoices and related functions. A network 18 is a digital audio/video file distribution network and a network 20 is a command and control network such as Ethernet.

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As shown in Fig. 2, the headend site includes a Headmaster station 22 which supports and operates a program manager portion of the insertion system software. The program manager software's primary function is the coordination of all insertion events within the insertion system. The program manager assigns insert events and advances DAV files and related audio/video signal matrix switcher 24 instructions to available players 26 via the DAV network 18. The program manager software also gathers operation and performance data for further processing via the office manager 16 software and technical maintenance logs and diagnostics. The Headmaster station 22 generally includes the same physical hardware as the processor 12.

The DAV network 18 is the main digital interconnect, uniting the office manager software of the processor 12 with the Headmaster station 22's program manager, archival media service, the player array 26, the matrix switcher 24 and associated peripherals. While the matrix switcher 24 can be manually operated remotely via the DAV network, note that the switcher 24's primary insert operations are not conducted over the network. These operations are conducted via a separate, dedicated link from the player array 26. The digital insertion system player array 26 includes minimally of a computer, a small, fast access hard drive for short term DAV file storage, matrix switcher software, switcher 24 control and analog signal interconnects, and a card for

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decompressing and processing DAV files and replicating or regenerating real time analog audio/video signals. It is preferred that the insertion system include several players.

The switcher 24 is a digitally controlled audio/video signal matrix switcher. Sources into the matrix switcher 24 are analog audio, video and control signals coming from cable network feeds, video cassette players and the player array 26. Destinations from the switcher 24 are outgoing cable channels, analog video cassette recorders and digitizing systems. Signal routing commands for the switcher 24 are normally provided by the players 26 via Ethernet 20 via vertical interval command signals (VICS) added to the player 26's outgoing video. Additional routing commands may come from the program manager software in the Headmaster station 22 or from the office manager 16. As with most routing systems, the matrix switcher 24 is a key component of the advertisement insertion or broadcast installation. Thus, it is designed for high reliability with redundant paths and power.

In the smallest advertisement insertion system or broadcast installations a less expensive primary/secondary player routing scheme may be substituted for the matrix switcher 24. In larger cable systems where the business office and headend are often different sites, the processor station 12 and the Headmaster station 22 are generally installed in separate locations. A digital two-way link,

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optionally via the cable system itself or an Ethernet, integrates the processor 12 and file server 14 into the DAV network as a remote auxiliary Headmaster station 22. The option of identical, mirrored file archiving at two different sites provides for a high degree of data protection.

Connecting the outside world to a digital audio/video advertisement insertion and broadcast system may be accomplished via normal modems or Ethernet for traffic instructions and correspondence. DAV files may be transmitted from elsewhere to a processor 12 site via overland T1 or T3 service or other medium high-speed digital transmission schemes. Like analog video tapes, portable digital media such as optical disks in both 5.25- and 12-inch formats or spooling tapes can also be forwarded to the processor 12 site. The processor 12 station joins Ethernet or the DAV network only periodically to perform routine file maintenance tasks or act as an auxiliary Headmaster. Thus, the separate processor 12 location also acts as a locally supervised insertion system gateway to ensure the data integrity of the local insertion or broadcast system. Incoming DAV files may be viewed, verified and modified locally, migrated from temporary storage to the primary DAV file servers 14 and made available to the insertion or broadcast system.

The processor 12 and its office manager software may spend most of a typical workday off the Ethernet 20 and/or the DAV network 18, maintaining only a

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remote monitoring terminal on the Ethernet to follow Headmaster station 22 and player 26 operations. A remote monitor terminal 28 may also be connected to the Headmaster station 22 by conventional phone lines. This allows office manager 16 to monitor and control Headmaster 22 operations in the event that the high-speed digital connections fail. Most of the time, the processor 12 and its office manager software 16 are occupied generating new DAV files and traffic schedules, conducting billing and other related business operations. In large installations, the office manager 16 software may reside and operate in separate work stations, leaving processor 12 free to create new DAV files. The processor 12 normally joins the Ethernet or DAV network only to update and unify the local and Headmaster 22 file servers 14.

The mass storage technologies used in the DAV file servers 14 do not necessarily have to provide for real time DAV file replication or instantaneous random access. Incoming audio/video programs are digitized initially at the processor station 12 and stored to its smaller, faster magnetic drive. This new DAV file is subsequently sent to both main archive media file servers 14 at less than real time data rate if necessary. During normal insertion system operation, DAV files and accompanying timing and matrix switch 24 instructions can be loaded from the file server through the Headmaster 22 along the DAV network 18 to the available players 26, again at lower than real time rates if necessary.

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Upon insertion or broadcast play back, the players 26 then replicate or regenerate the DAV files as real time analog signals from their smaller, faster on board hard drives. This approach makes the use of slower, massive storage schemes very viable. A bank of six 12-inch digital optical disks providing 30 G bytes serves as a practical storage medium for the main file servers 14. Digital spooling tapes become practical for long-term storage of infrequently used DAV files.

Small audio/video advertisement insertion or broadcast system configurations for a handful of insert or broadcast channels may be continuously operated with only one combined master station. Thus, the processor 12 and the Headmaster 22 can be the same physical station, and the office manager 16 and program manager functions can share the master platform. The smallest system, designed for single channel operation also incorporates the player 26 functions as well. Redundant DAV file storage and media management is still an optional capability of smaller systems. Player 26 platforms may be assigned to perform as an auxiliary Headmaster/program manager. Thus, reliable system operation is easily maintained with a minimum of additional hardware components. Since the present insertion or broadcast system is constructed on a modular bases, additional players 26 may be added over time.

Having now described the system of the invention, its operation will now be discussed. The execution of

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an insert or broadcast event is as follows. The system selects an upcoming event from the master traffic schedule for insertion or broadcast. It then calculates the total storage space required for all DAV files included in the insertion event. Whenever more than one DAV file is to be inserted as a single event, all DAV files for the event are sent to one player 26. There, they are segued seamlessly in real time from the player's drive. The program manager seeks and assigns an available player 26 to execute the event, and verifies that there is sufficient space in the players hard drive to store the event's DAV files. The DAV files, timing data, and a matrix switcher 24 insertion instructions are sent to the player array 26. The timing data consists of the actual precise time from the Headmaster 22's calibrated master clock, the scheduled time for the insert if it is to be locally time triggered, the total running time of the DAV files, and the scheduled duration of the insertion as scheduled by the network. The insert control instructions contain event trigger source and routing information to operate the switcher 24 for switching the network program signal and the players 26. Once a player 26 receives its DAV files, timing data and insert control instructions, it performs its assigned work without any further instructions. The system logs the DAV files and associated control data as being copied to the player 26 and the event as being delegated to the ready player 26 for execution.

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Once assigned the player 26 immediately orders the switcher 24 to provide a video sample of the incoming network program feed scheduled to be preempted by the player's assigned insert event. If insert trigger and timing data are provided in the incoming programs vertical interval, the player 26 can decode and respond instantaneously as there is no need for any preroll time as in prior art systems. This signal also serves as a genlock reference for the player's on board sync generator. The player is genlocked to this video source.

At the precise insert time, a player 26 optionally may disable the full genlock function, and allow its on board sync generator to remain locked only to the incoming 3.58 MHz color frequency. This technique maintains a tight, but indirect horizontal and vertical sync phase to the reference during the actual insertion event. This performance option facilitates vertical integral transitions to/from the insertions while providing high system isolation from any incoming program sync disruptions. Sync disruptions cannot adversely affect player 26 service during the insert event. Thus, video frame stores, processors and other signal conditioning hardware is minimized. The player array 26 then instructs the matrix switcher 24 to switch the destination channel from the network program feed to its analog output. The player 26 seamlessly plays and segues all the DAV files scheduled for insertion in the event. At the end of the insert event, the player orders the matrix

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switcher 24 to switch the destination channel back to the original program feed and switch off its incoming reference video feed. Optionally, the player 26 can insert DAV file tracking and other verification data into its output video vertical interval for detection and signal verification after the matrix switch has occurred.

The player 26 verifies locally that its DAV files were executed properly, and logs which files were played. This information is maintained in its own performance journal. The player 26 releases the disk space for new DAV files, and updates its performance journal. When the program manager is available, the player 26 informs the program manager via this journal that events have been properly executed. The program manager records the properly executed events into its master performance journal. The insert event and related activity is now completed.

DAV files present within the players 26 are not edited together as in traditional analog video tape. They remain independent files as duplicated from the DAV file server 14, and may be played in any order any time. Thus, to modify an event already assigned to a player 26, the program manager simply sends any new DAV files needed for the event and then sends the new set of event timing data and instructions. Some of the players 26 may be further equipped with an audio/video input signal digitizing circuit card. This option allows the remote generation of DAV files at the headend from any incoming program source

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switched to these players by the matrix switcher. This provides the insertion system with digital program capture and time shifting capabilities. Program length is ideally limited by the player's available hard disk space. In larger systems players may be assigned as groups and staggered by the program manager to digitize longer programs in segments. The input circuit card equipped player is assigned to each capture event by the program manager in the same manner as a normal insert event. Again, once necessary event timing and switch control data are provided by the program manager the player will perform the capture function independently. Once a player is loaded with its event and ready to perform the insertion, as a secondary task it verifies that it has more disk space available. It sends the program manager its current disk map of existing files and space for evaluation. The program manager determines the player's capacity to handle more assignments and accept more DAV files for subsequent insertion events.

The program manager continues converting the master traffic log into player assignments and loading insertion events as far in advance as the aggregate storage and routing abilities of all the players can support. Since the actual insertion event operating commands are distributed to the players along with the DAV files, both the Headmaster/program manager and the backup office manager and all DAV file servers may be temporarily taken out of service. In short, the DAV network 18 may be shut down entirely. The programmed

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players continue to function normally and independently, directly controlling the matrix switcher 24 and inserting their events until all on board DAV files and insertion instructions are executed.

Currently, JPEG compression schemes available from Avid Technology of Burlington, Massachusetts, deliver full resolution 60-field images at data rates ranging between 40 and 50 K bytes per frame. The data value used throughout this disclosure is 50 K bytes per frame. This rate translates into full motion images occupying about 1.5 M bytes per second of storage. Digital stereo audio requires about an additional 200 K bytes per second, for a conservative total storage requirement of 1.8 M bytes per second or 108 M bytes per minute for total storage on a 5 G byte optical disk side of about 46 real time minutes. As MPEG-II compression schemes become viable there is an anticipated 3-to-1 compression performance improvement resulting in 138 minutes of real time broadcast quality program stored within a 5 G byte disk. The overall DAV network traffic is also lowered to about one-third using MPEG-II methods. This results in typical real time rate DAV file transfers at 600-700 K bytes per second.

The operating character of the DAV network 18 changes very substantially as multiple DAV files can now be shipped along the DAV network in real time, decompressed at the player and air played in real time.

An important aspect of the present invention is

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the editing capability in conjunction with advertisement insertion. Because the material to be inserted is stored in DAV files, the contents of the files may be readily edited to change program content. A media composer from Avid Technology of Burlington, Massachusetts, can be utilized to edit the information stored in a DAV file. Importantly, such editing or modification is accomplished with no analog degradation or it can be used to send quickly assembled stories, for example, fast breaking events, directly out over a cable system.

As MPEG-11 and other compression methods come into use, the matrix switch 24 will evolve into a broader analog and digital signal path controller, including JPEG and MPEG-II decoders and digital format transcoders that can be switched into pathways and employed by the switch to provide unified signal outputs to different channels.

What is claimed is:

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Claims

1. Digital audio/video insertion system comprising:
analog audio/video source information;
apparatus adapted for digitizing, compressing and
storing the information;
playing apparatus for decompressing the
information and regenerating an analog signal; and
patching apparatus adapted to insert the
regenerated analog signal into a broadcast or cable
channel at preselectable times.
2. The system of claim 1 further comprising editing
apparatus intereconnected with the digitizing,
compressing and storing apparatus for editing the
digitized information.
3. The system of claim 1 wherein the playing
apparatus comprises an Yi array of players and the
patching apparatus comprises a digitally controlled
audio/video signal matrix switcher.
4. The system of claim 1 wherein the compressing
apparatus includes a JPEG chip, video board and bus
apparatus to accommodate 60-field per second
full-motion, full-resolution video.
5. The system of claim 1 wherein the storage
apparatus employs magnetic disks.

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6. The system of claim 1 wherein the storage apparatus comprises optical storage disks.
7. The system of claim 1 further including a digital interconnection network interconnecting the digitizing, compressing and storing apparatus, the playing apparatus and the patching apparatus.
8. The system of claim 3 wherein the patching apparatus controls a broadcast channel.
9. The system of claim 1 further including means for editing a channel insertion log.
10. The system of claim 1 wherein the playing apparatus verifies locally that its files were executed and logs which files were played.
11. A digital video insertion system, comprising:
 - means for receiving analog signals representative of video information;
 - means for digitizing, compressing and storing the analog signals received through the means for receiving;
 - means for decompressing and regenerating an analog signal from selected, digitized, compressed, and stored analog signals; and
 - means for inserting the regenerated analog signal into a channel at preselected times.

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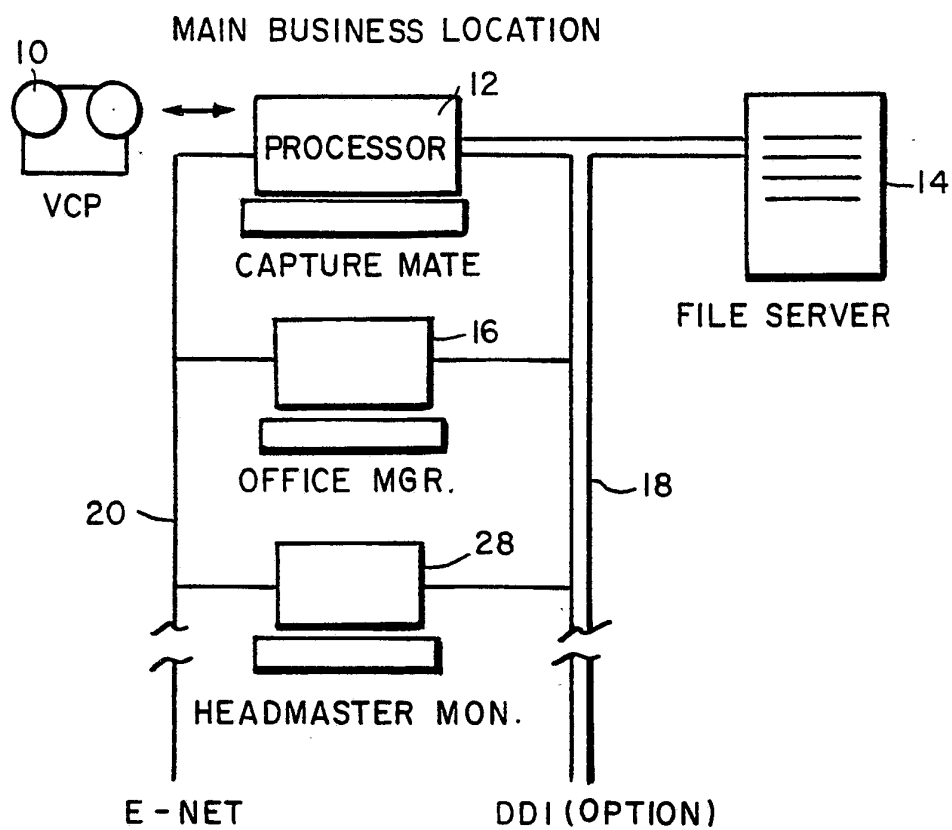


FIG. 1

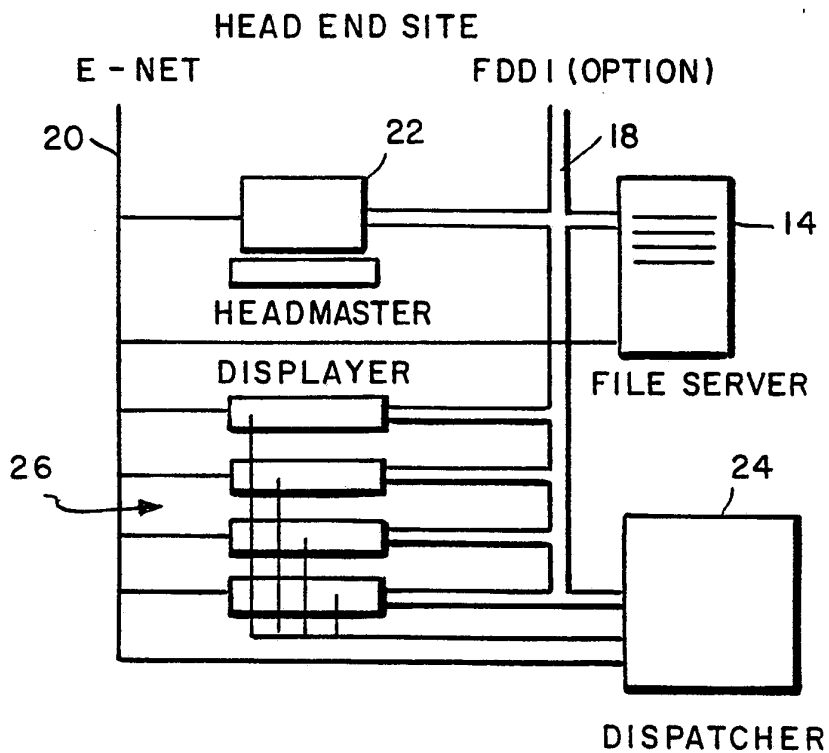


FIG. 2

INTERNATIONAL SEARCH REPORT

International Application No

PCT/US 93/03239

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) ⁶		
According to International Patent Classification (IPC) or to both National Classification and IPC		
Int.Cl. 5 H04N7/10		
II. FIELDS SEARCHED		
Minimum Documentation Searched ⁷		
Classification System	Classification Symbols	
Int.Cl. 5	H04N	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched ⁸		
III. DOCUMENTS CONSIDERED TO BE RELEVANT⁹		
Category ¹⁰	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³
A	EP,A,0 443 933 (ARCOMIS) 28 August 1991 see column 1, line 1 - column 3, line 1 ---	1
A	US,A,4 724 491 (LAMBERT) 9 February 1988 cited in the application see abstract ---	1
A	US,A,5 029 014 (LINDSTROM) 2 July 1991 cited in the application see abstract ---	1
A	FUNKSCHAU. vol. 62, no. 14, June 1990, MUNCHEN DE pages 60 - 62 , XP134715 U. BERGER 'Computer an den Schaltstellen' see the whole document -----	1
¹⁰ Special categories of cited documents : "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art. "&" document member of the same patent family		
IV. CERTIFICATION		
Date of the Actual Completion of the International Search 31 AUGUST 1993		Date of Mailing of this International Search Report 0 2. 09. 93
International Searching Authority EUROPEAN PATENT OFFICE		Signature of Authorized Officer DOCKHORN H.S.A.

**ANNEX TO THE INTERNATIONAL SEARCH REPORT
ON INTERNATIONAL PATENT APPLICATION NO.**

US 9303239
SA 72788

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report.
The members are as contained in the European Patent Office EDP file on
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31/08/93

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP-A-0443933	28-08-91	FR-A- 2658678	23-08-91
US-A-4724491	09-02-88	None	
US-A-5029014	02-07-91	None	