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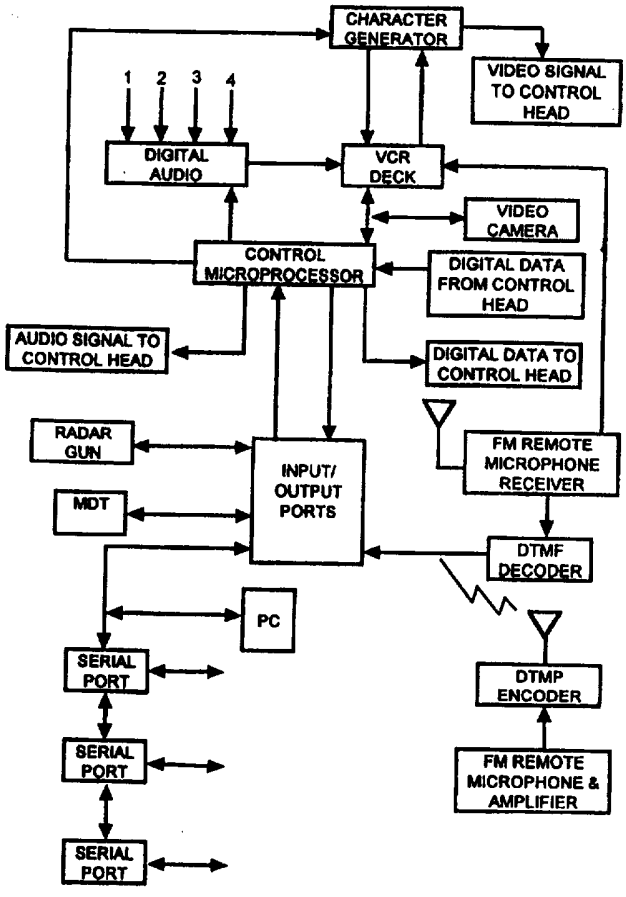
(57) Abstract

A data documentation system comprising a video camera for producing a video signal, a video recorder for recording the video signal upon a magnetic tape, a controller for controlling the functions of the video recorder that comprises a system controller and a control head, wherein the control head comprises a monitor display panel and touch screen overlaying the display panel, the touch screen divided into a plurality of sectors such that a function of the video recorder can be selectively enabled by touching a sector of the touch screen. The control head is connected to the system controller by a single lightweight coaxial cable. The system is software driven, which allows frequent updates and modification without undue burden and allows the system to be customized by interaction with essentially any outside electronic device. Peripheral devices may include light bars, police radios, radar and laser guns, vehicle sensors, auxiliary cameras and microphones, FM microphones, computers, MDTs, GPS systems, interfaces with building security systems, and the like.



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LAW ENFORCEMENT VIDEO DOCUMENTATION SYSTEM AND METHODS

Technical Field

The present invention relates generally to video recordation of one or more events and more specifically to an evidence-gathering law enforcement video recordation system and method which is substantially tamper-proof.

Background Art

Mobile video documentation systems have become common in law enforcement. Basically these systems comprise a video camera and microphone with a video recorder. The video camera is usually mounted to view out of the windshield of a patrol car. However, just having a basic recording system is not adequate for a law enforcement application. A recording system must be simple; requiring little training for the police officer and it cannot measurably interfere or distract from his law enforcement duties. Particularly, in an emergency situation, while it is important to record the incident for evidence purposes, the officer cannot be distracted by complicated controls.

In response to this need, several systems have been developed, such as disclosed in U.S. Patents 4,789,904 and 4,949,186. These systems usually include, in addition to the video camera, a video monitor, a data display panel, and a control console to control the various record and playback functions, all of which are in the cab of the patrol vehicle. These are in addition to the other equipment often used in the patrol vehicle, such as a radar gun, computer terminal, and the like. Since all the equipment must be controlled and/or viewed by the driver of the vehicle, there is a problem in equipment placement. The problem is aggravated by the fact that most of these units require heavy and cumbersome cabling leading to and from each unit. Thus, it is often difficult to install video recording systems that do not interfere with other functions of the law enforcement and other vehicle systems, such as the air bags.

Most systems also have a wireless body microphone so that conversations may be picked up when the officer is not in the vehicle. There are also interfaces between recording systems and radar speed detection systems. In addition to the normal recording functions, the status of a limited number of vehicle functions, such as light and siren status, the date and time, and radar gun data are recorded. If the recording is suitable for

use at a trial as admissible evidence of both the activity of one who may be in violation of the law and the conduct of law enforcement officers it must be demonstrated that the tape is authentic. A date/time image has been recorded upon each frame of the resulting video, as well as continuous tones and the like to indicate any tampering with the tape. However, these measures are proving inadequate in the face of a rapidly evolving technology that allows modification of taped images, even superimposed images and tones.

In summary, prior-art systems, while fulfilling several basic functions, still have inadequacies. They contribute to complication and overcrowding of the car interior and are difficult to install and maintain. Each component of the system is connected to heavy cabling that must be routed through the vehicle. This, along with the weight and size of the units, requires a permanent installation of a monitor, data read-out terminal and control panel in the vehicle, which can interfere with other vehicle functions, and be generally too conspicuous and intrusive. In addition, with rapidly evolving technology becoming available to law enforcement, a law enforcement agency may wish to interface the recording system with new systems, such as on-board computers, digital data transmission and receiving systems, and the like. Present systems offer only limited options in recording data, and if they can be so modified at all, are not easily modified to adapt to the new systems. System upgrades usually involve new circuitry which must be installed by removing the systems from the vehicle. With a large fleet of vehicles this can become cumbersome and expensive in a rapidly progressing field where frequent updates are necessary.

Disclosure of Invention

In brief summary, the present invention overcomes or substantially alleviates the aforesaid problems of prior law enforcement video systems. Basically, the present system of the invention involves combining the display and control functions of a control panel, display panel, and video monitor into one unit. This single control head unit comprises a microphone and video display monitor with a touch screen interface over the display screen of the monitor. By the novel use of picture-in-picture technology, the monitor can simultaneously display the output of one or more video cameras, as well as a menu system that the officer can activate by touching a touch screen overlying the monitor display. The control head is of a portable size and is connected with the rest of the system by a single coaxial cable.

The functions of the system are not permanently programmed into the system, but are controlled by software that can be loaded into the system from a separate computer through a suitable interface. This allows the system to be updated and expanded without expensive hardware upgrades and without disabling and removing the unit from the vehicle. The system can be upgraded at any convenient time in the field by personnel with only a small amount of training. The software system allows the system to be customized to interface with and record data from any or all of the systems in the vehicle, these include vehicle status readings, such as motor temperature and rpm, vehicle speed, transmission setting, gas tank and oil levels, and light bar and siren status, on-board computer systems with data communications, GPS navigation systems; auxiliary microphone inputs with separate audio recorded channels, such as for back seat covert microphones; remote control functions, such as vehicle lighting; radar/laser speed detection systems. Basically, the present invention allows implementation of essentially a "black box" that monitors and records any chosen function associated with the vehicle or output of any video, audio, radar, or other detection systems. The customizable menu system can be programmed to control not only functions of the recording system, but also through suitable interfaces the functions of other systems, such as the light bar, radar gun, etc. There is no "hard-wired" control panel, so functions can be added or dropped at will by merely downloading updated software and providing relatively simple interfaces, which avoids a major hardware modification and vehicle down time.

The equipment in the cab of the vehicle is reduced substantially in bulk by the combination in a control head of functions previously accomplished by separate

components, the monitor, data display panel, and control panel. The control head can be essentially the size of a portable LCD television monitor and communicates with the rest of the system with a light coaxial cable. Elimination of separate components and the heavy interconnecting cabling enables the a police officer in the vehicle to remove the control head and operate it in any convenient position, such as from his lap. The control head can even be unplugged and removed without interrupting the recording functions of the system.

The recording system produces a tape that is compatible for playback by any conventional VCR, but additionally includes digital data recording of separate data-channels, for any of the systems in the car, separate audio channels, and the like. This data recording not only provides a continuous record of the monitored systems, but also provides an authentication feature for authenticating the tape against tampering for use as evidence. In addition, special authentication data can also be recorded that would show if the tape has been tampered with. Any or all of the digital data streams can be encrypted before recording, which would render virtually impossible the reproduction of the authentication data by someone trying to modify the tape record.

The video system of the invention also comprises a system for updating the system software. By use of a serial connection with a customized update box, software can be updated in the field without removing the system from the vehicle. Software contained in a storage media in the box is read into the program storage of the video recording system, which will then run the updated software.

The video system of the invention also comprises a digital key system. A digital key that is programmed with user identification data is inserted into the video system, allowing the video system to recognize the user. The identification data can be recorded upon the video tape as part of the recorded evidence or used as in a security system to allow or limit access to all or selected portions of the video recording system to selected individuals.

Objects of the Invention

With the foregoing in mind, it is a primary object to overcome or substantially alleviate problems of prior law enforcement video systems.

It is another paramount object to provide a novel law enforcement or other authenticating video system and methods.

A further object of significance is the provision of a novel authenticating video system and methods which creates an authenticating video fingerprint.

An additional object of importance is the provision of a novel system and methods by which a video recording is authenticated.

A further object of primary importance is the provision of a novel system and methods by which a law enforcement video tape is created in such a way as to be admissible in a court of law.

Another object of importance is provision of a novel authenticable video system and methods which superimpose authenticating data comprising a code superimposed upon a video recording.

Still another primary object is provision of a novel law enforcement video recording system and methods which reset an authenticating code to its point of beginning for each new video tape inserted.

An additional significant object is provision of a law enforcement video system and methods which de-authenticate a resulting video recording when the video tape is modified by digital manipulation of the image, rewinding, or when the video recording and fingerprint indicia are not simultaneously produced.

A further object of value is the provision of a novel video recording system and authenticating system which operates in synchronization.

Another object is provision of a novel video and authenticating system and methods which create a discontinuity in the authentication when the video recording is subjected to tampering.

An additional object of significance is provision of a law enforcement video recording system and methods which obviate false charges and claims as to the conduct of one or more law enforcement officers.

A further object of significance is the provision of a novel video recording system and methods for use in law enforcement which provides for video preservation of authentic evidence of vehicle speed information concerning motorists cited for traffic violations.

An additional object of the invention is the provision of a system for updating software in video recording systems that is simple, reliable, and can be accomplished in the field without removing the video system from the vehicle.

Yet another object of the invention is the provision of a digital key that allows identification of a user of a video system by insertion of a digital key. The identification data may be recorded on the video tape as part of the recorded evidence. It may also be used in security functions of the video system, allowing access to selected portions of the system to only selected individuals. The digital key may contain set-up data that allows for the user to preselect functions and options that are to be activated upon the system startup.

These and other objects and features of the present invention will be apparent from the detailed description taken with reference to the accompanying drawings.

Brief Description of Drawings

Figure 1 is a schematic view of an updating system used to download updated software to a programmable video recording system comprising an update box serially connected to the video system.

Figure 2 is a detailed perspective view of the update box in Figure 1.

Figures 3A, 3B, and 4 are flow sheets of the video system software used in the system of Figure 2.

Figure 5 is a memory map for the software illustrated in Figures 3A, 3B, and 4.

Figures 6A and 6B are flow sheets of software used for the update box of Figures 1 and 2.

Figures 7A and 7B are perspective views of a control head for use in the video recording system of the invention.

Figure 8 is a schematic view of the system for programming a digital key with a programming interface box serially connected to a host computer.

Figure 9 is a perspective view of a digital key programming interface box, as in Figure 8.

Figure 10 is a schematic block diagram of an embodiment of the invention comprising a separate coax-connected control head and a software driven system controller.

Figure 11 is a schematic block diagram of the head controller of the system of Figure 10.

Figure 12 is a schematic block diagram of the portion system controller of the system of Figure 10 showing the communication to the head controller.

Figure 13 is a perspective view showing the front of a control head of the invention.

Figure 14 is a perspective view showing the rear of the control head of Figure 13.

Figure 15 is an exploded view of the control head of Figure 13.

Figure 16 is a elevation of the front of the control head of Figure 13, showing a display on the display panel.

Figure 17 is a flow sheet illustrating the menus displayed on the control head monitor.

Figures 18A to 18E are flow charts illustrating software used in an embodiment of the invention.

Figure 19 is a spectrum analysis graph illustrating the subcarrier system of storing data on a video recorder tape.

Figure 20 is a block diagram illustrating an embodiment of the invention.

Figures 21 to 49 are circuit diagrams illustrating an embodiment of the invention.

Figure 50 is a schematic showing a video camera of the invention.

Figures 51A to 51PP, is a detailed flow sheet of an embodiment of the invention.

Figures 52, 53, and 54 are circuit diagrams of the control head of Figures 7A and 7B.

Figure 55 is a program flow sheet for software of the control head for reading a digital key.

Figure 56 is a program flow sheet for software of the video system for reading a digital key.

Figures 57 to 62 are program flow sheets for a system for programming a digital key.

Figures 63 and 64 are schematics of a computer screen of a host computer for programming a digital key.

Figure 65 is a circuit diagram of a digital key programming interface box.

Figure 66 is a view of a digital key.

Figure 67 is a circuit diagram of a software update box used to download new software into the video recording system.

Best Mode for Carrying Out the Invention

General Description of an Evidence Gathering Law Enforcement System

This description is an example of an evidence gathering system in which the various aspects of the present invention are incorporated. It is essentially a logging/recording system for evidence gathering and recording audio, video, and data on standard VHS tapes. The system allows for playback of audio and video in the patrol car. The main system box, preferably located in a vault in the trunk, houses a record/playback deck, a wireless microphone FM receiver, electronics for audio and video processing, and environmental control systems. The system box is preferably mounted with a docking system that allows removal of the box as a unit. The system box may be connected by

interface wiring to one or more cameras, microphones, light bar, radar/laser speed detection guns, and the vehicle wiring systems and status sensors.

The system user interface is provided by a head controller that is detachable and is located in the cab of the vehicle near the driver. The head controller comprises a small video monitor with a built in speaker and microphone. It is removably attached to the dashboard and can be removed and operated. It is small enough to be held in one hand while the user manipulates the controls with the other. The control head is connected to the system box through a single coax cable, similar to a microphone cable for a simple consumer tape recorder. The monitor is a modified TV monitor and retains its brightness, color, tint, and volume controls. It is modified to include a touch screen in front of the monitor that is used to control the system. Menus displayed under the touch screen are generated by the system to provide the user controls for the system.

Mechanical buttons of the control head are rewired to operate the zoom and focus function of the main camera. A plug on the side of the head controller allows an electronic key to be inserted for loading the officer's name, badge number, department, and system configuration information into the system. A three position switch allows for on/off operation of the system as well as "covert operation" where the monitor is off but the system is on, i.e., the system appears off but is fully operational.

The system, in its preferred embodiment, has an input for a main camera view out of the vehicle through the cab of the vehicle and second auxiliary for a camera located on the rear window, on the speed gun, or for an external auxiliary camera. One or more cameras can be chosen for recording through a picture-in-picture technology. Selection may be manual through use of the touch-screen menu system or automatic upon activation of the radar speed gun or light bar. Output of more than one camera is displayed by a picture-in-picture technology. For example, the output of a telescopic aim camera mounted on a radar gun can be inserted in the image of the main camera into a small window. The cameras and other peripheral devices can be controlled by serial communication to and from the main system.

An auxiliary camera may also be placed in the main housing in the main camera, but directed opposite to the main camera. With this configuration, the main camera is pointed to view out of the windshield, which places the auxiliary camera to view the patrol car interior, particularly the rear seat. The general configuration of this double camera is illustrated schematically in Figure 50, showing the camera housing 301, the

main camera 303, and the rear-looking auxiliary camera 305. The main camera is directed forward (arrow 311, and the rear-looking camera is directed in the opposite or rear direction (arrow 313). Each camera is connected to the system controller by means of serial cables 307, 309.

Several audio inputs can be provided. In this example, four audio inputs are provided and can be recorded together on the conventional audio track of the VHS tape or may be digitally recorded separately on a proprietary side carrier. The four video channels are the microphone in the control head, the FM wireless body microphone, a rear cabin microphone for recording persons in the back seat of the vehicle, and audio input from auxiliary systems. Channels have automatic gain control. The audio record and playback channels are chosen by means of the touch-screen menu system or can be automatic. For example, a second officer can remain in the vehicle and listen to the wireless microphone worn by the first officer.

Recording of any of the video or audio channels may be initiated manually through the menu system, automatically by activation of a peripheral device, such as a light bar or radar gun or a DTMF code sent from the wireless microphone, or by a serial data input from a mobile data terminal, or automatically by tapping the touch screen twice.

A decapitation circuit is used to determine whether a loss in communication with the head is due to the officer turning off the system by selecting the off switch or whether it was disconnected. This allows the system to continue recording if the head is disconnected, so the officer can disconnect the head so that it appears that there is no system but continue to record from any or all audio and video inputs.

Digital data, e.g. system status data, date/time data, frame number/elapsed recording with record stop/start data, and authentication data is recorded upon the VHS tape in the vertical interval.

General Schematic of the System - Figure 10

Referring to Figure 10, which is a schematic flow sheet, the system is built around an industrial-type recording deck, such as JVC Model SR-L900U (VHS/NTSC color). Video signals from a video camera are directed to the deck through a character generator. Audio signals from the wireless FM microphone are also directed to the deck. The functions of the deck are controlled by a control microprocessor which receives data from various components of the system and processes the data and sends a digital control signal

to the deck. The video camera is also controlled by the control microprocessor to control its functions, e.g. focusing, zoom, shutter speed, aperture opening, by digital control signals from the control processor. The user interface of the system is a control head that receives data from and sends data to the control microprocessor via a coaxial cable. This is described in further detail below in Figures 11, 12, 7A, and 7B. By means of input/output (I/O) ports the control microprocessor communicates with the environment, e.g. radar guns, light bars, vehicle status sensors, and mobile data terminals (MDT). The I/O ports also provide the means for downloading the operation software for the microprocessor through a personal computer (PC). These ports are preferably serial, but parallel ports are contemplated. The ports are preferably RS232-type ports, except at least one port is a RS-485 port for interfacing with a personal computer or a customized software updating system for software downloading and the like. In addition, several RS232 ports can be daisy-chained from an RS485 port, providing as many RS232 ports as desired.

A particularly notable feature of the present invention to the ability to record on the VCR deck up to four high capacity digital channels, which are advantageously used for recording digital audio.

The microphone is an FM microphone/transmitter that an officer can wear upon his body. Incorporated in the microphone circuits is a DTMF (an industry standard tone series) tone encoder. This encoder sends out a coded signal when the microphone is turned on. A microphone FM receiver receives the signal. A DTMF decoder decodes the sent signal and communicates the same via an I/O port with the control microprocessor. Each system has its own unique code and only if the code received corresponds with the system does the control processor instruct the deck to start recording. This DTMF coding prevents the system from responding to another transmission, such as from another FM microphone that is on the same frequency.

The video camera is a conventional CCD color video camera. The camera has power inputs and outputs for the video signal. There is also a control line for system control of zoom, shutter speed, and iris setting/sensitivity. A suitable camera is available from SONY as Model EV-310V (8 to 1 zoom, with auto focus and auto iris).

Communication Between the Control Head
and System Controller - Figures 11 and 12

The user interface of the system is in the form of a control head connected to the main system controller housed in a vault in the trunk by a single coaxial cable. Figures 11 and 12 are block diagrams illustrating the communication circuits between the head controller and the system controller. Figure 11 is the circuitry in the head controller and also shows other elements in the control head associated with the display monitor 95 and touch screen 96, which together function as a user interface.

Referring to Figure 11, in the control head are a microphone with amplifier, video monitor screen, audio monitor speaker, and touch screen. Data to the head comprises video and audio signals from the VCR deck and system controller and digital control signals from the system controller. From the control head to the system controller are audio signals from the microphone and digital data from the touch screen 96. A conventional approach to this communication problem would be to provide separate communication lines for each function, which would result in a thick bulky cable between the control head and system controller. To avoid this problem and allow all the above communications to occur over a simple one-line coax, a circuit schematically represented in Figures 11 and 12 is used.

Referring to Figure 11, the control head comprises a modified television receiver unit with a color liquid crystal display panel or monitor screen 95. A touch screen 96 overlays the display panel 95. The touch screen is divided into six indication or push-button sectors to correspond with choices from the menu displayed as soft buttons on the underlying display panel 95. The touch screen 96 sends a signal to the touch screen microprocessor indicating which sectors, if any, have been touched.

The output of the touch screen microprocessor is a serial digital signal, which is the input of a modulator that produces a modulated wave containing the touch screen data on a 2.9 MHz carrier. The control head microphone and amplifier provide an input to a modulator circuit that produces a modulated signal on a 2.1 MHz carrier. The outputs of the 2.9 MHz modulator and the 2.1 MHz modulator are fed through a filter that prevents extraneous feed-back signals and are then directed to the coaxial cable.

Referring to Figure 12, which shows a schematic of the control circuits in the system controller unit in the vault, the modulated 2.1 MHz and 2.9 MHz signals form the control monitor and are taken off of the coaxial cable and each directed through respective filters to filter out extraneous signals. The 2.1 MHz audio carrier is demodulated in a

demodulator to reproduce the audio signal produced by the head controller microphone. The touch screen 2.9 MHz carrier is likewise demodulated to produce the digital signal from the touch screen microprocessor.

The unit in the vault produces a video/audio signal to be monitored in the control head. This signal is modulated on a 45.75 MHz modulator, which corresponds to the intermediate frequency (IF) of the receiver circuits in the control head. The signal is basically a standard TV signal (with a proprietary side carrier explained later). The 45.75 MHz carrier is directed to the coaxial cable through a hybrid circuit. Digital data to the control head from the system controller is modulated on a 2.5 MHz carrier by a modulator and directed through a filter to the hybrid circuit. Digital signals on 2.1 and 2.9 MHz carriers originating in the control head come down the coaxial cable. The hybrid circuit is designed to allow passage to the 2.1 MHz and 2.9 MHz signals from the control head and the 45.75 MHz video/audio signal to the control head, but allow little signal of the 2.5 MHz modulated signal to the filters of the demodulators.

Referring again to Figure 11, in the head controller a hybrid circuit separates the 2.5 MHz modulated signal, which is directed through a filter to a demodulator which produces the digital signal input for the touch screen microprocessor. The remaining signal from the hybrid circuit is directed to a filter for the 45 MHz intermediate frequency and to the receiver circuits of the monitor, which displays the video image originating in the system controller on the display panel, and directs the audio signal originating in the system controller to the speaker. The original tuner in the TV monitor is disconnected from the receiver circuits (as shown by the dotted line) and the 45 MHz signal line from the filter is connected in its place.

The control head does not have its own power supply, so it receives its power from the system controller through a +9V bias on the coax line. A power supply line is directed from the coax to the receiver circuits, the touch screen and display panel circuits. A low frequency filter filters out the modulated signals and extraneous signals to create a direct current signal.

Control Head - Figures 13 to 16

The control head is the user interface to the system. The control head 101 is a modified miniature TV monitor with an active color matrix LCD. Any such TV monitor is suitable and can be modified in a similar fashion to that in this description. In the

present example, the TV monitor was a CASIO™ model TV-7700B. The display panel is an active matrix color display with a 3 inch diagonal measurement. For use in the invention, most of the original TV receiver is used. A new circuit board and a microphone is added. A touch screen is placed over the monitor display and the plugs and control buttons are rewired as appropriate. The original tuner circuit is not used and is disconnected.

Reference is now made to Figures 13 through 15 which are views of a control head 201 of the invention. The illustrated control head is a modified CASIO 7700B TV receiver. In Figure 13, the original volume control 203, bright control 205, and phone miniplug 207 retain their original functions. The three-way switch 209, originally functioning as a OFF/VHF/UHF, is rewired as OFF in the bottom position, COVERT MODE in the middle position, and ON in the upper position. The original channel selection buttons function as zoom controls 211, 213 for the main video camera. The original channel call button functions as a shift button 215 which, when operated with either of the zoom buttons 211 or 213, controls the focusing of the main video camera. The monitor speaker 215 is for audio signals received from the system control unit which may be tape play back audio or monitored signals from any of selected audio inputs; such as the FM body microphone. The original display panel 217 is retained and is overlaid by a custom touch screen 219. The touch screen 219 is of conventional construction of non-shatter-type glass and is customized to fit over the monitor display and have six separate touch sectors.

Referring to Figure 14, showing the rear of the control head of Figure 13, slots 22 are cut into the original battery hatch cover 221 for ventilation and are desired because of the added circuitry. VELCRO™ fabric 225 in a T-shape is attached to the back of the case 223 so that the control head 201 can be attached to a matching VELCRO fastener in the cab of a patrol automobile. The mount originally intended for the TV antenna is modified to receive a miniature control head microphone 241, with the face of the microphone extending through the hole originally for the antenna mounting screw. The original external antenna jack is modified as the coax cable jack 227. The audio/video jack 229 retains its original function. Some old police transmitters can interfere with the video/audio carrier in the coax, and the video/audio signal can be transmitted to the control head through a separate coaxial cable plugged into the audio/video jack 229. The original power jack is used as a key input jack 231. The system is started with an

electronic key 233, with a matching plug for the key input jack 231. The tint 235 and color 237 controls are retained.

Reference is now made to Figure 15 which shows a monitor head of Figure 13 in an exploded view. The original battery holder in the TV monitor is cut out and the space used to house a new circuit board 243, containing new circuits added to the monitor. Circuits for the touch screen are also on board 244 placed behind the display panel 217. New boards 243, 244 are connected by ribbon cable 245. Wires 249 connect the original circuit board 247, which is modified to communicate with the new circuitry and change some of its functions. As described elsewhere herein, controls are rewired for a new function, such as the OFF/COVERT/ON switch 209, the coaxial cable plug 227, and the camera control buttons 211, 213, and 215. The original speaker 215 is retained and remains connected to the original receiver board 247 through wires 251. The original receiver board is connected to the display panel 217 through ribbon cable 253. Specifics of the new circuits and alterations are described in greater detail below.

Figure 16 shows the control head 201 in use. The control head 201 is mounted (as indicated by the arrows 269) upon a vehicle dashboard 265 by means of a VELCRO strip 267 on a bracket 268 mounted on dashboard. The VELCRO strip releasibly attaches to the VELCRO 255 (Fig. 14) on the back of the control head 201. The touch screen 219 and underlying video monitor display 217 allows monitoring of video recording or playback and also is used to display menus which are activated by the touch screen. The touch screen 219 is divided into six regions or buttons 259A-F. The boundaries between the six regions are indicated by dotted lines 271 in the Figure, but the boundaries are not ordinarily visible. In the monitor display, soft buttons 263 are displayed, which indicate menu choices. The user 257, by pressing or touching the touch screen sector 259A-E overlying the button 263, the action indicated by the soft button is selected. For example, MENU OFF is selected by pressing sector 259F and STOP selected by pressing sector 259D. The displayed menu is the RECORD MONITOR menu described elsewhere in this description. The menu soft buttons 263 are superimposed upon the image being recorded 261. Also displayed and recorded is a picture-in-picture frame 273 from a secondary camera which, in this example, is a telescopic camera view of a speed gun showing the license plate of the vehicle in the main image. Also displayed (and also being recorded) are status logos 275, such as "R" record-on, "L" light-bar-on, "74" speed of viewed vehicle. The control head 201 communicates with the system controller by means of a

coaxial cable (1/8 inch one conductor with shield) that is connected to the monitor head 201 by a 1/8 inch jack, plugged into plug 227.

In a typical embodiment of the system, the system is operated by turning on the unit by means of a switch on the control head. A logo appears on the screen indicating that the unit is in standby mode. The logo information is stored in an EPROM and can be a representation of the department badge or symbol. The system goes through an initialization routine that includes detecting a tape in the video recorder. During this process the monitor screen will first show "NO TAPE DETECTED, INSTALL BLANK TAPE." If a tape is detected and it is blank it automatically records about 20 seconds of the logo, including date/time data. If there is data already recorded on the tape, the system finds the end of the last recorded portion to begin recording after the recorded portion. This is to prevent recording over already recorded data.

If the system requires a security key, the officer inserts the key in a jack in the side of the unit. The security key can be issued to each officer, and is encoded with identification data specific to each officer. The screen shows a "READING KEY" message, during which key data is read and a logging routine is executed. The key may then be removed and the system operated.

With the standby logo displayed on the screen, the system can by manually activated by touching the screen that initiates a main menu. A menu appears with up to six "buttons" that are displayed under the six sectors of the touch screen, respectively. The buttons are color coded to indicate their function or status, by various combinations or lettering color and background color for the soft button. For example, a red background to the lettering shows that a feature is off, green background shows that feature is on. VCR control buttons are shown with a blue background. Other colors can be used for other indications or functions. The soft-button can also be displayed without background color and may incorporate other visible features, such as button shape, blinking buttons, alternating colors, and the like. In a like manner, logos shown on the screen may be shown in various colors, shapes, and display modes.

Alternate Control Head

Reference is now made to Figures 7A, and 7B which show an alternate control head design. This control head functions the same and has the same control buttons and

features as that illustrated above in Figures 13 through 16. This control head differs in that it is not a modification of a premanufactured TV monitor, but is designed from the ground-up specifically for use as a control head. Accordingly, new circuits are used in place of the CASIO circuits of the above design. In addition, the construction is of a more durable construction using heavy gauge metal, making it more suitable for law-enforcement applications.

The alternate control head 701 has the same controls as the one illustrated in Figures 13 through 16. On the front is an LCD panel 703 with an overlying touch screen, constructed essentially as described above. On the bottom are the display controls; contrast 705, tint 707, and color 709. Also included is the serial connector 711 for connection to a cable for communication with the central processor of the video recording system. To insure a better connection, a bayonet-type BNC connector is used instead of the 1/8 inch plug used previously. The back comprises apertures for cooling 713 and a slide bracket 715 for mounting in the vehicle. At the top is the mounted speaker (not shown). On the right side are the volume control 717, the ZOOM IN button 719, ZOOM OUT button 720, AF OFF button 721, the three-way switch 723 for OFF/COVERT/ON. On the left side is the jack 725 for insertion of the digital key. The ZOOM IN and ZOOM OUT buttons normally control the zoom function of the video camera. When the AF OFF button is depressed, the ZOOM IN and ZOOM OUT buttons control the focusing of the video camera.

Menu System

Reference is now made to Figure 17 which is a flow sheet of an illustrative implementation of the software controlled menu system. The rounded boxes represent menu screens. Menu choices are shown as soft buttons on the display monitor superimposed over the selected camera video, as described above. In Figure 17 the menu choices are represented by rectangles in the rounded boxes or by trapezoids or rectangles on lead lines leading from the rounded boxes. A trapezoid menu selection indicates a branch to a menu elsewhere on the figure.

When the system is first turned on, the legend "NO TAPE DETECTED, INSTALL BLANK TAPE" is displayed, whether or not there is a tape in the recording deck. If a new tape is detected, the system controller automatically records 20 seconds of the

standby logo at the beginning of the tape, including date and time of starting of the tape. If a previously recorded tape is in the video deck, the legend "CHECKING TAPE, PLEASE WAIT" is displayed and the system forwards to find the last recorded portion of the tape. At this point, the officer inserts his security key if such is required by the programming in the system and a "READING KEY" legend is displayed. The system controller reads the data in the key after which the legend "REMOVE KEY" is displayed.

The first display after the system is started and initialized is the STANDBY screen, which does not display any soft buttons, but a standby logo, such as the department symbol. Referring to Figure 13, the control monitor 201 is shown displaying a standby logo 291. The STANDBY screen can also be displayed if the system timeouts after a predetermined period of inactivity in any menu screen and the system is not in record or playback mode. By touching any of the six sectors on the touch screen from STANDBY, the RECORD menu screen is displayed. Referring to Figure 17, the RECORD screen displays soft buttons, NEXT, CAMERA, AUDIO, and RECORD. The CAMERA and AUDIO screen are set-up which will be explained below. Selecting RECORD by pushing the touch screen sector overlying the RECORD soft button puts the system in record mode and the RECORD MONITOR screen is displayed. All selected inputs will be then be recorded. The system may also be programmed to enter the record mode, based upon input from any of the various I/O channels, such as activation of the light bar, turning on of a remote microphone, activation of a radar speed detection gun, and the like. The input channels can also be manually selected (through the setup menus) or automatically selected. For example, turning on a radar gun may initiate video input from the main video camera directed out of the windshield and an auxiliary aiming telescopic camera mounted on the radar gun with the auxiliary video appearing as a framed picture-in-picture over the main video output. In addition, the record mode may be initiated by tapping any sector of the touch-screen twice in quick succession from any menu or mode.

Referring to Figure 17, the RECORD MONITOR screen normally does not show any soft buttons, showing the selected camera video with appropriate status and character displays (e.g. date/time). By touching any of the touch screen sectors a menu is displayed with the soft buttons CAMERA, AUDIO, INSIDER, MENU OFF and STOP. The CAMERA, AUDIO, and INSIDER select the setup menus described below. MENU OFF

turns off the menu to show the soft button-free RECORD MONITOR screen. Selecting OFF discontinues the record mode.

From the RECORD menu screen, selecting NEXT displays a PLAY menu screen with the soft buttons NEXT, FF, REW, and PLAY. Selecting FF, REW, or PLAY, initiate the fast-forward, rewind, or play-back modes, respectively, of the video recording deck. In the play-back mode a PLAYBACK MONITOR screen is displayed showing the play-back signal from the deck from of any soft buttons. Pressing any touch screen sector initiates display of soft buttons, PAUSE, REVERSE SHUTTLE, FORWARD SHUTTLE, MENU OFF, and STOP. Pause, reverse shuttle, and forward shuttle initiate the indicated modes of the deck, STOP discontinues play-back, and MENU OFF returns to the soft button-free PLAYBACK MONITOR screen.

From the PLAY menu, selecting NEXT displays SETUP A menu, with soft buttons, NEXT, MORE, CAMERA, AUDIO, RADAR, and TIME/DATE. Selecting NEXT in this menu and in the menus described below returns to the RECORD menu. Selecting CAMERA displays a menu for setting of the video camera inputs with the soft buttons, FRONT/REAR, PIP ENABLE, FOLLOW RADAR, AUTO/MAN FOCUS, SET ZOOM, and EXIT. EXIT is used in this menu and all other describe menus to exit the menu to the STANDBY SCREEN. The FRONT/REAR soft button indicates which video cameras have been enabled for input by a contrasting color and/or alphanumeric logos on the soft button. Cameras can be selected by repeatedly pressing the soft button until the desired indication is reached. Cameras may be, for example, the main front camera pointed out of the windshield and an auxiliary camera such as a rear camera directed out the read window, a rear or rear-facing camera viewing the rear seat, an outside auxiliary camera, and a telescoping aiming camera on a radar gun. Typically, a system will have two video cameras, and main front camera, and any one of the auxiliary cameras.

PIP ENABLE allows enablement/disablement and shows the status of the picture-in-picture feature, where the video of a second selected camera is shown on the video monitor in a frame overlying the video of the main front camera. FOLLOW RADAR allows enablement/disablement and shows the status of the follow radar feature. The follow radar is used in conjunction with a dual radar-gun system with one gun pointing forward and one gun pointing to the rear. The officer can select either the front or the rear gun. With this feature enabled, the main front and an auxiliary rear camera will be

switched to follow the radar guns, with the front camera switched on when the front gun is selected and the rear camera switched on when the rear gun is selected. AUTO/MAN FOCUS allows enablement/disablement and shows the status of the a manual focus feature. Normally the main front video camera is in an automatic focus mode. Enablement of this feature disables the auto-focus mode of the video camera and allows the officer to manually focus the camera.

SET ZOOM allows programming of an automatic zoom feature for the front camera. This feature allows the officer to program the front camera to go through the automatic zoom sequence whenever the transmission of the vehicle is set in PARK. An illustrative sequence would be a wide zoom showing the overall picture, followed by a narrow zoom to more clearly show a vehicle in front of the patrol car and permit reading of the license plate number, or the camera can be setup up to automatically zoom in on a license plate and begin to change the sensitivity of the camera (darken down) to adjust to light conditions or go slowly through the sensitivity range of the camera to get at least one clear picture. This may be required at night where the license plate is brightly lit or back lit where an automatic exposure setting may not show the characters on the plate. The automatic sequence may be initiated by the officer, for example, by providing a ZOOM option on a menu or by putting the transmission in the park position. The ZOOM option is programmed by pressing SET ZOOM which presents a menu with the choices, WIDE, ZOOM, TEST, SELECT, and EXIT. The office, using the zoom controls on the control head sets to a wide setting and presses WIDE, and likewise sets to a zoom setting and presses ZOOM. Pressing TEST will test the settings by automatically moving to the zoom setting and holding, then moving to the wide setting and holding. SELECT confirms the settings.

The AUDIO selection on the SETUP-A menu screen displays the soft buttons, FRONT, REMOTE, REAR, AUX, LISTEN, EXIT. FRONT, REMOTE, REAR, AUX enable/disable the front control head microphone, remote body FM microphone, rear cab microphone, and auxiliary microphone, respectively, and show by contrasting colors the status of each. LISTEN allows enablement/disablement of a listen feature and shows its status. The listen feature permits a second officer to monitor the input from the remote microphone from the control head speaker.

The RADAR selection on the SETUP-A menu displays soft buttons. MODEL UP, MODEL DOWN, FRONT, REAR, LASER, and EXIT. Pressing MODEL UP and MODEL DOWN buttons scrolls through a list of radar gun models supported by the system, with a selected gun displayed as an alphanumeric logo. FRONT and REAR enable/disable front and rear radar guns. LASER enables/disables an optional laser speed gun. This allows a configuration with both a radar and a laser gun.

The TIME/DATE selection from the SETUP-A menu displays the soft buttons UP, DOWN, SET TIMEOUT, AND EXIT. UP and DOWN toggle advance and reverse the time/date value, respectively, which is displayed as an alphanumeric logo. SET-TIMEOUT toggles through timeout values displayed as a numeric logo. The timeout value is the time the system waits before it time outs to the STANDBY screen. OK is pressed to confirm the date/time and set timeout values selected. EXIT will restore the old values.

Pressing MORE from the SETUP-A menu, displays a SETUP-B menu with soft buttons, NEXT, MORE, SCREEN, PIP, AUX FUNCTIONS, and RESET. Pressing SCREEN displays soft buttons UP, DOWN, LEFT, RIGHT, SELECT, and EXIT. The UP, DOWN, LEFT, and RIGHT buttons move the display on the monitor in the indicated direction, and SELECT confirms the position. EXIT will return the screen position to its previous position.

Pressing PIP from the SETUP-A menu displays a menu for setting up the position of the picture-in-picture (PIP) frame on the monitor screen. Similar as in SCREEN, soft buttons UP, DOWN, LEFT, and RIGHT move the PIP frame, which is confirmed by SELECT or canceled by EXIT.

Pressing AUX FUNCTIONS displays a menu with the soft buttons. ENABLE LIGHT/SIREN, REC. FROM LIGHT/SIREN, DOUBLE TAPE SPEED, and EXIT. ENABLE LIGHT/SIREN enables/disables a function that turns on the light bar and siren whenever the touch screen display is tapped twice quickly to place it in record mode. REC. FROM LIGHT/SIREN enables/disables a function that automatically turns on the record mode of the system whenever the light bar/siren is switched on. DOUBLE TAPE SPEED allows the officer to adjust the speed of the double tape required to enable the record mode, and functions similar to the routines on PCS used to adjust the double click

speed of the mouse. Menu choices UP, DOWN are presented to adjust the speed, which are confirmed with an OK option, or which can be canceled by EXIT.

Pressing RESET from the SETUP B displays a reset menu for returning the system settings to default values. An ARE YOU SURE? is pressed to confirm the reset. CANCEL cancels a reset and returns the settings to pre-reset values.

Pressing MORE from SETUP B displays a SETUP C menu with soft buttons, NEXT, MORE, PORT ASSIGNMENTS, VCR, UTILITIES, and SECURITY. Pressing PORT ASSIGNMENTS displays a menu with soft buttons THRESHOLD UP, THRESHOLD DOWN, SOURCE, DESTINATION, ASSIGN, and EXIT. The THRESHOLD UP, and THRESHOLD DOWN choices allow adjustment of the threshold voltage values for the analog ports. For example, a line to a light bar will show the light bar is activated when the voltage in the line is above about 6 volts. Detection can also be determined by a voltage drop diode, in which case the voltage may be between about 11.2 and 12 volts. The SOURCE and DESTINATION allow assignment to ports for gathering data and for peripheral control, respectively.

Pressing VCR from the SETUP C menu displays soft buttons SP/LP, 24 HR, TAPE, and EXIT. SP/LP selects either the SP or LP table speed in the video recording deck. 24 HR enables/disables a 24 hr mode. When in 24 hr mode during recording, the video record deck is instructed to record in a time lapse mode, recording only every fourth video frame from the video camera. In this mode a regular 120 VHS tape will last 24 hrs. This mode is useful for unattended surveillance and can be used to keep the system recording overnight.

Pressing UTILITIES from the SETUP C menu displays soft buttons, BEGIN DOWNLOAD, ABOUT, RUN DIAGNOSTICS, RTC HISTORY, DISPLAY OTD, and EXIT. BEGIN DOWNLOAD initiates the routine for downloading updated system software into the main microprocessor.

Pressing RUN DIAGNOSTICS from the UTILITIES MENU initiates a diagnostic program for the system. RTC HISTORY will display the history of the real time clock, showing the dates and times when the real time clock was set. This information is stored in non-volatile memory on the main board. ABOUT displays version, date, and copyright information on the software. DISPLAY OTD enables an officer to display "off top data", the data that has been recorded in the vertical interval.

Pressing SECURITY allows the setting of levels of security levels. Thus, for a particular user, as identified by the electronic key inserted into the control head, access or non-access to any of the menus or functions of the system can be defined. Any user can be added or deleted by ADD and DELETE, respectively, and a personalized access code can be defined. SELECT and EXIT confirm or cancel the choices, respectively.

Pressing the MORE key on the SETUP C screen displays an INSIDER menu. The INSIDER option illustrates the manner in which the present system can be expanded to interact with any number or outside devices or be adapted for specialized law enforcement functions. Specifically, through INSIDER, peripheral equipment is enabled that allows a police officer to communicate with and control inside building security systems. Through a radio link connected to a serial port of the system, digital data and commands can be sent to and from a bank security system with a like radio interface. The officer can remain in his patrol car and receive video from any of the video surveillance cameras of the security system and audio from security listening devices. The security systems can be accessed by appropriate security codes so the officer can selectively determine with which security system to interface. This allows an officer to check several buildings (warehouses, banks, offices, and the like) from one position without leaving his patrol car. In an emergency, such as a fire or bank hostage crisis, the officer can from the patrol car operate any camera of the system and determine the nature of the emergency, the number and location of suspects and hostages, and the like. To one of ordinary skill, it can be seen how the system can also be adapted in like manner for other functions, such as for covert surveillance, monitoring and recording from wire taps, hidden cameras, and bug transmitters, temporary security and command centers for special events, natural catastrophes, and the like. This is possible because the present system can easily be modified with an appropriate number of serial I/O ports for interface with computer, and other serial devices, and the system is software driven, which software can be easily downloaded.

The INSIDER MENU has soft buttons ACCESS CODE, CAMERA, AUDIO, AND AUX CONTROL. Pressing ACCESS CODE presents a menu with numbered soft buttons for entering access code, ½, 3/4, 5/6, 7/8, 9/0, and ENTER. The access codes can be used to permit access to any features of the system requiring security. For example, assuming a user's security level does not permit him access the INSIDER/CAMERA

menu. In an emergency, he can be given a security code that allows him access. In addition, a bank, for example, may require a security code for access to its security system, which may rotate from day to day.

The CAMERA button displays an inside camera control menu, i.e. to move the camera and scan a room. The buttons displayed are LEFT, RIGHT, UP, DOWN, SELECT, AND MENU OFF. LEFT, RIGHT, UP, and DOWN control the pan and elevation controls on the camera mount. SELECT is for security systems with multiple cameras and allows the office to select the security camera to be monitored. MENU OFF clears the screen of soft buttons so that they will not cover any view of the video camera.

The AUDIO button allows control of audio inputs from the security system. GAIN UP, GAIN DOWN, and GAIN AUTO adjusts the volume up or down or set to an automatic gain control for an audio input. SELECT allows selection of one of multiple audio inputs from the security system.

The AUX CONTROL button from the INSIDER menu allows control of auxiliary functions available to the inside security system such as locking doors (LOCK DOORS), and control of lights (LIGHTS). INTERNAL MONITORS disables the internal security system, which may be desirable if, for example, a hostage taker perceives the security cameras are monitoring him and demands that they be shut off.

General Description of the Software

Referring to Figures 18A to 18E, which show a general flow sheet of software in the main system controller.

The Power_Up routine is initiated by the main control unit, including the standby circuits, and the like, is powered up. In the system, the operating parameters of the deck and the like are stored in non-volatile battery backed RAM, so that if there is a power failure, the system will return to a former state when it is turned on again. However, if this is not desired, if for example, the system is in an improper state, the major initialization, initiated by pressing the third sector while powering up, will clear the memory of the battery backed RAM.

At this point, the standby circuits are functioning and the system then enters a loop through various system routines. First shown in the loop is a Check Power routine. This routine queries the control to determine the ON/OFF status of the power switch in the

head controller. If the system is already in a recording mode, which may be the control head previously was unplugged and the system was left on by means of the decapitation routine. The system may have already been in record mode or automatic recording initiated by, for example, turning of the light bar, siren, or body microphone. If the system is not in recording mode, a full power on routine is initiated that turns on all of the circuits in the system.

The control head is then queried to determine if any of the control buttons have been operated by the officer, i.e. whether the touch screen has been touched, or any of the zoom/focus buttons have been touched. If the touch screen has been touched, the position, or the identity of the sector of the six in the touch screen that was touched, is returned. Likewise, if any of the zoom/focus buttons were operated, the identity of desired operation is returned.

The status of the NADY (FM remote microphone) and the tape deck are queried, and the suitable status icons are displayed on the control head monitor screen. These status icons, indicate, for example, on/off status of remote microphone and whether the deck is in record mode or play mode.

The soft timer loop prevents the menu from being rewritten on each loop iteration, which would be undesirable as the menu usually would often take longer to write than an iteration.

The menu maintenance routine is then initiated. Based upon the data read from the control head. If the touch screen has been operated, the routine determines the state of the existing menu display and depending upon that determination and the touch position, a DrawScreen Operation routine draws the appropriate menu screen. For example, if the STANDBY screen is being displayed, the initial RECORD menu will be drawn on the menu. If a touch screen sector corresponding to a displayed soft button was operated, the appropriate screen will be drawn in response. For example, if NEXT is pressed from the PLAY menu screen, the SETUP_A menu screen will be displayed, or if MENU OFF is pressed from either the PLAY MONITOR or RECORD MONITOR screens, the menu will be erased from the monitor.

At this point, the system determines if the system is in the record mode, and if it is, it records digital into the vertical interval in the next frame, by increasing the frame and control track counter and writing the digital data into the vertical interval.

In VCR control, the system determines if any control commands are to be sent to the video tape deck and if there are any it sends them.

The system then enters an input/output routine for the thermistor channel measuring vault temperature of analog input section (R158, Figure 37). If the temperature is too high, the fan is turned on or to a higher speed through instructions to circuit 189 in Figure 25. If the automobile transmission is set in Park, the automatic zoom cycle is initiated. If either the light/bar or the siren are turned on, the video recording deck is set in record mode.

The flow sheets in Figures 18D and 18E, show interrupt routines for timing signals, serial communication, frame counter, and bit stream.

Image, Data and Authentication Recording

Character Generator

Commercial decks come equipped with a character generator for stamping the recording with, for example, time and date. However, in the present system, the as built character generator is inadequate to record all of the identification and authentication data that is required. Accordingly, the as built character generator is disabled and a new character generator with expanded capabilities is placed on the signal line between the recording deck and the camera video output.

The character generator is designed to imprint any data or logo anywhere upon the video frame as transmitted from the video camera. In a standard TV video frame there are 525 scan lines, where only about 480 are actually used for the active video image. To define the end of a video image and the start of the next one, there is a vertical interval, which consists of 44 lines. The lines in the vertical interval are routinely used for transmitter testing by TV stations and for encoding for such things as closed captioning.

In the present invention, 8 lines in the vertical interval are used to encode the frame with digital data by means of the character generator which converts the digital data into an analog signal which is written to the vertical interval, appearing as a bright and dark dot on the scan line. The lines are those ordinarily unused and are chosen not to interfere the equalizing and sync pulses (for example, starting at line 10 to 18). For visible alphabetic characters and other visible images, such as date time, department logo, status

logos and other visible indicia, the character generator generates a logo based on data in an EPROM and writes the logo to the appropriate location on the screen. Thus, the character generator is used in adding visible images to the active video portion of the frame and also to encode the tape with digital data in the vertical interval. Data that can be generated and encoded on the tape by the character generator include, for example, in the vertical interval: any digital data, authentication codes, date time, department identification and officer identification data, length of tape remaining, tape start/stop data, frame sequence numbers, tape content data regarding date, time, and length of recorded events, and in the active video; time date, department logo, system status and vehicle status logos, graphics for the menu system, and officer and department identification data.

The amount of data recorded on one line in the vertical interval is 64 bits. There are 8 lines recorded in each field or sixteen in each frame. A new frame is generated 30 times a second, so that data can be recorded at a theoretical rate of 30,720 bits per second, which amounts to a practical rate of about 24,000 bits per second, taking into account, for example, horizontal blanking signals that cover some bits. As can be clearly understood by this description, the present invention is not limited to data recording on a frame-by-frame basis. For example, a repeating stream of data may encompass several frames per cycle and the cycle length may change at different times during the recording. Furthermore, the data stream can combine frame by frame data, such as a frame sequence number, with a data cycle that extends over several frames. Thus, the system can be easily expanded to record data from any number of peripheral devices by modification of the driving software in the control microprocessor.

Basically the character generator in recording mode determines which portion of the screen is being recorded. If, in the vertical interval, the character generator generates a serial digital stream of bits in the form of an analog signal that is recorded in the vertical interval, appearing as dark and light dots on a scan line. In playback this analog signal is separated from the vertical interval and digitized for retrieval of the data. If a visible portion of the screen is being recorded, the character generator selects input from a video camera and if instructed by the main processor, generates a logo based upon EPROM stored character data, to represent a status logo, an alphanumeric logo, or department logo, which is then is superimposed over the video signal of the camera or cameras. Thus, input from either video camera can be placed at any point on the screen, which can be

used for a picture-in-picture effect or to tile various video images on the screen. Alphanumeric and status logos can be placed in any visible portion of the screen. Accordingly, any system status information, as well is input from any peripheral device, can be displayed on the head control monitor and recorded, such as light bar status, radar gun output, vehicle speed, and the like. The department logo can also be placed on screen or recording at the beginning of a tape or recording session. The monitor in the control head displays the signal being recorded and provides the user interface during standby and playback. In standby mode, the character generator generates a suitable standby indication logo, which can be the department logo, which is superimposed over the selected camera input or inputs. Menus in the form of soft buttons corresponding the touch screen sectors are generated when the menu routines of the system are activated and superimposed over the video input for display upon the monitor. During playback, the character generator can generate suitable playback status logos for display on the play back screen.

The present example differs from Example I in that in Example I there were separate character generators for characters and another for binary authentication data, and the signals for each were combined on the screen. In addition, the binary authentication data was placed in the active video portion in the form of a bar graph, rather than in the in the vertical interval and was recorded on a field-by-field basis. The present system has one generalized character generator that can place any output anywhere and in any color on the screen.

One of the advantages of having digital data recorded in the vertical interval is that before recording, the data can be scrambled or encrypted, and someone wishing to modify the tape cannot directly read the data. The data appears to be random, meaningless bits and without some means of decryption and reencryption, modification of the data would be very difficult and any attempt would be quickly evident as a discontinuity in the data stream. Thus, the digital data, in addition to providing a record of useful data, also provides tamper-indicating data stream for authentication.

Since the process is driven by the controlling microprocessor, which is programmed by software, the system can be easily customized to record from any data source that can be electronically interfaced with the system. This not only includes system status data, instructions executed by the officer, but data connection through input/output ports. The emerging technology is increasingly toward digital communication Mobile Data Terminals

(MDTs) are now available, which are basically laptop computers hooked through a digital radio link to a central computer. MDTs enable the officer to obtain, for example, quick identification information using finger prints through a digital scanning screen. By a routine modification, the present system can be adapted to record data from and playback data to such devices. The present system enables an essentially "black box" record of all the communications, vehicle status, and the like, as well as collect authenticated evidence during apprehension and interrogation of suspects Since the present system is not hard-wired or dedicated to recording specific information from a specific device, by modification of the driving software it can be customized to essentially any law enforcement application.

Subcarrier Data Recording

Reference is now made to Figure 19, which is a spectrum analysis graph of signal strength versus frequency. In conventional VHS video recorder systems, the electronics generate a carrier of about 3.9 MHZ containing the video information. The bandwidth of the video carrier does not have sufficient bandwidth to carry the color information so a secondary color carrier of about 68 KHz is modulated to carry the color information. This is the signal that is sent to the record heads for recording upon the tape. The audio is recorded on a separate audio longitudinal track on the tape.

Between the color and the video carriers is a guard band to prevent the audio and color information from mixing. In the present invention, a third proprietary carrier for data is added in this guard band (at about 1.5 Hz) that is used to record digital data. The practical rate of recording is about 256,000 bits a second, compared to 24,000 bits a second achieved by recording to the vertical interval. In an actual application, the data to the proprietary carrier is divided into four channels of 64,000 bits/sec. Each of these channels is used as a digital audio track. The much more rapid rate of recording and the data capacity of the subcarrier allows the recording of digital audio channels to separate tracks. This supplements the normal video track where all the video channels are combined. Thus, up to four audio tracks can be recorded separately and thereby be isolated upon playback from the other audio inputs. The separate channels would typically include the microphone input from the cab (the microphone in the control head, a rear seat microphone, a body FM microphone, an auxiliary microphone or a second FM

microphone, or the like. A channel can also be used to separately record any conversations over the police radio system.

The proprietary subcarrier is added to the video signal produced by the deck, just before it goes to the recording heads, preferably just before the last amplifier before the heads, thus, only minor modification of the recording circuit is required.

An advantage of the sub-carrier recording system is that the tape it produces is completely compatible with any standard VCR for playback purposes. A tape recorded with the proprietary subcarrier will still have the conventional video and color information carriers recorded and will appear to the VCR as an ordinary tape. The proprietary subcarrier will be ignored to ordinary equipment, because the subcarrier is placed where it does not affect the other carriers and it will not be evident in the video picture during playback of the tape. Access to this carrier will be possible only though a VCR designed to access the subcarrier and digitally process the carrier.

The proprietary subcarrier can also be used as an authentication signal. Someone trying to edit the video record on the tape to falsify, using for example a sophisticated video image editor, would erase or at least disrupt the proprietary sub-carrier. Therefore, an interruption or discontinuity in the proprietary subcarrier would clearly indicate tampering. Since such equipment is not designed to read a signal at the location of the proprietary subcarrier, it would go undetected by all but the most sophisticated alterers with specialized test equipment. Furthermore, altering or rewriting a new subcarrier to the tape would be impossible with standard equipment and difficult in any case, particularly if the digital data is encrypted. In addition to the audio channels, digital data channels can be created by a bit stealing, or rob bit stealing routine, that contains authentication data, e.g. field sequences, time/date, and the like. Even if a proprietary subcarrier is somehow restored, there would still be an interruption or discontinuity of the authentication data stream in the subcarrier, which data stream would be nearly impossible to alter or reproduce if an encryption routine is used.

Serial I/O Ports

The control processor communicates with the environment by means of I/O ports, which in this system are serial, which unless otherwise noted, are of the RS232 standard. The peripheral devices that have to communicate with the control processor have serial

interfaces. For example, speed radar or laser guns have serial outputs for gun status, measure vehicle speed, distance, and the like. While the standards for different guns are different, the software of the control processor can be modified to recognize any standard. The software can be written to communicate with any variety of guns, allowing flexibility and interchangeability in the system not achievable with hard-wired systems.

The video camera likewise communicates with the control process through a serial I/O port, to control the functions of the camera, such as the zoom, focus, color control, light sensitivity, and shutter speed.

One special port is provided with an RS485 standard, which is a much higher speed port than the RS232 ports. From the RS485 ports, several RS232 ports can be daisy chained to provide as many interfaces as required for any application. Theoretically an unlimited number of serial interfaces may be added in this manner, but for practical reasons relating to the data transfer speed, up to about 16 interfaces can be added. A larger number, e.g. 256, may be added if transfer speed is not critical. The serial interfaces can be added by the mere addition of simple conventional interfacing hardware.

The RS485 port is used to download updated software into the system, which can be from a portable computer. Thus, system upgrades can be made in the field and disassembly or removal from the vehicle (and the accompanying downtime) is not required. In addition, the training required for downloading the upgrade is not large, thus, upgrading the systems for a large fleet is not a laborious operation. The system can also be upgraded using a specialized updating computer-memory circuit box wherein the memory is loaded in the shop and the box carried into the field, connected to individual surveillance systems, and the software downloaded from the box memory into the surveillance system memory.

The RS485, can also be used for communications between a PC and the system controller during operation of the system, which allows the PC to monitor operation and function as a diagnostic tool, mainly for the purpose of correcting "bugs" in the system, e.g. software errors, timing problems, and the like.

If new equipment is introduced, the hardware for interfacing with the system already exists in the form of serial interfaces, thus, most peripherals can be made compatible with the present system with simple conventional serial communication circuits and appropriate communication software. Thus, the possibilities for expansion and customization far

exceed the systems of the prior-art, which involve "hard-wired" interfacing and programming requiring significant hardware modification by skilled technicians to upgrade the system, assuming an upgrade is even possible.

Operator Interface and Operation of the system

The system is operated through a user friendly system. The hardware is based around a small liquid crystal, double scan color video monitor, from which the recording or playback input form one or more cameras can be monitored, and which shows appropriate system-status indicators. A touch screen overlaying the monitor combined with soft buttons displayed upon the monitor provides means by which an officer can control the system.

System Controller

Located in the trunk is a case which contains a JVC industrial VCR made of a thick gauge steel, e.g. 14 gauge. The vault itself is essentially of known design with a releasable electrical connector to allow removal of the system, the essential difference in the present invention resides in the electronics and software used to drive the system. The vault also includes the main system electronics and interfacing circuits for communicating with the control head and peripheral devices and environmental sensors, such as the cameras, microphones, light bar, radio, and the like. The vault also contains environmental (temperature) control equipment, power supply, and any receivers for FM microphones, the power supply, interfaces for vehicle audio channels.

General Block Diagram of System

Referring to Figure 20, the video documentation system can be physically divided into a vault unit mounted in the trunk, containing a video tape recorder and the support and control means for the tape recorder, a control head unit, which essentially provides the user interface for monitoring on controlling the system and also a cab microphone, and peripheral devices that create data to be recorded, such as one or more video cameras, extra cab microphones, FM body microphones, rear seat microphones, computer systems, a light bar, vehicle status sensors, and any other peripheral device which may be used in law-enforcement and produces data for evidence in an electronic form.

The system controller or vault unit is preferably mounted in an environmentally regulated vault in the trunk of the patrol vehicle, to secure the unit against tampering, and protect it against damage. Figure 21 is a block diagram showing the basic electronic components in the vault.

Referring to Figure 21, the card edge connector is essentially a connector system that allows an easy removal of the vault from a docking plate. Necessary lines from the outside enter the vault to the connector, as shown by the lines on the left side of the block. In this example, there are connections for two cameras, an external video output, an input for the control head coaxial cable, a connection to the receiver antenna for the FM (NADY) body microphone, auxiliary on and off controls, and power connections. In an expanded system, other input connections are easily provided for interface with other peripheral devices. The card edge connection directs the outside lines to the system controller, which provides control circuits for the system.

The system controller receives data origination from the other components and peripherals of the system, by means of software in the main microprocessor, uses the data to control the functions of the recorder, communication with the user interface, i.e. the head controller, and send appropriate control to the other components and peripheral devices of the system.

The character generator, under control of the system controller, creates all of the video titles, logos, etc. that are superimposed over the video camera inputs and creates the picture-in-picture effect. The camera video with the added elements from the character generator are recorded by the video tape recorder and are sent to the monitor in the head controller.

The video tape recorder is a standard commercial video tape recording system. The video tape recorder is modified to connect to the system controller and video components of the system and to disable the built-in character generator, which is replaced by the new character generator.

The audio switch permits control of the various audio channels, e.g. which are to be recorded and which are to be monitored. Control is from the system controller, which can base control as selected by the patrolman and initiate automatic recording or monitoring or certain channels, based upon the data received from the peripheral devices, as for

example the on/off sensor in the light bar, or signal from the FM microphone receiver DTMF decoder.

The FM Receiver is a receiver unit for an FM body microphone transmitter. The FM Receiver is a commercial unit modified to interface with the present system. Any commercially available system is suitable, such as any of the NADY XL series, available from NADY.

The voltage regulators and power controllers provide suitable power lines for the various components in the vault, as well as devices connected to the vault that do not have their own power system, such as the head controller, the video cameras, and any other such auxiliary unit.

The head communications provide the system for communicating between the system controller and the head controller. This communication is through a single coaxial cable, enabling a great versatility in the design of the head controller.

Circuit Diagrams For
Circuits in the Vault Unit

In the circuit diagrams described below, the parts described and depicted are commercially available items, with the exception of the touch screen, which as described was custom made with six sectors and to fit over the screen of the monitor screen. Many features of the below circuits involve standard practice, for example in interfacing with other components, timing, signal modification, and the like. These circuits may not be described in complete detail, but a person of ordinary skill in the art can deduce and reproduce the circuits and design suitable circuit boards from the description of the their function contained herein.

Circuit Diagrams for the
System Controller - Figures 22 to 27

Referring to Figure 22, the system controller is subdivided into five sections, COM1 (Figure 23), COM2 MISC I/O (Figure 24), RELAYS, VCR CONTROL (Figure 25), CPU (Figure 26), and ANALOG INPUT (Figure 27)

Referring to Figure 26, showing the main system CPU, main processor U51 is a 8032 chip, which is a preferred chip because of its low power consumption. Shown are address and data lines, AD lines and A lines, to the other circuits. Pull up resistors on

the data lines are provided to keep the lines high unless a device pulls the line low. RN2H, RN5A, RN23A.

U48 is a watch dog timer which monitors activity of U51 and resets it if it detects that it is not doing anything. U50 is a counter. U45 is a memory chip. U40 is a flash EPROM chip which contains the main programming for the CPU circuit. It is in U40 that the main system programming is contained that drives the system. Chip U52 is input/output (I/O) circuit to the video recording deck and I/O ports.

The I/O ports are shown on Figure 23, COM1 which communicates with the main processor through lines on the left side. This circuit is essentially a UART processor U33 supporting a series of RS232 buffers (the MC1488, MC1489 and MC1489A chips) for receiving data from and transmitting control data to peripheral devices. Serial outputs TX1, TX2 and inputs RX1, and RX2 are for serial devices, such as a video camera or a radar or laser gun. The RTS1 and RTS2 lines are available in case there is a peripheral device that requires handshaking signals. Circuit 187 producing output to VPP creates a programming voltage or for a downloading signal for the EPROMS in the CPU, the PIC processor, and the head controller. U26A provides a clock signal from crystal X3 for COM2 on Figure 24.

Referring to 24, UART processor U18. The circuit labeled RS485 MULTIDROP is an RS485 port. U17A and U31C are dedicated serial buffers for transmission to and reception from the standard cab video camera. Chips U34 and U41 are for communication with the POWER CONTROLLER, main CPU and voltage regulator described below. It is through this port that the programming in EPROM U40 can be updated.

Referring to Figure 27, ANALOG INPUT, processes auxiliary inputs from such items as the light bar, back-up lights, and any of various vehicle status sensors which introduce signals through the AD2_IN lines on the left. These inputs are analog sensors sensing voltage and can, for example, detect when the voltage rises from 0 to above a threshold voltage of about 6 volts. Therefore, the on/off status of various devices can be detected. The voltage from the gas/tank gauge can also be measured to input gasoline levels to the system. With information from these sensors, the system can place an icon on the video monitor to signal the officer and it can record the information on the video tape in the vertical interval. U46 is an analog digital converter, with the analog voltages

coming in on lines CH1-8 on the left, and comes out on lines AD0 to 7 as serial digital data. Some of these data inputs are dedicated, such as channel 6, which measure temperature in the vault by means of thermistor R158, which can be used to control the fan operation.

Figure 25 shows the CPU relay and transistor drivers. Processors U35 and U27 are for information between the video recording deck and the CPU. The AD lines coming in from the left into U35 send control signals to the deck, and the CPU determines status of the deck through the AD lines coming into U27. U36 and U37 are optoisolators that make either of lines AUX_OUT1 our AUX_OUT2 high, as determined from commands from the CPU through U25, and are used to operate outside auxiliary equipment. Relays K1 to K4 are relay circuits that control outside devices through commands of the CPU through U25 and enable control of any voltage source. One such device could be light visible from outside of the car that shows that the system is in record mode.

Circuit 189 is a voltage regulated constant current amplifier/noise suppressor for controlling the DC brushless fan (connected through U6) used in the environmental control. Pulses for driving the fan are supplied by C126, while Q17 and R190 supplied a continuous flow to recharge C126. D39 controls the recharge rate, depending upon the demands of the fan motor. The signal from the CPU through U25 commands the fan to turn on or off.

Circuit Diagram for the FM
Wireless Microphone Receiver

Figure 28 shows the modifications made to NADY™ wireless microphone receiver, which modification is to essentially add a DTMF decoder. The receiver is connected through connector J1 to the receiver audio output through NADY_AUDIO. A DTMF DECODER is connected to the audio output and decodes DTMF tone code from the microphone transmitter, which is transmitted when the microphone is turned on. If the code corresponds to the programmed code of the unit, it pulls the control line NADY-REC high to signal the system controller to initiate recording.

Circuit Diagram for the
Audio Switch - Figure 29

The Audio Switch, shown in Figure 29, controls, based upon communications from the system controller audio channels which are to be monitored in the speaker of the head controller and which are to be recorded by the video tape recorder.

Audio inputs from the FM microphone receiver NADY_AUDIO, rear cabin microphone REAR_CAB_AUDIO, and an auxiliary input AUDIOIN1, are first modified with automatic gain control amplifier circuits, 170, 171, 172, respectively. These circuits use a photo-coupling system using photo-couplers U1, U11, and U3. The photo-couplers are LEDs hooked to a cadmium sulfide photo-resistor, and U8B, U9A, and U9B are amplifiers. When the voltage reaches a certain point, the LED is turned on, which causes a change in resistance and adjusts the audio level. The auxiliary input can be used, for example, for a second body microphone, a second rear cabin microphone, or a surveillance microphone.

The output from the microphone in the head controller already has an automatic gain controller circuit, so the head microphone output from AUDIO1, and the output of each automatic gain amplifier are directed without additional AGC circuits to a record channel switch U2 and head speaker switch U7. For the playback signal PLAY_AUD, an AGC circuit is also not necessary. The record channel switch U2, based upon digital signal from the system controller through lines 0 to 3 of AUDIO_SEL, switches each audio channel on or off through REC_AUD and AUDIO_OUT, which are connected to the video recorder for recording. The outputs of the U2A-D switches are combined and directed through summing amplifier 174 before being directed to REC_OUT and AUDIO_OUT.

In a like manner, the head speak channel switch U7, based upon digital signal from the system controller through lines 4 to 7 of AUDIO_SEL, switches each audio channel on or off through HEAD_SPK, where the audio is directed eventually to the speaker in the control head, except that head speaker input from AUDIO1 is not directed to the head speaker to avoid an inevitable feed back if such occurred, because of the physical proximity of the head controller speaker and microphone. The outputs of the U7A-D switches are combined and directed through a summing amplifier 173 before being directed out through HEAD_SPK. In addition, the audio playback output from the video

tape recorder is directed to the switch for monitoring of tape playback in the head speaker.

Optionally, a tone generator, sending an audio tone output through line TONE, is switched by U17B, based upon data from the system controller through line 8 of AUDIO_SEL, providing an audio feed back tone to the head speaker whenever a segment of the touch screen in the head controller is touched. TONE is a square wave generated by a microprocessor. The AUDIO(1...5) lines samples the audio inputs and directs them to system controller to be used by a digital audio system where the audio is recorded on a proprietary subcarrier on the tape.

Circuit Diagram for
Power Controller- Figure 30

Referring to Figure 30, a microprocessor U4 is used for power management of the system. One of the features of the invention is that the system can be turned off from the control head. In order to detect an "ON" from the head down the coaxial cable, some circuits must be on. However, you do not want to keep all of the circuits on when the system is "off" because of excess drain on the automobile battery. In addition, the system is such that control head can be unplugged and the system will continue to record. Accordingly, there must be circuits that can distinguish between an "off" selection from the head and a head unplugging.

The imbedded processor U4 gets power through the line+12V REGULATED when the circuit is operating. When the system is off, the power does not come from the +12V REGULATED line, but from V_BAT. A series of LEDs at LED1 combined with Q1 from a voltage regulator with an extremely low quiescent current, allowing the system to draw less than 0.0008 amps when off, as compared 3 to 4 amps peak when the system is on. When the system is off, a +12V potential is intermittently directed up the coaxial cable via the HEAD_POWER lead by switches through Q4 and Q6. Since only a small amount of current can go up through this lead, substantially insufficient to power the monitor head, there will be a large drop on the lead with the head controller turned on. The power controller U4 sees this voltage drop and detects the small current via U51, and asserts the SYSTEM POWER line, applying power to the rest of the system. U4 and U51 must then communicate with each other to determine if the main microprocessor, U51, is operating properly. If there is no communication, U4 shuts the system off and then

back on again to reset U51. If U51 operates properly, it communicates with U4, instructing it to turn on the monitor. Circuit 180 monitors the head controller lead for voltage and current. If it detects a short circuit, such as if the cable were shorted or the plug was touching a metal surface, it communicates this information with U51.

While in the record mode, an officer may unplug the control head so that it is not evident that he has a recording system. To distinguish unplugging the control head from turning the control head off, there is a "decapitation" routine. If the control head is turned off or unplugged, communications between the control head and U51 stops. Upon cessation of control head communications, the U51 turns off the HYB_ON/OFF line in Figure 43 and U51 sees that there is no current being drawn by the control head. There is a capacitor located in the control head labeled 114 in Figure 47 that, if the control head is connected but turned off, will hold a charge for a short period of time once switches Q4 and Q6 are shut off. If circuit 180 detects this charge being retained by the capacitor, it informs U51 that the control head had been turned off and the system can then be shut down. If the control head is unplugged then the capacitor is not present and the voltage drops almost instantaneously, a condition detected by U4.

Circuit for Interface with
Video Recording Deck - Figure 31

Figure 31 shows card connections and interface electronics to the JVC video recording deck, using processor U8 for controlling and switching signals. Switching circuit 181 is used for processing the control track signals coming from the video recorder. These signals control where the frame is on the video tape and are used by the present invention to determine how far on the tape has been recorded by counting the control track pulses. Whenever the recorder is stopped, the output of the counter can then be displayed on the video monitor in the control head, telling the officer how long he has been recording which indicates how much tape is left. This information can also be processed to construct a table of contents containing recording duration, date, and time of each recorded segment, which data can be written to the vertical interval. This permits the officer to easily find any section for playback from anywhere on the tape. Date/time data can be continuously written, so that if an officer wishes to review a recording from a specific date and time, the recording can easily be found by reading the data in the vertical interval. In addition, a data header in the vertical at the beginning of the tape can

be created which contains content data of the tape. When a tape is begun, the first 20 seconds or so can be used to display the department logo and in this section the vertical interval can be updated each time the system is shut off, or before the tape is replaced. Circuit 181 is a Schmidt trigger built around U23 which converts the differentiated square wave pulses from the control track into a well behaved square wave going between 0 and 5 volts, which then is directed out through CTRL_TRK. The U23C diagram shows the power connections to the U23 chip, VCC (+5 volts) and VEE (-5 volts).

Circuit Diagram of the
Voltage Regulator - Figure 32

Figure 32 shows the voltage regulation system. Z1 is a BNX002 noise suppression circuit connected to the vehicle battery and ground through BAT_SUPPLY and BAT_GND, respectively. Fuse F1 below Z1 is a fuse for a fan for the environmental control system of the vault. The fan may be powered off the feed for the rest of the system at TP4 but this would require a higher capacity, and hence less sensitive circuit breaker CB1. A less sensitive circuit breaker may not react to as many failures in the system. Circuits are provided to eliminate spikes and the like, such as RV1. Q9 is a switch that turns the system on/off based on signals from the PIC processor through line SYS_POWER. This is the switch that turns on the main processor after the head controller is powered up, which then begins communicating with the control head, as described in the description for the power regulator.

Voltage switching regulator U22 regulates the voltage up to 18 volts for the video recording deck, which requires that voltage. The 18 volts are then directed to U28 which regulates the voltage back to 12 volts. In this manner there is a regulated 12 volts that is independent of the actual battery voltage, which may drop to about 8 volts or below and rise up to about 14 volts or above without affecting the system. Voltage regulator U39 provides a regulated 5.8 volts at line 5.8VDC. The 5.8 volts are dropped to 5.4 volts by diode D22, which is used for power by the video recording deck. The 5.4 volts are dropped to +5.0 volts by diode D17, which is used for power by the rest of the system. Analog and Digital +5V supplies are separated into ANALOG +12 and VCC (+5 Volts), respectively, by a capacitor/resistor network to prevent digital signals from interfering with analog devices.

Analog regulator U54 takes unregulated battery voltage from V_BAT_SW and regulates it to 10 volts for the video camera. Voltage regulator U47 also takes voltage from V_BAT_SW to a -5 Voltage to VEE (digital) and AVEE (analog). A +12 voltage through ANALOG +12 is produced by Q18, R191, and C129 to eliminate power supply noise.

Circuit Diagrams for Character Generator - Figures 33 to 40

The character generator generates the characters that appear on the screen, logos, graphic information, and the data characters that go to the vertical interval and selects camera input and enables picture-on-picture with the video from two cameras. A block representation of the character generator in Figure 33 shows the external electrical connections to the generator.

Figure 34 shows the connector assignments for the connectors between the system processor main board and the character generator.

Figure 35 is a block diagram of the character generator, the character generator comprises a video processor (Figure 36), a matte generator (Figure 37), a pulse generator (Figure 38), and logic circuits A and B (Figures 39 and 40, respectively).

The video processor in Figure 36 shows inputs for two video cameras, CAM1_V and CAM2_V. The integrated circuit U1 acts as a switch to select input to be recorded from CAM1_V or CAM2_V. Circuit 190 is a ground referenced back-porch clamp. This keeps the characters at a consistent brightness. Circuit 192 is also a clamp circuit, but simpler, for the play back signal from the video recorder. The incoming signals from CAM1_V or CAM2_V after passing through the switch U1, is switched to output REC_VID or CVID. REC_VID is a line to the video recorder for direct recording of the video image. CVID is an input to the character generator PULSE GEN. The image switch to CVID is also branched to processor U2, which combines the camera video entering with appropriate vertical interval data, logs, characters, and the like, and produces a combined signal through pin 3 for recording on the video tape. Switches U8C, and U8D line up the video signal for the appropriate mode before directing it out through MOD, and to the 45.74 MHz modulator. In the playback mode the video from the video recorder through PLAY_VID goes through the character generator to superimpose menu selections for play, record, and rewind, etc. and then to the monitor via MOD. In record

mode. the signal comes from the video camera through CAM1_V or CAM2_V. through the character generator to superimpose data from vertical interval. appropriate status logos, and the like. Circuit U3 is a digital switch that switches between a mode for superimposing visible characters on the video. and superimposing digital data to the vertical interval. EXT_VID_OUT is any auxiliary video output.

A matte generator output is received through MAT_GEN from the circuit illustrated in Figure 37. which generates color. The matte generator receives digital data into U25 and 28A through lines on the left from the pulse generator. and LOGICA and B circuits. (Figures 38. 39. 40). Color subcarrier signals come in from the pulse generator through I and Q on a standard color subcarrier frequency of 3.58 MHz. The transistor trios 195 are digital to analog converts and with the balanced modulators U21 and U22 produce a color signal at MAT_GEN.

The LOGIC (A) and LOGIC (B) circuits illustrated in Figures 39 and 40 construct the characters/logos and determines the display color for the character generator. using data from the central processor U51 in Figure 26. The PULSE GENERATOR in Figure 38 provides all of the timing information for these circuits. What these circuits do is take the CVID signal from the VIDEO PROCESSOR. which is essentially amplified camera video from the selected video camera (CAM1_V or CAM2_V) and separates out all of its components. For example the I and Q subcarrier signals needed for the MATTE GENERATOR (Figure 38). the blanking signal which indicates whether a portion of the video frame is in the visible portion or a non-visible portion (BLKG in Figure 38). and the like. Timing signals are also generated. through. for example. lines VTIC. CD. and LD. The HQ lines are horizontal timing signals and the VQ lines are vertical timing signals.

The LD signals are for timing the processing incoming and outgoing data. Each microsecond interval is broken into four 250 nanosecond intervals. During the first interval. the character color is loaded. during the second the next character is loaded. during the third commands from the system processor are received. and during the forth commands are sent back to the system processor. Referring to Figure 39 (LOGIC (A)). the A. the AD. *CGRD. *CGWR lines are lines that communicate with the CPU (Figure 25). Chip U58 is a RAM chip. The AQ lines are the data lines. and most of the remaining circuitry is for reading or writing data to the memory location and arbitrating

whether U58 data is being written to a tape, whether tape data is being written to the U58, whether data from U58 is being sent to the central processor, or whether U58 is receiving data from the central processor.

The circuitry around U41 and U50 is an arbitrator that coordinates the timing of the central processor and the character generator. The circuit around U56, U57, U54, U18, and U51 is the vertical interval read and write circuit. It either takes data from the vertical interval, which goes through U58, or writes data to the vertical interval on the tape.

The CG and DS signals contain the character video information to be written to the visible portion of the screen. CG the "white" portion of the character, and DS (drop shadow) the dark portion surrounding the character. The signal CG1 and DS1 from U51 are white information and black information, respectively, for writing data to the vertical interval as an analog signal. In playback of the tape, the analog signal from the vertical interval CVID provided through the VIDEO PROCESSOR, is converted to a digital serial signal by U56 and is then converted into a parallel signal by shift register U54. U18 then dumps the data to the U58 RAM chip when a timing signal is received. In U58, the data can then be accessed by the central processor. The HQ and VQ lines are data from the pulse generator that determine the character position on the screen.

Referring to Figure 40, LOGIC (B), which is a continuation of Figure 39, LOGIC(A), the AQ data lines are data from a gate U50 for the AD lines in LOGIC (A) giving position information, or are data lines from the U58 RAM. The VQ lines for vertical timing and the HQ lines for horizontal timing. EPROM U27 is programmable memory that contains data for the character fonts, foreign language characters, status logos, department logos, and the like. U52, U53, and U55 convert the EPROM data into digital serial signals representing video, which are directed through CG and DS to the VIDEO PROCESSOR where they are combined with the video signal. U19 and U20 are gating circuits that selectively send data from the AQ lines to the CD lines or the PG lines which go to the MATTE GENERATOR circuit (Figure 37).

The FED output is based upon data going to the MATTE GENERATOR through the CD lines, which represent a color. The colors are represented by a two digit hexadecimal number between 00 and FF, except that FE is reserved as a control character. When FE is represented by the data in the CD lines a signal is generated in FED to the VIDEO

PROCESSOR, which returns through GFE, through U28D to U20. The character, which is then generated in the next 250 nanosecond interval then is not a video character but is used by U20 to instruct the VIDEO PROCESSOR, through VID_SEL to select inputs from video camera 1 or 2, through pins, Q1 to Q3 to select a page in the U27 EPROM, or select a page (color palette) through the PG lines in EPROM U25 in the MATTE GENERATOR (Figure 37). Chip U47, which is controlled by U20 through pin Q6, provides data to the VIDEO PROCESSOR data of what should appear on the screen, i.e. the character information to control the display while a control command is being processed. Here we can see that any character (including logos) and color can be placed at any point on the screen. In addition, input from either of two cameras can be dynamically selected and placed on the screen, which enables a picture on picture effect, where the output of a second camera is displayed in a small frame superimposed over the video picture from the first camera. This is useful, for example, where there is a telescopic sighting camera mounted upon a radar gun, to show exactly where the gun is pointed in a wider image from the first camera, which is usually the regular camera mounted in the cab.

Card Connection Diagrams Figures 41 and 42

Figures 41 and 42 show card connectors to the outside environment. Figure 41 shows the card connector on the docking plate to which the vault unit is attached and shows the card connected to coaxial and pin connectors that are in turn connected to various peripheral devices as indicated. Figure 42 shows the mating connector on the vault or system controller and shows in connections to various lines in the system.

Circuit Diagram For Head Communications - Figure 43

Referring to Figure 43, the digital signal from CPU U51 enters a modulation circuit 151, which modulates the signal on a carrier of 2.462 MHZ. The modulated signal is directed through a filter circuit 159, which prevents extraneous signal feed-back into the modulator, and then through hybrid circuit 165, which guards the filters 161, 163 of the demodulator circuits from the excessive strength of the modulator 151 output. The signal is then directed to the coaxial cable to the head controller through CTRLHD_COAX. The HEAD POWER lines have the regulated power that powers the control head. Since

there is also some power in this line when the system is in the OFF mode (as described elsewhere), a signal at HYBLON/OFF is used to turn off the hybrid circuit when the system is in the OFF mode and to turn it on when the system is in the ON mode.

Data demodulator circuit 153, and audio demodulator circuit 154 demodulate the modulated data and audio signals, respectively. These signals come from the control head CTRLHD.COAX through the hybrid circuit 165. The data signal, which is modulated on a 2.894 MHZ carrier is then directed through filter 161, which prevents signal feed back into the demodulator 153, to data demodulator 153. The data demodulator 153 demodulates the modulated data carrier into a digital signal, which is then is directed out through RXO.

The audio signal, which is modulated on an 2.095 MHZ carrier is directed through filter 163, which directs the signal into audio demodulator 154. The audio demodulator 154 demodulates the modulated audio carrier into an audio signal, which is then is directed out through AUDIO1.

The video signal from the character generator for display on the monitor in the head controller from MOD.VID and the audio signal for the head speaker from HEAD.SPK are modulated into essentially a standard TV carrier of 45.75 MHZ, which corresponds to the intermediate frequency of the receiver circuits in the head controller by IF modulator 155. This circuit contains a tuning coil L2, which adjusts the audio frequency to match that of the monitor head circuits, which is essentially the only adjustment of the circuit required for communication with the control head. The chip U14 is a standard chip used in, for example, VCR equipment, to create a standard TV signal. The modulated carrier is directed through the hybrid circuit 165 and to the head controller coaxial cable CTRL_HD.COAX.

Description of Circuit Diagrams
of Control Head - Figures 44 to 48

Referring to Figure 44 which is an overall schematic showing the circuit boards. Lead line CTRLHD.COAX is the line from the coaxial cable. The first board labeled CASIO MONITOR is the original circuit board in the commercial video monitor. The monitor was a Casio TV-7700. Most of this board is left unaltered with the some exceptions to adapt it to the invention and reconnections to the buttons and jacks, as will become evident in the description below. Board CTLHEAD is a new control board added

to the monitor. This is the board that replaced the battery compartment. Board TOUCH SCREEN provides the interface electronics for the six sector touch screen.

Figure 45 shows the additions and connections to the monitor board CASIO MONITOR. The coaxial cable W4 is connected to the board via phone plug P4. In the original TV Monitor P4 was the antenna input, which was disconnected from the tuner and then reconnected as shown. Circuit 101 is a filter circuit that taps off the 45.75 MHZ carrier signal coming from the coax and directs it to the input to the existing Casio receiving circuitry 103. This is conventional receiver circuitry well known in the art and is not shown in detail. The unfiltered portion of the signal is directed to SIG/PWR for connection to the CTLHEAD circuits. In the original monitor the two tuning buttons and the "Channel Call" are reconnected, since the tuner is disconnected from the receiver circuit 103 leaving these without their original function. These are connected as shown in 107, the two tuning buttons become the IN/FAR and OUT/NEAR buttons and the Channel Call button becomes a shift button, SELECT, so the IN/FAR and OUT/NEAR buttons can be used for zoom control of the video camera, or by pressing the SELECT button used for focus control of the video camera. Since the control head derives its power from the coax, the original power input is not required and is used for a program key, as explained elsewhere in this description. The original three position switch (originally for Off/VHF/UHF) is reconnected as shown by 109. The first position is for turning the system off. The second position allows the system to be on in a recording (through +9V SW), but the monitor remains off. This is a covert mode, so that the system will appear to be off to a suspect sitting in a car, but it will still be on except for the monitor display. The third position is the normal operating mode of the system directing power both to +9V SW and MON +9V with the main system on and the monitor on.

The CTLHEAD circuitry is illustrated in Figure 46 and is subdivided into circuits 02-1 and 02-2. The 02-1 circuit communicates with the touch screen and a touch screen controller of conventional design, which sends status information of the touch screen through the eight data lines 133. Reference is now made to Figure 47, which illustrates circuit 02-2. The signal coming from the CASIO MONITOR board has an input at SIG/PWR and is directed to a head duplexer or hybrid circuit 111. The hybrid circuit 111 is designed to protect the filters of the data demodulator 113 from the full signal strength

of modulators 121 and 123 by preventing the bulk of the modulator signals from reaching the demodulator circuit 113. The hybrid circuit 111 directs the coax signal to demodulator 113 through a filter circuit 119. The 2.462 MHZ carrier signal in the coax signal is then demodulated to produce a digital data stream that is directed though SER-IN to circuit 02-1. This is data generated by the control microprocessor in the main controller for instructions to the control head system. The main component of the data demodulator is a 4HC4046 chip.

To modulate the digital data produced by the control head so that it can be sent down to the coaxial cable, data modulator 121 is provided. Digital data comes in through SER-OUT from the 02-1 circuit and is modulated on a 2.894 MHZ carrier.

Power for the circuit comes up through the coaxial cable as a +9V potential and appears at SIG/PWR. A low frequency filter circuit 130 provides +9V for powering the various components in the control head through +9V. From the +9V the power leads are directed through switch circuit 109 on Figure 45 and then selectively to MON +9V to power the monitor and +9V SW to power the remaining components.

An audio signal is produced in the control head by a head microphone MIC XI and passes though an amplifier 125 and an automatic gain control (AGC) amplifier 127. The AGC uses a photo-optocoupled system around a cadmium sulfide cell U7. The signal is then passed to an audio modulator circuit 123, through a pre-emphasis network 128. The audio modulator 123 is similar to the data modulator circuit. The audio modulator 123 modulates the audio signal originating in the microphone on a 2.095 MHZ carrier for transmission on the coax cable.

The frequencies of the modulators 121, 123 are regulated by a reference signal from the 02-1 circuit (Figure 48) through REF.

The combined carrier signals from the audio and data modulators 123, 121 are directed to the coaxial cable through the hybrid circuit 111. A filter circuit 129 between the hybrid circuit 111 and the modulator circuits 121, 123 prevents signals from interfering with the 45.75 MHZ video. The combined modulated signals are then directed through SIG/PWR to the coax line through the CASIO MONITOR circuit in 13B.

Reference is now made to Figure 48, which is a circuit diagram of circuit 02-1, the main head processor U9 is an S87C752 chip. The head processor U9 communicates with the touch screen through connector P5, which is connected to data lines 133 in Figure 46.

P5 connections 2 through 7 each correspond with one of the six sectors or buttons on the touch screen and communicate the status of the button by bringing a high signal low when the button is pushed. Circuit 135 is provides an interface of additional input controls and communicates with the main processor U9 through pins 19, 13, 14, and 15. This input can be used, for example, for a radar gun plugged directly into the control head. The status of each of the camera control buttons is communicated to the main processor through SELECT, IN/FAR, and OUT/NEAR. The main processor U9 is programmed to "bit-bang" or combine the data from the touch screen, camera control buttons, and any other data it receives into a digital single serial output through SER-OUT. This signal is processed by the modulator 121 in Figure 47 for transmission down the coaxial cable. The main processor U9 receives instructions from the 02-2 circuit through SER-IN, which are data signal originating from the main controller.

A crystal oscillator Y1 provides a clock for the main processor U9, and also a reference signal through REF for the modulators 121, 123 in Figure 47. A power regulator circuit 131 is used to produce appropriate power sources for the various electronic components of the head, i.e. VCC (+5V), AVCC (+5V) and -5V.

An optional circuit that may be added in the control head is a speaker mute when the system is recording from the control head microphone. This prevents hiss produced by the Casio monitor circuits from feeding from the speaker to the microphone, which are in close proximity.

Referring to Figure 49, which is a circuit of the touch screen controller that is disposed just behind the display panel. A connector TOUCH SCREEN connects with the touch screen by means of a ribbon cable, the signals of which are routed to U3, which is basically a switch. Together with U4, the circuit functions as an oscillator with a frequency dependent upon which key sector of the touch screen was touched. The oscillator is not very stable, so the microprocessor U2 processes the signal, to determine if variations in its signal are actually from the screen being touched and communicates though CON1 with the control head control board, which connects to P5 on Figure 48.

Circuit Diagrams of Alternate
Control Head - Figures 52 to 54

Reference is now made to Figures 52 through 54. These Figures are the circuitry for the control head as illustrated in Figures 7A and 7B. These circuits have the same function as those shown in Figures 44 to 49, and that description applies largely to these circuits. The principal differences are a consolidation of the circuit boards and a new audio/video circuit replacing the as-is Casio circuit board shown in Figure 45. The new audio/video circuit is shown in Figure 53, and represents standard practice. The video section is built around a MC44301 chip, U11, and the audio section is built around an NE604A chip, U10. A -30 volt power supply is provided for the LCD display, with power and the video signal going to the display through CN3. Figure 52, is analogous to Figures 48 and 49, showing the main controller built around U3, and the touch screen interface built around U7. The push buttons, S1, S2, and S3 have the same function as buttons 1, 2, and 3, (in envelope 105) in Figure 45. The digital key is connected via connector jack JK1, which is also a standard 2 wire connector. Likewise, the key comprises a matching jack, which is a standard sized coaxial jack. The electronic portion of the key is potted or molded into a non-conductive polymer on the end of the jack. A regulated power supply is built around U6, a MAX747 chip for the various components in the control head. It is fed +10 volts from the main controller. The circuit in Figure 54 is essentially the same as Figure 47 and the description for that Figure applies for Figure 54.

Security Key or Programming Key

If desired, the system of the invention may include a digital security key, which is illustrated as 233 in Figure 14. The key may comprise a write-once memory or 128 bytes (such as DS2502). The key communicates with the system through the control head by means of 2 wire connectors. If the control head is a modified CASIO monitor, the connector is the jack originally used as a power input .

Reference is now made to Figure 66. The digital key 233 comprises a two-conductor jack 601 that matches the plug in the control head, which is preferably a standard sized coaxial power plug. The electronic portion of the key 603 is potted or molded into a non-conductive polymer on the end of the plug, but is shown here in an exploded view for

illustration purposes. The electronic portion, i.e. a memory chip, is connected through two of its leads 605, 607 to the conductors of the jack. The electronic portion is covered by a housing 609, which preferably incorporates an attachment ring 611 for attachment to a key ring or an identification fob.

The key can contain information of the officer's identity, name, badge number, agency number, authorization level, user function, and may also contain any other digital data, such as set-up parameters for automatic individualized setup of the system. The key can be programmed using conventional programming techniques. The authorization level data can be used to create various access levels in the system. For example, a technician may have access to all of the system functions, including downloading of new system software. As another example, officers not assigned to traffic duties may not have access to the radar gun control circuits, but have access to the INSIDER routines.

The key may also store set-up parameters that are used to set up the system when it is turned on. This can be used to customize the system for a particular agency or a particular user. In addition, when the key data is used for different authorization levels, the set up data can set up menus consistent with the authorization level. Set-up data can be used to enable any of the options of the video system when it is turned on. An alternate language that is programmed into the video system software can be selected. The 24-hour surveillance mode can be selected. Heater options for heater control in the main system box can be selected. The digital key can be programmed so that any function that a user desires is enabled or disabled upon start-up of the system.

Head Controller Software
for Key Reading Module

Reference is now made to Figure 55, which is a flow sheet of the software in the control head for reading the digital key and sending the key data to the main video system software. A key header is sent to notify the main system software that a key is being read and initiate the key reading module in the main program. If a key is not attached to the control head, the first byte sent after the header to the system software is an "X", followed by the second byte, the complement of "X". "X" is any suitable distinctive control byte. Third and fourth bytes sent are the same as first and second, respectively.

If a key is attached to the control head, a loop is entered in which the first byte from the DS2502 chip in the key is read. The first byte sent after the key header is a "Z". "Z"

is a distinctive control byte different from "X". The second byte is the "Z" complement. The third byte is the data byte read from the key, followed by the fourth byte, the complement of the data byte. The loop counter is incremented and the program repeats the process in order to read the next byte from the key. This process is repeated until all 128 bytes in the key have been read, upon which the data stream is concluded by sending twice, "X" and "X" complement. The data from the DS2502 chip is read using essentially the software routines suggested by the manufacture, as disclosed in, for example, Dallas Semiconductor Data Book - Automatic Identification ©1995, pages 258 to 260.

Main System Software for Key Reading
Module of the Video Recording System

Reference is now made to Figure 56, which is a flow sheet of the software module in the CPU of the video recording system for reading key data from the head controller. The module initially reads the key header sent from the control head software. If the reading of the key header is successful, the system enters a loop which reads the "Z", "Z" compliment, data and data complement bytes (in bytes 1, 2, 3, and 4, respectively). The "Z" and data bytes are compared with their complements and the first byte is read to determine if it is "Z". This is to verify the communication connection, verify the data integrity, and determine if the data stream is properly synchronized. If the first byte is "X", this indicates that no key is in the system or an early termination of the data stream from the head controller, which means the data has come out of synchronization, and the data stream was not received properly. If the compliment comparisons are successful and the first byte is "Z", the data byte is read into a data buffer, COPINFO. The loop then repeats and this is continued until the end of the data is reached, i.e. when the loop counter reaches 128. If the key header cannot be read, or either of the byte complement comparisons fail, an error indication is returned for processing by the video recording system software, for example, to display an error icon on the video display monitor, to block access to the video system, or to allow only a limited use of selected functions.

Programmer for the Digital Key

Reference is now made to Figures 8 and 9. In order for the digital key to function with the video recording system it must first be programmed with appropriate identification data. The digital key is programmed using a system for writing the data to the chip in the key. Figure 8 is a schematic showing a programmer interface connected to a host computer in which data is entered and stored. Figure 9 is a perspective view of the programmer interface.

In use, the key programmer 801 is connected to a host computer 803. Information to be stored on the digital key is entered and stored in the host computer and transferred to the programmer via an interconnecting RS232 serial connection 805. A digital key 807 to be programmed is inserted into a jack 809 on the programming box, and the data is written into the memory of the key.

The front panel of the key program box has three indicators, KEY IN 813 which indicates that a KEY is in the jack and in communication with the jack. COMM 815 indicates that the program box is in communication with the host computers. ON 817 indicates that the system is on. On the back panel (not shown) is a 5-pin power input jack, an on/off switch, and a conventional RS232 serial interface for serial connection with the host computer.

Software in Key Programmer

Reference is now made to Figure 57, which is a flow sheet of the software in the key programmer interface box. The program starts with a variable initialization routine followed by a routine that establishes serial communication with the host computer. A loop is then entered wherein the call command processing module receives commands and data and sends data to the digital key.

Reference is now made to Figure 58, which is a flow sheet of the Command Processing Module. This is the routine for receiving commands and data from the host computer and storing the data in the DS2502 in the digital key. Execution loops through this routine until communication with the host computer terminates. In the routine, the host sends a command to the key programmer, and based upon the command, the programmer executes a selected routine. In the Figure, the commands are sent as control bytes, "A", "P", "R", "S", and "I", which represent distinctive bytes different from one

another. The control bytes are preceded by a byte represented by "*", which indicates that a control byte immediately follows.

If the first command byte is not an "*" and the programmer is not in receive mode (MODE = RX), the programming is terminated and the system waits for the next command from the host. If the first command byte is an "*", and the second control byte is either "A", "P", "R", "S", or "I", the system branches to a selected routine, otherwise it terminates.

The branch for the second byte = "A" initiates a data receive mode. In this mode data from the host is received and stored for later transmission to the digital key. The data reception module is built around a loop that in turn reads and stores in a program buffer, each of the 128 data bytes that are to be sent to the digital key.

Reference is now also made to Figure 59. The branch for the second byte="S" calls the Key Present module, which is used to determine if a key is present in the box. The DS2502 Key reset module is called, which returns values for variables "Shorted" and "Present". If either variable =1 indicating the key jack is shorted or the key is not present, an error code "E" is returned for transmission to the host computer. The DS2502 Key Reset module is a routine for resetting the DS2502 chip in the key and is based essentially on routines suggested by the manufacturer, as in for example, Dallas Semiconductor Data Book - Automatic Identification ©1995, pages 258 to 260.

Reference is now also made to Figure 60. The branch for the second byte ="P" initiates the program key module. This program module is build around a loop that reads each byte in turn from the program buffer and calls the DS2502 program key module. The program key module is a routine for programming the DS2502 chip in the key and is based essentially on routines suggested by the manufacturer, as in for example, Dallas Semiconductor Data Book - Automatic Identification ©1995, pages 258 to 260. The routine determines if the key was programmed successfully using conventional routines from the manufacturer, and returns a key program failed or program success indicator for transmission to the host computer. Before programming a key, the routine also calls the Key Present module, referenced above, to determine if the key is present in the box.

Reference is now also made to Figure 61. The branch for the second byte ="R" calls the Read and Transmit Key Data Module. This module is for reading data from the digital key and transmitting it to the host computer. After determining if the key is

present, the routine executes a loop that reads in turn each data byte from the digital key by means of the DS2502 Key read module and stores the data byte in the Keydata array. When all 128 bytes have been read and stored, the contents of the array are transmitted to the host computer, followed by a success indication. The Key Read module is a routine for reading the DS2502 chip in the key and is based essentially on routines suggested by the manufacturer, as in for example. Dallas Semiconductor Data Book - Automatic Identification ©1995, pages 258 to 260.

Reference is now also made to Figure 62. The branch for the second byte ="I" calls the Reset System module. This module resets the programming box system by clearing the data and the serial buffers, and resets the system variable MODE to idle mode.

Software for the Host Computer

The host computer may be any suitable system that can communicate with the programmer box through a suitable interface. While any suitable serial or parallel data transfer connection is contemplated, the connection will most often be through a RS232 serial interface. The host computer is usually a PC (IBM compatible), or Apple Macintosh, running a suitable operating system. The host system is basically a database system containing data fields in each record for the data that is to be stored in the digital key, as well as any other information found suitable. Figures 63 to 64 are schematic representations of screens in an actual implementation running under Windows 95 on a PC. It is understood that similar implementations can be made for OS/2, Unix, or the Macintosh operating systems.

Reference is now made to Figure 63. For system security, a log-in screen requiring a password is preferred when the program is executed. Since a key programming system may be used for more than one law enforcement agency, or an agency may wish to subdivide their data system, the system can open any file indicated in the Default Drive/Path box and the Agency Name and ID boxes. The system operator inputs his user name and password to gain further access to the program. After this point, the system operates in a manner similar to a data-base program, with record screens for entering and editing data in the individual fields, for retrieving selected records for editing or deletion, or for programming a new digital key.

Reference is now made to Figure 64, which shows a record screen, showing the data fields. These are data that can be programmed into the digital key, and can then be used for officer identification by the video recording system, as explained elsewhere. The first six fields represent agency personal identification data.

In the Key Information square, data can be written to the key, or data retrieved for review. Also, an indication of if and when the record data was recorded into a key, and the serial number of the key is shown. Key options button enters a subroutine to set up the options of the key, e.g. the startup options. The indication on the face of the button indicates whether options have been defined or not defined.

Selecting the Program Key Button, serially sends the record information to the Key Programmer, which then reads the data into the key. Read Key retrieves the stored data on the key for review. Since the memory chip in the digital key is a once-only storage device, updating key information is accomplished by programming a new key and discarding the old key.

The data in the fields can be used as a basis for security access of the video system, for example to bar access to certain persons or limit access to selected video system functions. For example, the data in Agency#, Badge#, Rank#, and Serial# can be used alone or together to limit access of discharged individuals or of those without suitable security clearance, and prevent use of discarded or lost digital keys.

Other suitable utilities may also be provided, such as a screen that shows the raw bit data as stored or to be programmed onto the digital key. It is understood that the data may be encrypted, coded and/or in any suitable fashion to prevent copying and allow the data to be stored in the limited memory of the digital key. It is also understood, that all of the data fields may or may not be programmed onto the digital key. The format of the data in the key memory may be in any suitable form or order.

The other fields and buttons represent data and functions frequently found in data-base systems. The system may also show successful communication with the programmer interface box, and contain other utilities for diagnostic functions and data manipulations.

Circuit of Programming Interface

Reference is now made to Figure 65 which is circuit diagram for a system for programming a digital key. The programmer is for programming the chip in the key, which is a Dallas™ semiconductor 2502 three pin device. The programmer is connected to two leads the 2502 chip through connector CON3. This chip is a one-time programmable device. The circuit to program the key is based upon manufacturer suggested circuitry for programming this chip. The interface circuit comprises primarily Q1, D2, Q3, R6, C12, R2, R1, and Q4. The software program for programming the chip is resident in memory chip U6, which controls microprocessor U3, which is a 83C52 or 80C52 chip. Alternately, the microprocessor may be a 87C52 with the program resident in the microprocessor.

The PGM line from pin 6 of U3 and the DATA line from pin 3 control the programming interface. The programming illustrated is based largely upon programming suggested by the Manufacturer. U1 is the watch dog timer, DS1232, from Dallas Semi-Conductor. The programmer communicates with a computer through connector, CON1. U2 is a MAX232 chip for a RS232 level interface. C3, C2, C6, C1, C9 are components used to decouple and for the functionality of U2 interface. LD1, LD2, and LD3 couple with R3, R4, and R5 and are indicator lights indicating program status. X1 is the crystal oscillator for the microprocessor coupled with C7 and C8. C15 and C5 are bypass capacitors for the microprocessor.

CON2 is the power inlet from the power supply for the interface, and SW1 is the power switch. Chip U4 is a data latch or data address latch used by the microprocessor in interface with memory U7 and U6. U7 is a 6264 memory chip, and U6 is a 27C512 memory chip where the interface programming is resident. The programming is executed by the program loaded out of U6. The data from the program goes out CON3 to the key, which is provided via CON1 from the program in the PC. In summary, the PC program relays its information via CON1 to the processor U3, which then takes that information and presents it to CON3 for storage in the memory chip in the key.

Flow Chart of System
Software - Figures 51A to 51PP

Figures 51A to 51PP show a specific implementation of system software and is basically a detailed version of the flow-sheet shown in Figures 18A to 18E. The flow

sheet is self explanatory, particularly when read in conjunction with the description of Figures 18A to 18E, the operation of the hardware, and the menu system above.

Description of System Downloading for Updating Software of the Video Recording System Program Update Box

As discussed above, an RS485 port is provided for connection to a computer or the like for updating of system software. One implementation of this can be through a customized update box that is connected to the video recording system. The update box automatically communicates with the video system upon startup and updates the software without user intervention.

The update box functions much like a floppy disk drive in a standard computer system. In a computer system, a program copied from the floppy disk can be set up to run when the computer is booted-up. The program on the hard drive can be changed by copying a floppy disk with a new version of the program to the hard disk.

The update system of the video system functions much in the same way. The update box is analogous to a floppy disk drive and a flash memory chip in the box that contains updated software is analogous to the floppy disk. If the update box is connected to the video recording system correctly through the serial interface and the box is powered up, the contents of the flash memory chip in the update box will be copied to the video recording system memory when the video system is booted or turned on. After the update is complete, the video recording system will execute the new program update when it is rebooted.

Operation of the Update Box

Reference is now made to Figures 1 and 2, which are respectively a schematic view of an update box 821 connected to a video system 823 and a perspective view of the update box 821. The update box 821 and video recording system 823 are connected through a serial interface cable 825 through RS485 serial interfaces on the video system and the update box. The update box is completely self-contained with a power supply built around rechargeable batteries. The batteries in the update box are first charged with switch 827 in the charge position and using an appropriate 9V AC adaptor. Switch 827 is then toggled from Charge to Run, and a green LED indicator POWER OK 830 lights

to indicate that the batteries have been charged. The video system is then turned on, and after a few seconds, the green LED UPDATING indicator 831 will begin to flash as the program is updated and the program is verified. When the verification is successful, the green UPDATE OK indicator 833 lights up. The update box is then turned off. The video system is then turned off and turned on again, at which time the video system will run the updated software.

In the event of an error, or a premature halting of the downloading, an appropriate red LED will light. COMM ERROR 835 lights when communication cannot be established with video system. The VERIFY ERROR 837 lights when the verification of the program has failed. ERASE ERROR 839 and PROGRAMMING ERROR 841 light when there is difficulty in writing or reading either the update box memory or the video system memory.

The CHARGE LED 843 lights when the switch 827 is at the charge position and an AC adaptor is connected to the update box. A Force Update or reset switch is used to activate special testing or diagnostic routines, and is not normally used.

Bootloader Program in
the Video Recording System

The bootloader program is analogous to the boot program in a standard computer that directs the computer to determine if there is a floppy drive disk with a program there to execute. In a like manner, the bootloader looks for the presence of the program update box. If the update box is found, the bootloader will then request and load the entire contents of the update box flash memory ROM and load that into the video system memory. After the update box is disconnected and a complete power off/on cycle, the machine will then run the newly loaded program.

Reference is now made to Figures 3A and 3B, which together are a flow sheet of the bootloader program in the video recording system. This is the program that the video recording system uses to download new system software into itself from the program update box. This program is executed when the video system is turned on and the system booted. First the program determines if there is an update box attached to the serial port for the update box. If the update box does not respond, the normal startup of the main program continues. If a box is detected, the downloading sequence is initiated. After sending a request for download and receiving an acknowledgment, the current software

version is sent to the update Box. If appropriate acknowledgment is received, the main downloading loop of the program is entered which comprises a request for the next data block and a test for an acknowledgment of the request. The downloaded data is then read, which is in a 32 byte block. The checksum is read and checked. The program flash block is called. This program stores the program in the video system flash memory. After the program is downloaded, i.e. when the block counter reaches 4096, the downloaded program is verified. A request for verification is sent and acknowledged by the update box, and a verification loop is entered wherein the new downloaded software in the video system is sent back in 32 byte blocks to the update box, which verifies the block and sends an acknowledgment of the verification. After the verification ends, the program execution stops. The update box is then disconnected and the video system restarted with the new system software. If any of the acknowledgments or tests fail, the program is stopped. The system is then restarted and the downloading process begun from the beginning.

Reference is now made to Figure 4, which shows the flash program block used in the bootloader program in Figures 3A and 3B for storing the downloaded program in the flash memory. After it is determined that the flash memory is in programming mode, the 32 byte block just read from the update box is read into the flash memory, using the standard programming algorithm for the chip. The chip, in a current implementation is the Intel™ 28F001BX-B, and the programming suggested by the manufacture was used (Pages 4-190 to 4-191, Intel Flash Memory, 1994)

To maintain permanent integrity of the video system, a certain amount of memory is protected from being erased or written over, which can only be written over at the factory. In this memory, the bootloader program is stored.

Reference is now made to Figure 5, which is a memory map of the video recording system. The control lines A16 and NORM to the CPU control the memory used for execution of the program. A16 is the address line when toggles allow access to page 2 flash memory (<64K). NORM is the line that set up memory for updating and programming. It switches program execution to RAM. To be able to do downloading, the video system needs to be able to execute the bootloader program out of memory other than the flash memory holding the program. The flash memory will be erased (except for the lower 8K boot block) and cannot be programmed and have a program executed

therefrom at the same time. Accordingly, during updating, the boot block is written to 8K of system RAM to be used for program execution. When the NORM line is set to a low condition, the RAM memory is enabled for program execution. The program is started in the flash RAM which first copies the contents of the first 8K of the system flash memory into the RAM memory. The NORM line to the CPU is then brought low, and program execution begins at the very next line in corresponding RAM memory location. No external RAM is used for variable storage by the video system bootloader program.

Update Box Software

Reference is now made to Figures 6A and 6B which together is a flow sheet of the main software of the update box. This software communicates with the bootloader program in the video system. The first part of the program is a series of loops where the update box reads commands from the video system bootloader software. The program with a loop wherein the update box awaits a Hello command from the video system. When a hello is received, the system waits for a request to download. When the request to download is received, the system waits for version information from the video system. The system then enters a loop wherein the update box program sends the program stored in its flash memory to the video system as a series of 32 byte blocks. The video system sends a request for a block, after which 32 bytes are read from the flash ROM into a buffer (TXBuffer). An acknowledgment, the contents of the buffer, and the a check sum are then sent to the video system. This is repeated until the contents of the flash memory have been read and sent, i.e. when BLKCOUNT > 4096. A LED light on the control box panel is flashed at each execution of the loop. The program then enters a program verification section wherein the program sent to the video system is verified against the contents of the Flash memory. The update box system waits for the request-to-verify command from the video system. After which it enters a loop wherein it reads blocks of the program sent from the video system and compares it with the corresponding blocks in the flash memory. If the verification is not successful the "error" LED is turned on and the program terminated. In every execution of the loop, the "Updating" LED is flashed. When the verification process is completed, i.e. when BLKCOUNT > 4096, the "UPDATE OK" is turned on the program is terminated.

Circuit Diagram of Update Box

Reference is now made to Figure 67, which is a circuit diagram of the update box used to remotely update the software in the video system. The update system is powered by 1.25-Volt NiCad batteries BT1, BT2, BT3, and BT4. A power supply/charger is built around U1, a charge controller BQ2003 from Benchmark Semiconductor, which basically controls the charge rate and the charging of the batteries in general and determines whether the batteries have been completely charged. Diode D1 is a green LED indicator that indicates charge status. R6, R8, R9, and R10 determine the charge voltage and the charge setup. VR2 is a 5-volt voltage regulator and coupled with Q1 and Q2 provide regulated power of the microprocessor U8. CN1 is the power inlet connector for the battery charge AC adaptor. DE, the tranzorb, helps eliminate spikes and transients. D4 is a diode to protect against reverse application of voltage and block DC current from the batteries from going back out of the connector. The switch S1 allows the system to be set up for charge mode or for operation.

Diode D5 is a 5.6V zenier diode to protect against overvoltage. U6B, R14, R13, R17, R12, D8, R16, R18, Q3, D7, and R15 are part of a comparator circuit, using D8 as a 1.2V reference, to indicate battery status, i.e. to indicate when the batteries are low.

Diodes D9 through D14 are indicator LEDs to determine program status as described in Figures 1 and 2. These are driven by the update system software, as described in Figures 6A and 6B, to show status of the system and errors in the software transfer. Switch S2 is a bypass switch that allows for user intervention as determined by the update system programming, e.g. to interrupt the download. DS1232 is a watchdog timer reset circuit. C11, C12, and Y1 are the oscillator circuit for the microprocessor. The microprocessor, U8, is a 87C52 used in single-chip mode. U4 is an address but that allows interface to U3, which is a 28F001DX flash memory. This chip contains the system software for the video system, which is to be downloaded. It is capable of holding up to 128 Kbytes of information. U6 is used to decode the address space, to allow addressing 128 Kbytes, since only 64 Kbytes can be addressed by an 8052 chip.

U7 and U9 are used to interface to the RS485 serial interface, which is used to transfer the updated software to the video system through connector CN2 and cable CN1.

The chip U3 is functionally analogous to a floppy disc. This chip can be loaded separately with the updated video system software using conventional techniques for

programming these chips. The chip is then inserted in a socket in the update box. The update box can then be used any number of times for updating software in one or more video recording systems. The chip can be removed and a chip of yet a different update can be inserted. This not only provides an easy method of updating the system, but allows for customized programming to installed in selected video systems that may be optimized for a particular use. In actual practice, updated software can be supplied to a law enforcement agency as a sealed update box containing a chip with the updated software. Alternately, the law enforcement agency technician can replace the chip with a new chip.

* * * * * *

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiments are, therefore, to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

Claims:

1. A data documentation system comprising a plurality of data generating sources including video, audio, and digital data sources:

recorder for recording the tat data from the data generating sources;

reader for retrieving the recorded data;

data initialization system comprising a digital key with nonvolatile memory that is connected to the data documentation system when the data documentation system is booted, the memory containing data that selects startup options for the data documentation system.

2. A data documentation system as in Claim 1 wherein the data is the memory includes data identifying the user, and operation parameters.

3. A data documentation system as in Claim 2 wherein the operation parameters include data to enable or disable a function of the data documentation system.

4. A data documentation system as in Claim 3 wherein the functions include an alternate language, 24-hour surveillance mode, and options for heater operation.

5. A data documentation system comprising a plurality of data generating sources including video, audio, and digital data sources:

recorder for recording the tat data from the data generating sources;

reader for retrieving the recorded data;

security access controller, the security access controller adapted such that for a selected individual the security access controller permits selective access to one or more of the data generating sources or selectively permits retrieval of recorded data originating from on or more of the data generating sources, the selective access based upon the digital authorization coded assigned to the individual, the security access controller comprising a security code input to determine the digital authorization code assigned to the individual.

6. A data documentation system as in Claim 5 wherein the security code input comprises a digital key separable from the data documentation system and assigned to the individual, the key comprising a nonvolatile digital memory storage device containing a digital authorization code, and an electrical connector for separably connecting the key to the data documentation systems such that the documentation system can read the digital authorization code.

7. A data documentation system as in Claim 6 wherein the connector of the key comprises an electrical plug that inserts into a mating electrical jack electrically connected to the data documentation system.

8. A data documentation system as in Claim 6 wherein the nonvolatile memory contains data selected from at least one of the group consisting of agency data, operation parameters for the data documentation system, and individual identification data.

9. A data documentation system as in Claim 8 wherein the data is recorded by the recorder for later retrieval by the reader.

10. A data documentation system comprising a recorder for recording visual, audio and digital data, a reader for retrieving the recorded data and an electronic key system for limiting access to the system, the key system comprising a digital key reader for reading data from a digital key inserted into a connector of the system by the user, a processor for processing the data on the digital key to determine a security level of the user.

11. A data documentation system as in Claim 10 wherein the security level is used by the processor to limit functions of the documentation system available to the user.

12. A data documentation system as in Claim 10 wherein the security level is used by the processor to block access to the data documentation system.

13. A data documentation system comprising a recorder for recording visual, audio and digital data, a reader for retrieving the recorded data and an electronic user information key system for transferring data about the user to the data documentation system, the key system comprising a digital key reader for reading data from a digital key inserted into a connector of the system by the user, a processor for processing the data on the digital key for recording by the recorder.

14. A data documentation system as in Claim 13 wherein the recorder and the reader are a VHS system for recording to and retrieving data from a magnetic tape.

15. A data documentation system comprising peripheral devices including at least one video camera and at least one audio microphone, a recorder for recording output signals from the video camera and microphone, and a digital system controller that controls the functions of the video camera and microphone by digital control commands, the system controller driven by software stored in writable memory storage with circuitry to write the software programming into the memory storage.

16. A data documentation system as in claim 15 wherein the peripheral devices communicate with the system controller through digital serial interfaces.

17. A data documentation system as in claim 15 wherein the circuitry for writing the software into the writable memory comprises a digital interface for communicating with an external memory, wherein software stored in the external memory can be transferred through the serial interface to the writable memory.

18. A data documentation system as in claim 17 wherein the external memory is housed in a portable box, and the external memory is a non-volatile memory that is separately programmed and inserted into a socket in the box.

19. A data documentation system as in claim 17 wherein an updated program in the external memory is downloaded to the data documentation system when the external memory is connected to the data documentation system when it is booted.

20. A method for inserting digital data into a modulated audio/video signal that comprises a modulated carrier, a color subcarrier with the color information of the signal, and a guard band between the carrier and the subcarrier, the method comprising modulating the digital data on a frequency in the guard band at a band width that does not materially interfere with the carrier or color subcarrier to create a data subcarrier between the carrier and the color subcarrier.

21. The method of inserting digital data into an audio/video carrier of claim 20 wherein the digital data is at least one digitized audio signal.

22. The method of inserting digital data into an audio/video carrier of claim 20 wherein the digital data includes more than one digitized audio signal.

23. The method of inserting digital data into a video carrier of claim 22 the digital data additionally includes a digital data channel.

24. The method of inserting digital data into a video carrier of claim 23 wherein the digital data channel is accomplished by a bit robbing routine from the digital audio channels.

25. The method of inserting digital data into a video carrier of claim 23 wherein the digital data channel contains authentication data.

26. The method of inserting digital data into a video carrier of claim 23 wherein the digital data in the digital data channel is encrypted.

27. The method of inserting digital data into an audio/video carrier of claim 20 wherein the digital data is four digitized audio signals.

28. A subcarrier system for recording digital data on an audio video carrier that comprises a modulated carrier, a color subcarrier with the color information of the signal, and a guard band between the carrier and the subcarrier, the system comprising a modulator for modulating the digital data on a frequency in the guard band at a band width that does not materially interfere with the carrier or color subcarrier to create a data subcarrier between the carrier and the color subcarrier.

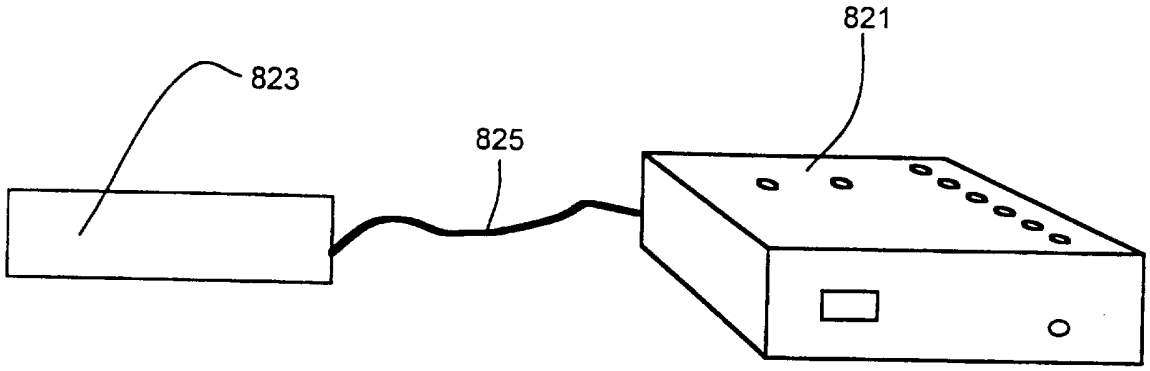
29. A data documentation system comprising a recorder for recording video data, and at least one control interface for remotely controlling and recording data from a building security system, the control interface comprising a transceiver that communicates with a transceiver of the security system for communicating data between the data documentation system and the security system, and for sending an authorization code from the data documentation system to the security system to initiate data communication between the data documentation system and the security system.

30. The data documentation system of claim 29 wherein the data transmitted between the security system and the data documentation system comprises at least one selected from the group consisting of video signals, audio signals, and digital data.

31. The data documentation system of claim 29 wherein the control interface comprises controllers for controlling functions of video cameras and audio signal generators in the security system, and selectors for selecting input from one or more of a plurality of video and audio signals generated in the security system.

32. A data documentation system having a dual video camera, and a video recorder, the dual video camera having a housing mountable in the cab of a police vehicle, a forward viewing main camera, and a rear viewing auxiliary camera, and the documentation system comprises a selector for selecting input from either or both the main and auxiliary cameras for recording by the video recorder.

Figure 1



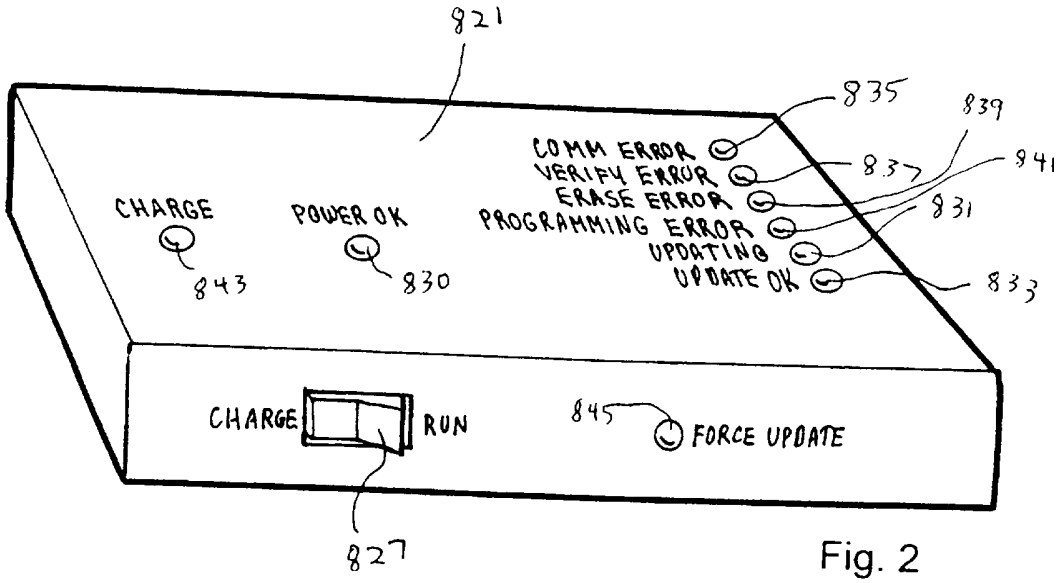


Fig. 2

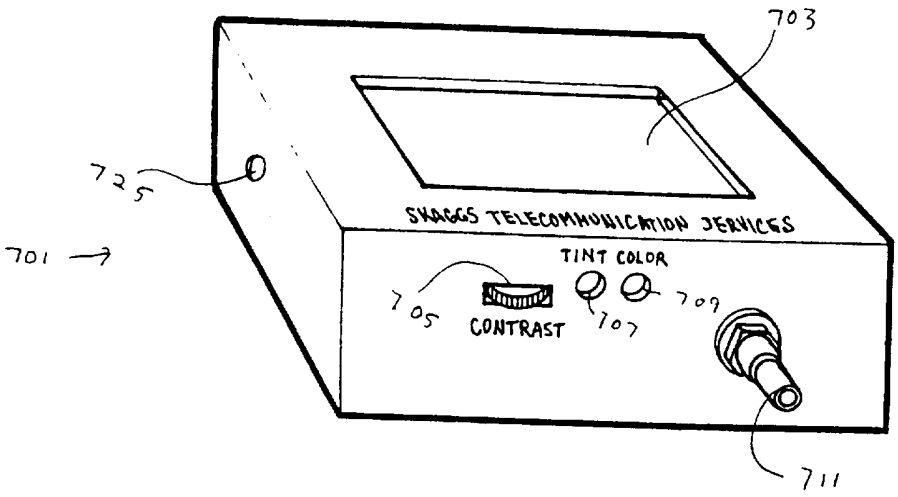


Fig. 7A

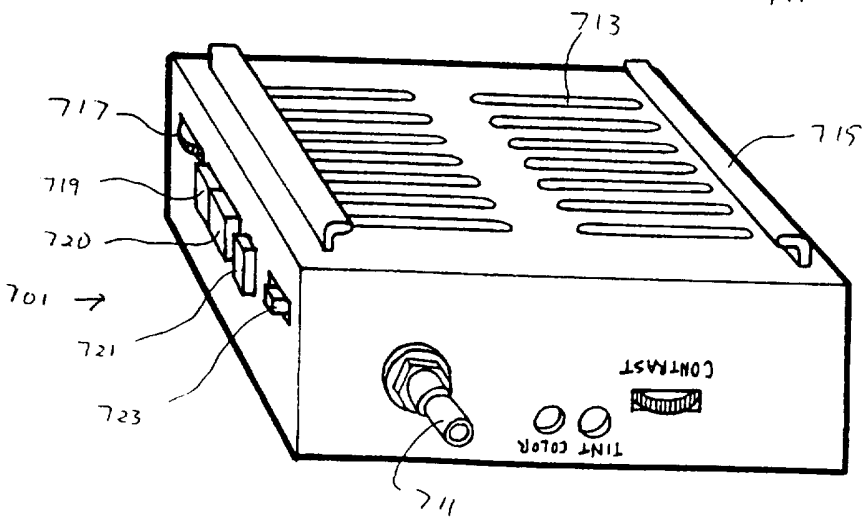


Fig. 7B

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Figure 3A

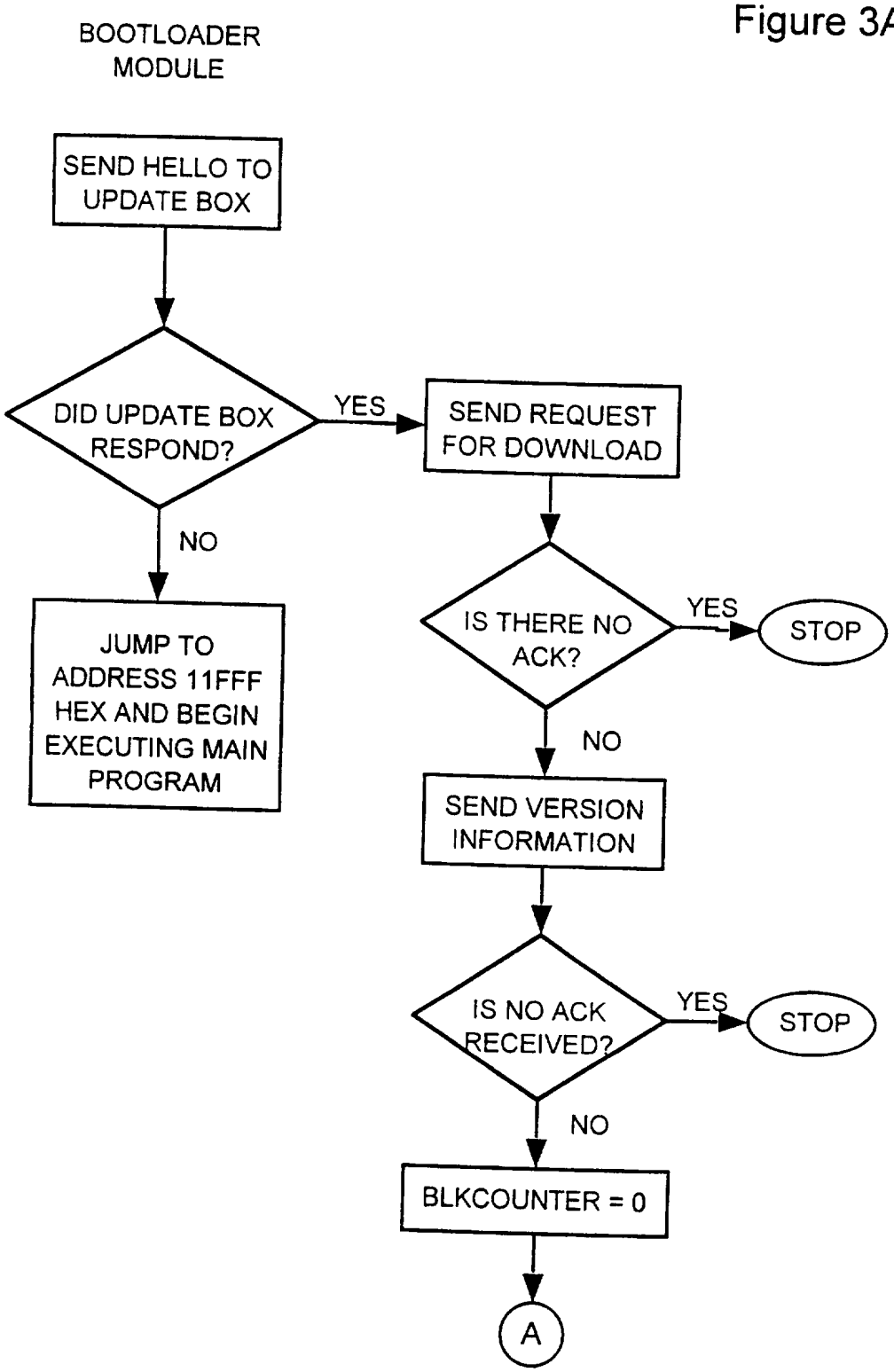

Figure 3B

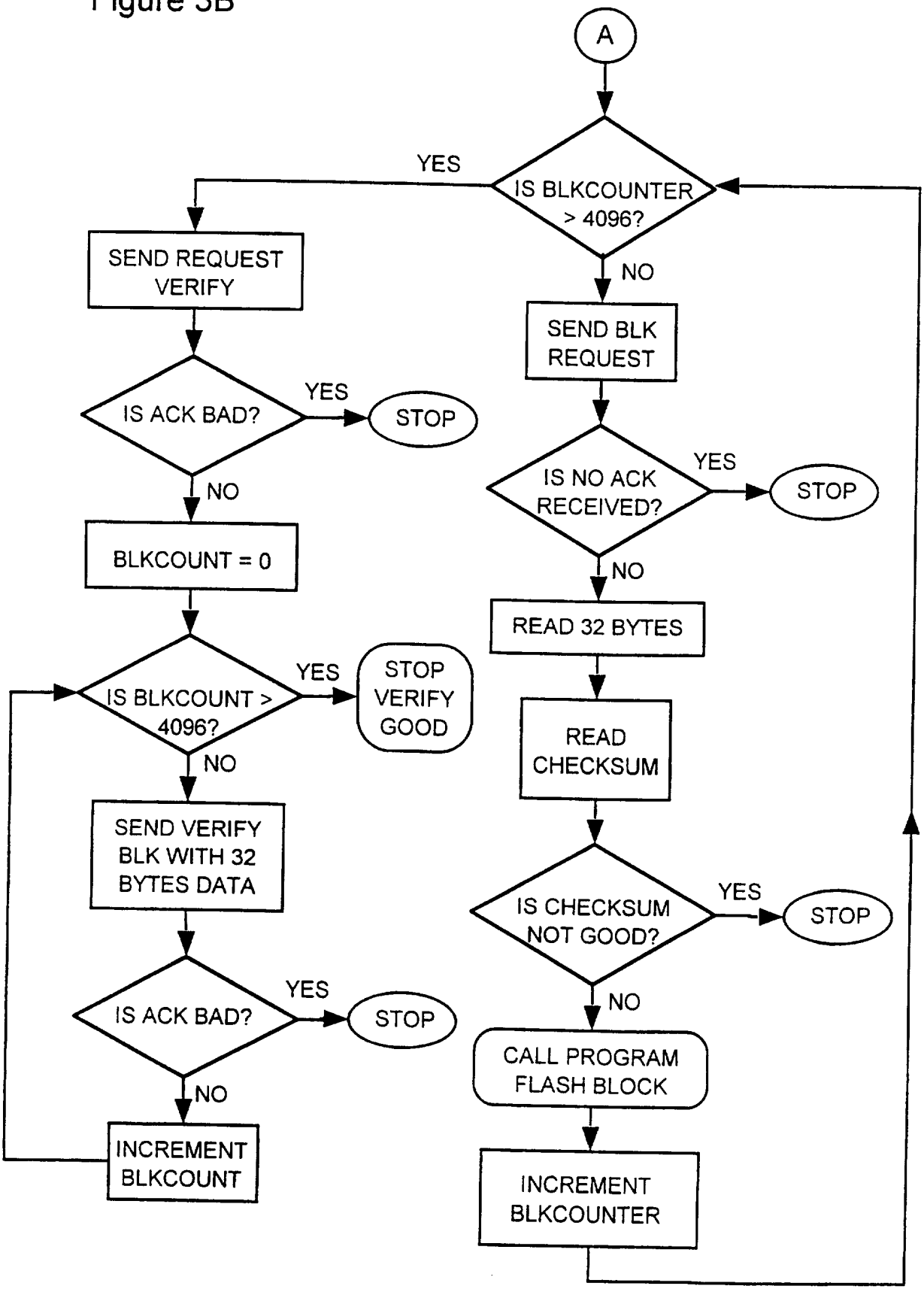
A
IS BLKCOUNTER > 4096?
YES
NO
SEND REQUEST VERIFY
IS ACK BAD?
YES
STOP
NO
BLKCOUNT = 0
IS BLKCOUNT > 4096?
YES
STOP VERIFY GOOD
NO
SEND VERIFY BLK WITH 32 BYTES DATA
IS ACK BAD?
YES
STOP
NO
INCREMENT BLKCOUNT
SEND BLK REQUEST
IS NO ACK RECEIVED?
YES
STOP
NO
READ 32 BYTES
READ CHECKSUM
IS CHECKSUM NOT GOOD?
YES
STOP
NO
CALL PROGRAM FLASH BLOCK
INCREMENT BLKCOUNTER

Figure 4

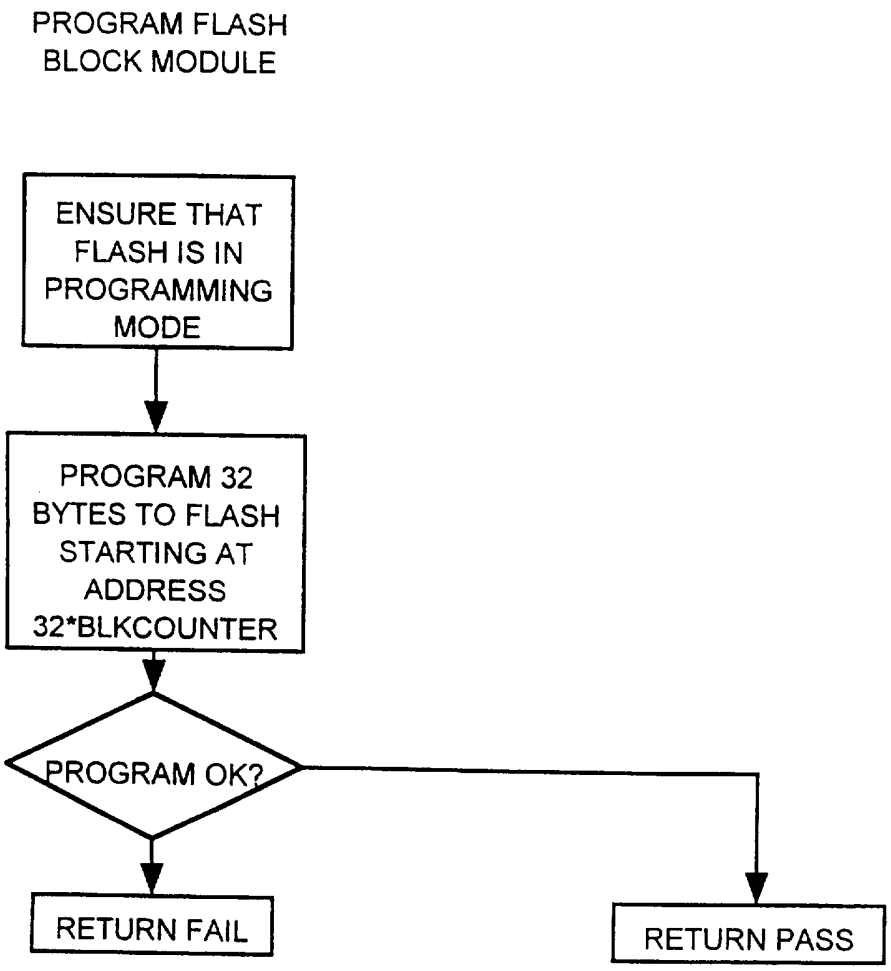
PROGRAM FLASH BLOCK MODULE
ENSURE THAT FLASH IS IN PROGRAMMING MODE
PROGRAM 32 BYTES TO FLASH STARTING AT ADDRESS 32*BLKCOUNTER
PROGRAM OK?
RETURN FAIL
RETURN PASS

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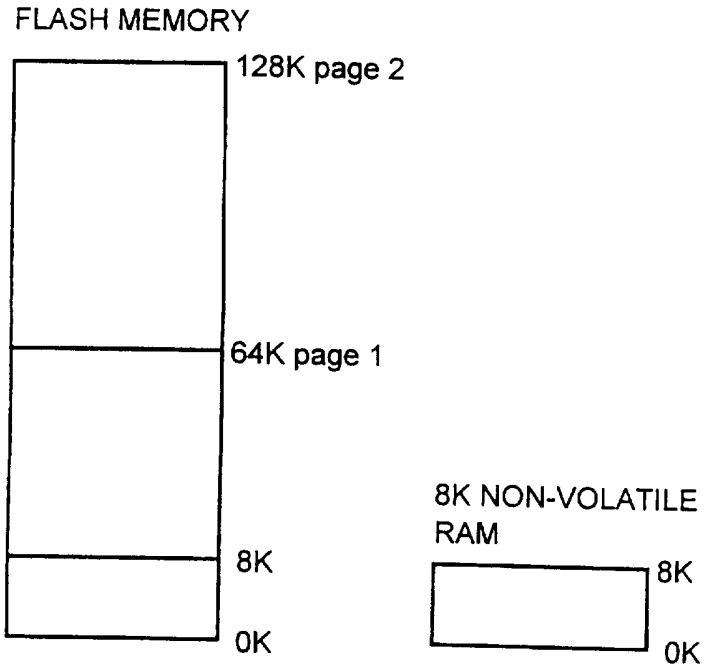
Figure 5



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UPDATE BOX MAIN SOFTWARE

Figure 6A

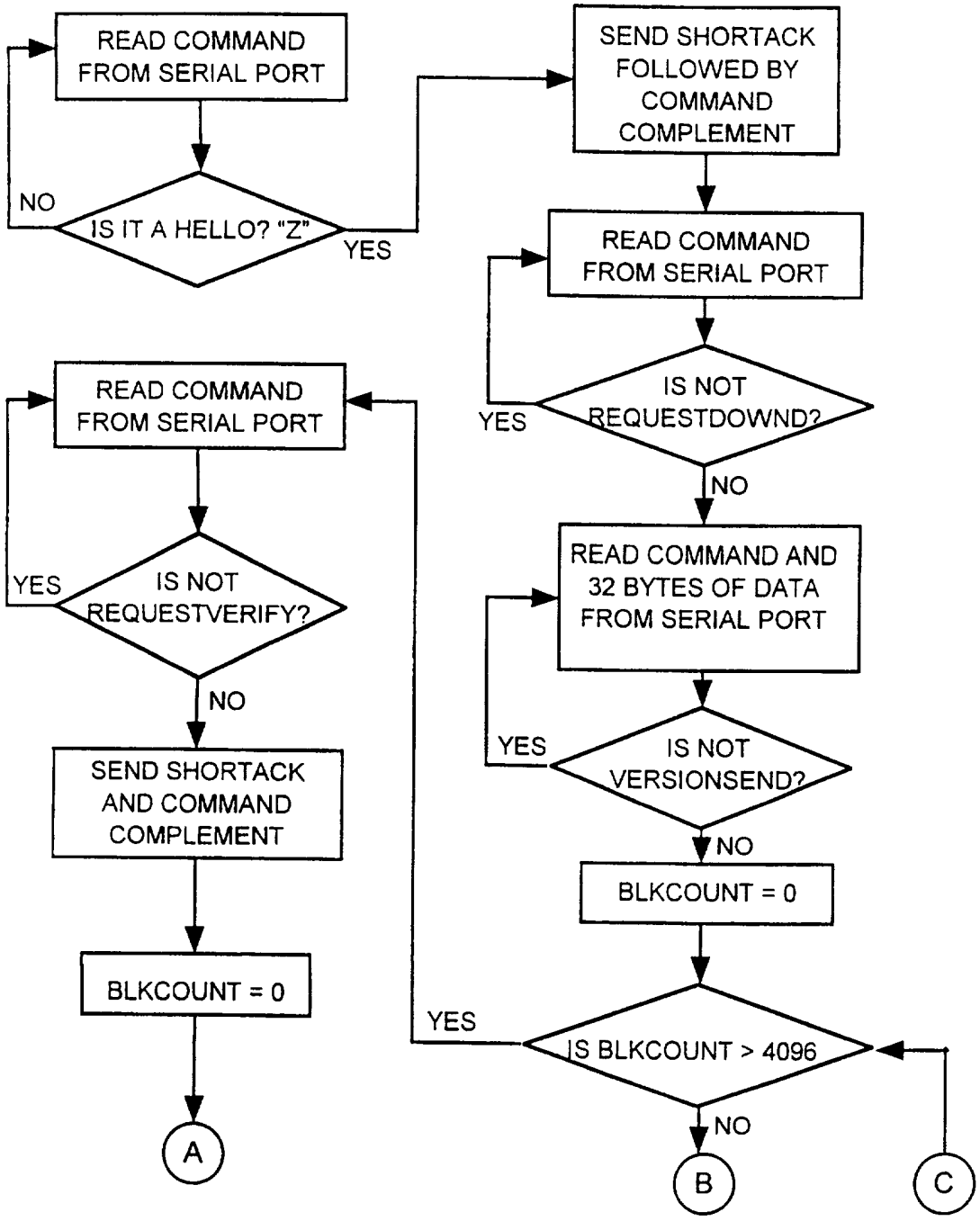

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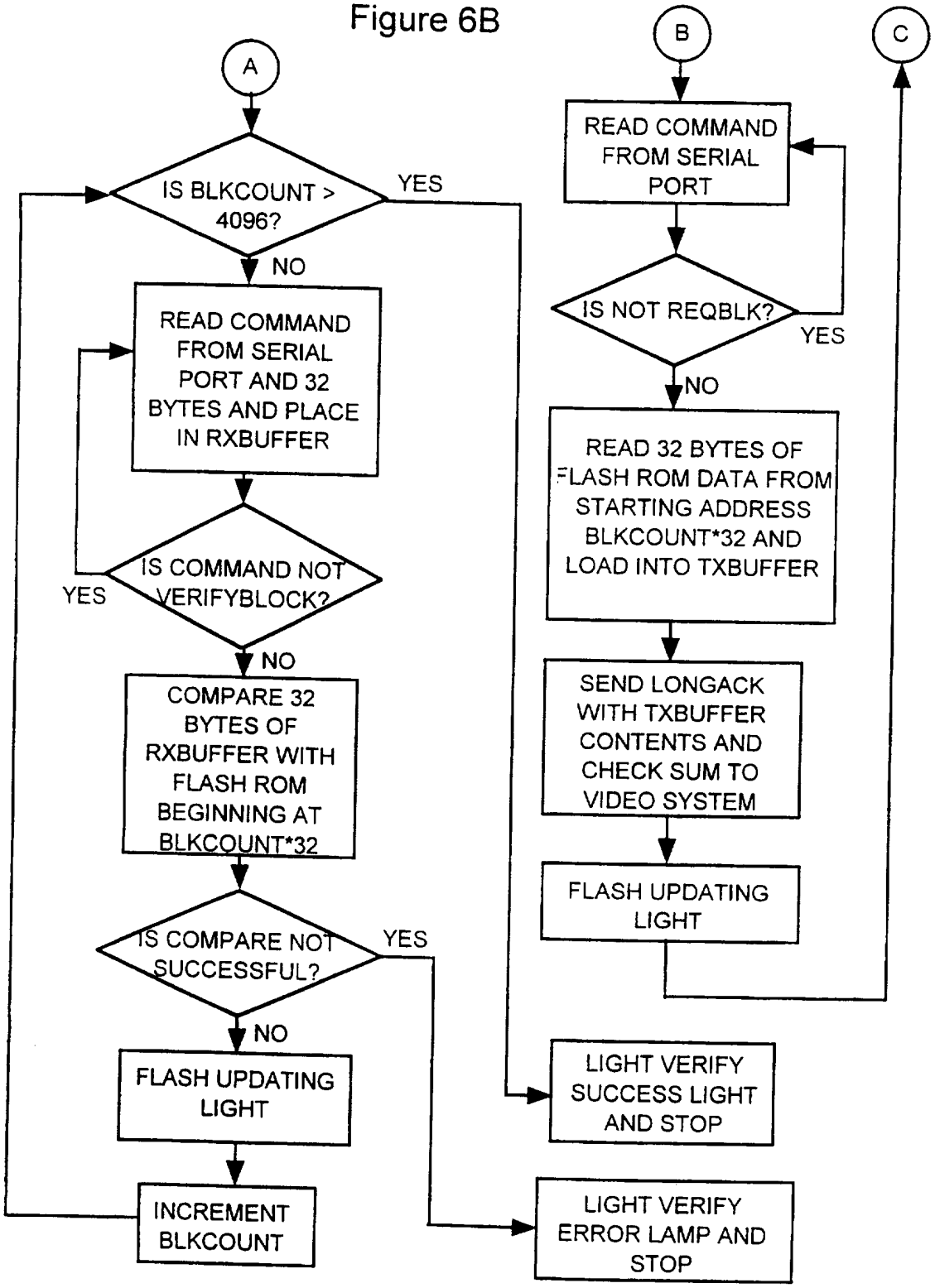
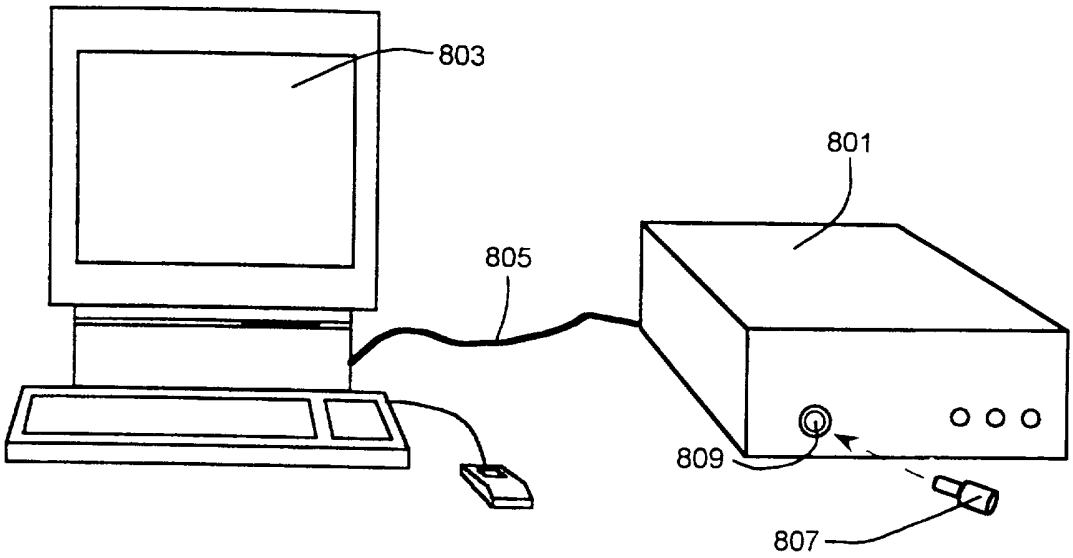
Figure 6B



9//09

Figure 8



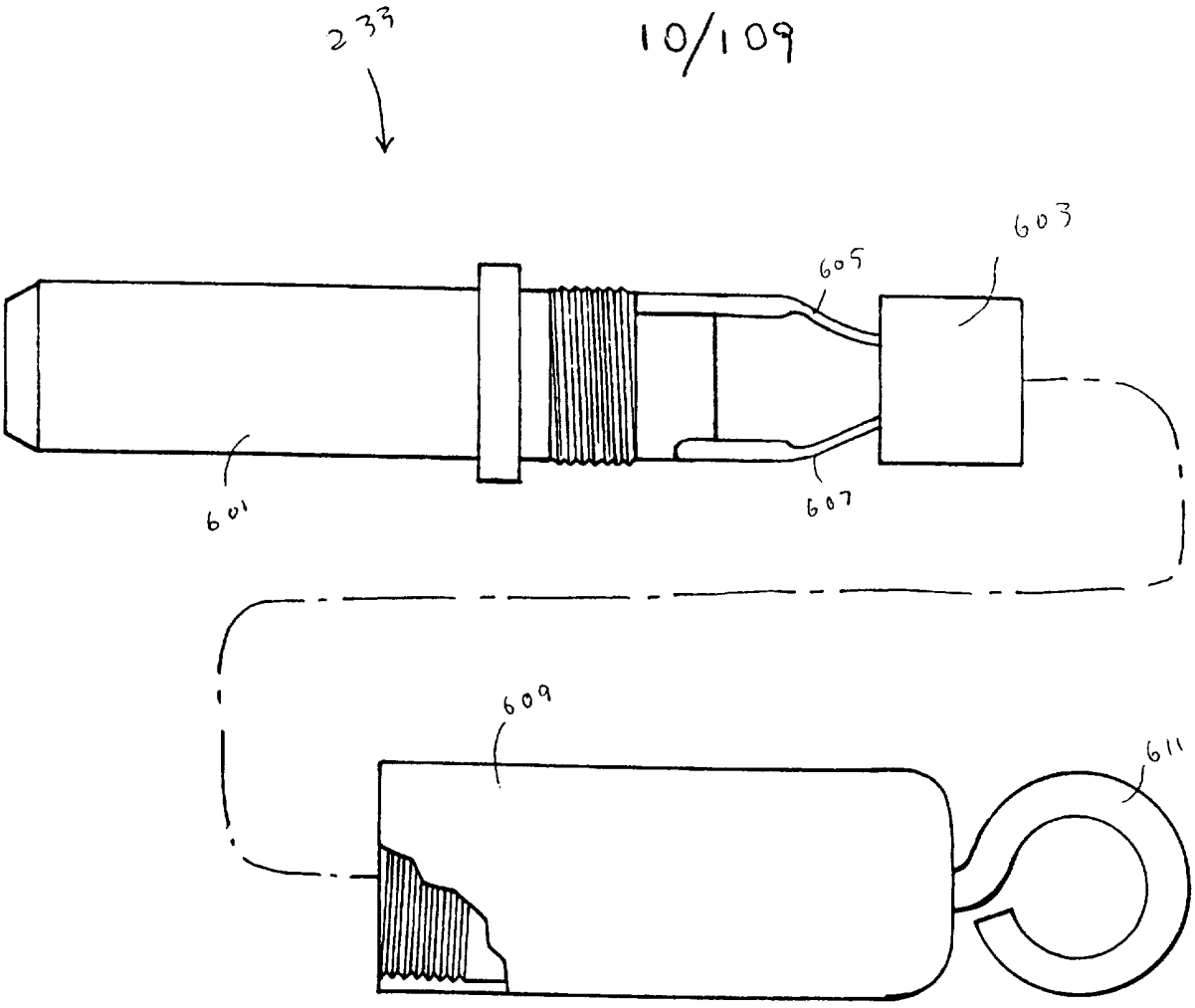

233
603
605
601
607
609
611

Fig. 66

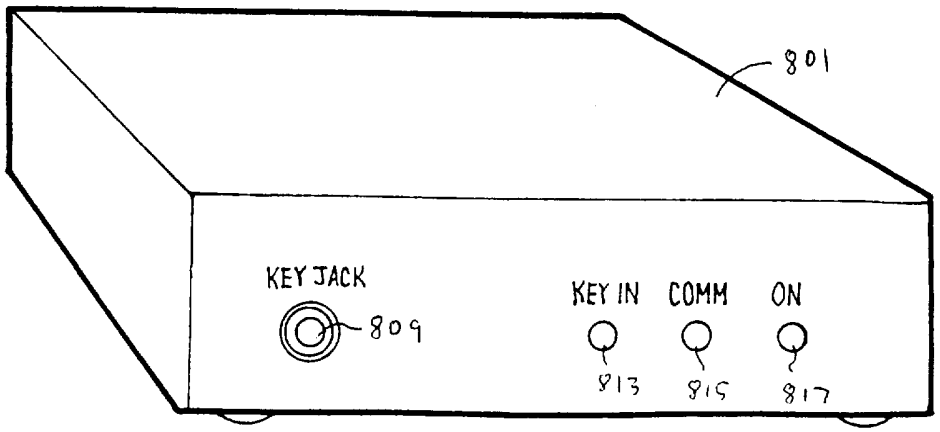
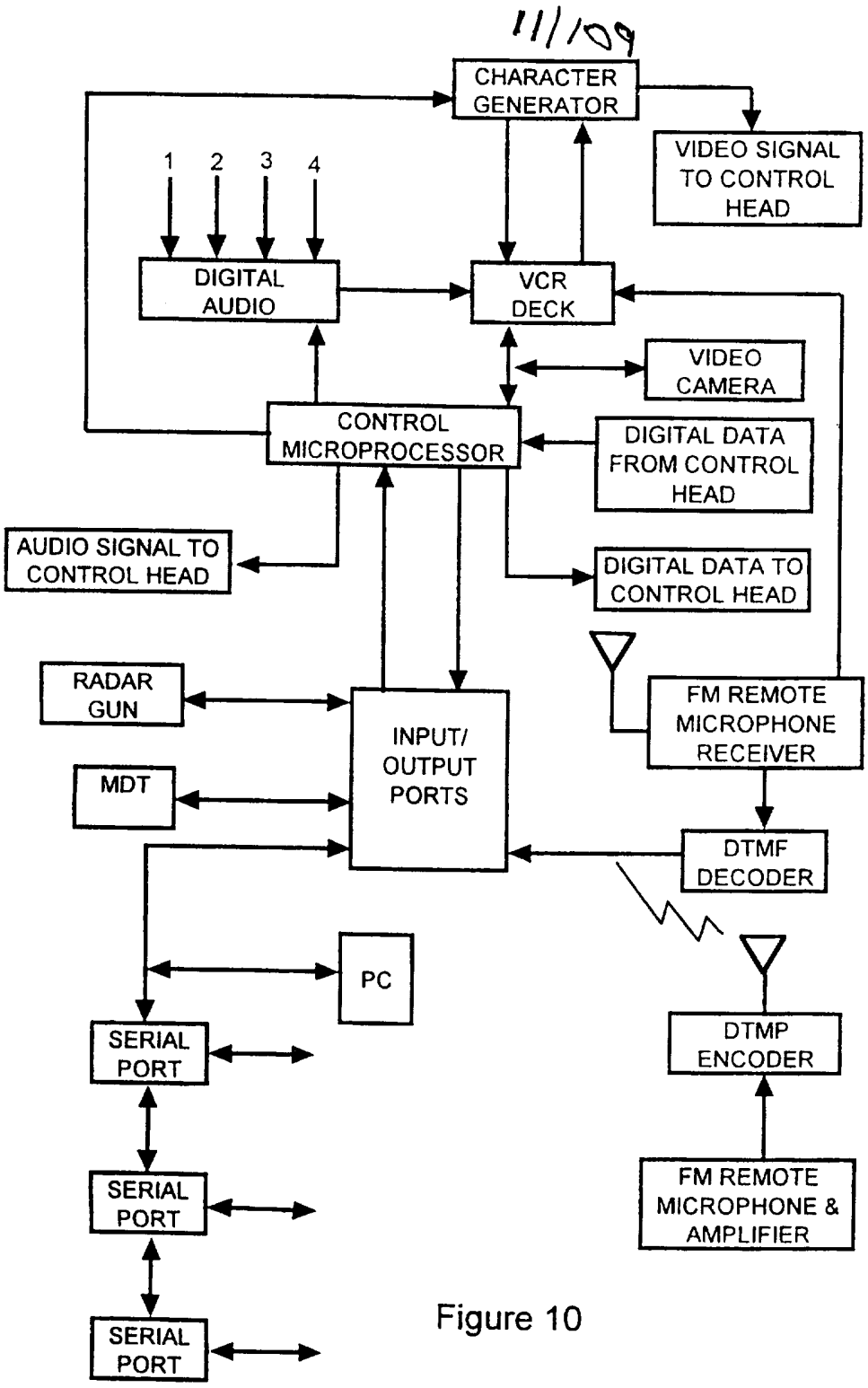

801
KEY JACK
809
KEY IN
COMM
ON
813
815
817

Fig. 9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CHARACTER GENERATOR
VIDEO SIGNAL TO CONTROL HEAD
1
2
3
4
DIGITAL AUDIO
VCR DECK
VIDEO CAMERA
CONTROL MICROPROCESSOR
DIGITAL DATA FROM CONTROL HEAD
AUDIO SIGNAL TO CONTROL HEAD
DIGITAL DATA TO CONTROL HEAD
RADAR GUN
INPUT/ OUTPUT PORTS
FM REMOTE MICROPHONE RECEIVER
MDT
DTMF DECODER
PC
SERIAL PORT
DTMP ENCODER
SERIAL PORT
FM REMOTE MICROPHONE & AMPLIFIER
SERIAL PORT

Figure 10

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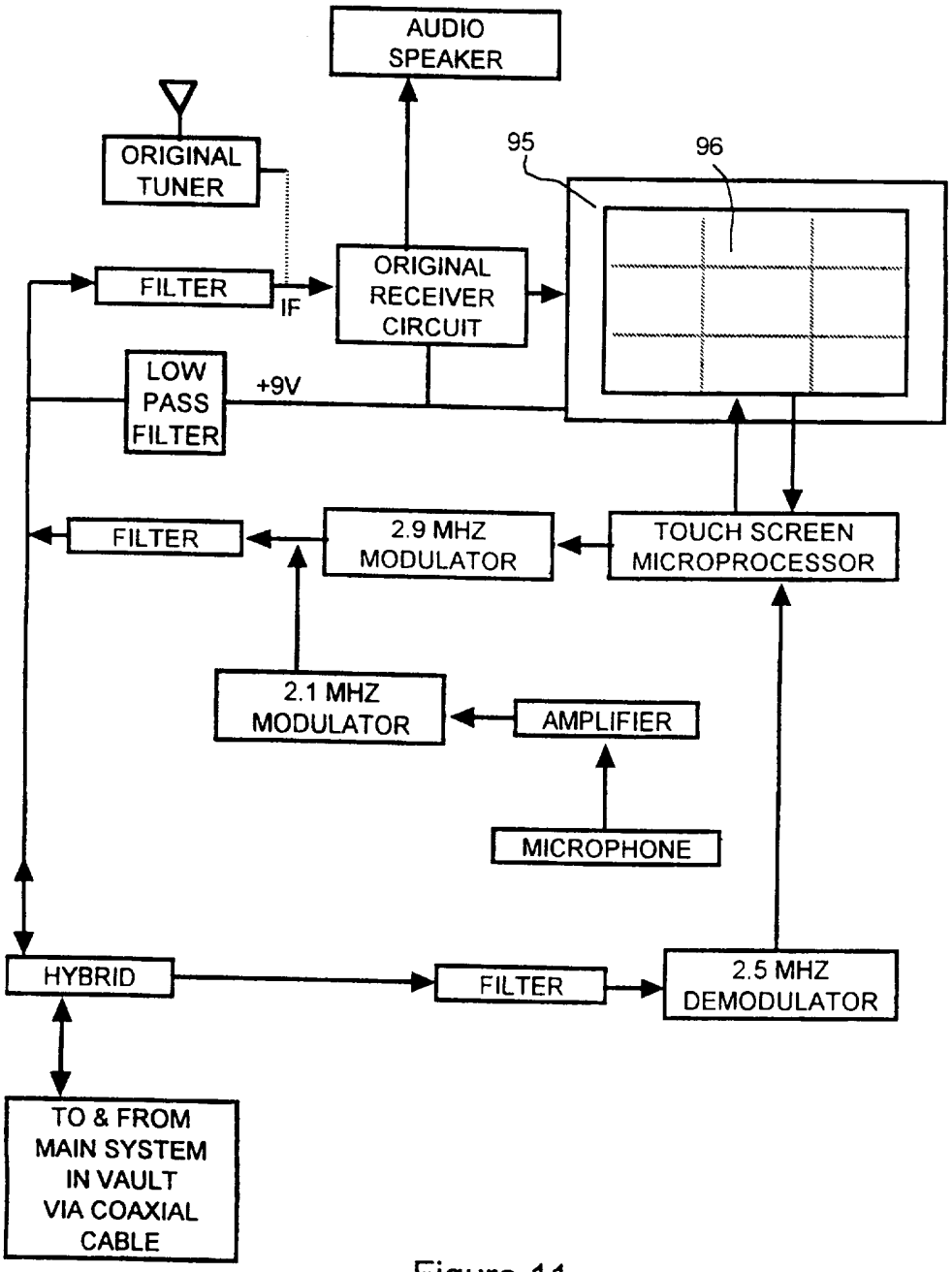

Figure 11

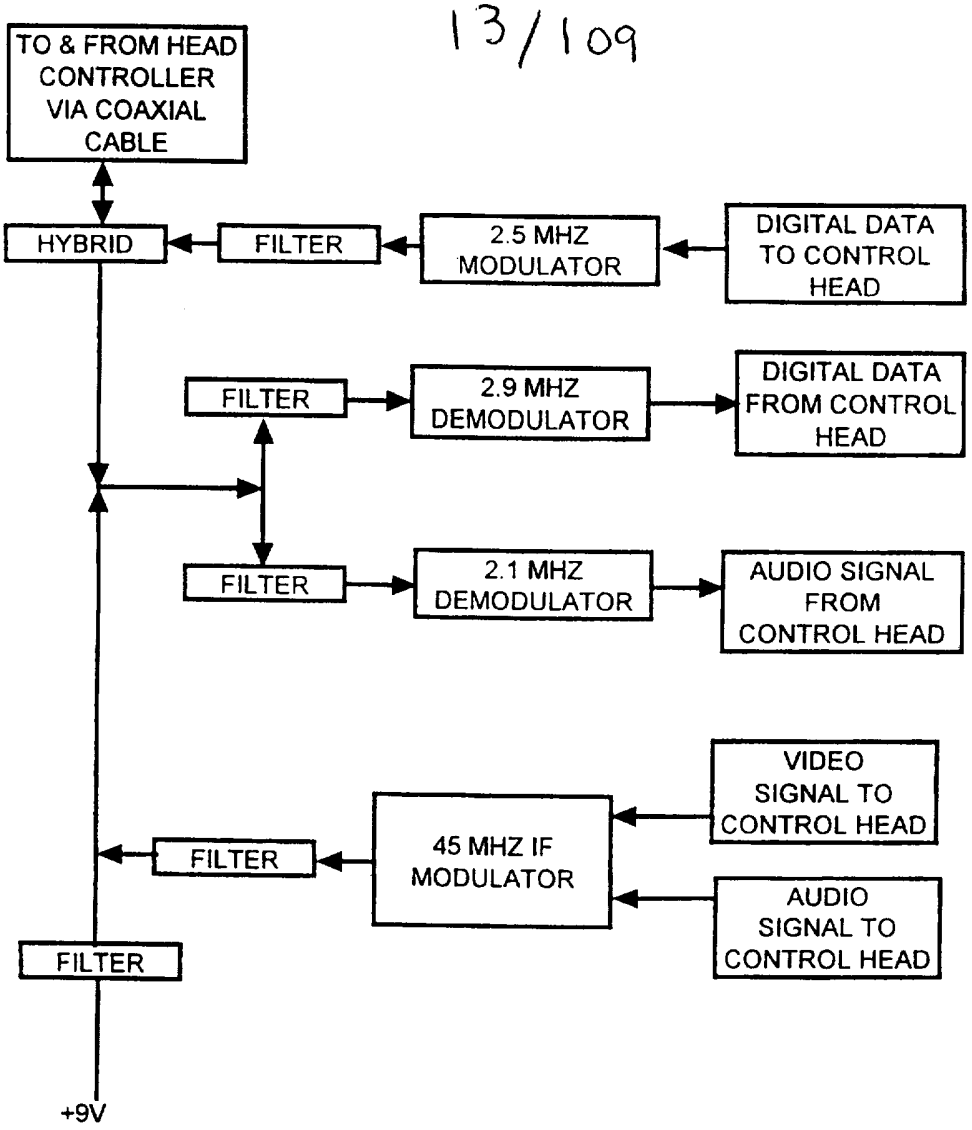
TO & FROM HEAD CONTROLLER VIA COAXIAL CABLE
HYBRID
FILTER
2.5 MHZ MODULATOR
DIGITAL DATA TO CONTROL HEAD
FILTER
2.9 MHZ DEMODULATOR
DIGITAL DATA FROM CONTROL HEAD
FILTER
2.1 MHZ DEMODULATOR
AUDIO SIGNAL FROM CONTROL HEAD
VIDEO SIGNAL TO CONTROL HEAD
45 MHZ IF MODULATOR
AUDIO SIGNAL TO CONTROL HEAD
FILTER
FILTER
+9V

Figure 12

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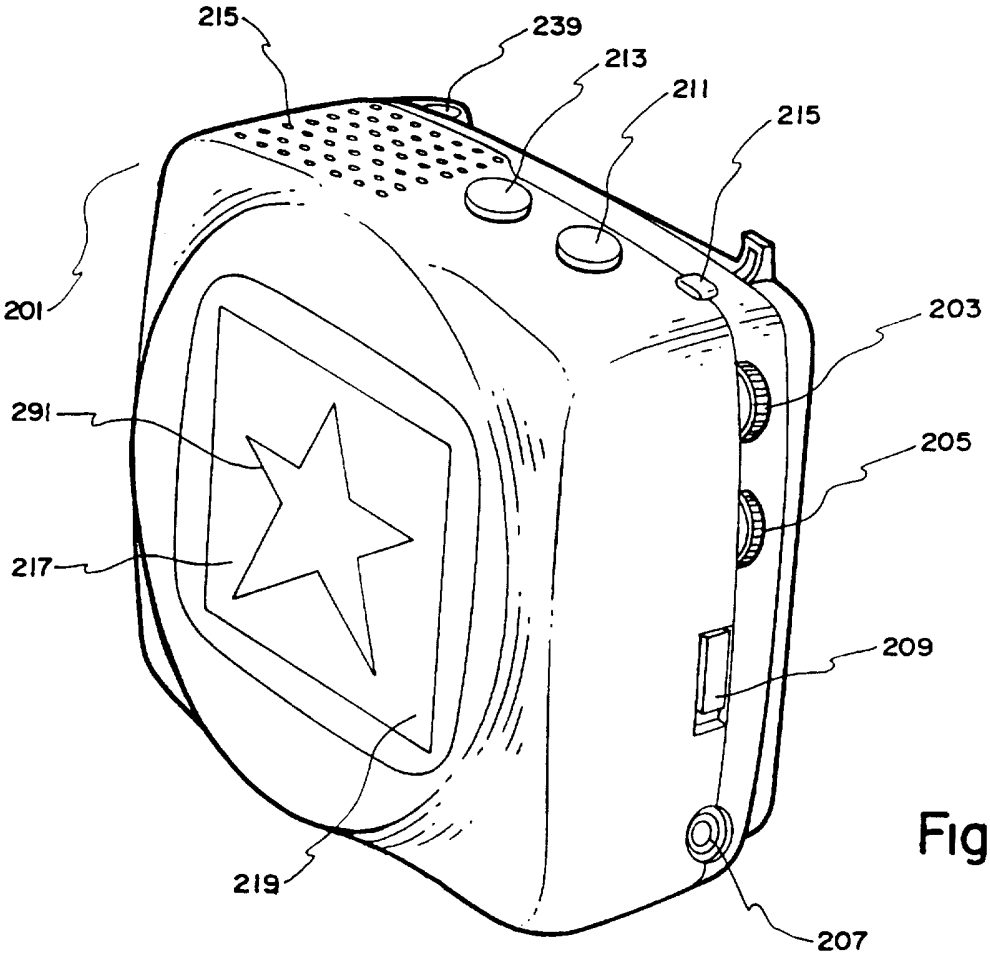

Fig. 13

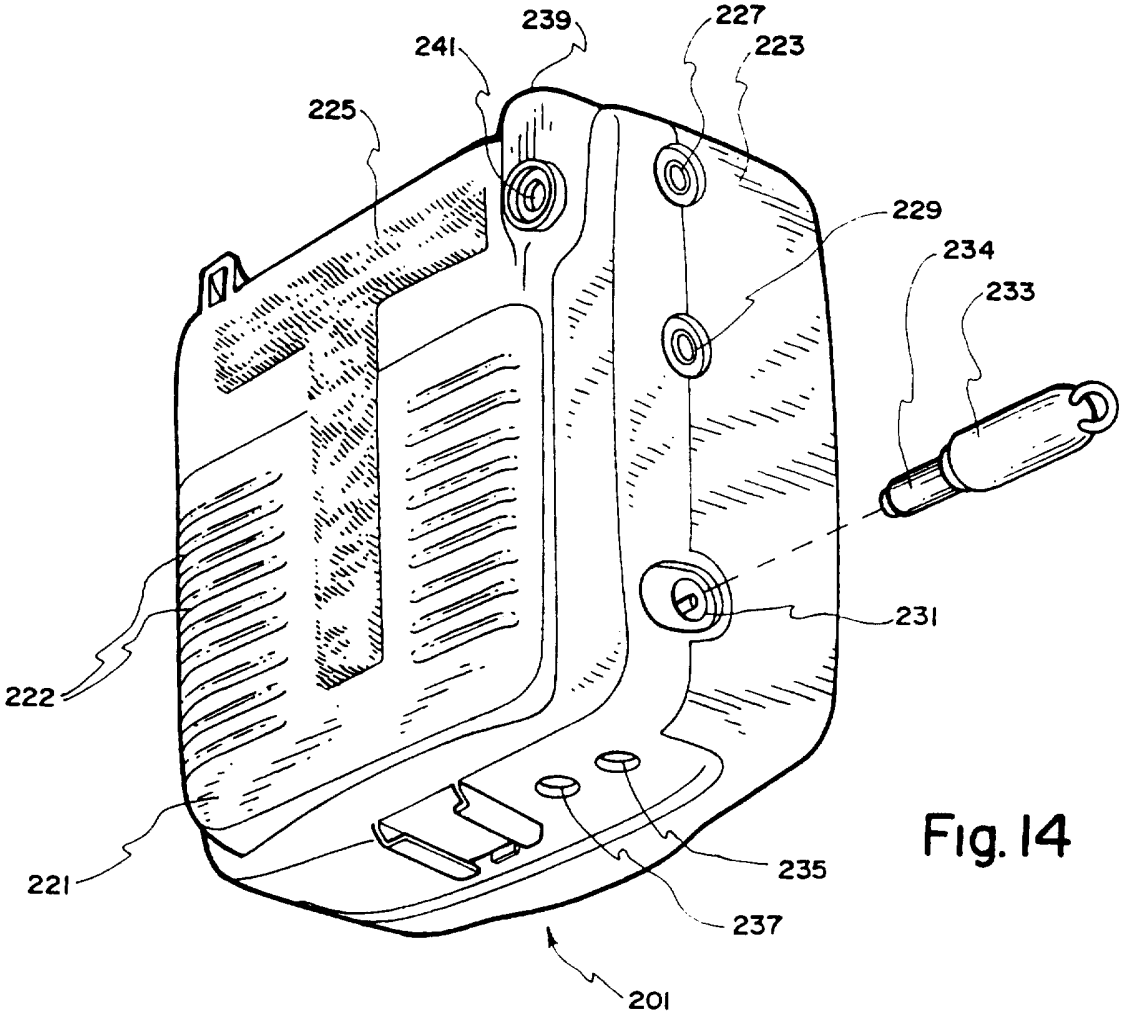

Fig. 14

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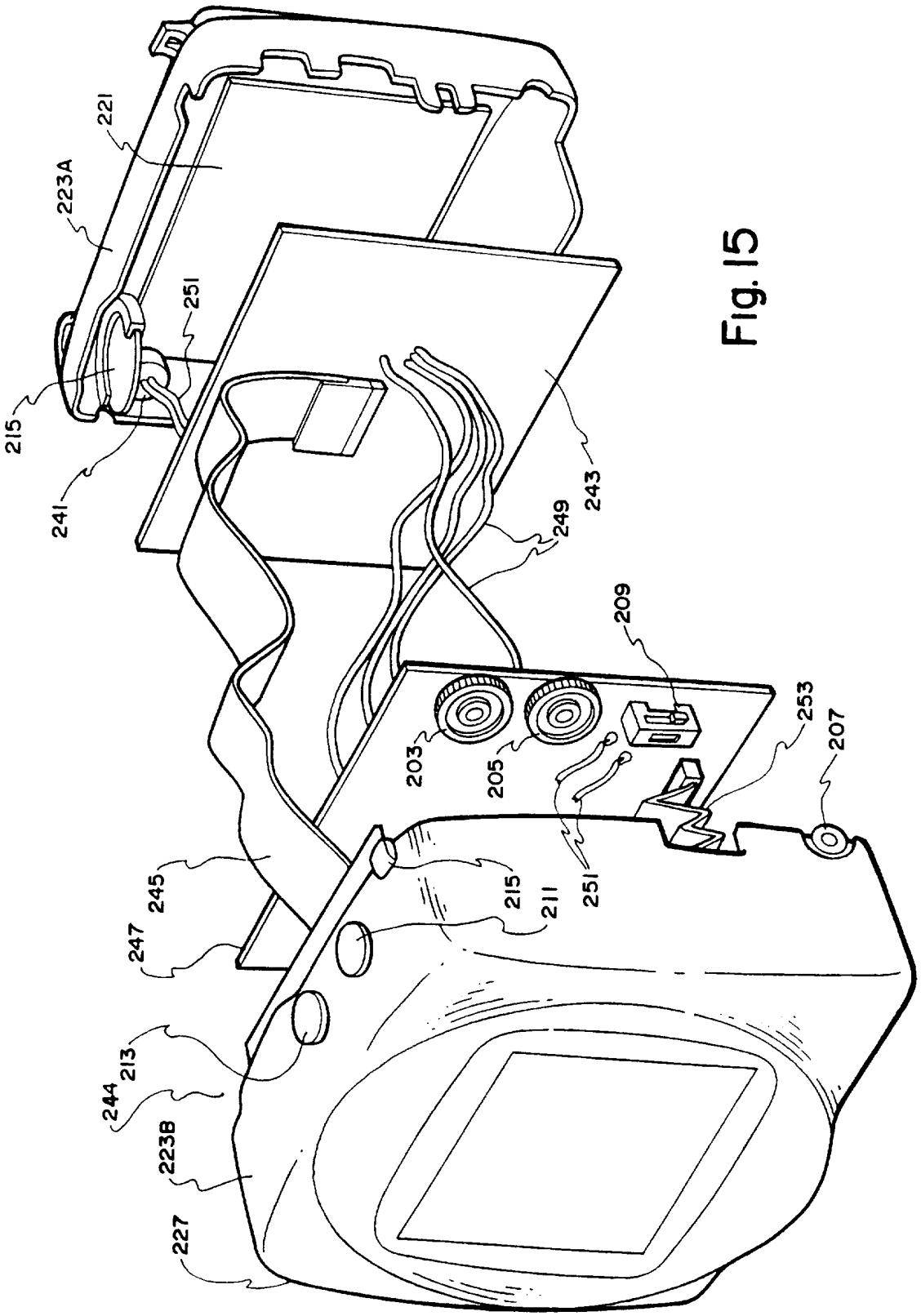
221
223A
251
215
241
243
249
209
203
205
253
207
245
247
215
211
251
213
244
223B
227

Fig. 15

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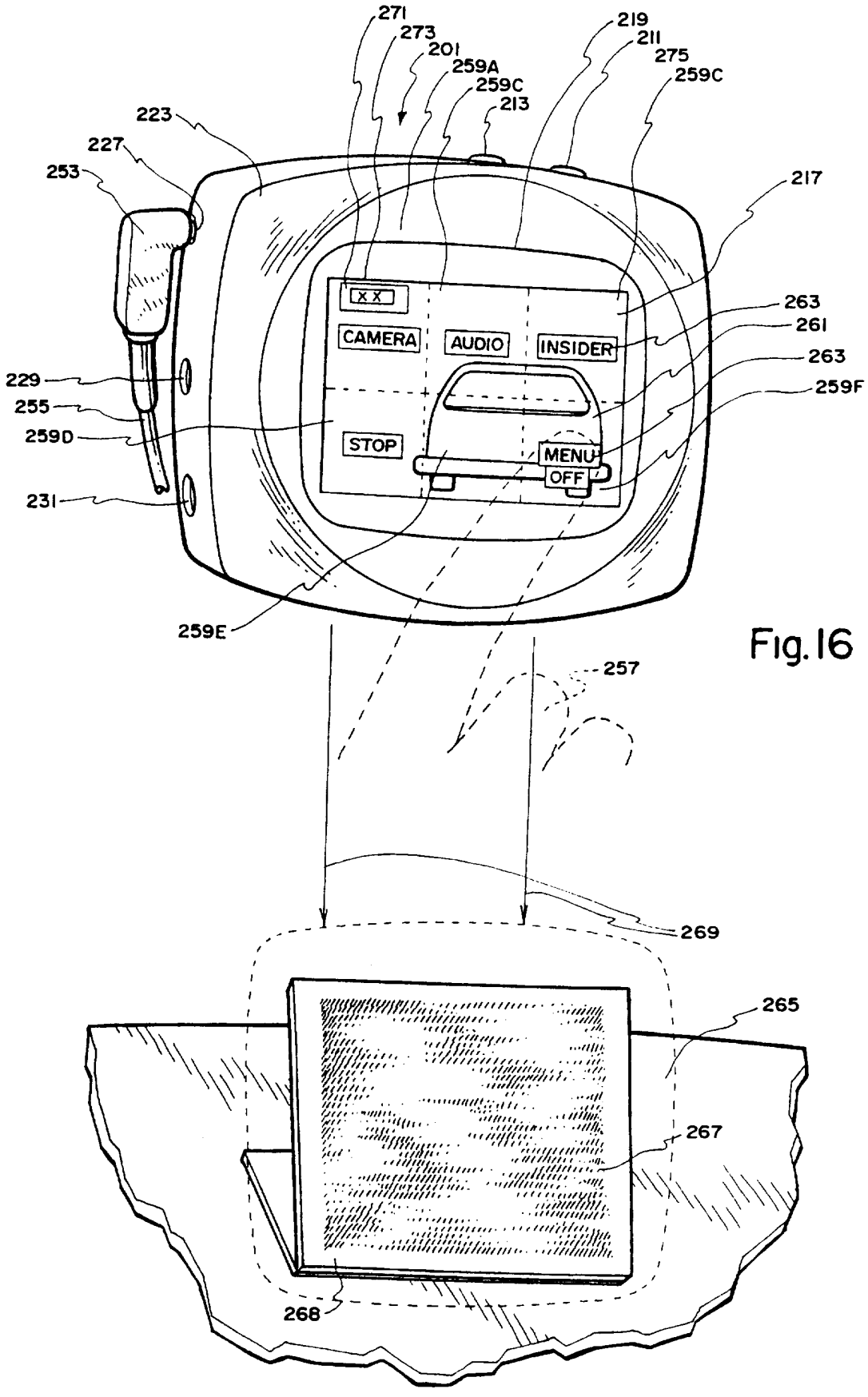
271
273
201
259A
259C
213
219
211
275
259C
223
227
253
217
263
261
263
259F
229
255
259D
231
259E
XX
CAMERA
AUDIO
INSIDER
STOP
MENU
OFF
257
269
265
267
268

Fig. 16

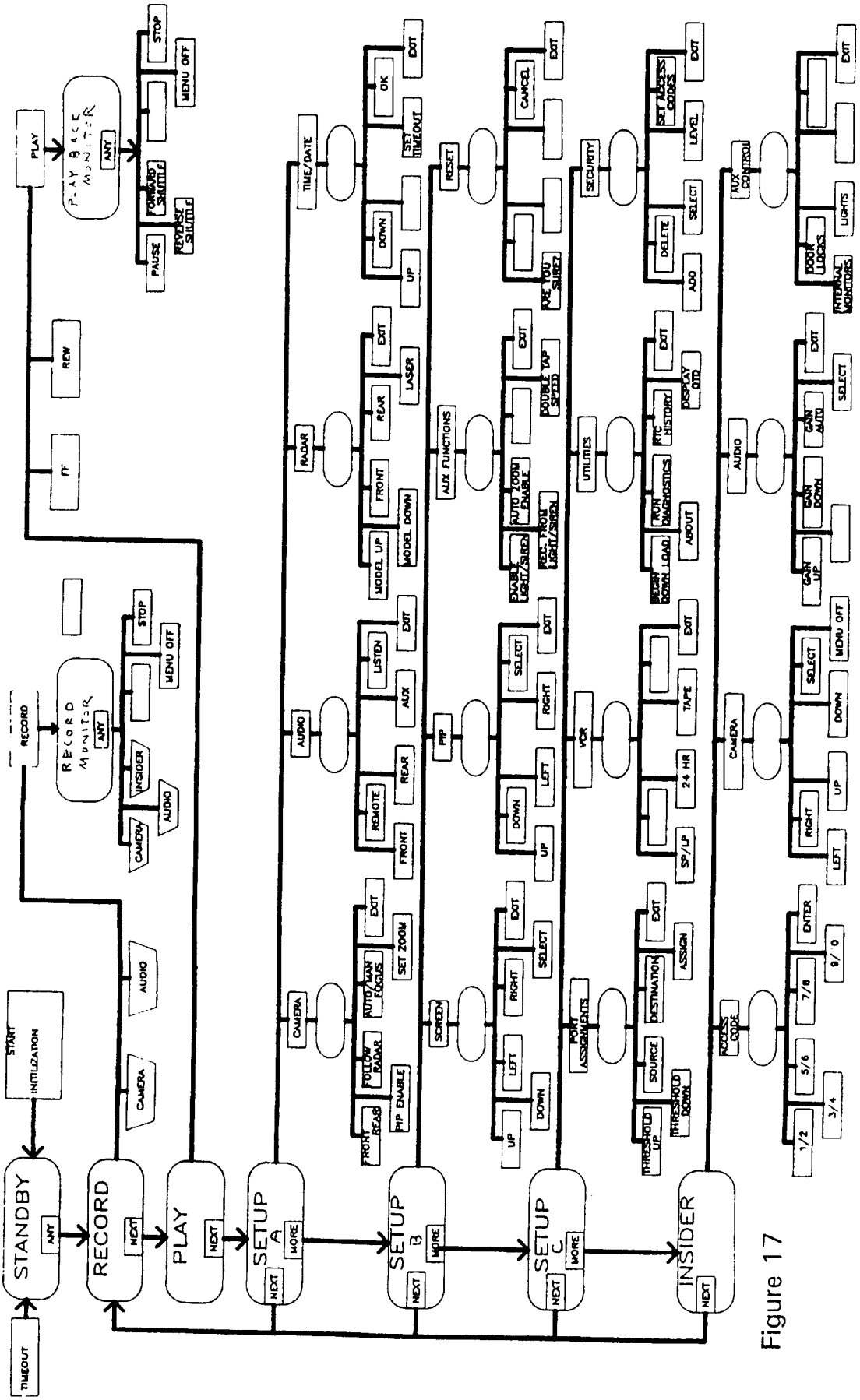
STANDBY
RECORD
PLAY
SETUP A
SETUP B
SETUP C
INSIDER
START INITIALIZATION
TIMEOUT
ANY
NEXT
MORE
RECORD MONITOR
PLAY BACK MONITOR
STOP
MENU OFF
INSIDER
AUDIO
CAMERA
REW
FF
PAUSE
REVERSE SHUTTLE
FORWARD SHUTTLE
RECORD
AUDIO
CAMERA
SCREEN
PIP
VCR
SECURITY
AUX CONTROL
ACCESS CODE
PORT ASSIGNMENTS
TIME/DATE
RADAR
AUX FUNCTIONS
UTILITIES
SET ACCESS CODES
INTERNAL MONITORS
DOOR LOCKS
LIGHTS
SET TIMEOUT
OK
CANCEL
ARE YOU SURE?
DISPLAY OTR
ABOUT
TAPE
24 HR
SP/LP
ASSIGN
SOURCE
DESTINATION
THRESHOLD UP
THRESHOLD DOWN
FOLLOW RADAR
AUTO/MAN FOCUS
SET ZOOM
PIP ENABLE
REMOTE
FRONT
REAR
LISTEN
MODEL UP
MODEL DOWN
LASER
AUTO ZOOM ENABLE
DOUBLE SPEED
REC. FROM LIGHT/SIREN
ENABLE LIGHT/SIREN
IRON DOWN LOAD
IRON DIAGNOSTICS
RTC LISTBOARD
GAIN UP
GAIN DOWN
GAIN AUTO
ENTER
1/2
3/4
5/6
7/8
9/0

Figure 17

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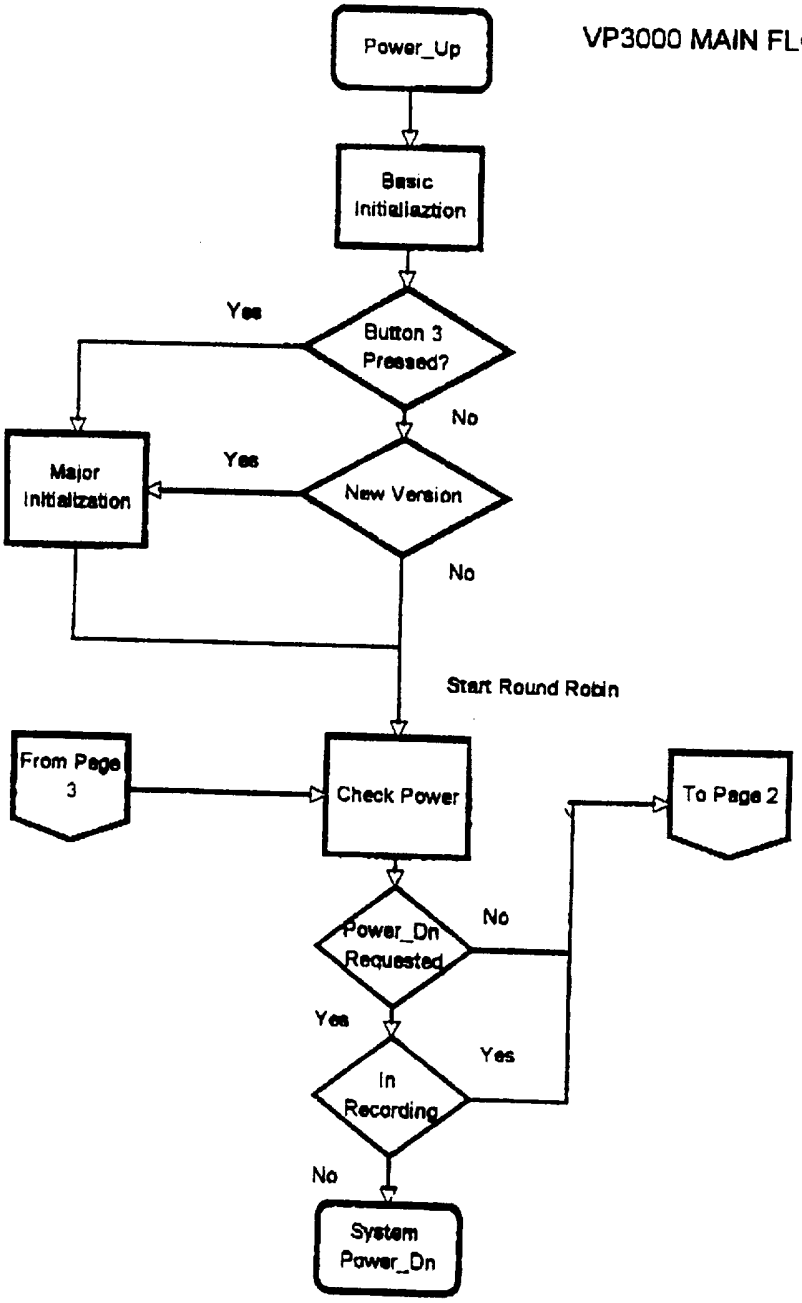

Figure 18A

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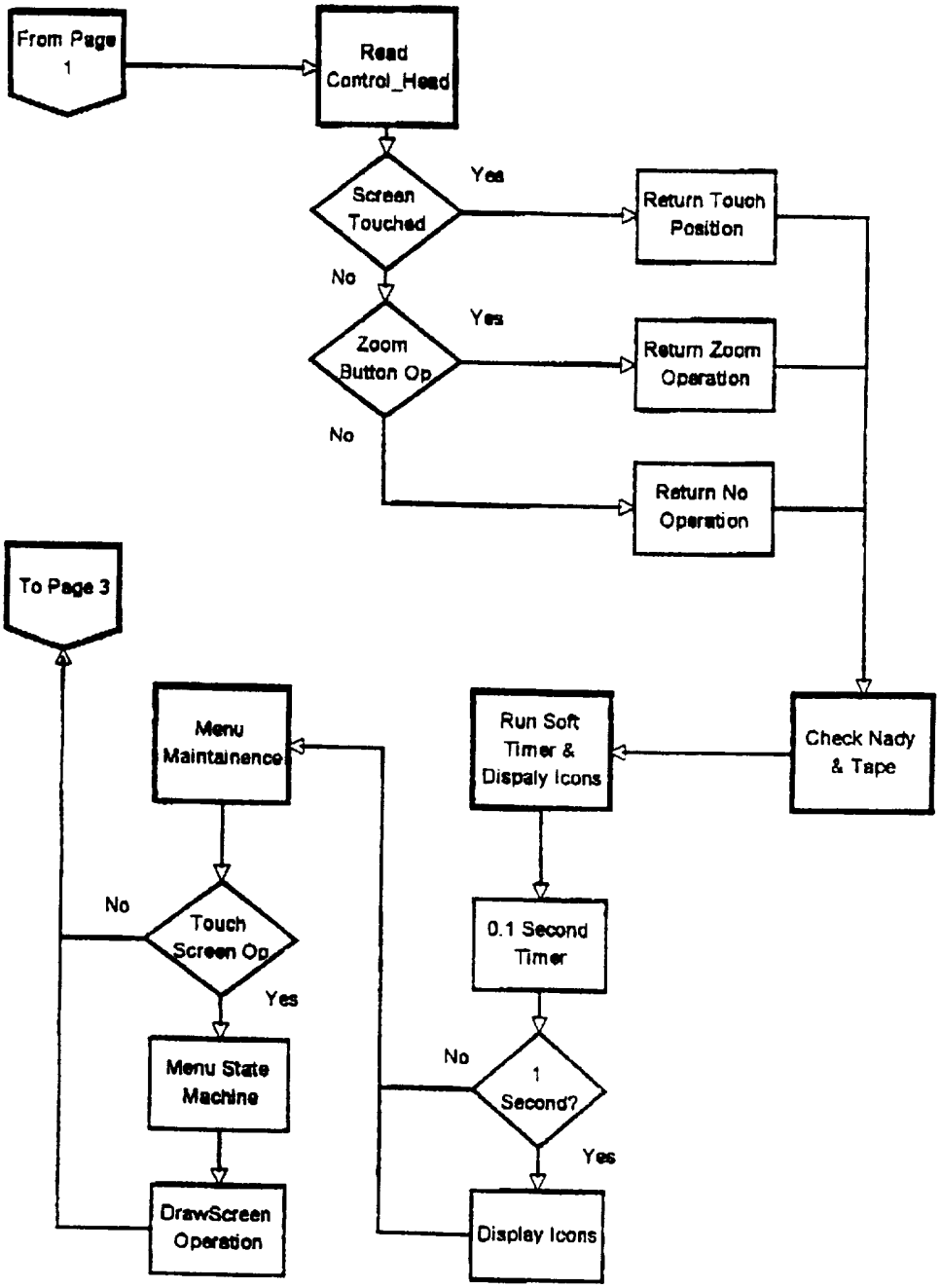

Figure 18B

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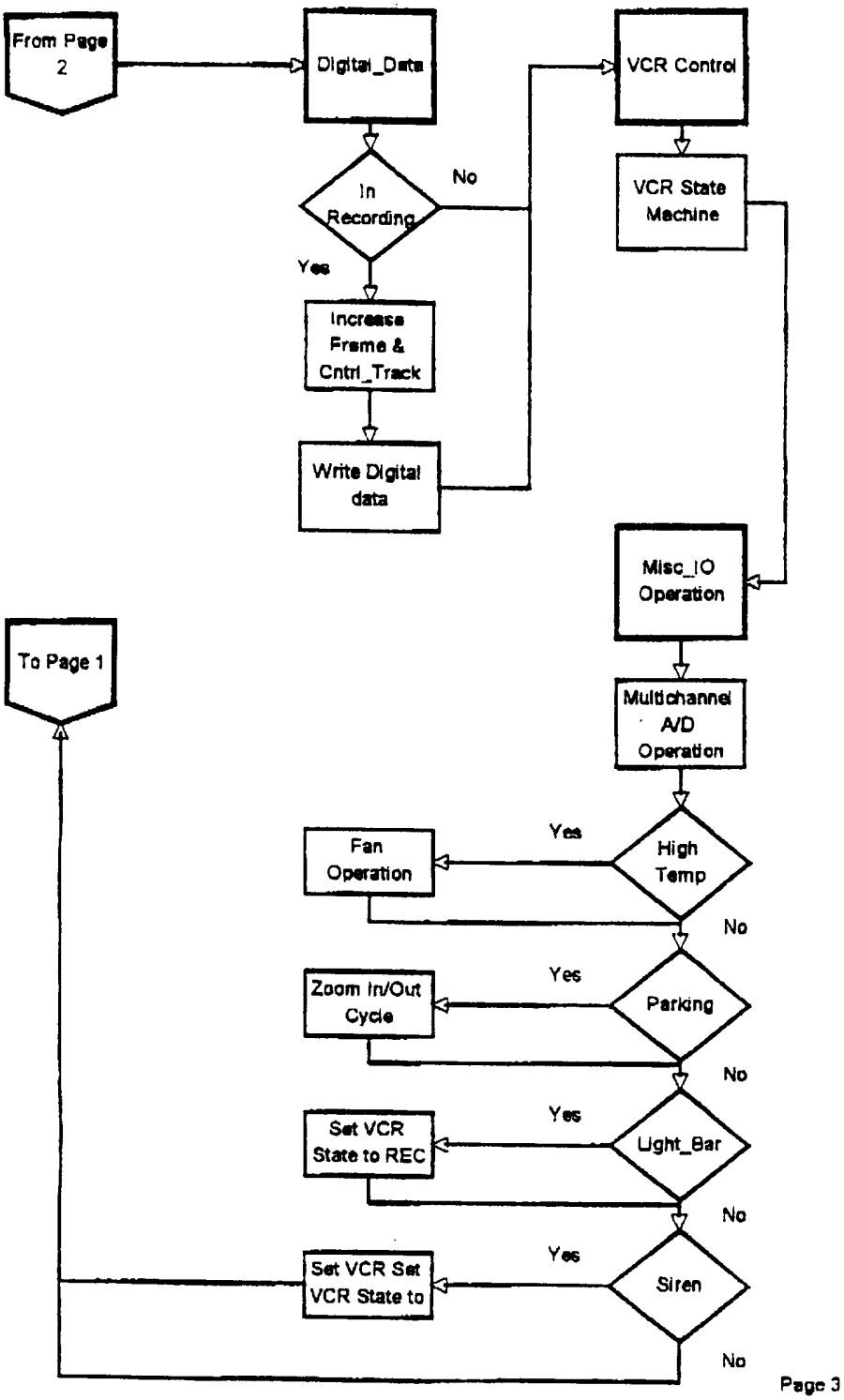

Figure 18C

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VP3000 INTERRUPT SERVICE ROUTINE FLOW CHARTS

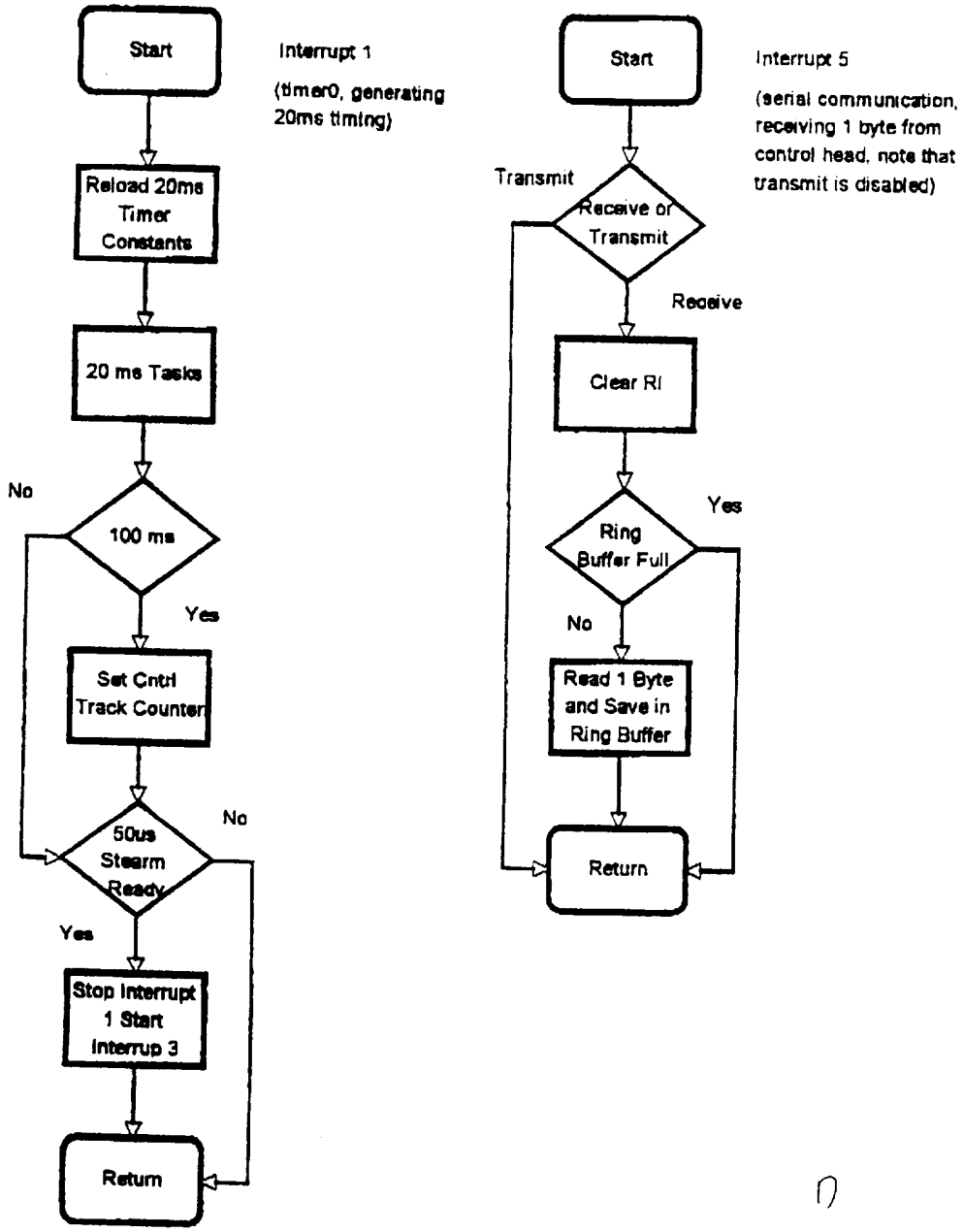
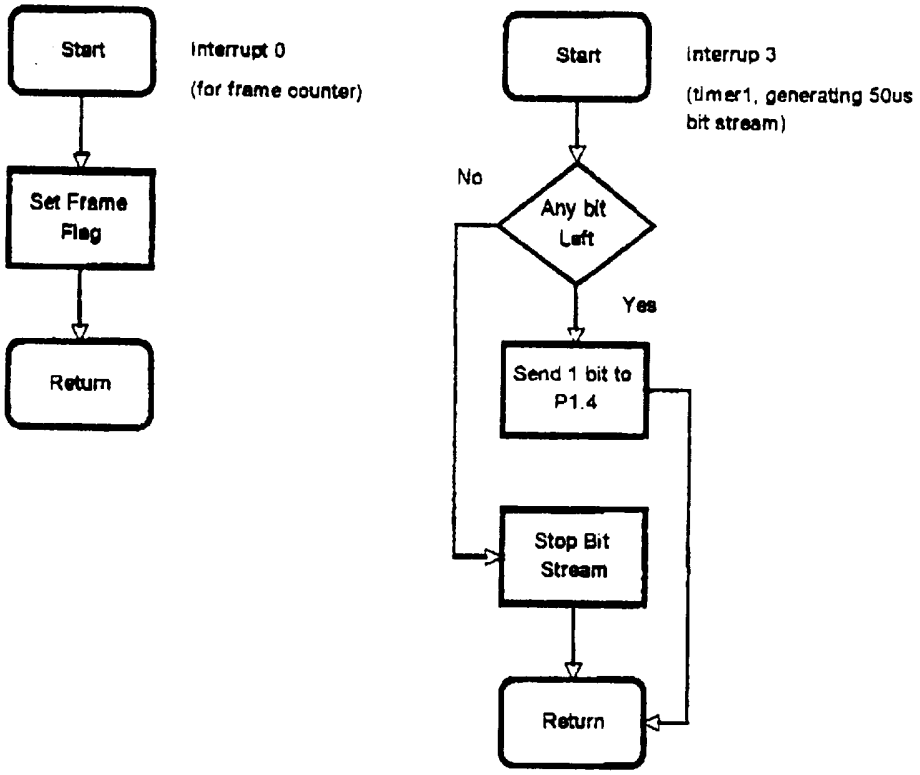


Figure 18D

VP3000 INTERRUPT SERVICE ROUTINE FLOW CHARTS



E

Figure 18E

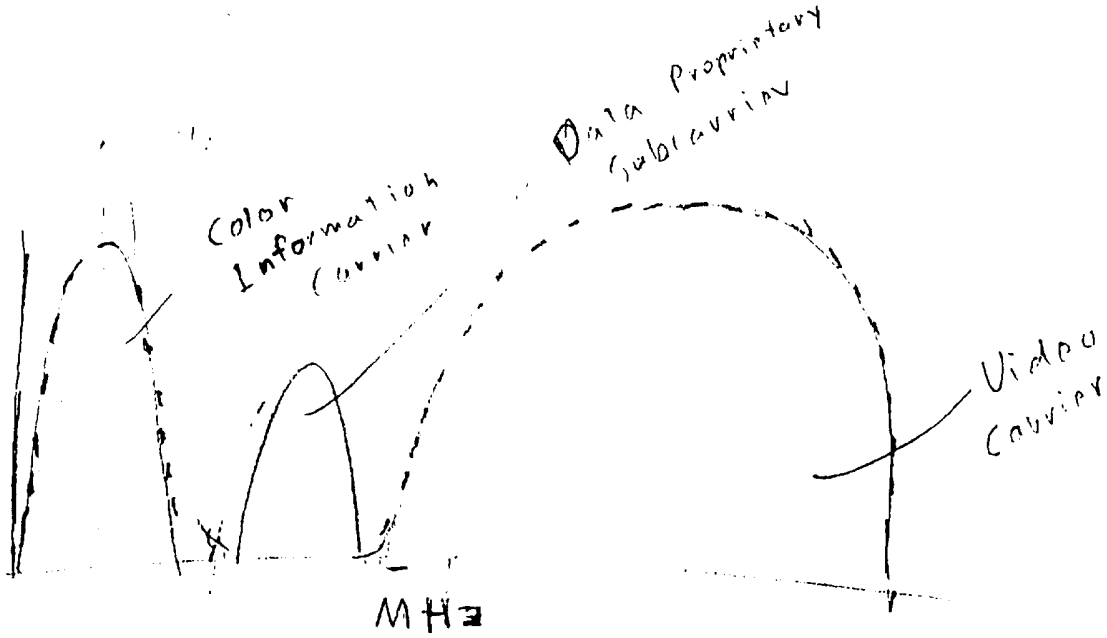

Color Information Carrier
Data Proprietary Subcarrier
Video Carrier
MHz

Figure 19

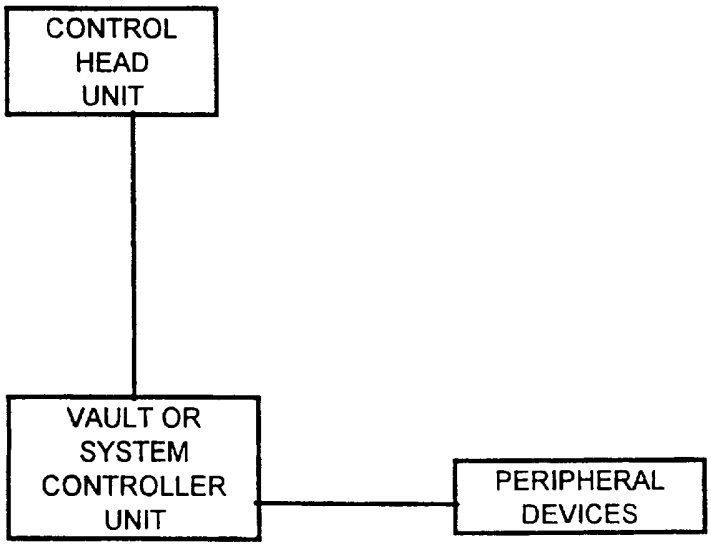

CONTROL HEAD UNIT
VAULT OR SYSTEM CONTROLLER UNIT
PERIPHERAL DEVICES

Figure 20

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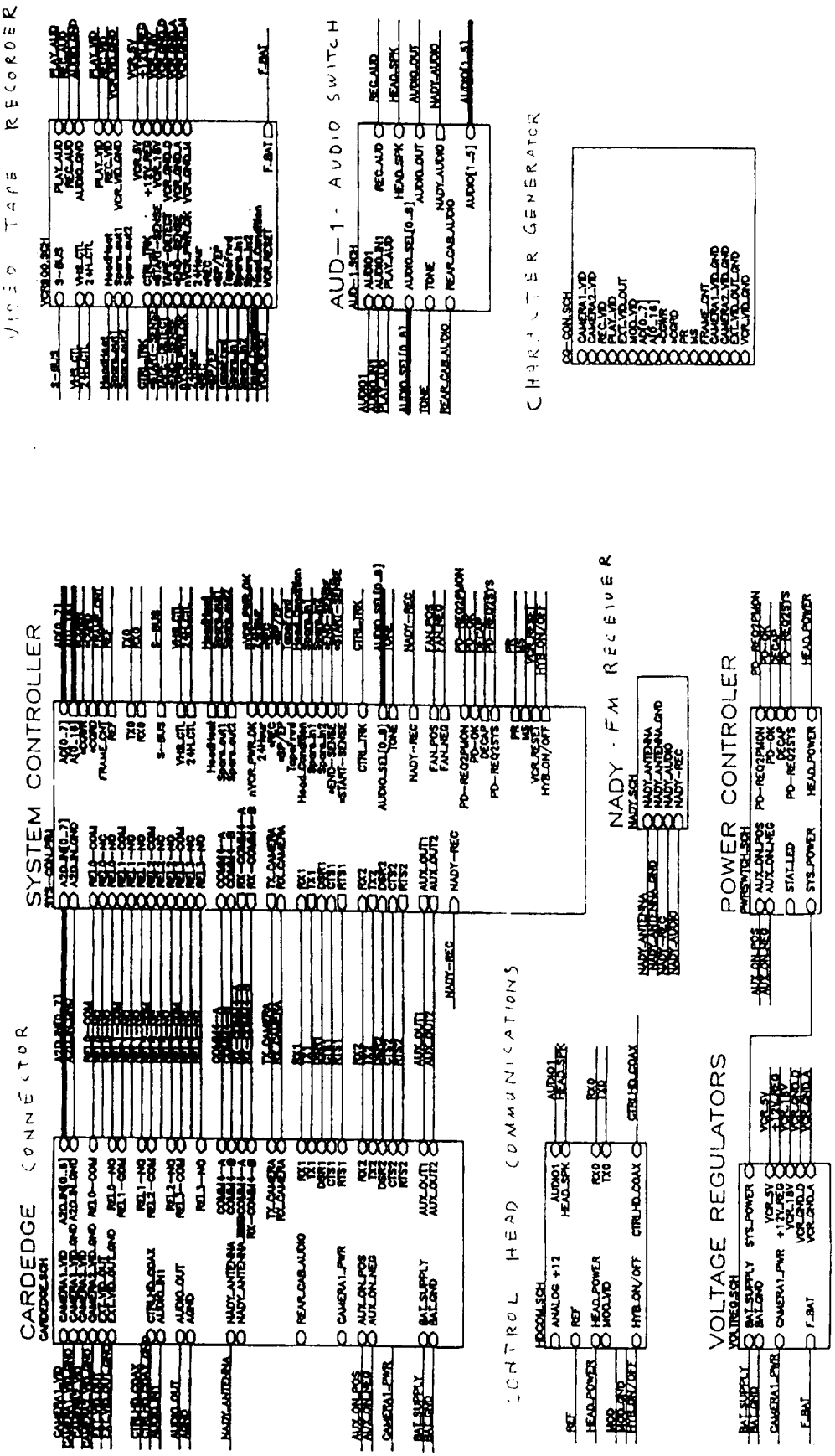

Figure 21

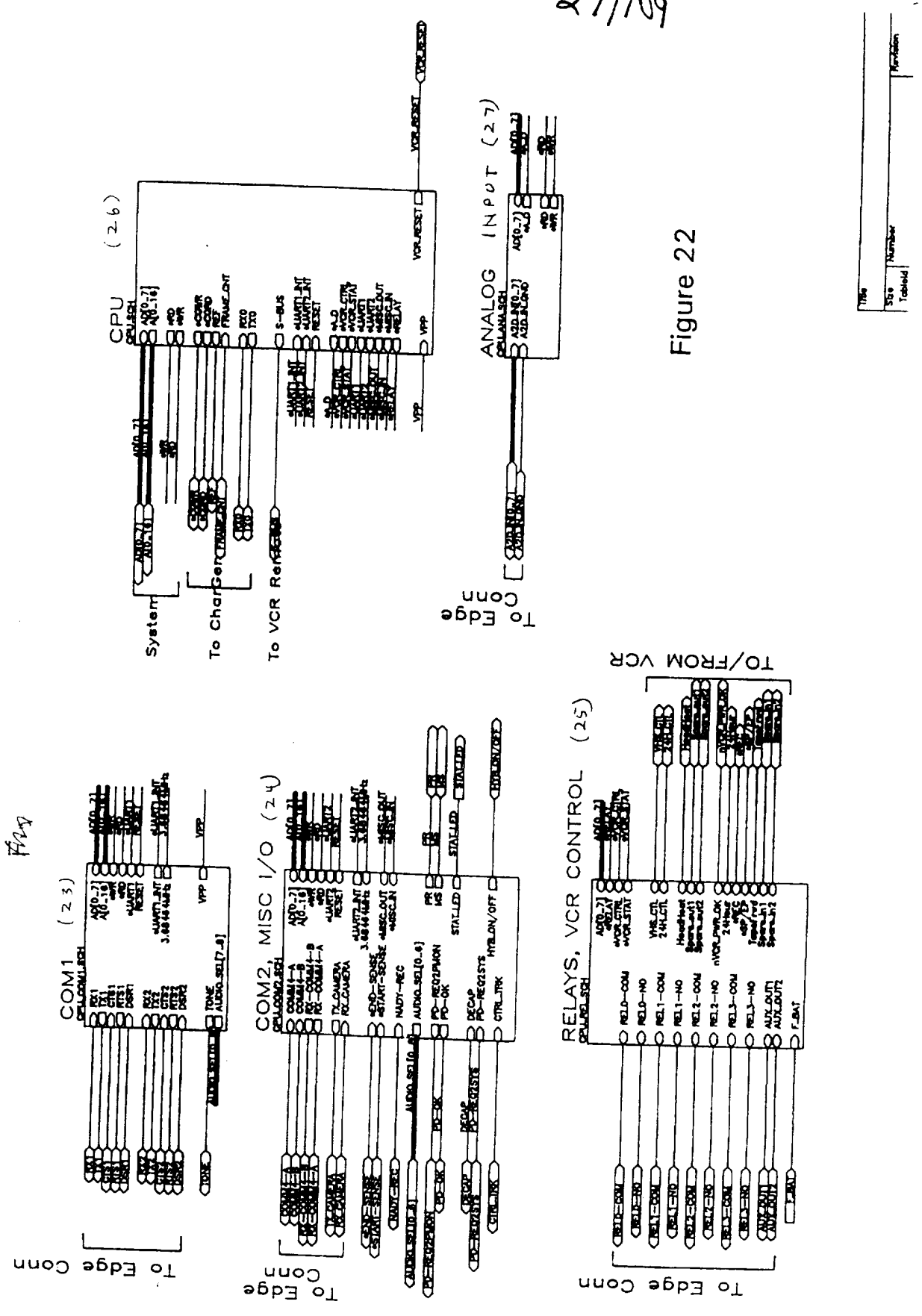
CPU (26)
ANALOG INPUT (27)
To Edge Conn
System
To Charger
To VCR Reset
COM1 (23)
COM2, MISC I/O (24)
RELAYS, VCR CONTROL (25)
TO/FROM VCR
To Edge Conn
To Edge Conn
To Edge Conn

Figure 22

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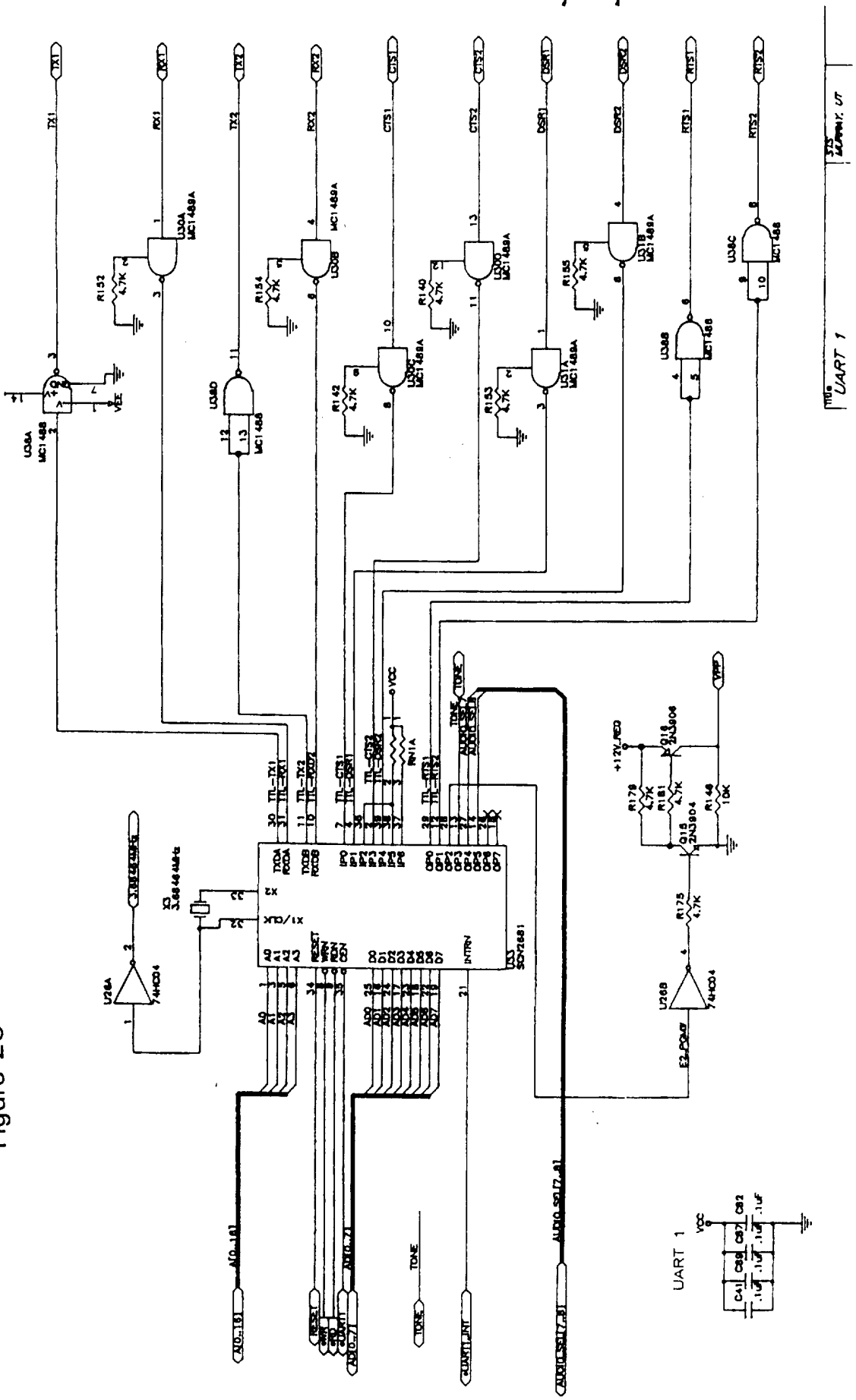

Figure 23

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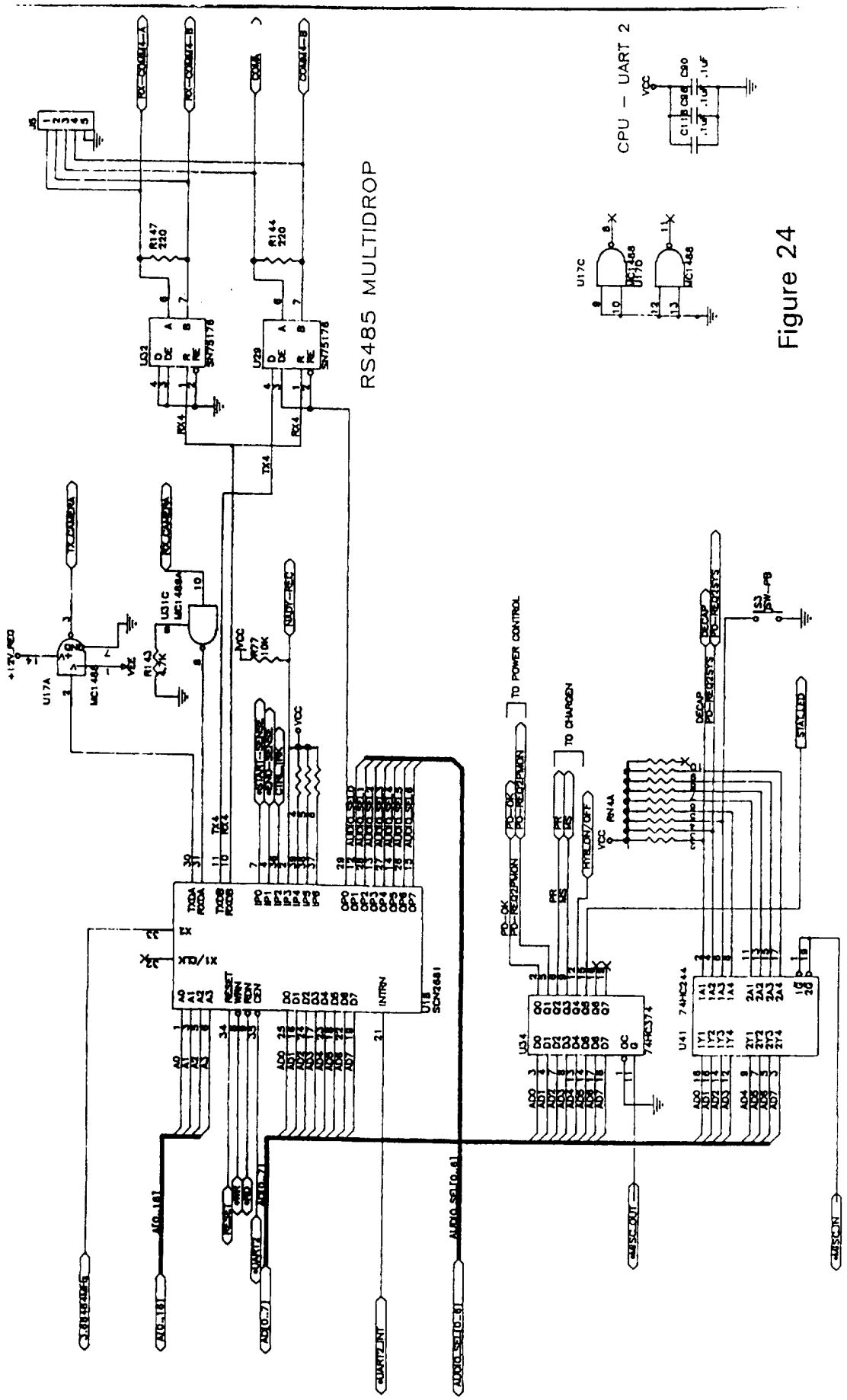

Figure 24

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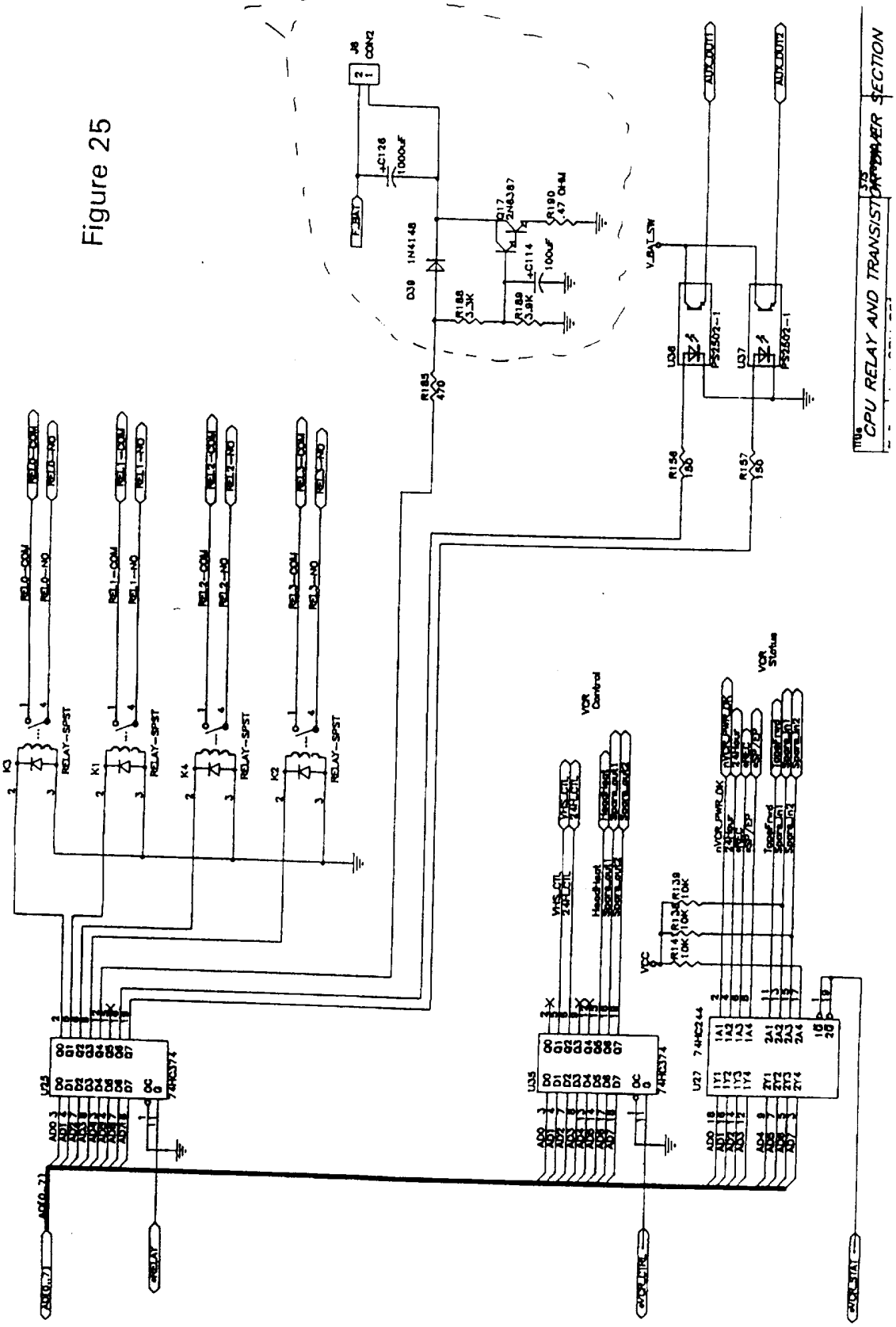
Figure 25



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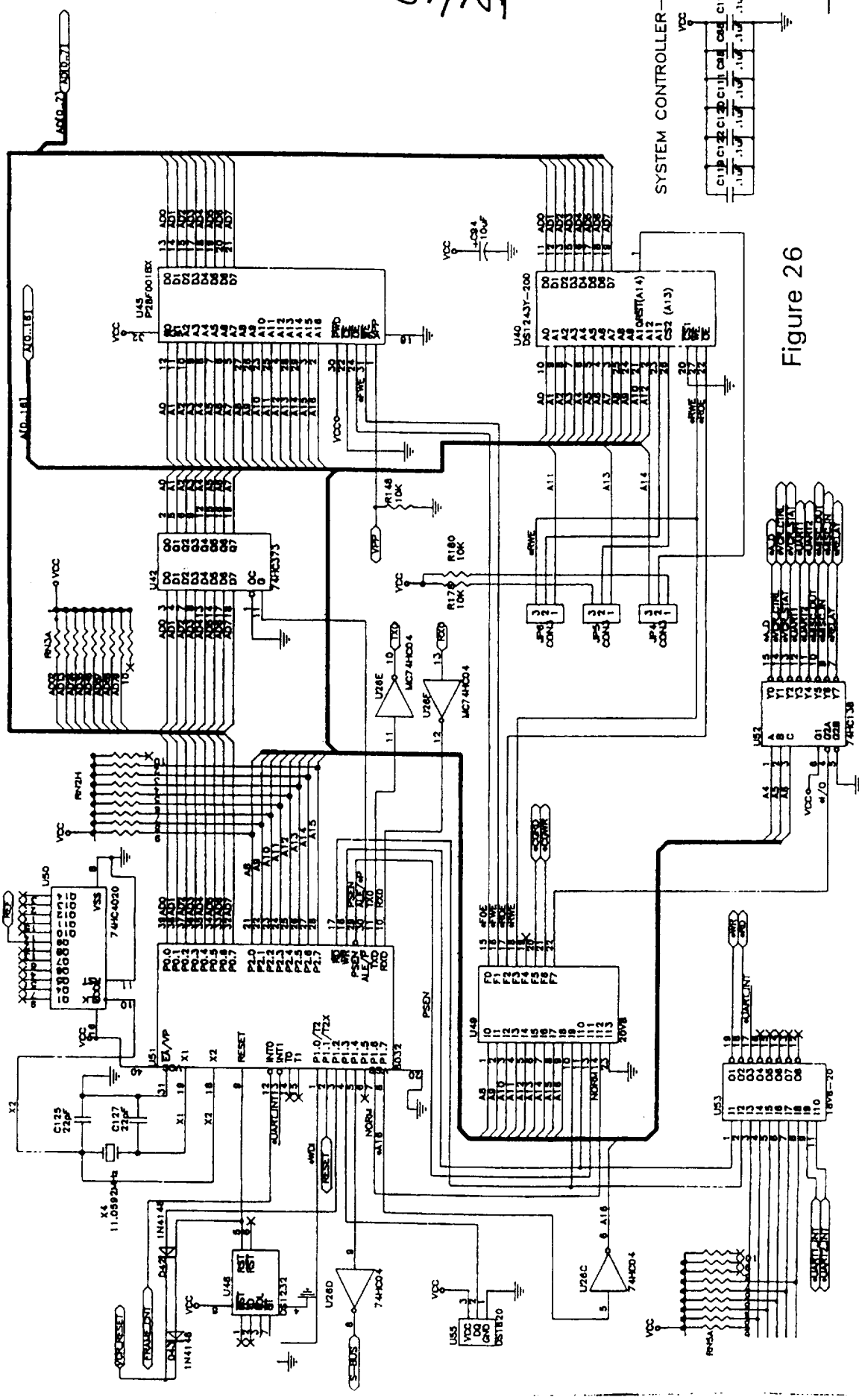

Figure 26

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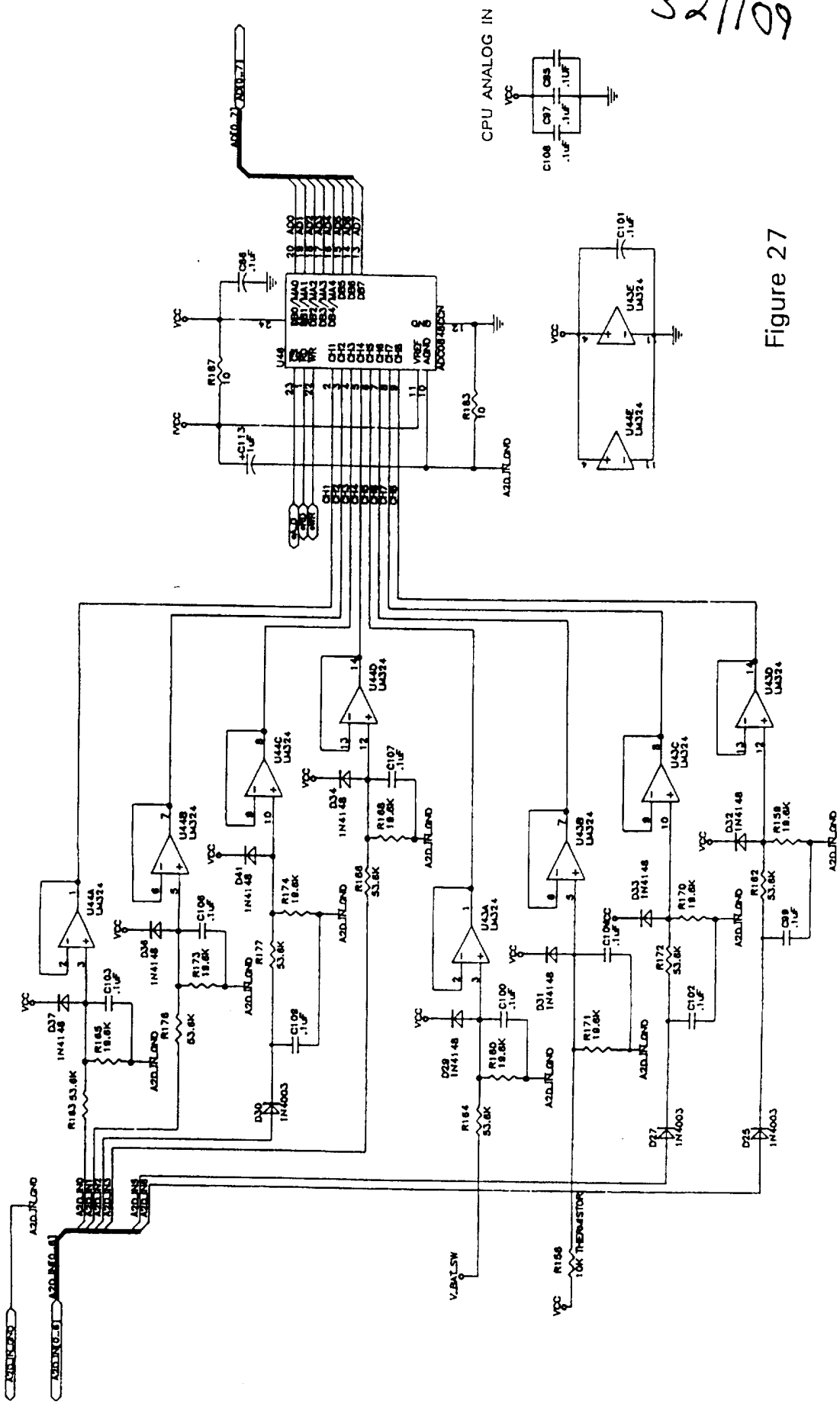
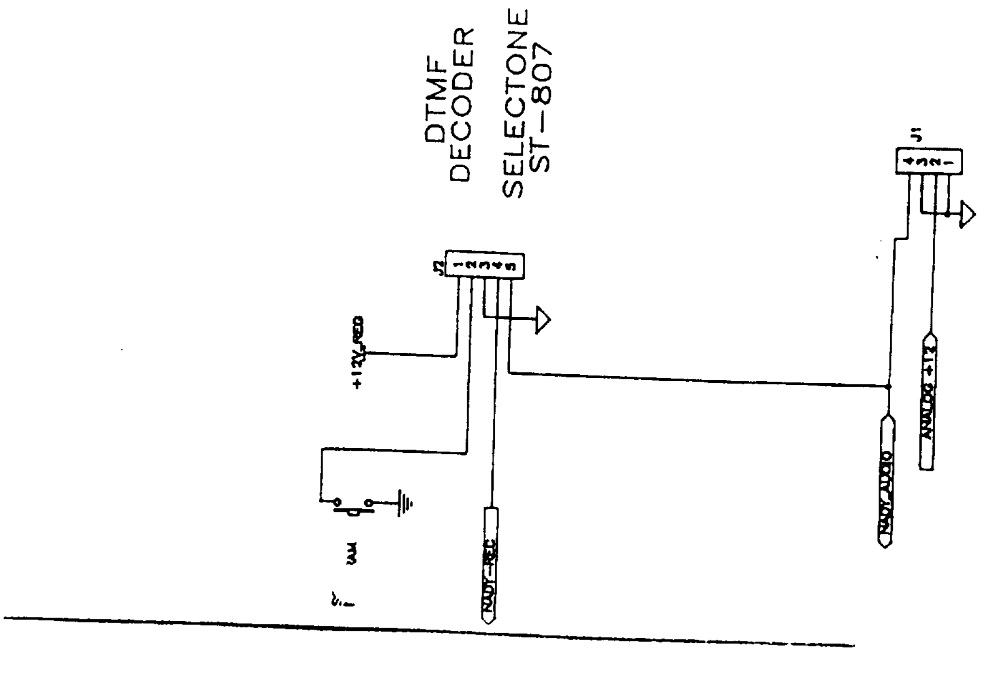


Figure 27

Figure 28



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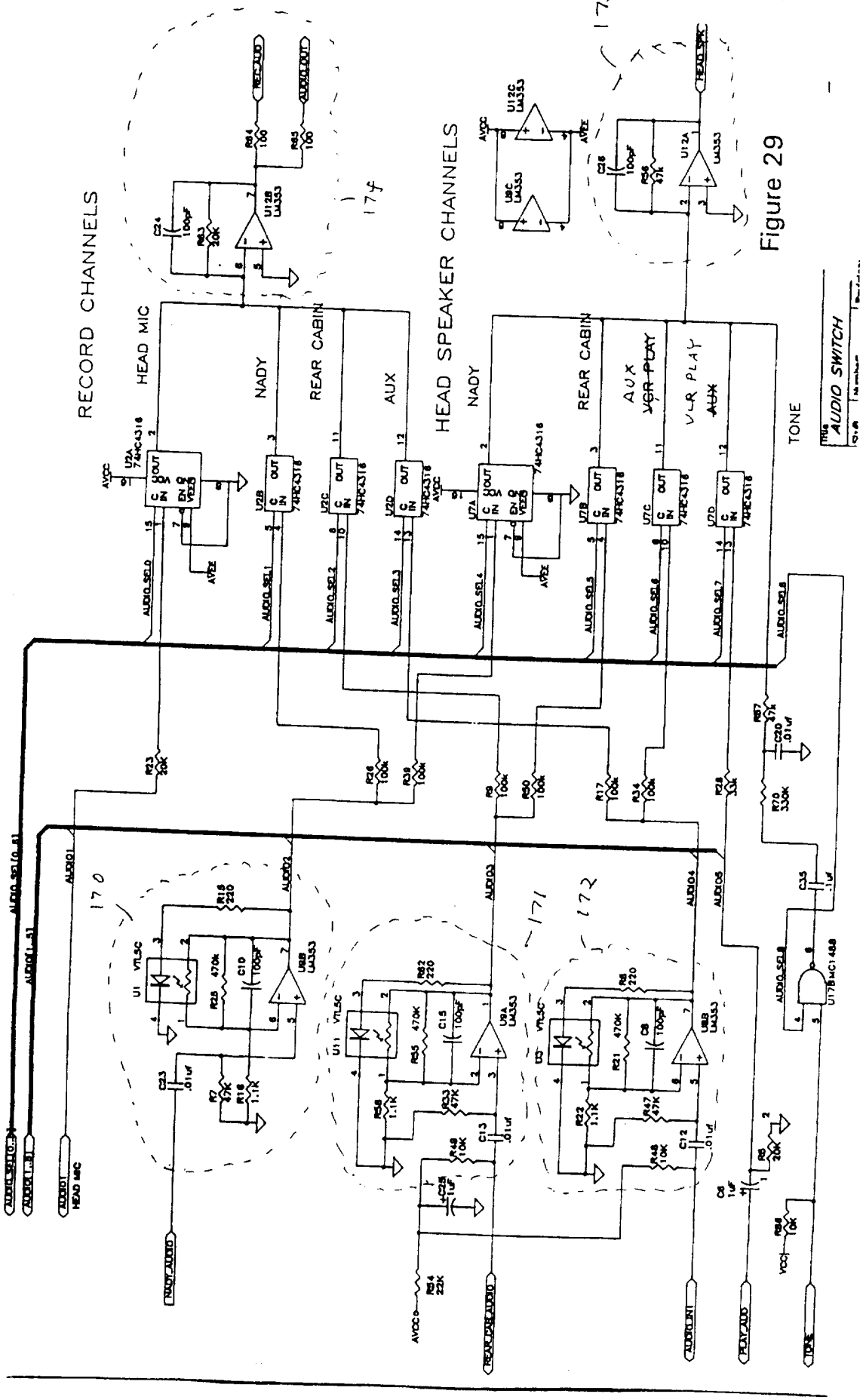

Figure 29

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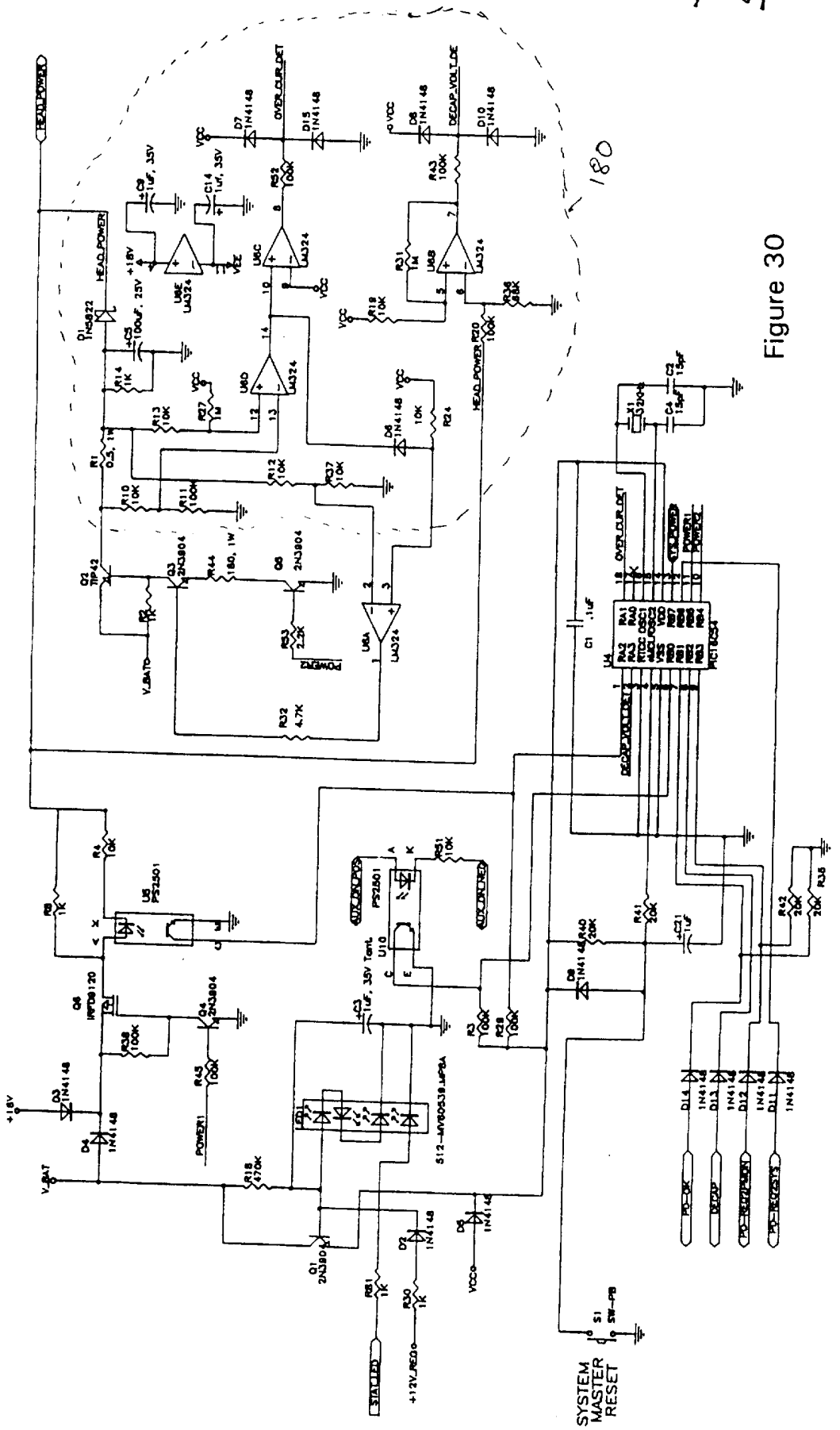

Figure 30

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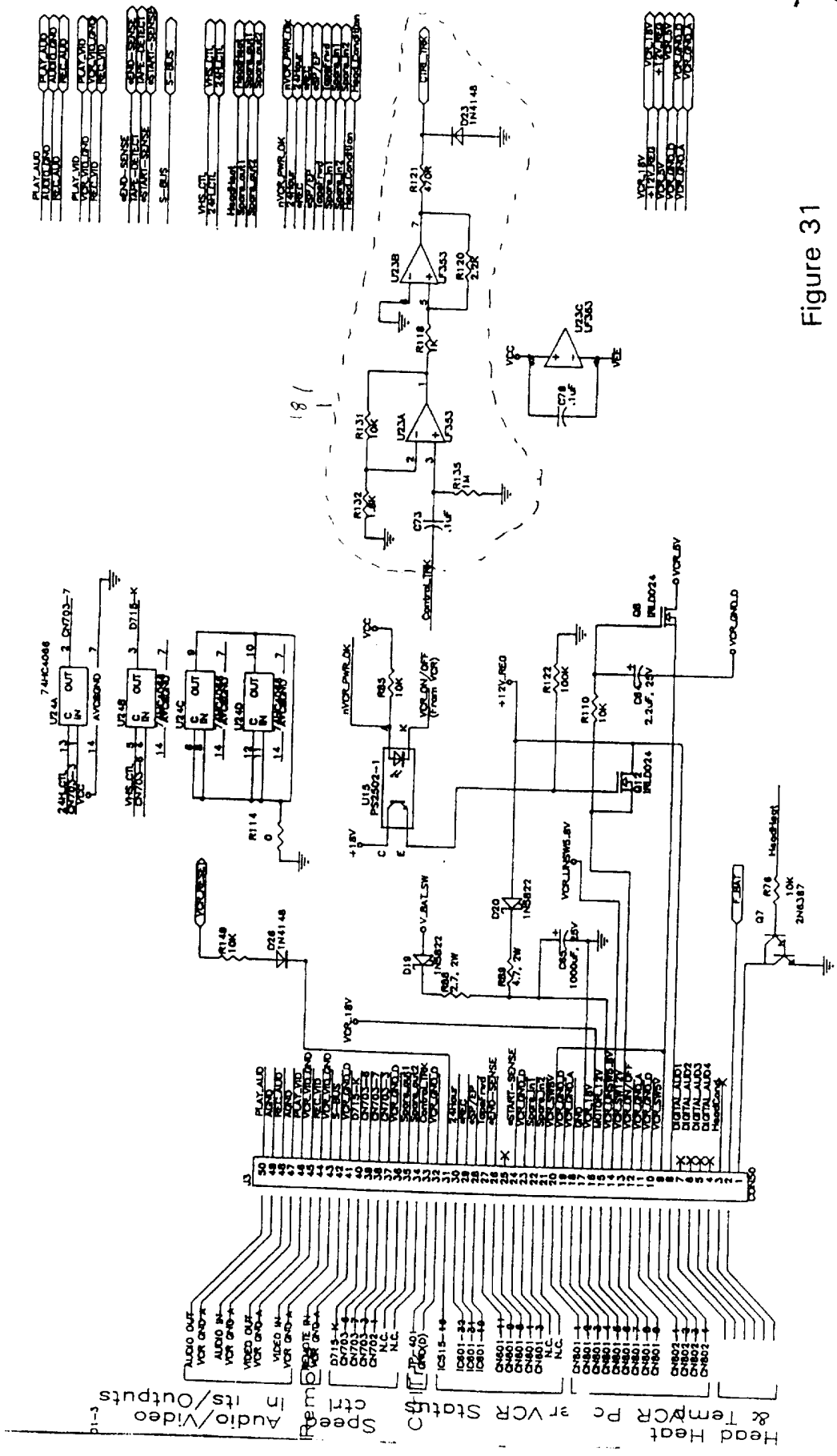

Figure 31

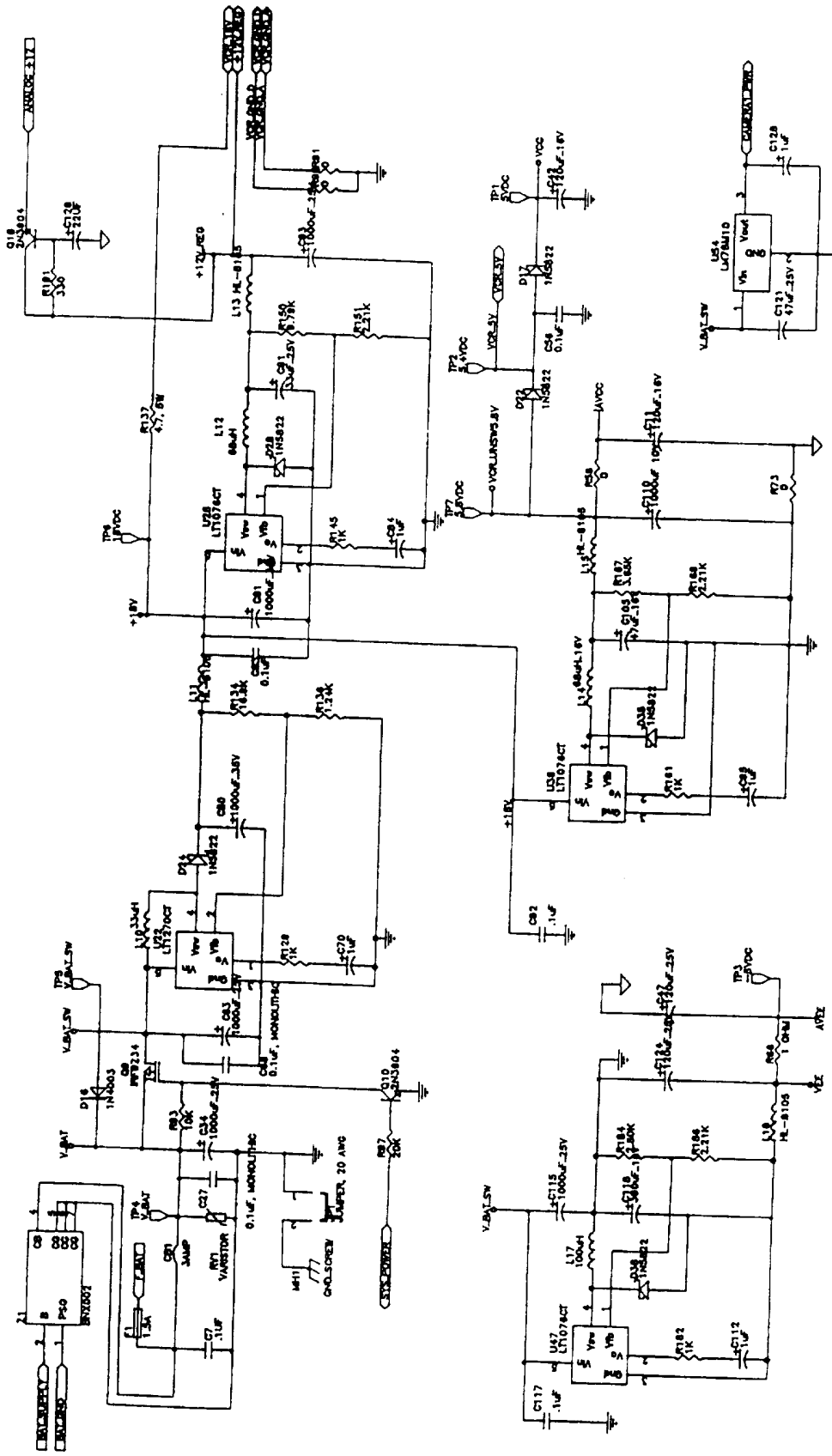

Figure 32

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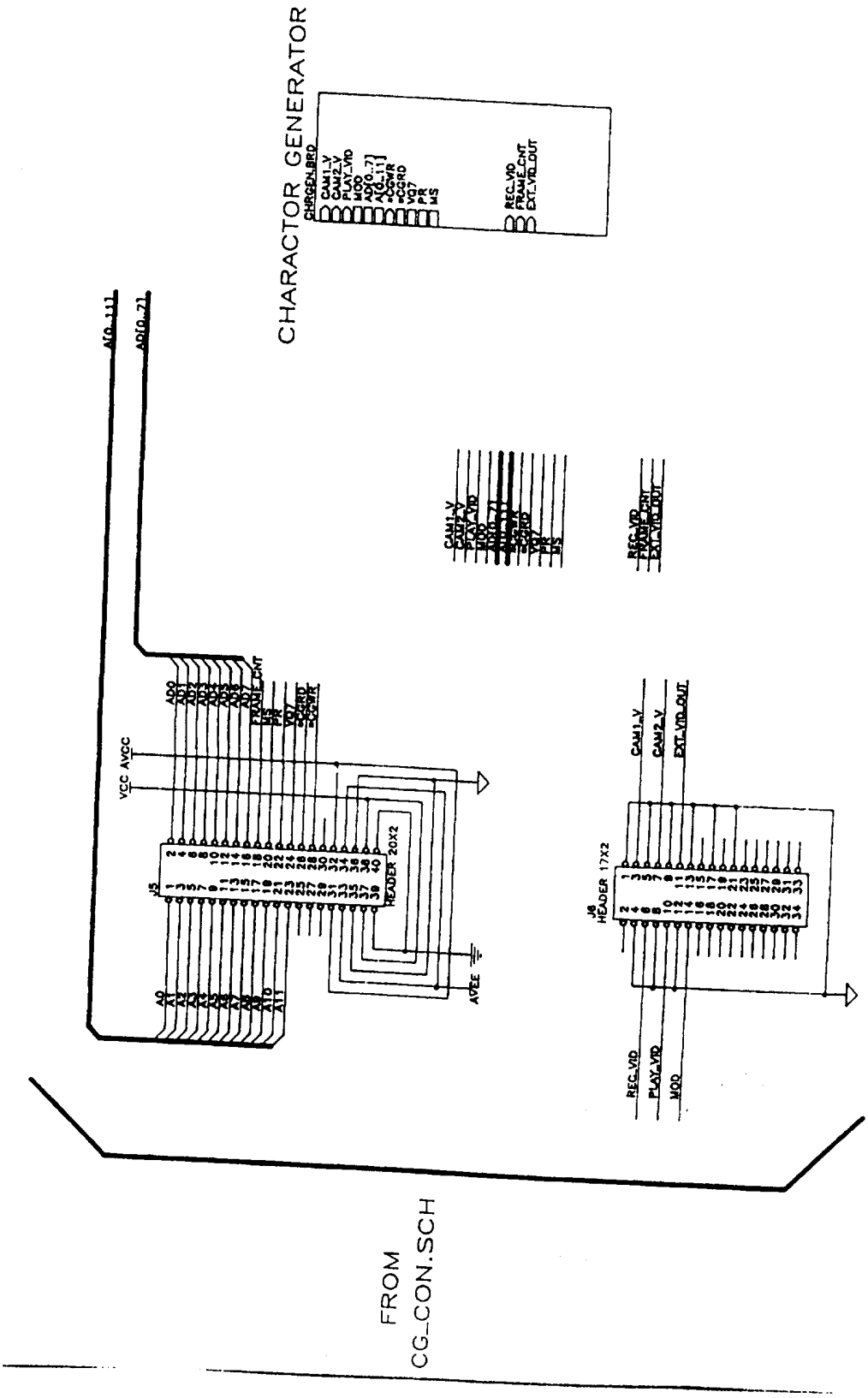

Figure 33

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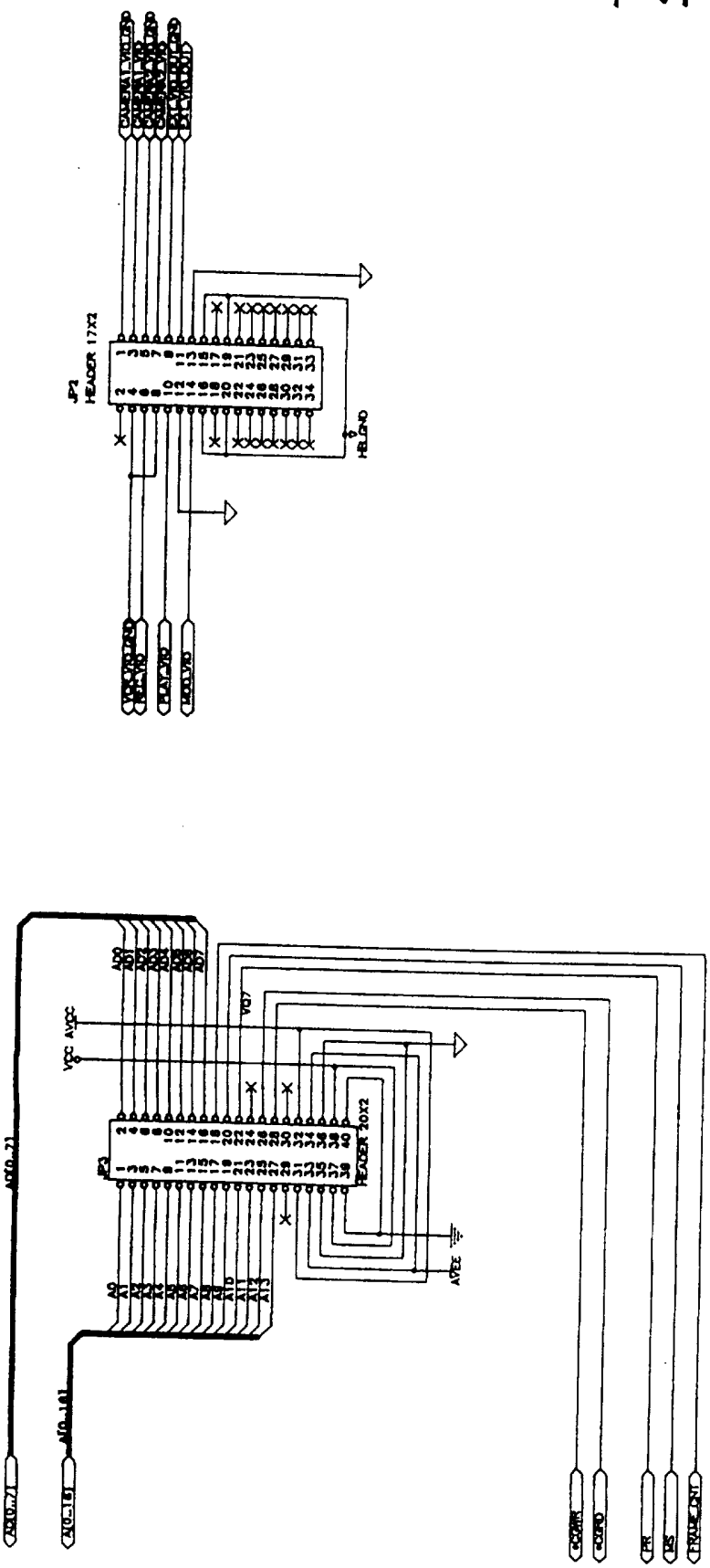

Figure 34

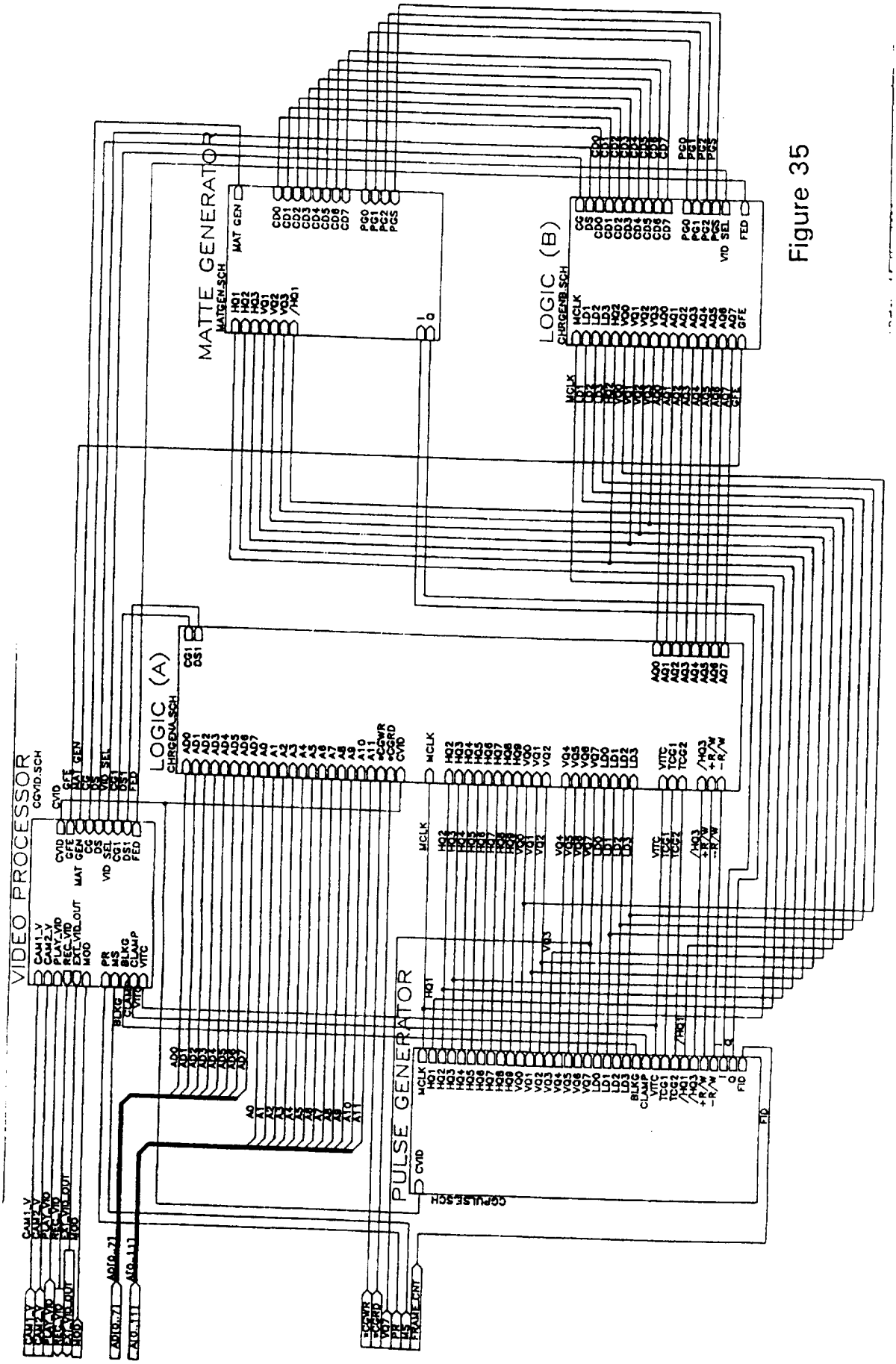
MATTE GENERATOR
MATGEN.SCH
LOGIC (B)
CHRGENB.SCH
LOGIC (A)
CHRGENA.SCH
VIDEO PROCESSOR
CGVID.SCH
PULSE GENERATOR
CGPULSE.SCH

Figure 35

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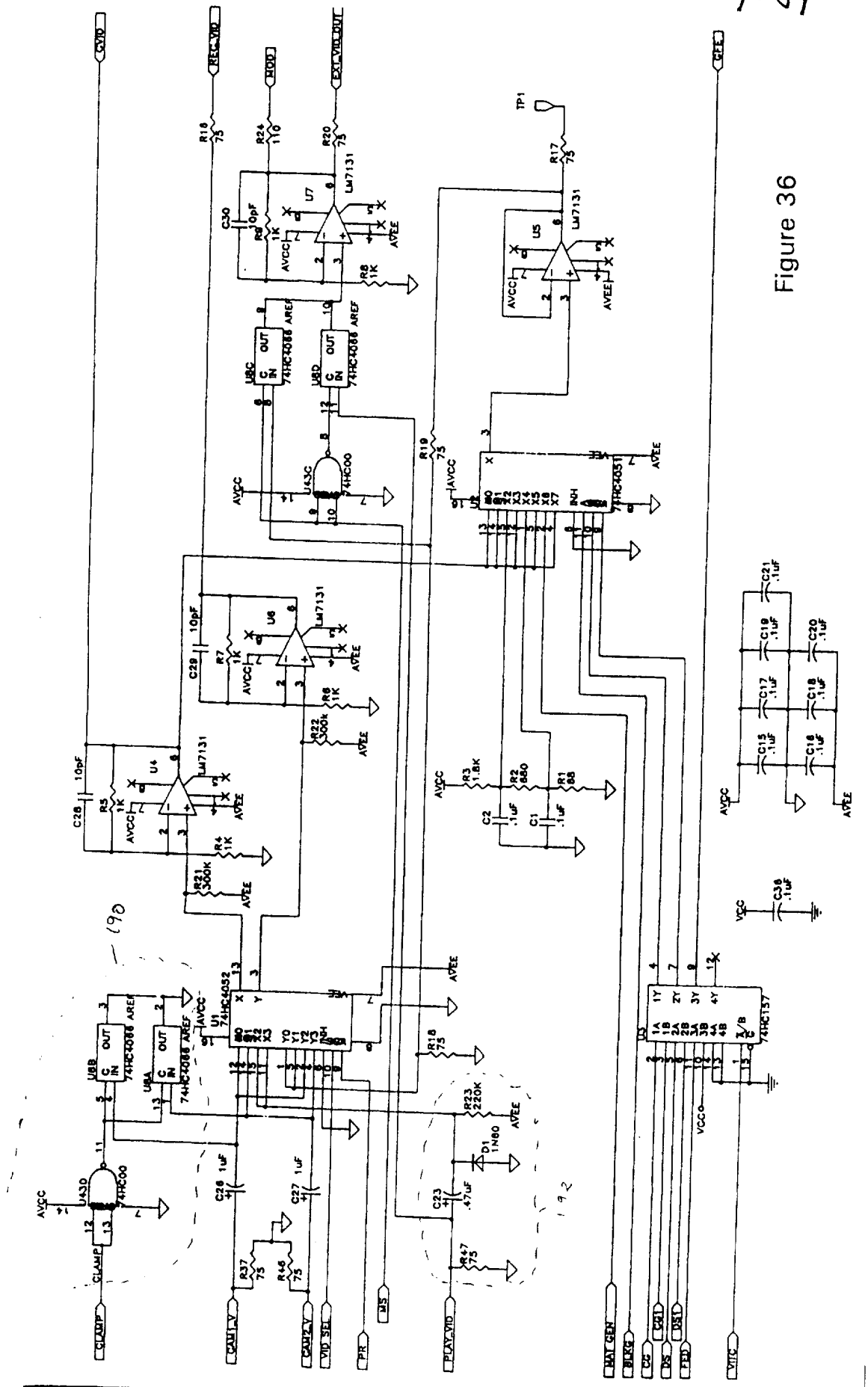

Figure 36

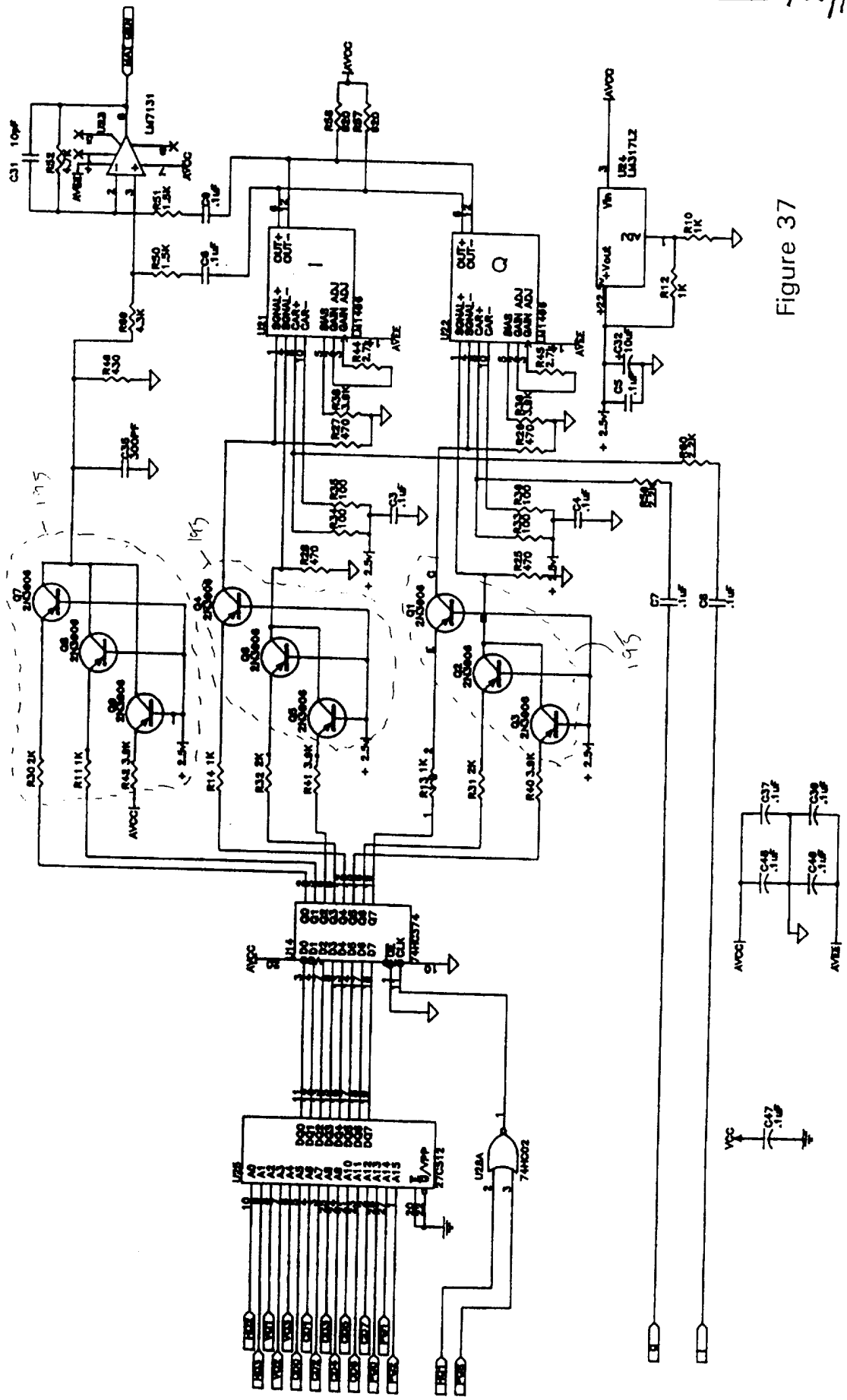

Figure 37

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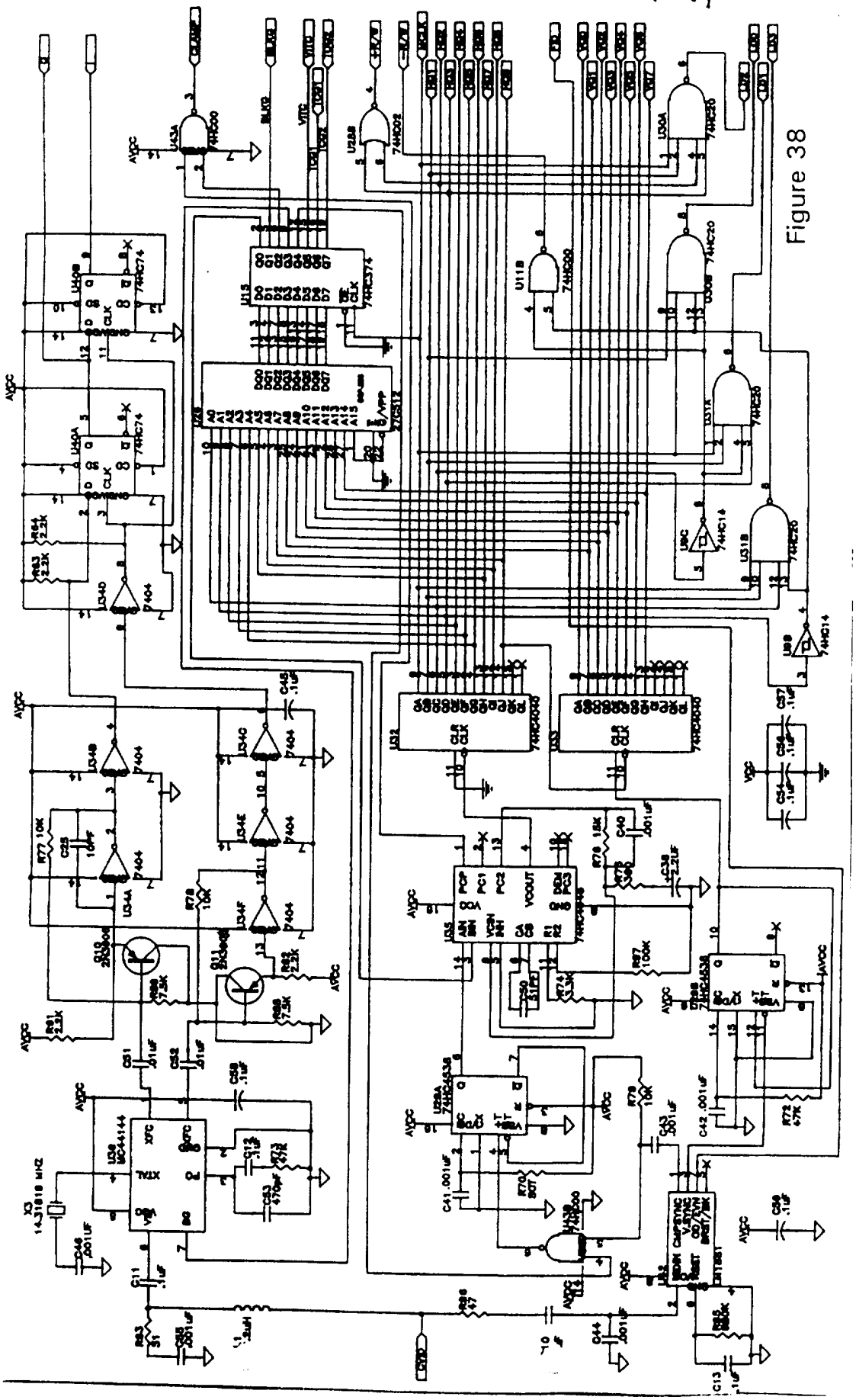

Figure 38

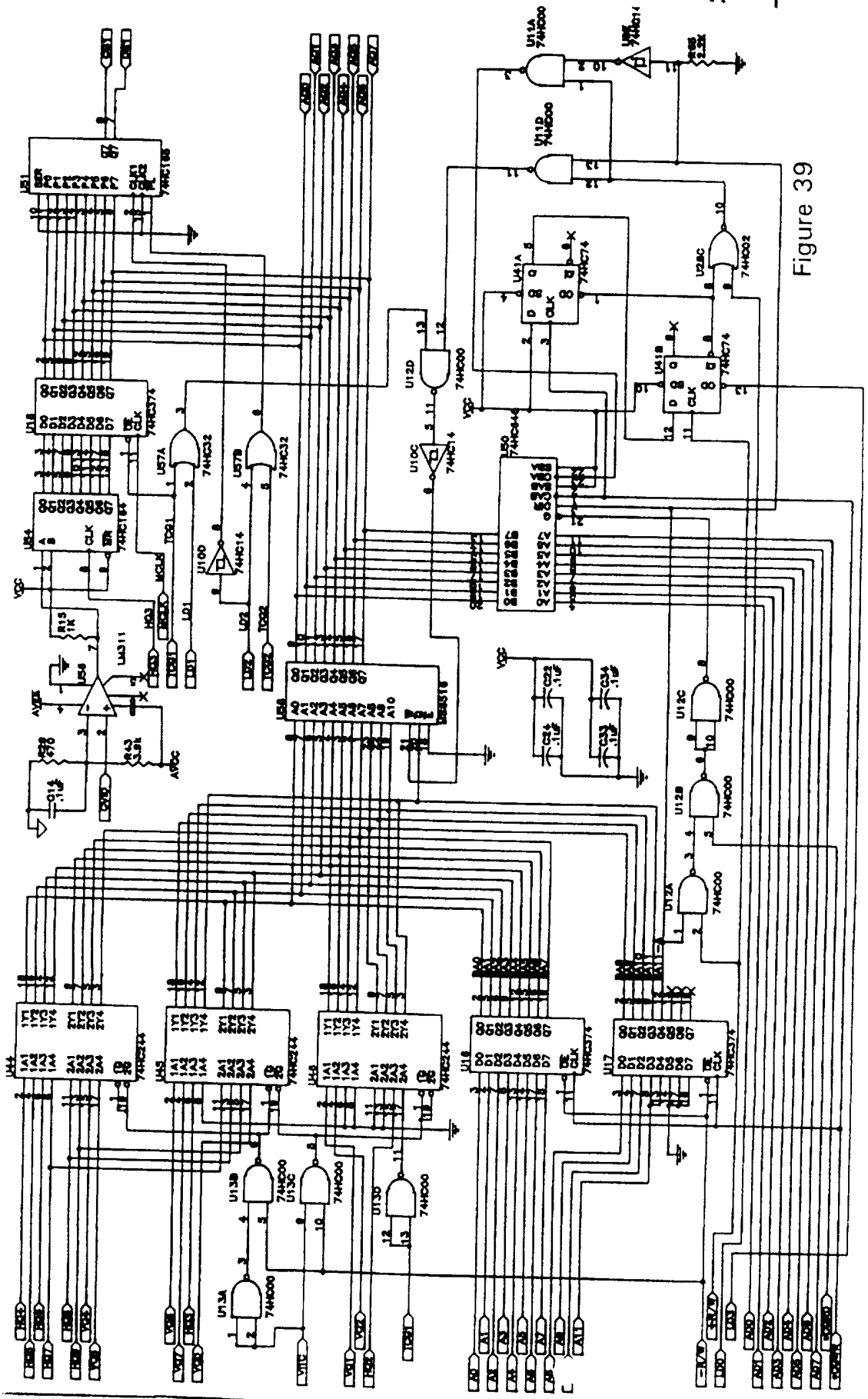

Figure 39

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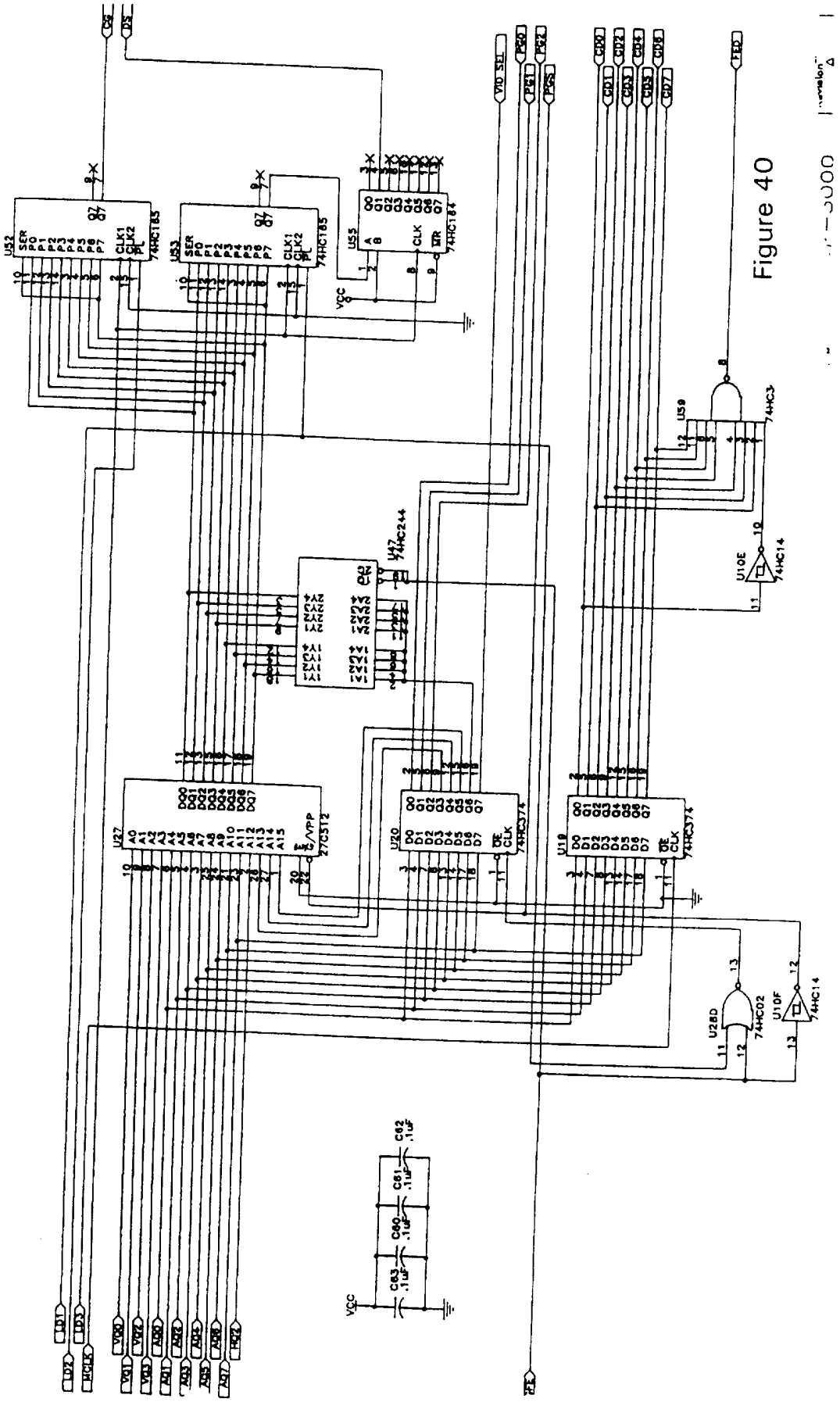

Figure 40

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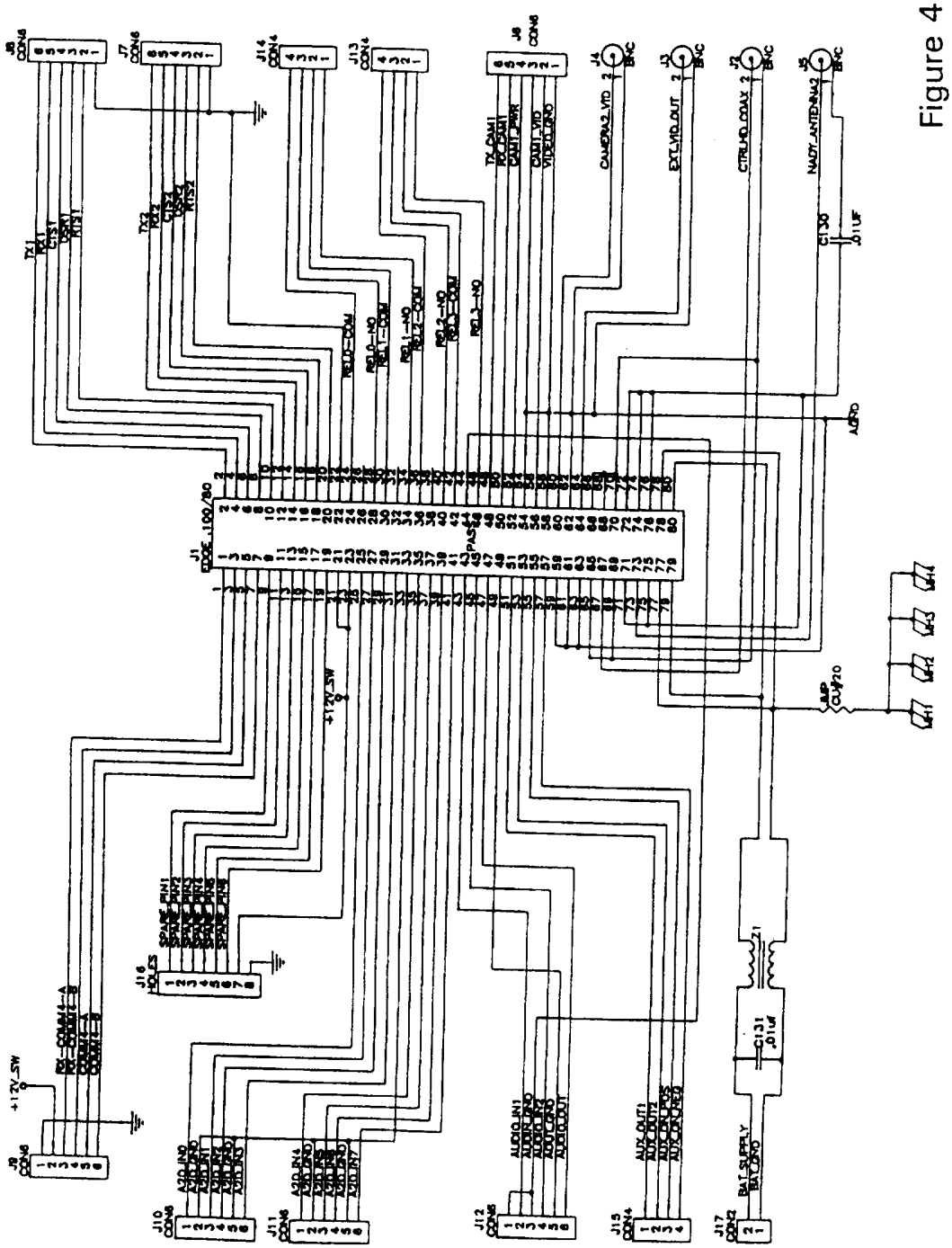

Figure 41

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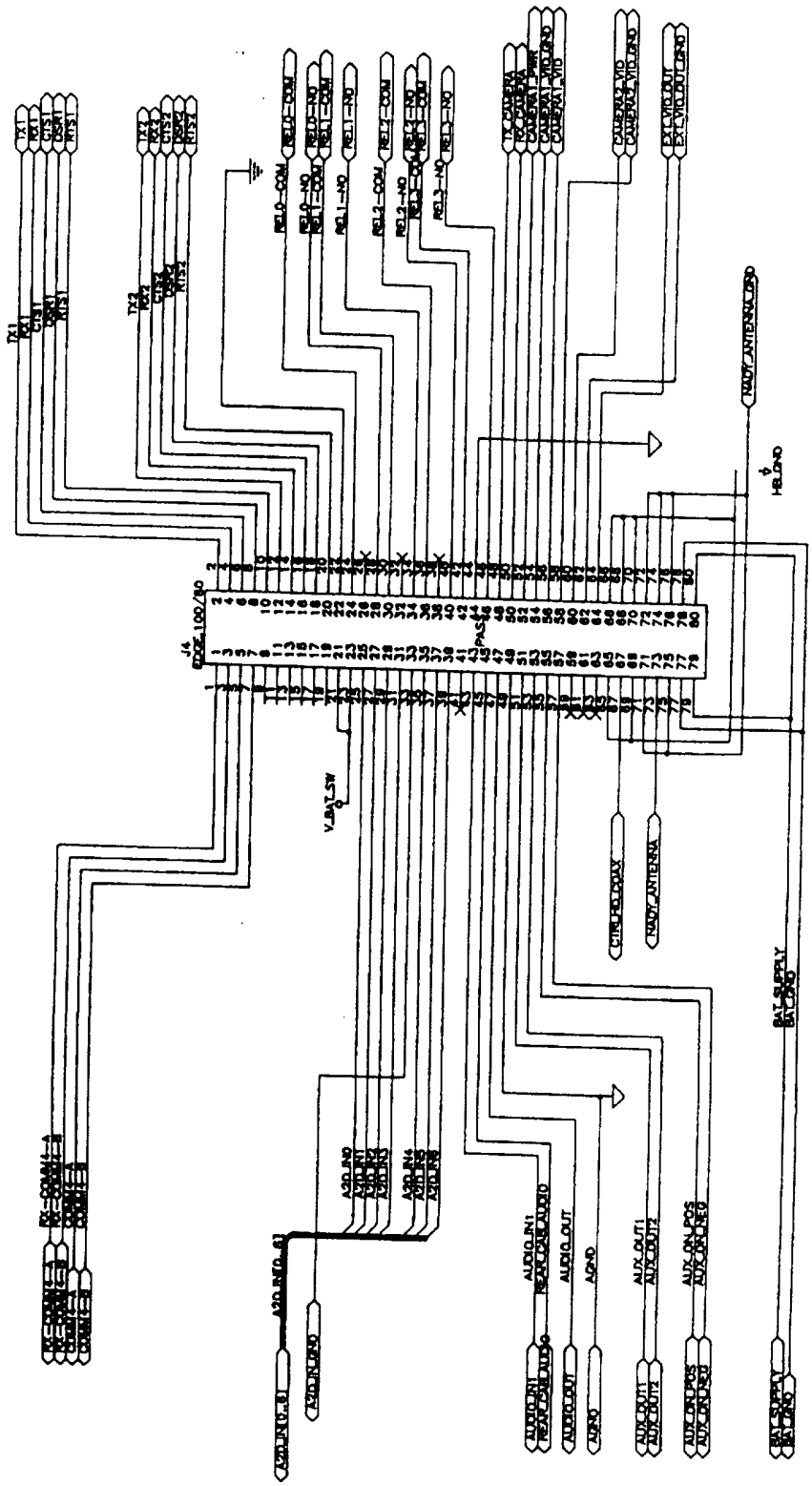

Figure 42

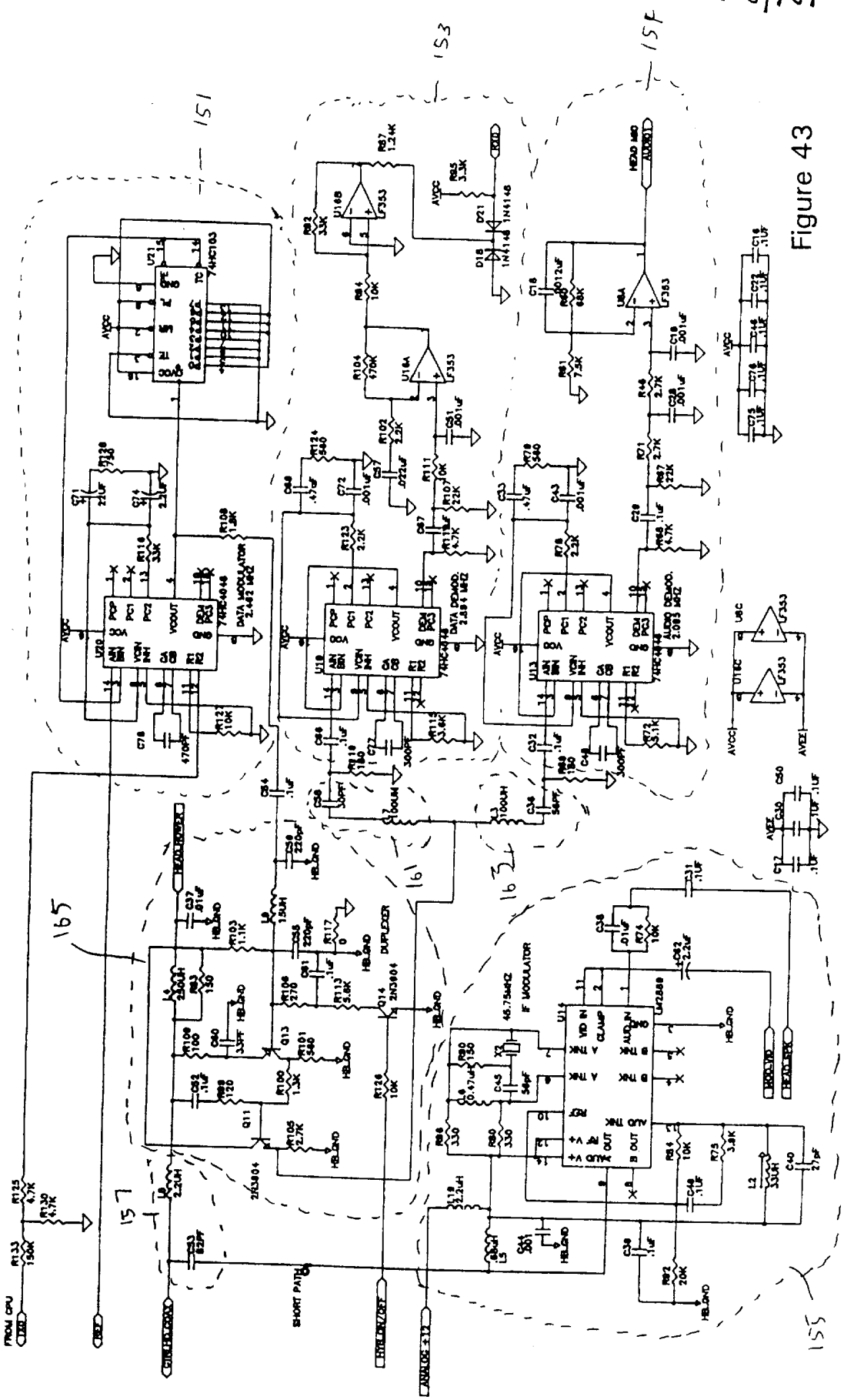
151
153
155
157
159
161
163
165
DUPLEXER
IF MODULATOR
SHORT PATH
FROM CPU
DATA MODULATOR 2.442 MHZ
DATA DEMOD. 2.481 MHZ
AUDIO DEMOD. 2.093 MHZ

Figure 43

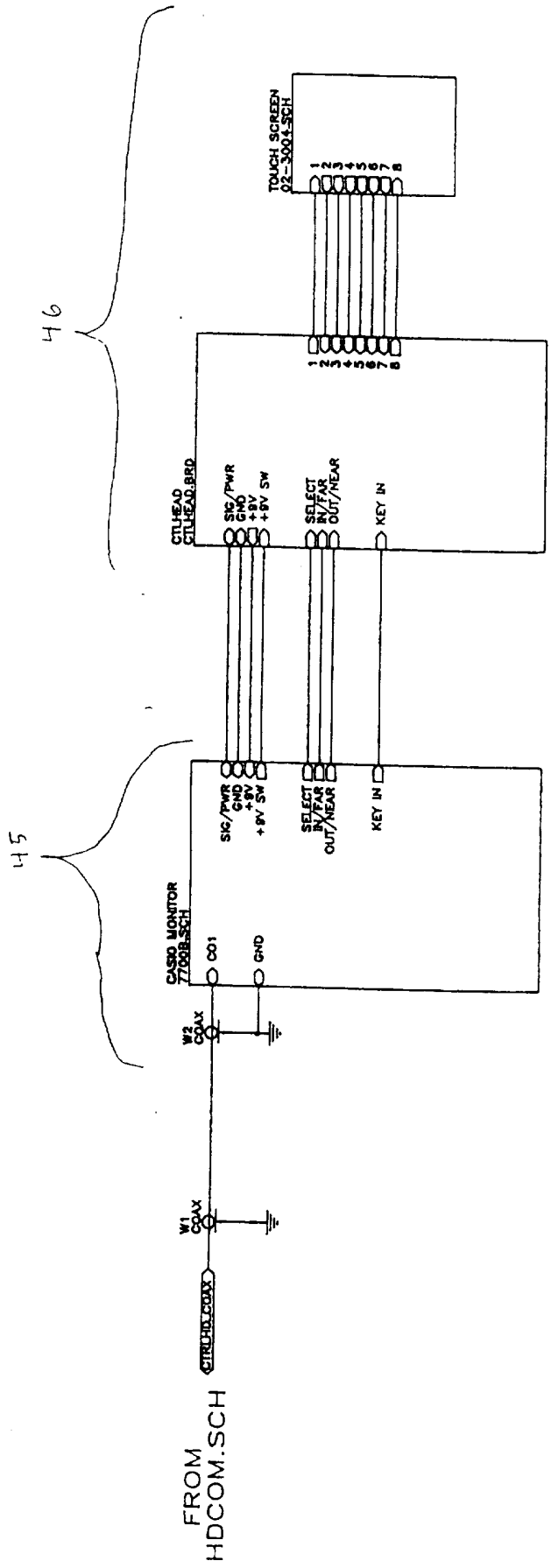
46
45
TOUCH SCREEN
02-3004.SCH
1 2 3 4 5 6 7 8
CTLHEAD
CTLHEAD.BRD
SIG/PWR
GND
+8V
+8V SW
SELECT
IN/FAR
OUT/NEAR
KEY IN
CASD MONITOR
77008.SCH
CO1
GND
W2
COAX
W1
COAX
CTRLHD.COAX
FROM
HDCOM.SCH

Figure 44

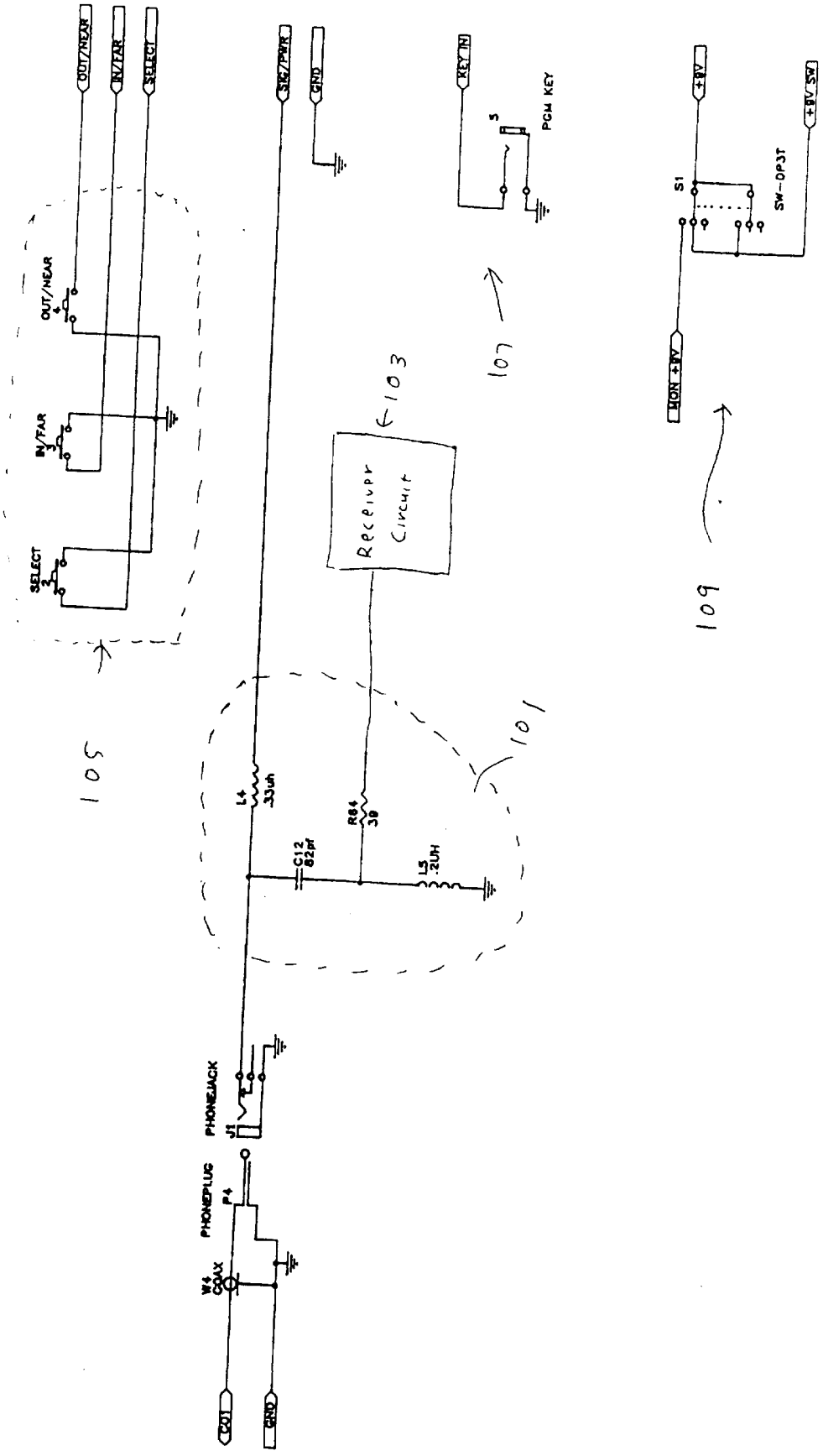
OUT/NEAR
IN/FAR
SELECT
SEL/PWR
GND
KEY IN
PGM KEY
+8V
+8V SW
S1
SW-DP3T
HON +8V
OUT/NEAR
IN/FAR
SELECT
105
103
107
109
101
Receiver Circuit
L4 .33uh
C12 82pf
R84 39
L5 .2UH
PHONEJACK
J1
PHONEPLUG
P4
W4 COAX
COUT
GND

Figure 45

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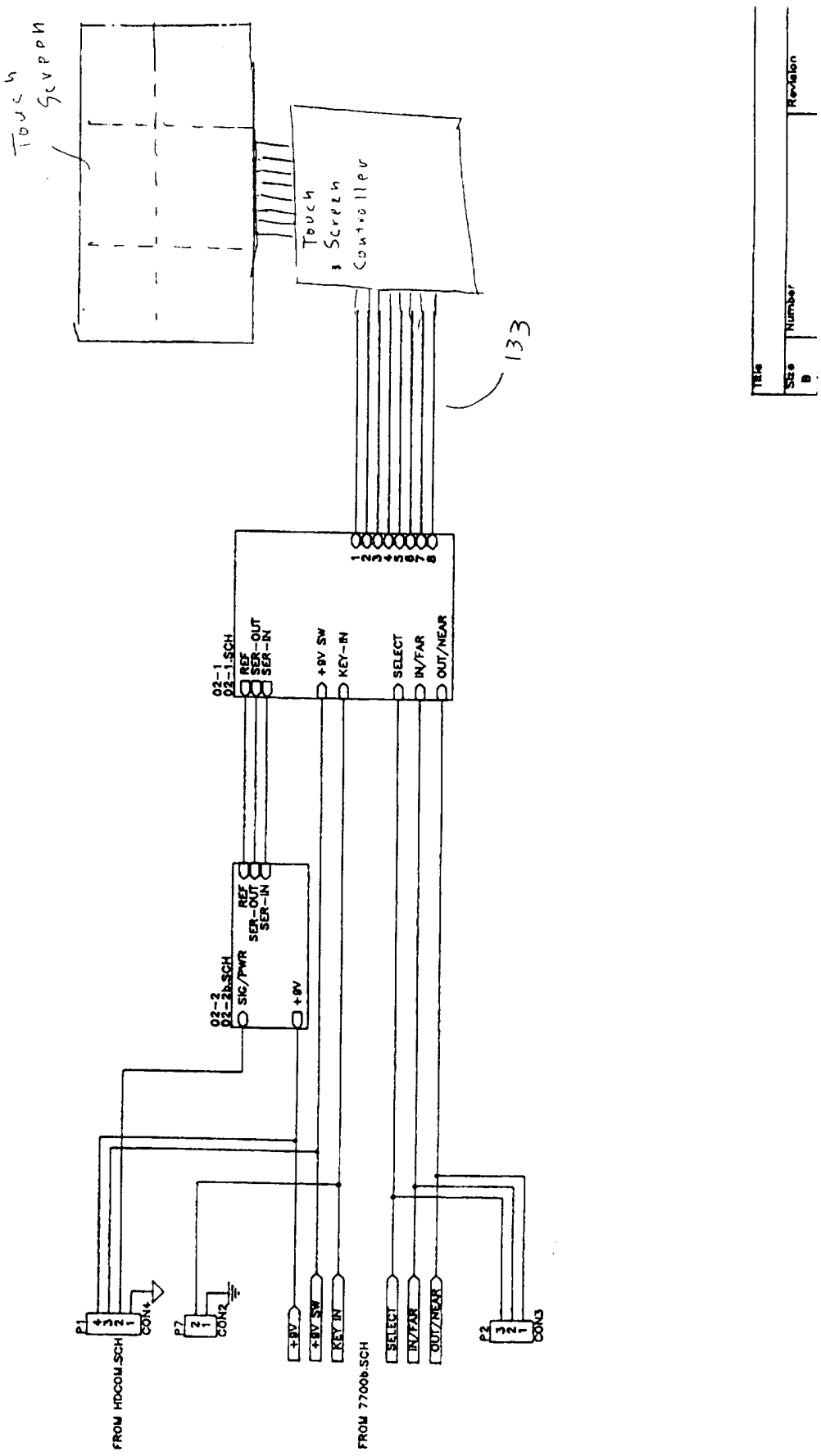

Figure 46

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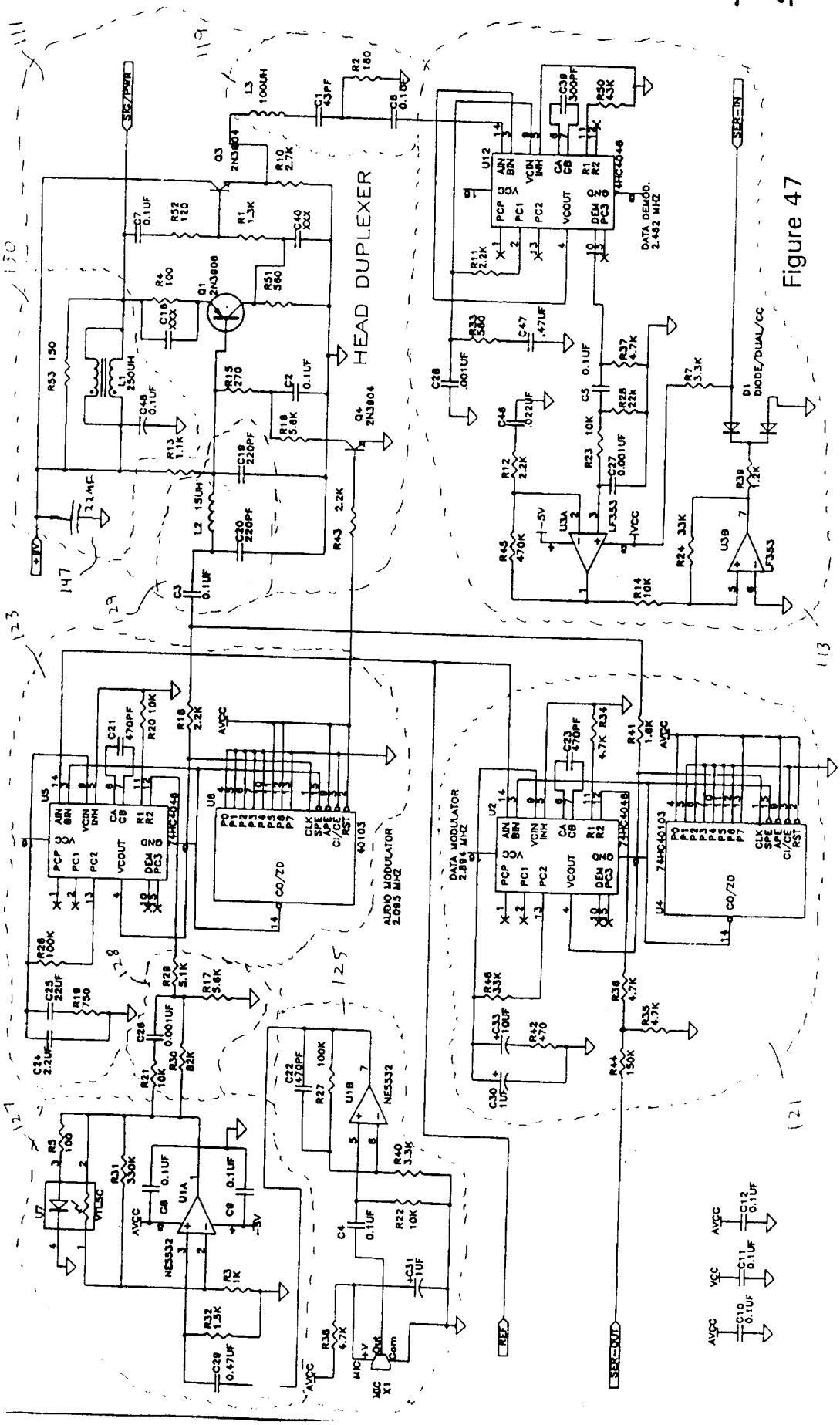

Figure 47

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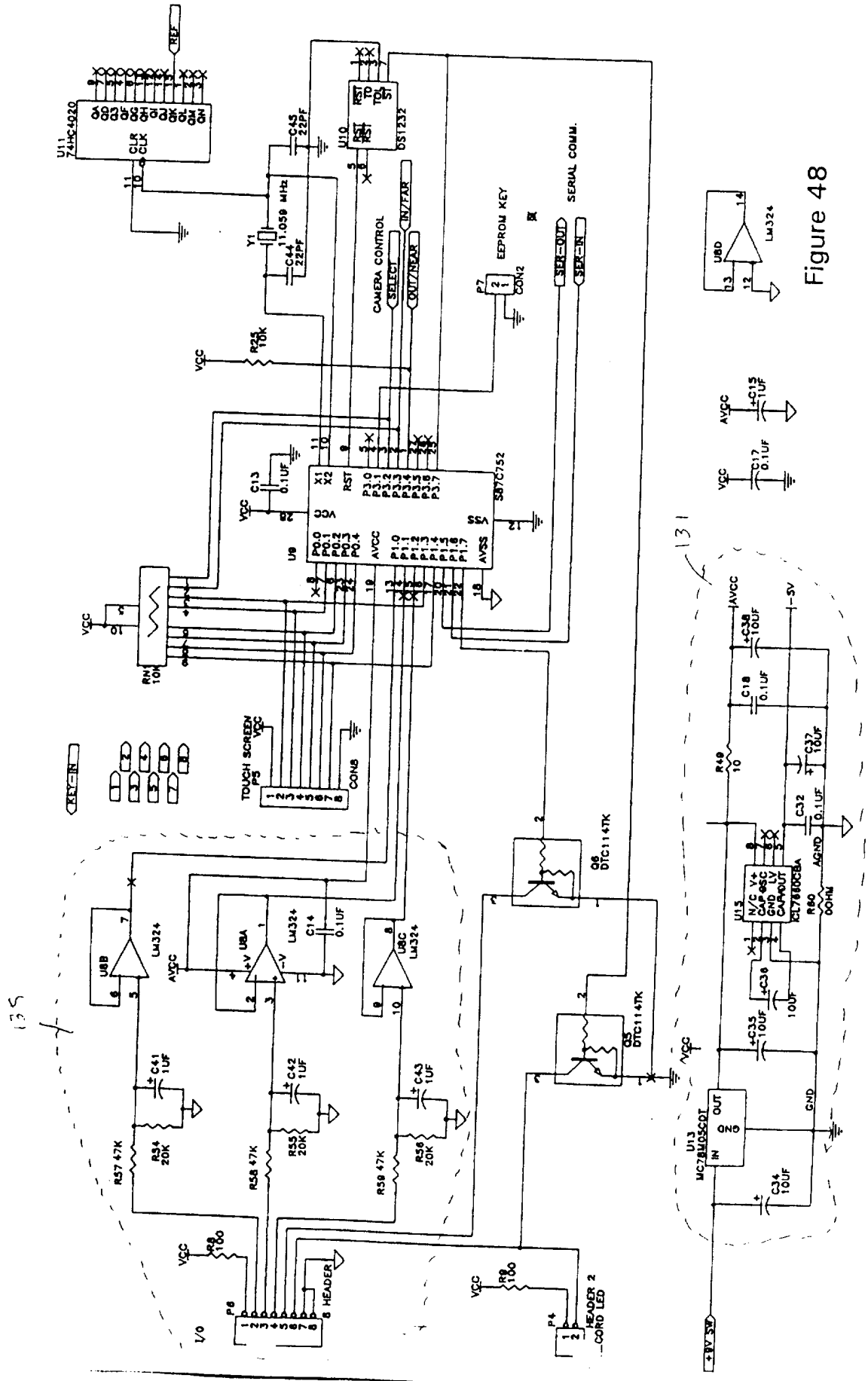

Figure 48

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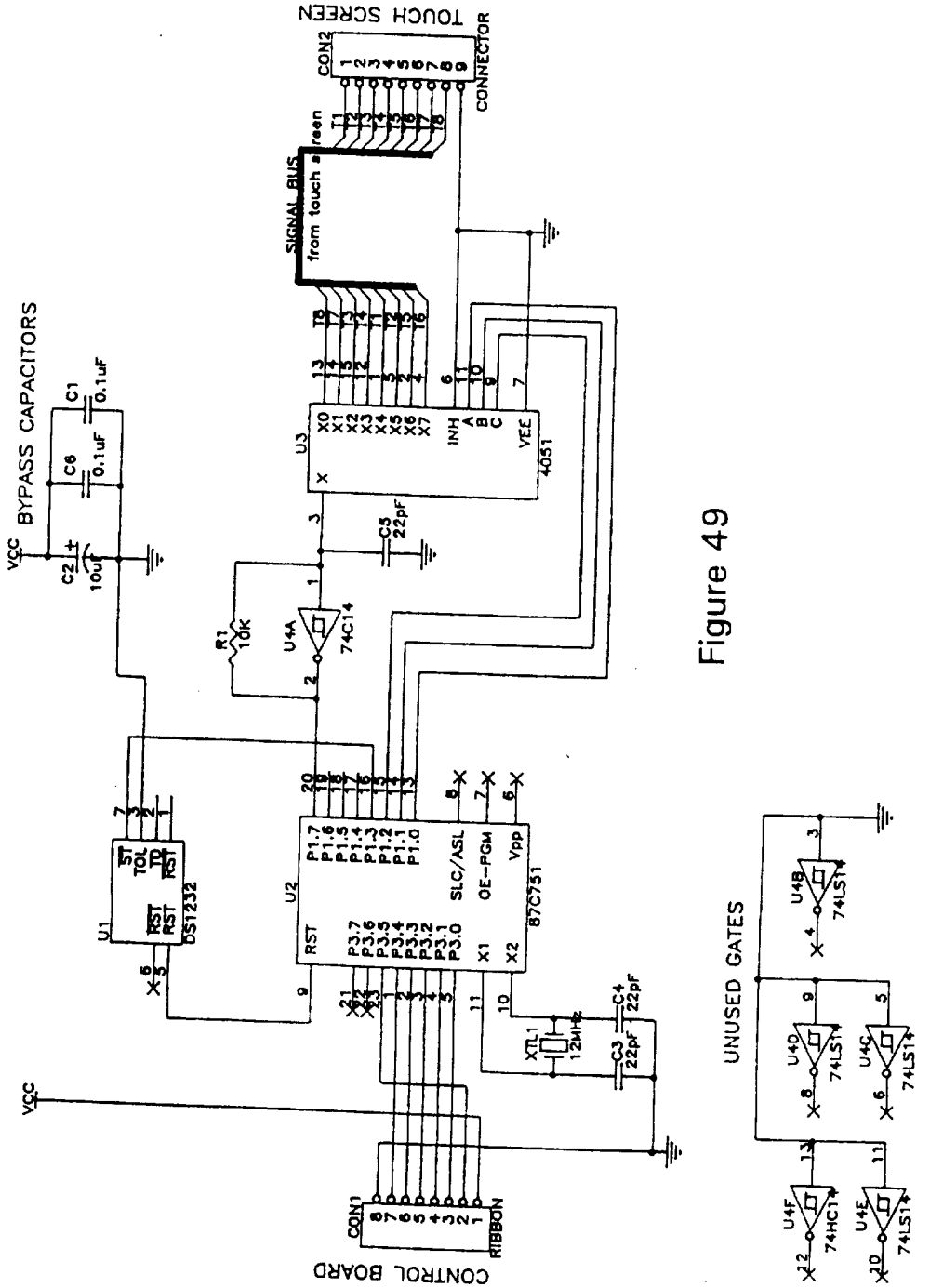

Figure 49

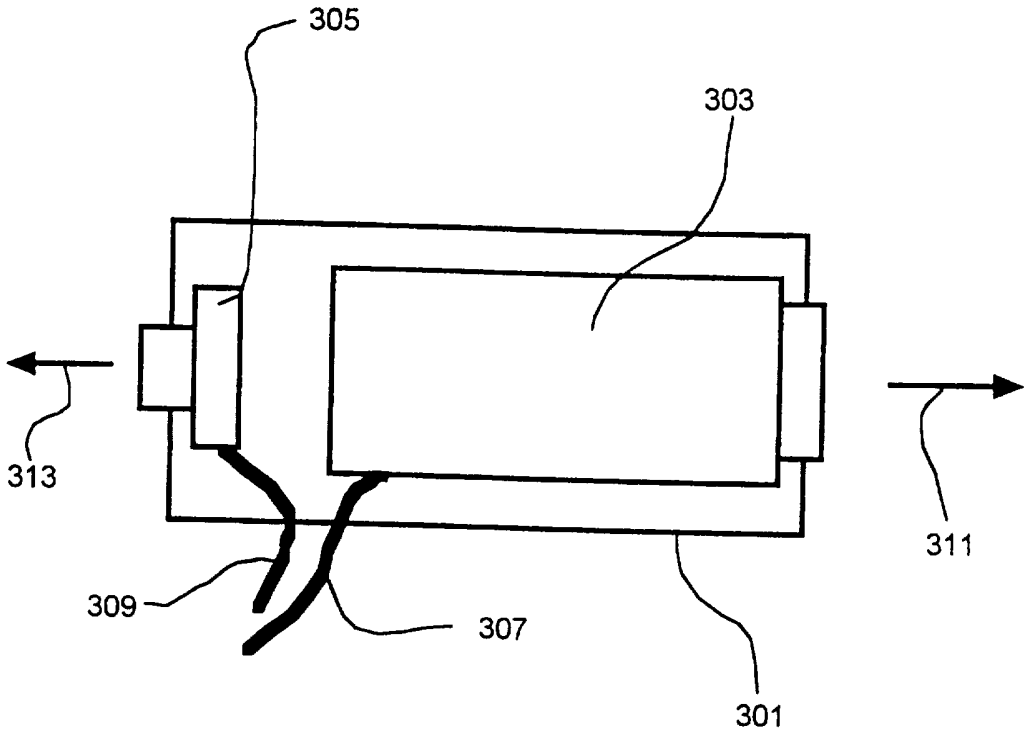

Figure 50

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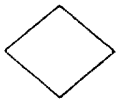
VP3000 SYSTEM BOARD SOFTWARE FLOW CHARTS

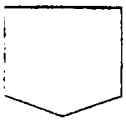
NOTATION:

START OR END OF A FUNCTION

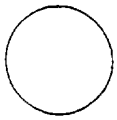
PROCESS



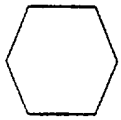
DECISION



OFF-PAGE CONNECTOR



CONNECTOR



PREPARATION

SUBROUTINE DOCUMENTED SEPARATELY IN MORE DETAIL

Figure 51A

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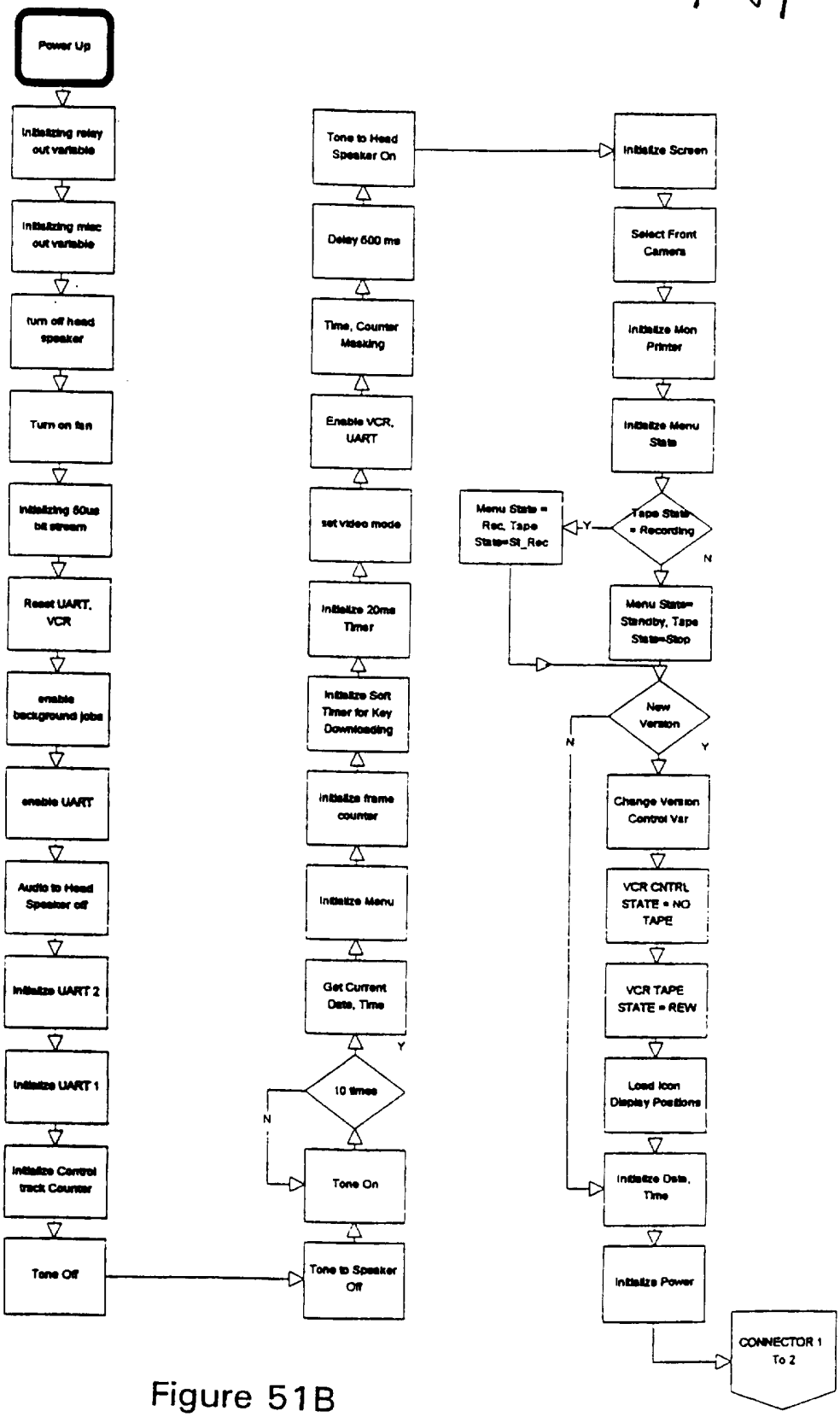

Figure 51B

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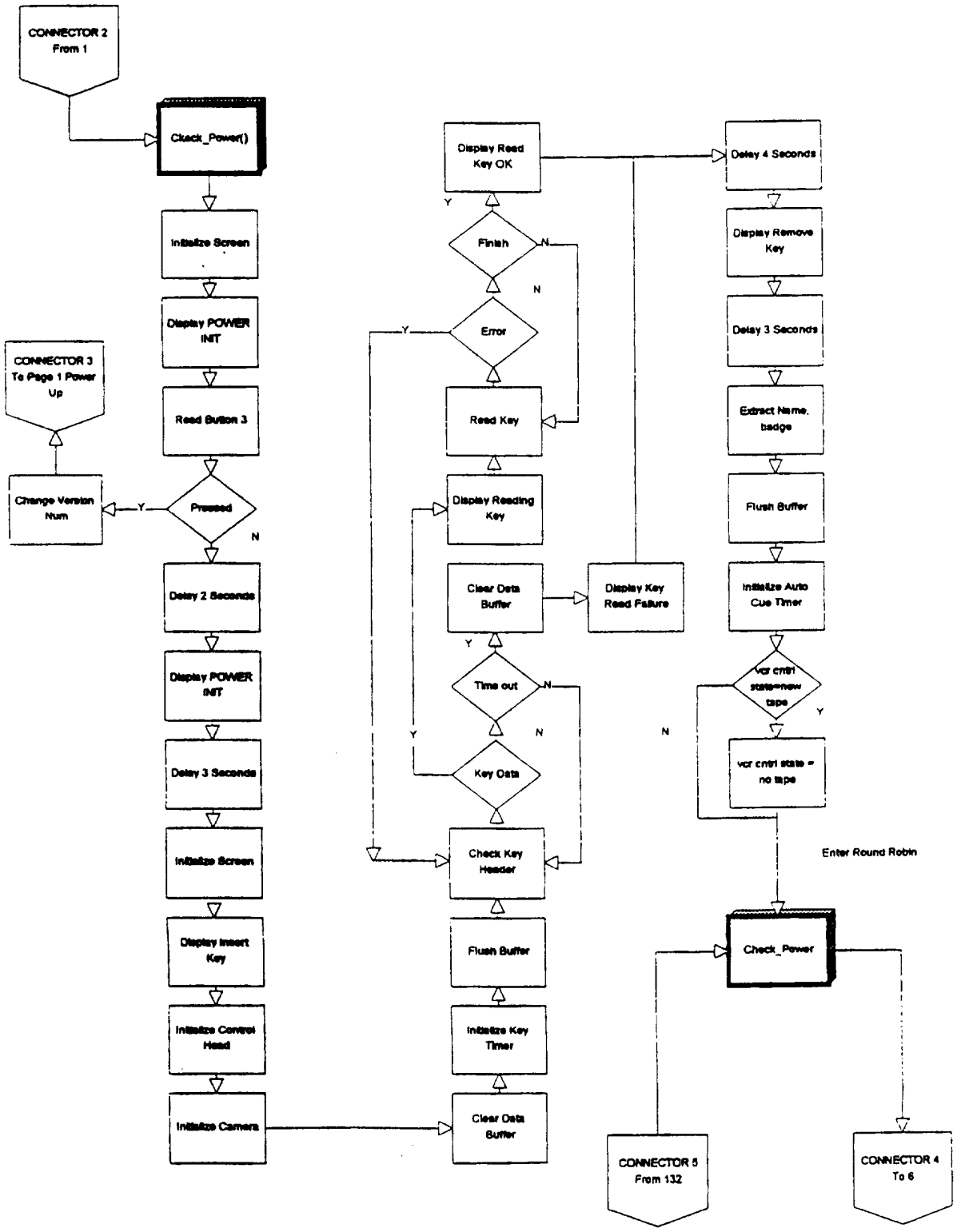

Figure 51C

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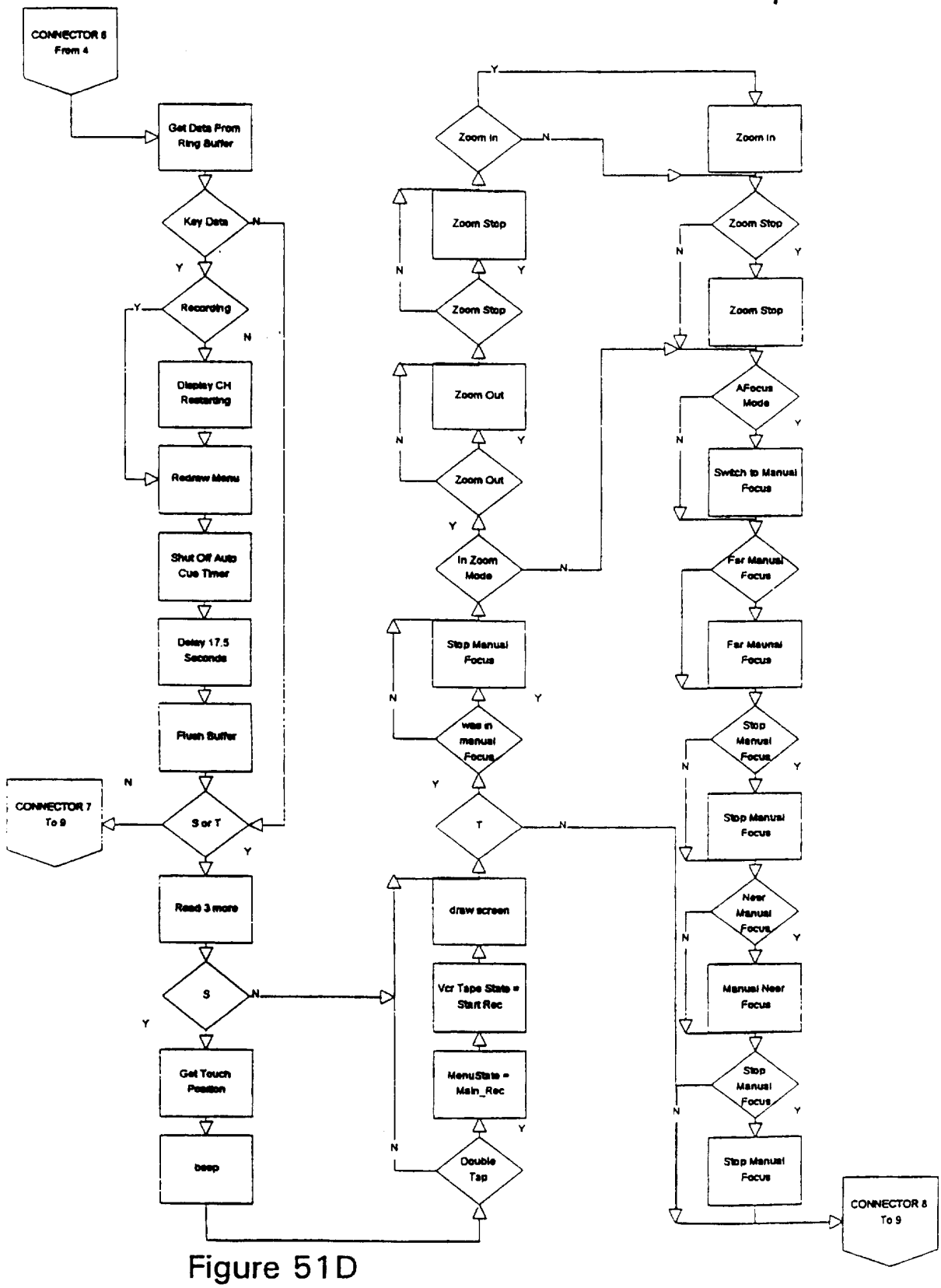

Figure 51D

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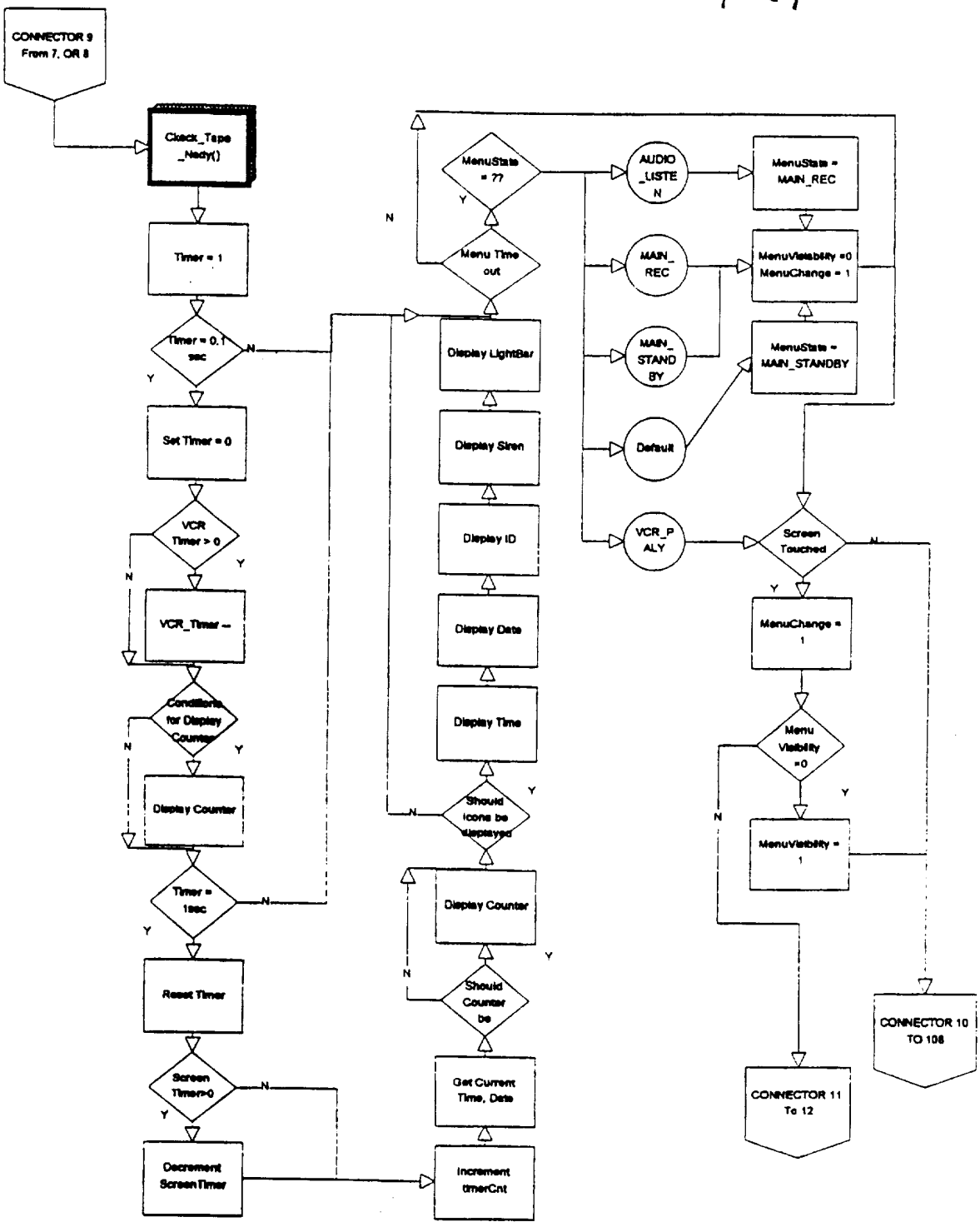

Figure 51E

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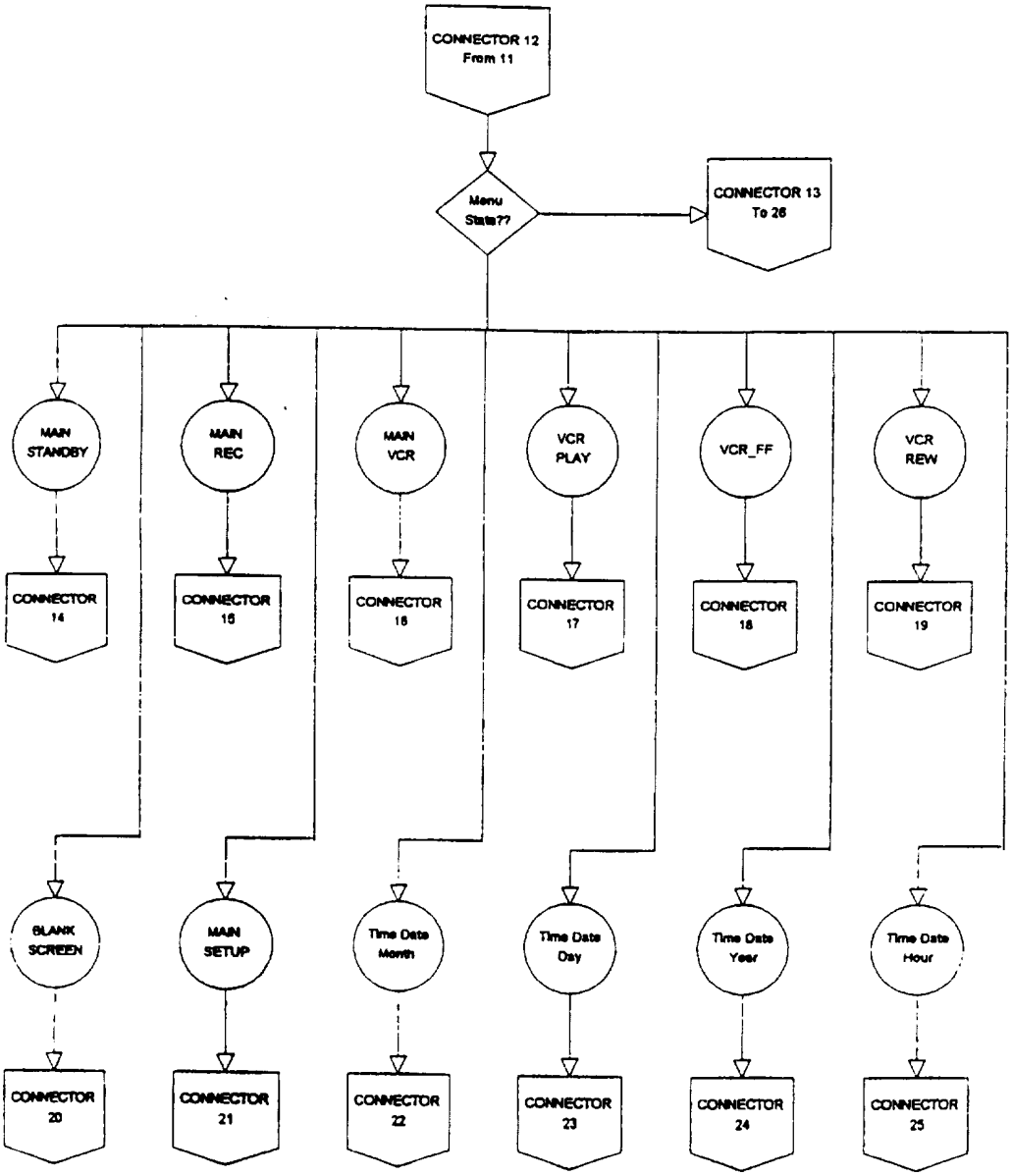

Figure 51F

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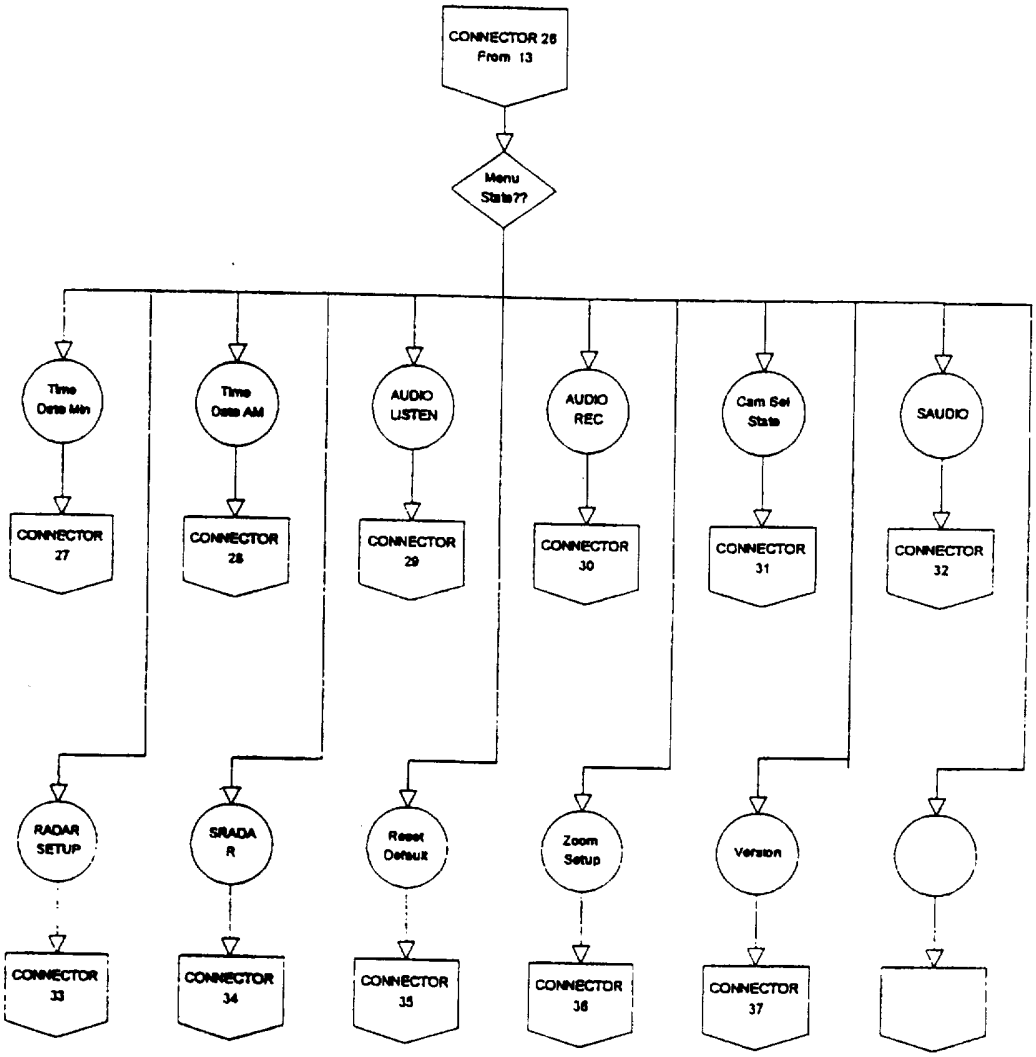

Figure 51G

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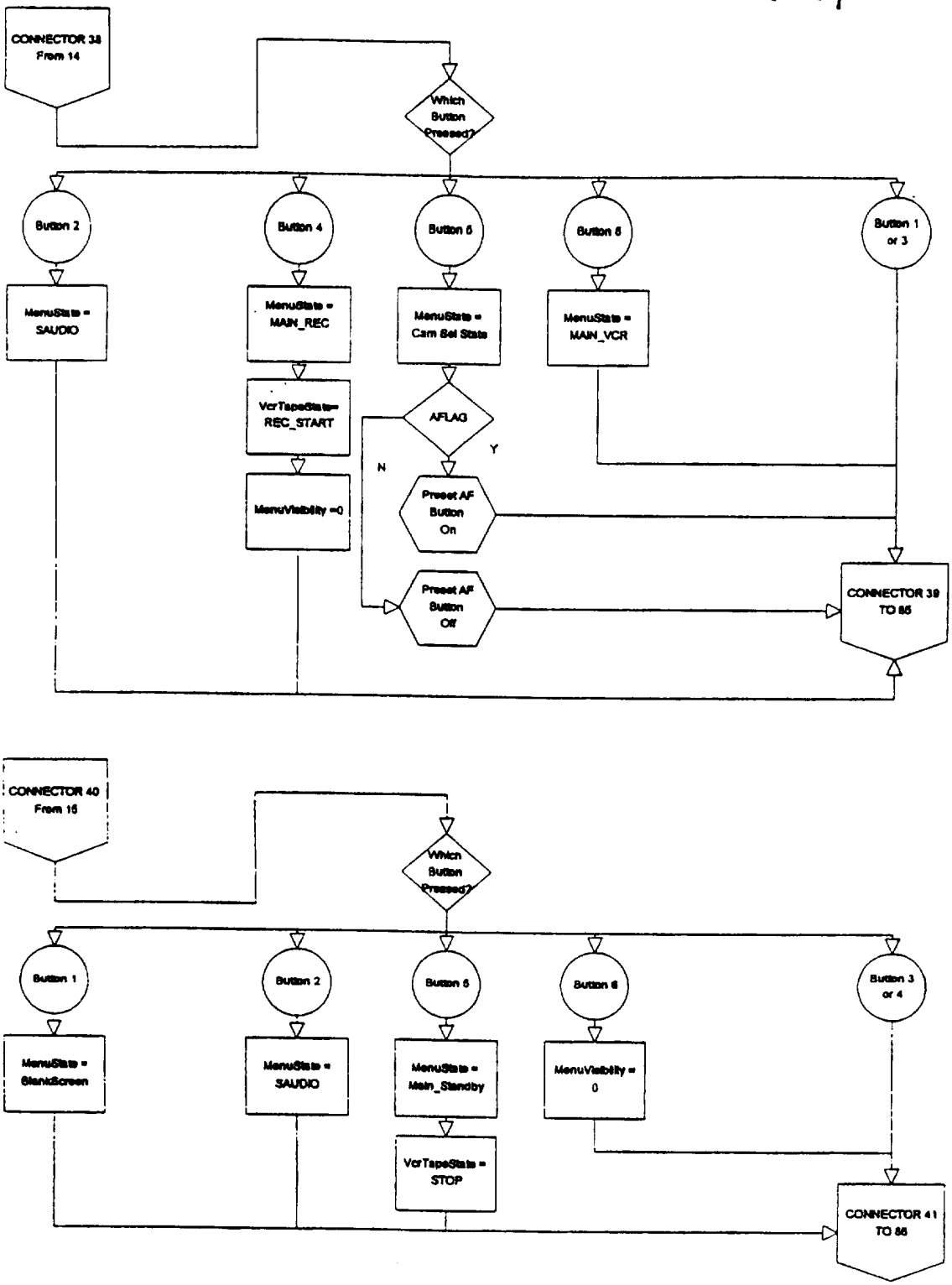

Figure 51H

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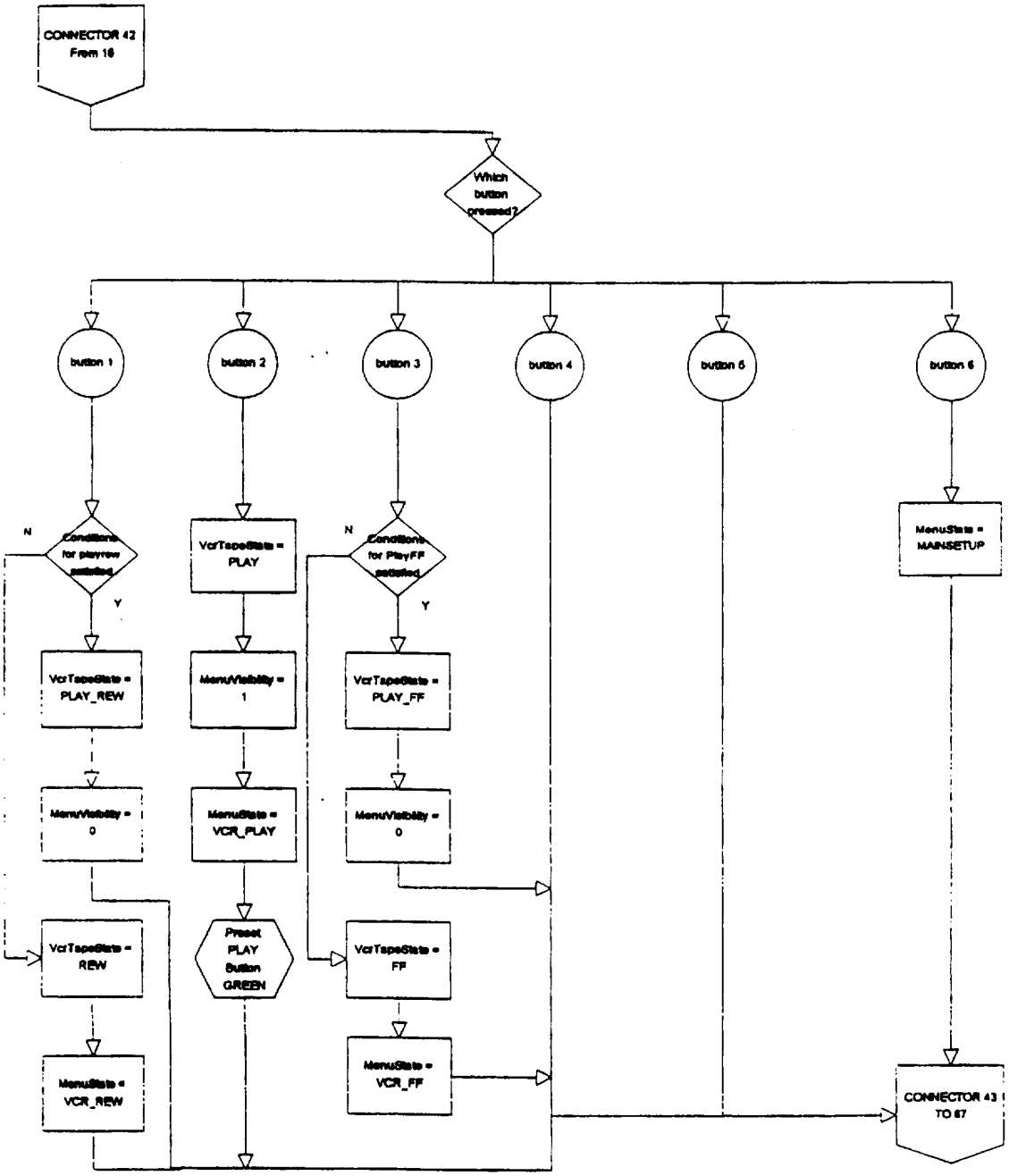

Figure 51I

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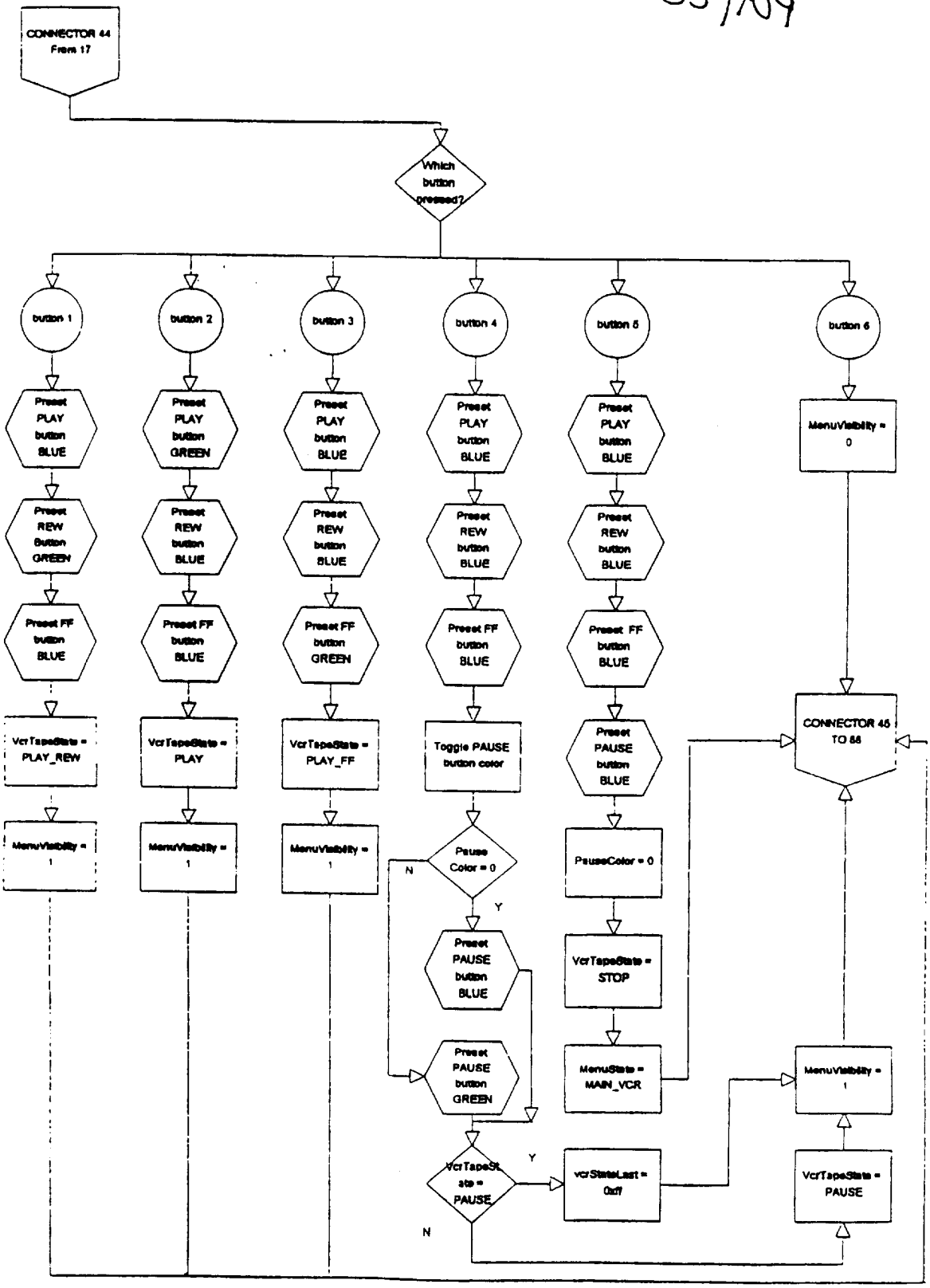

Figure 51J

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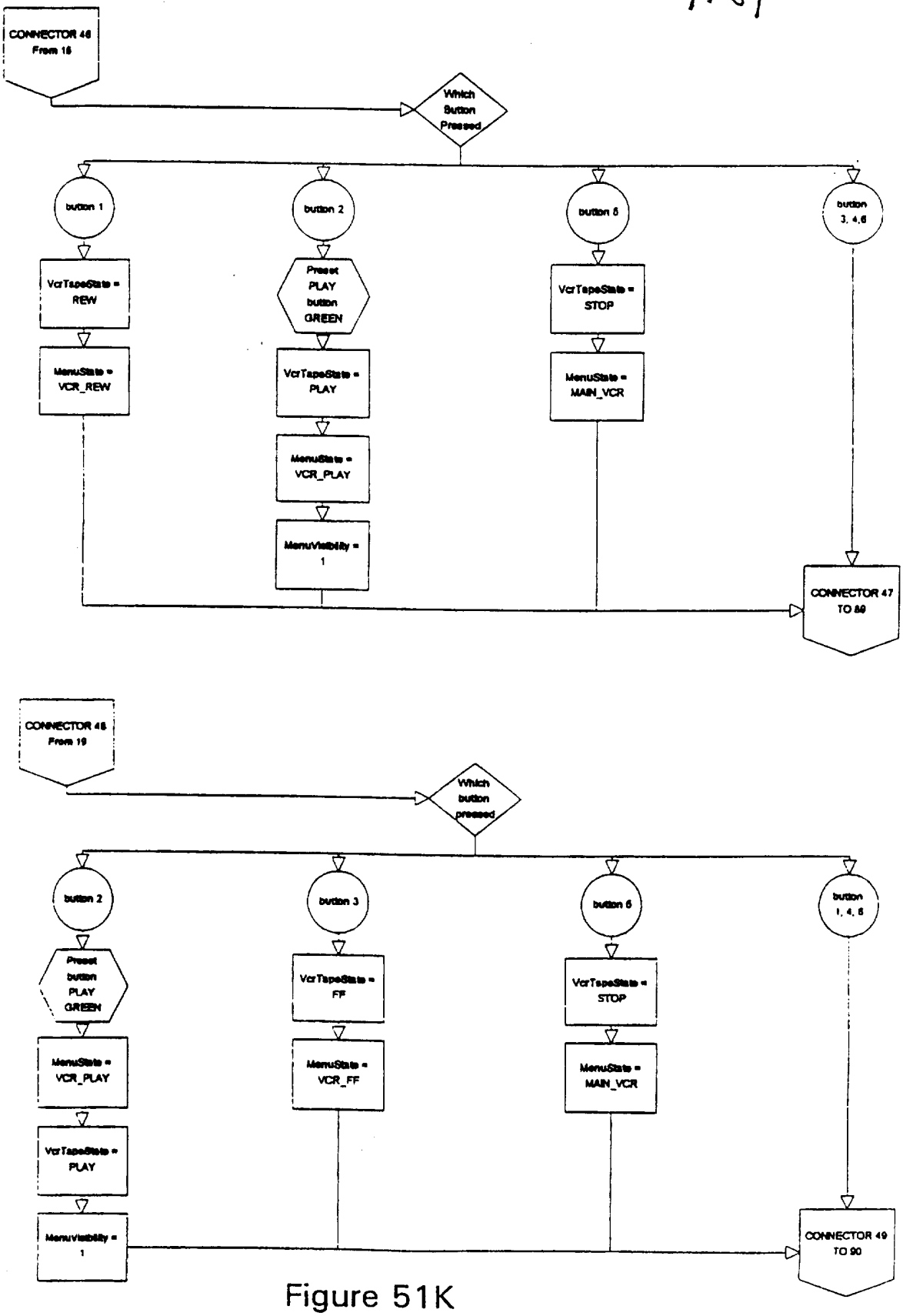

Figure 51K

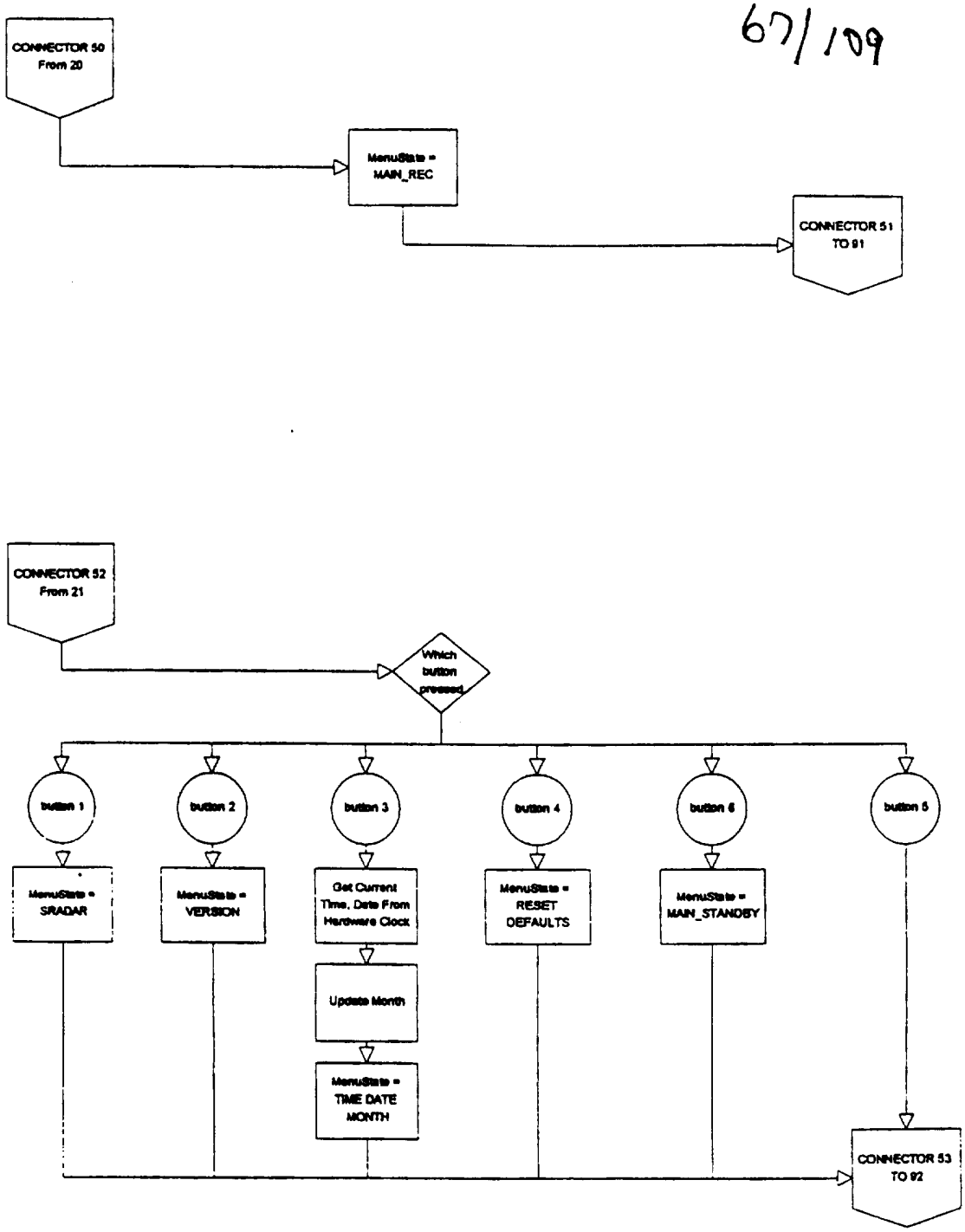
CONNECTOR 50
From 20
MenuState =
MAIN_REC
CONNECTOR 51
TO 91
CONNECTOR 52
From 21
Which
button
pressed
button 1
button 2
button 3
button 4
button 6
button 5
MenuState =
SRADAR
MenuState =
VERSION
Get Current
Time, Date From
Hardware Clock
MenuState =
RESET
DEFAULTS
MenuState =
MAIN_STANDBY
Update Month
MenuState =
TIME DATE
MONTH
CONNECTOR 53
TO 92

Figure 51L

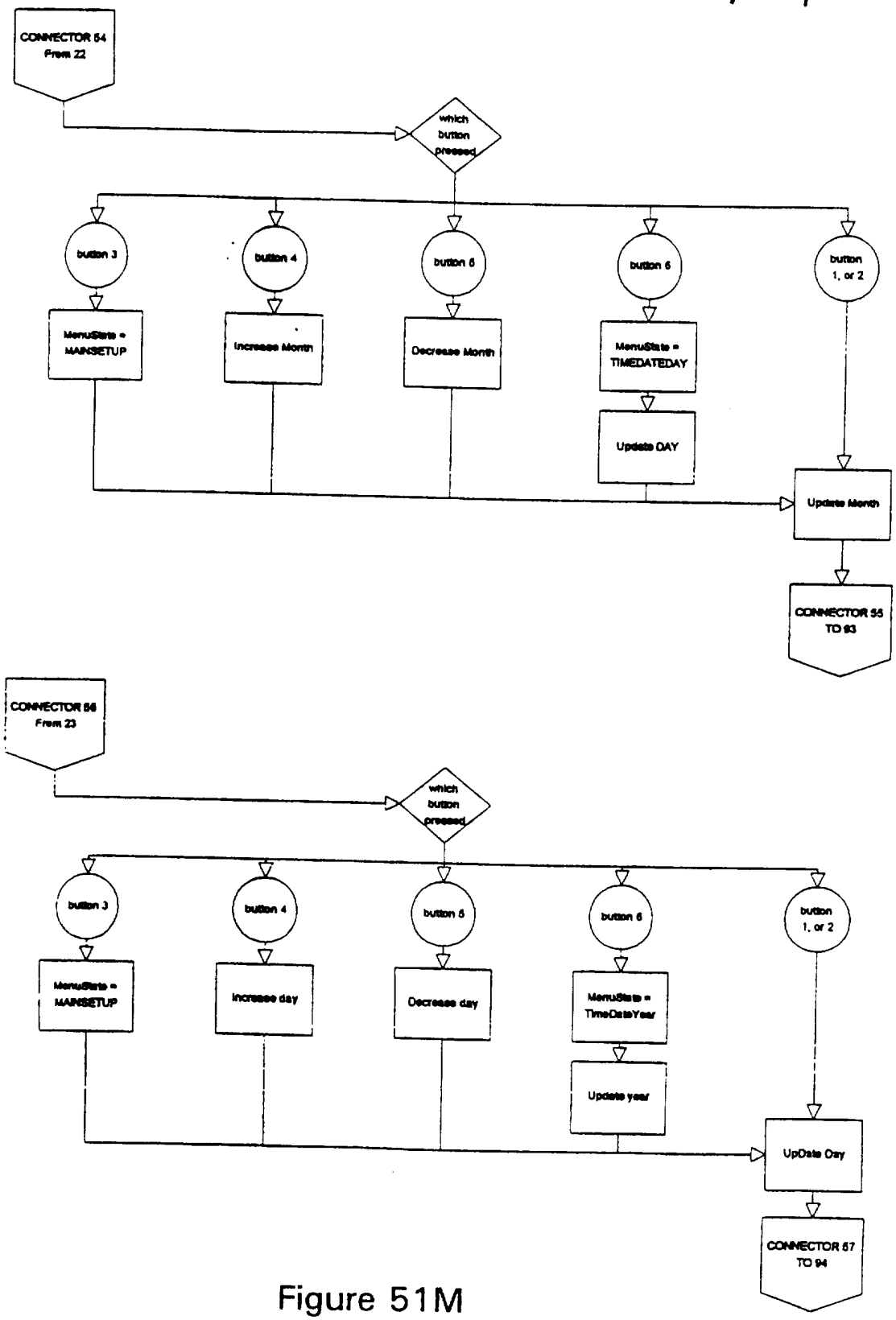
CONNECTOR 54
From 22
which button pressed
button 3
button 4
button 5
button 6
button 1, or 2
MenuState = MAINSETUP
Increase Month
Decrease Month
MenuState = TIMEDATEDAY
Update DAY
Update Month
CONNECTOR 55
TO 93
CONNECTOR 56
From 23
which button pressed
button 3
button 4
button 5
button 6
button 1, or 2
MenuState = MAINSETUP
Increase day
Decrease day
MenuState = TimeDateYear
Update year
UpDate Day
CONNECTOR 57
TO 94

Figure 51M

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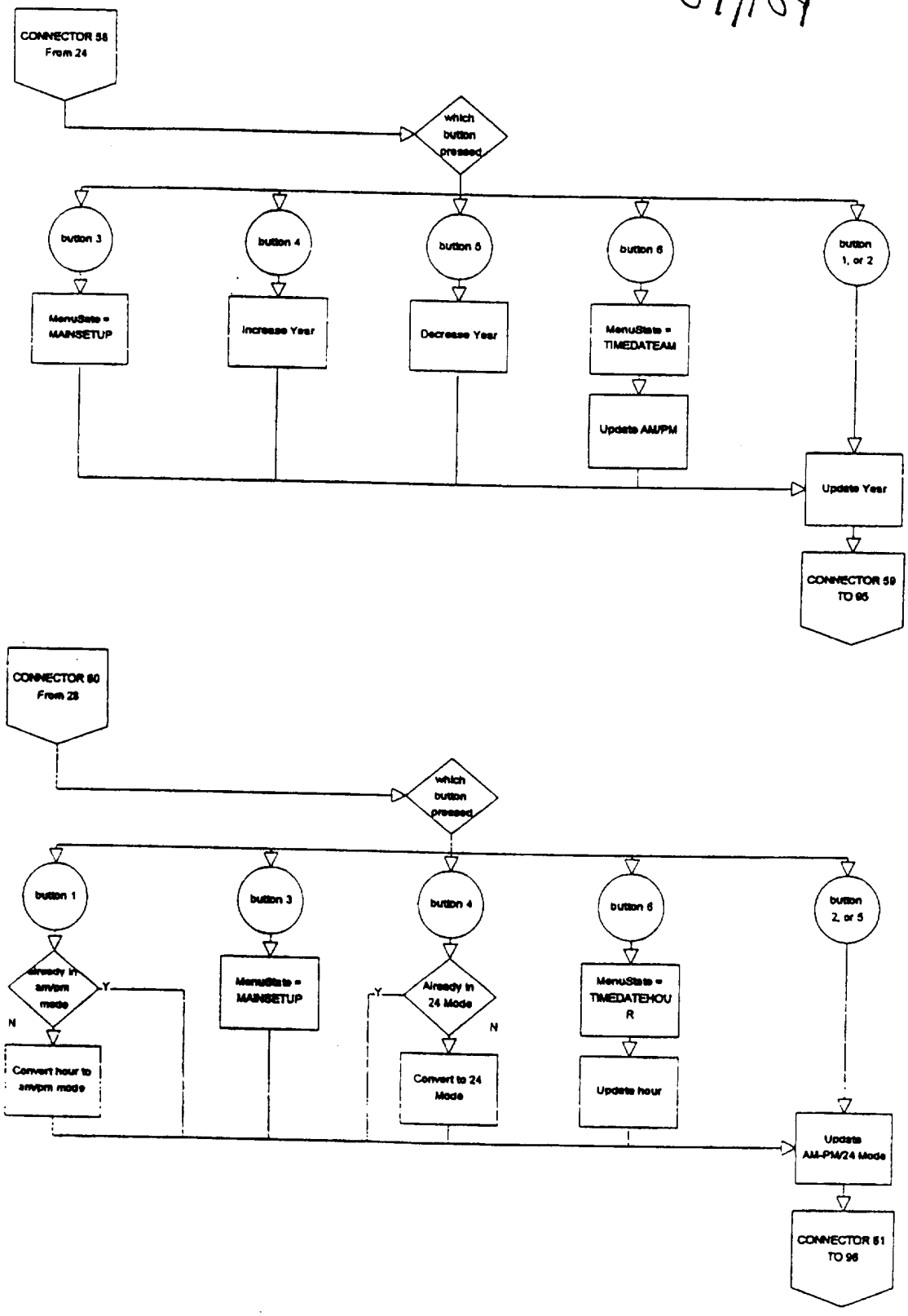

Figure 51N

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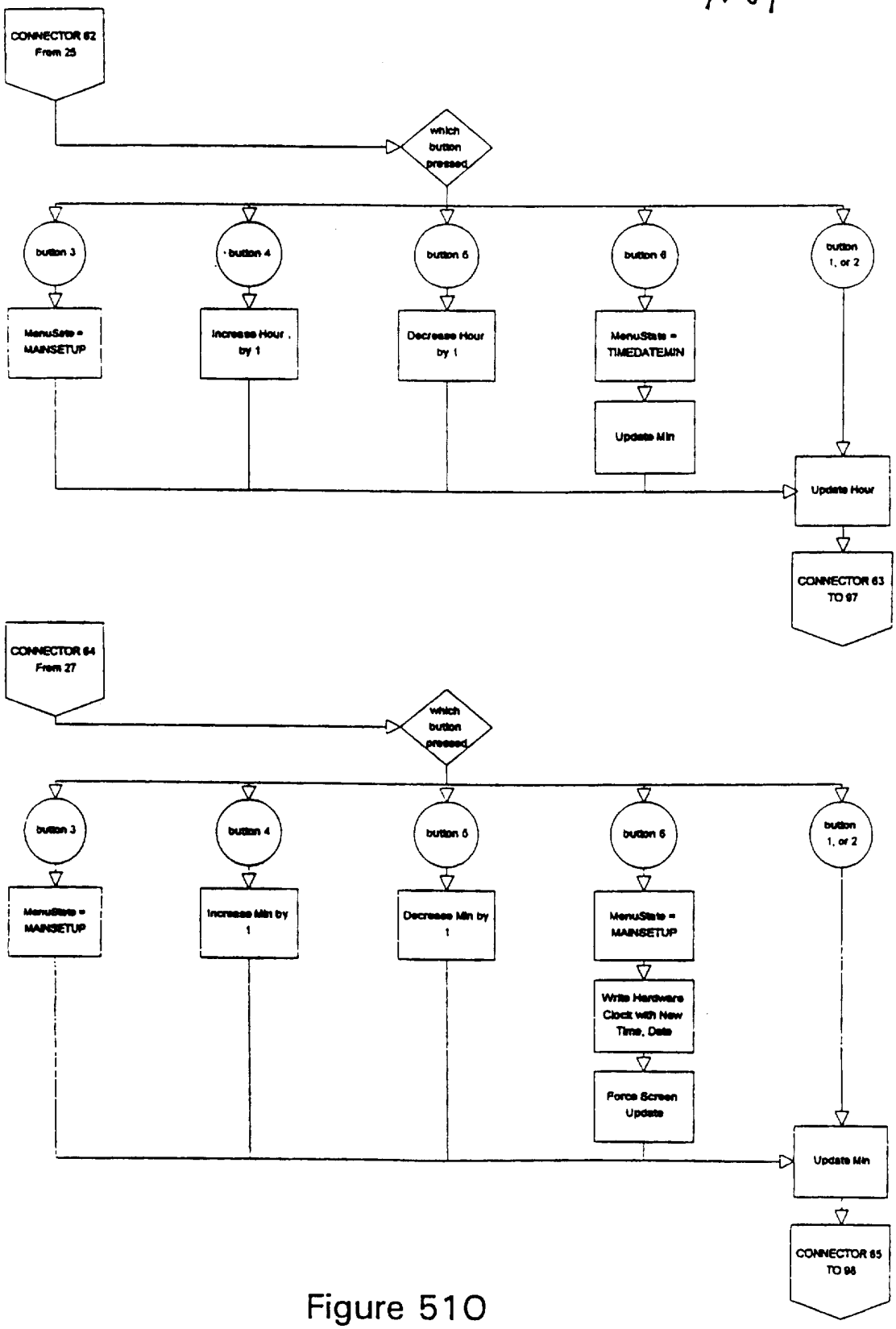

Figure 510

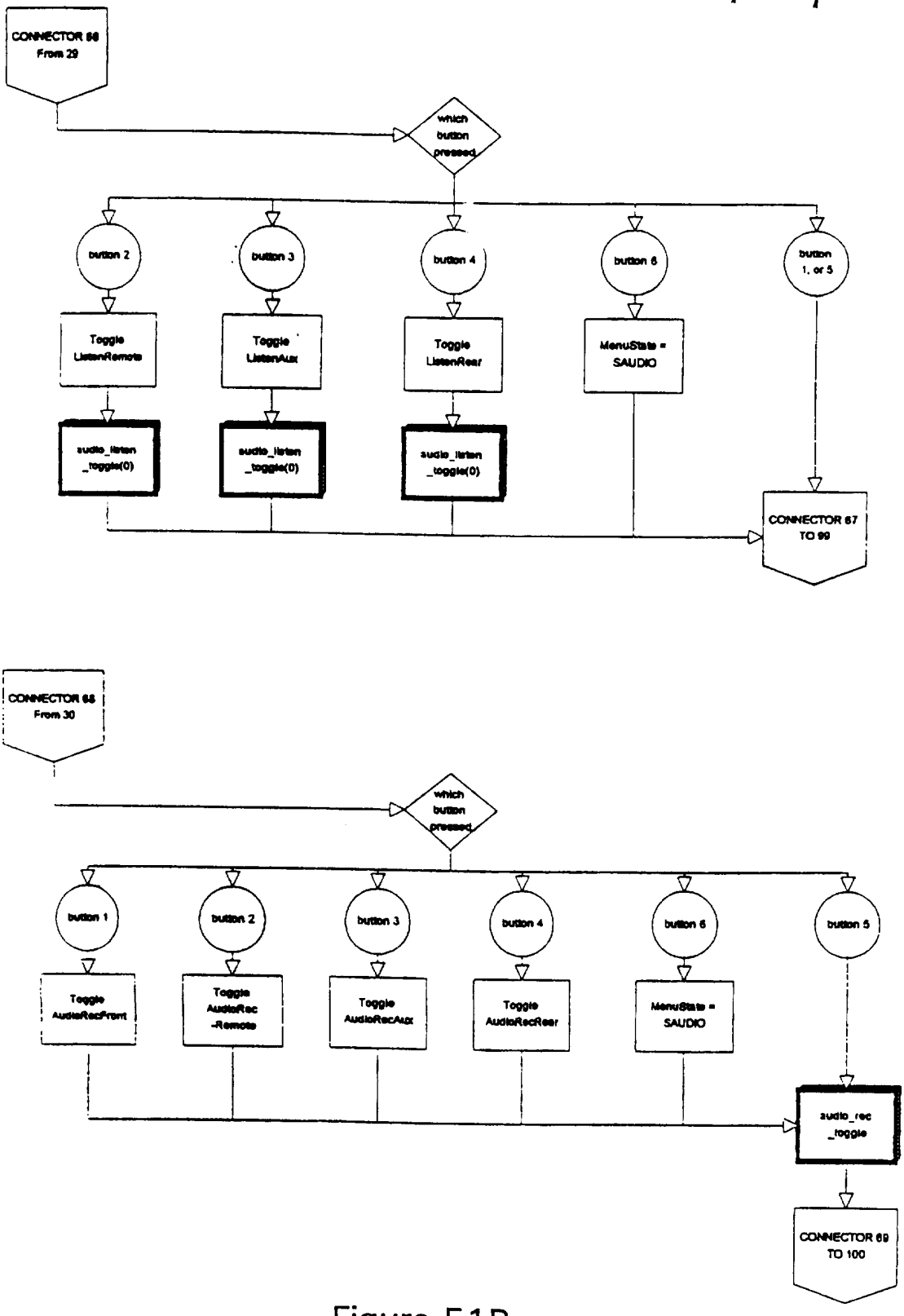
CONNECTOR 66
From 29
which button pressed
button 2
button 3
button 4
button 6
button 1, or 5
Toggle ListenRemote
Toggle ListenAux
Toggle ListenRear
MenuState = SAUDIO
audio_listen _toggle(0)
audio_listen _toggle(0)
audio_listen _toggle(0)
CONNECTOR 67
TO 99
CONNECTOR 68
From 30
which button pressed
button 1
button 2
button 3
button 4
button 6
button 5
Toggle AudioRecFront
Toggle AudioRec -Remote
Toggle AudioRecAux
Toggle AudioRecRear
MenuState = SAUDIO
audio_rec _toggle
CONNECTOR 69
TO 100

Figure 51P

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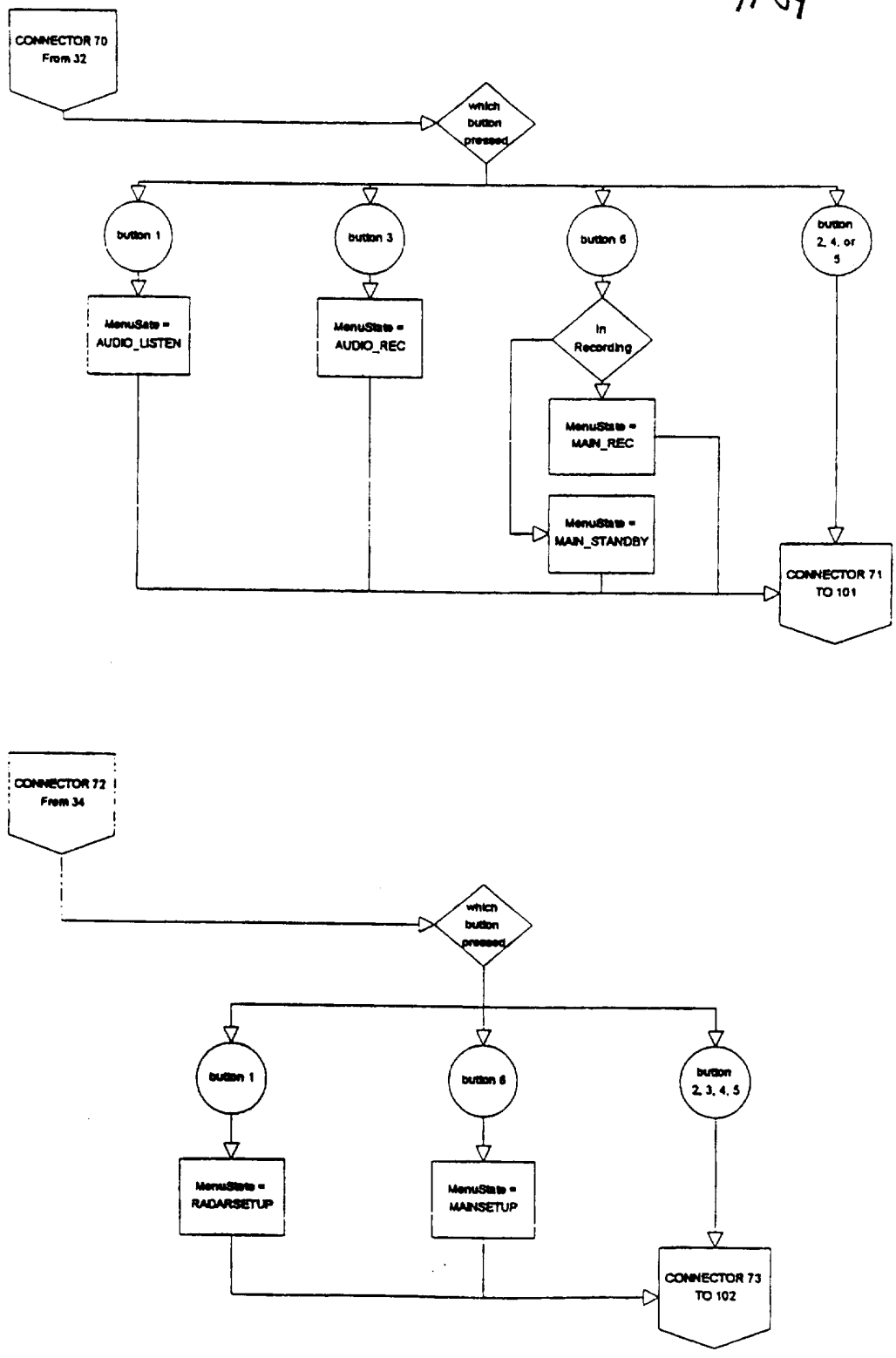

Figure 51Q

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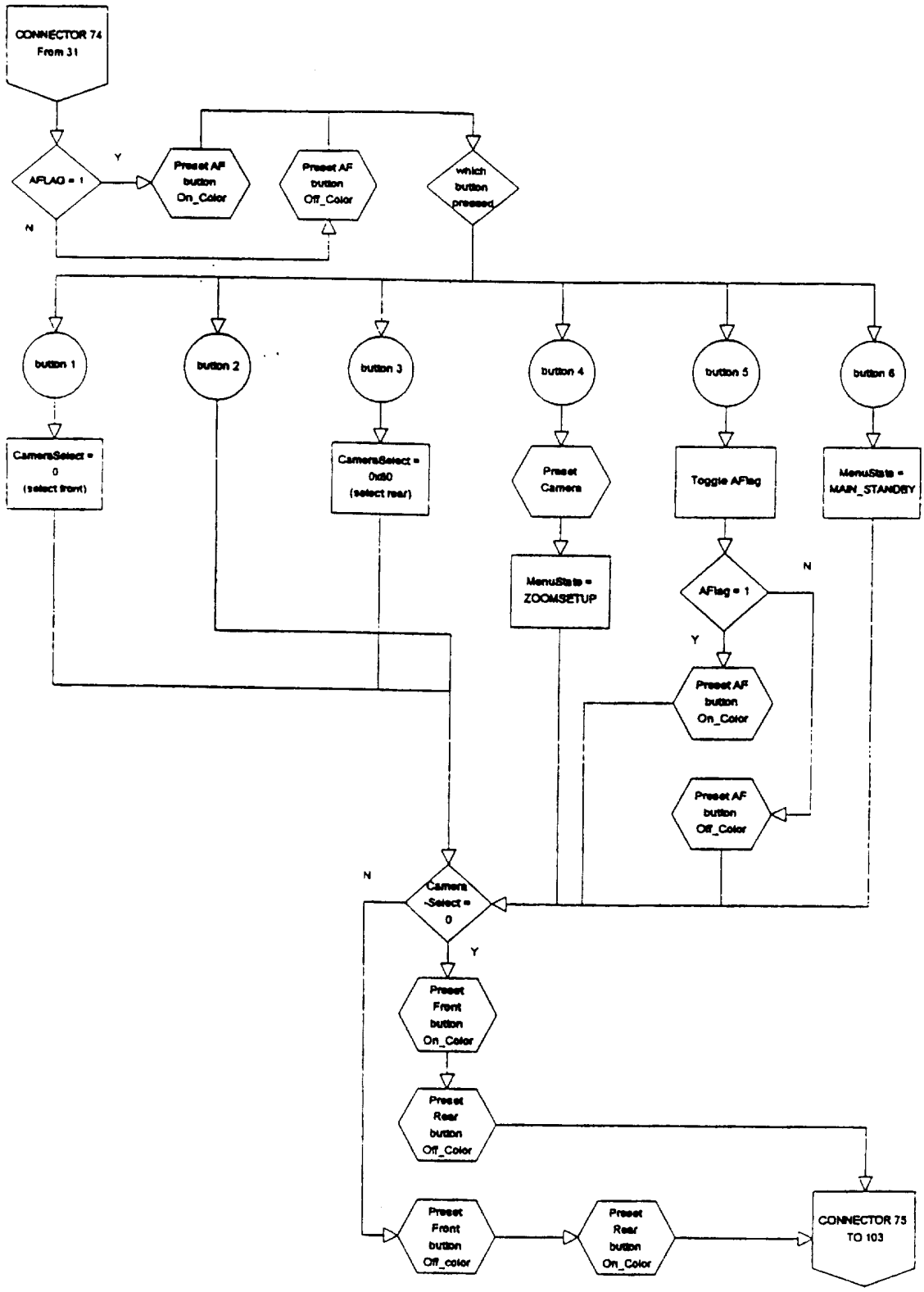

Figure 51R

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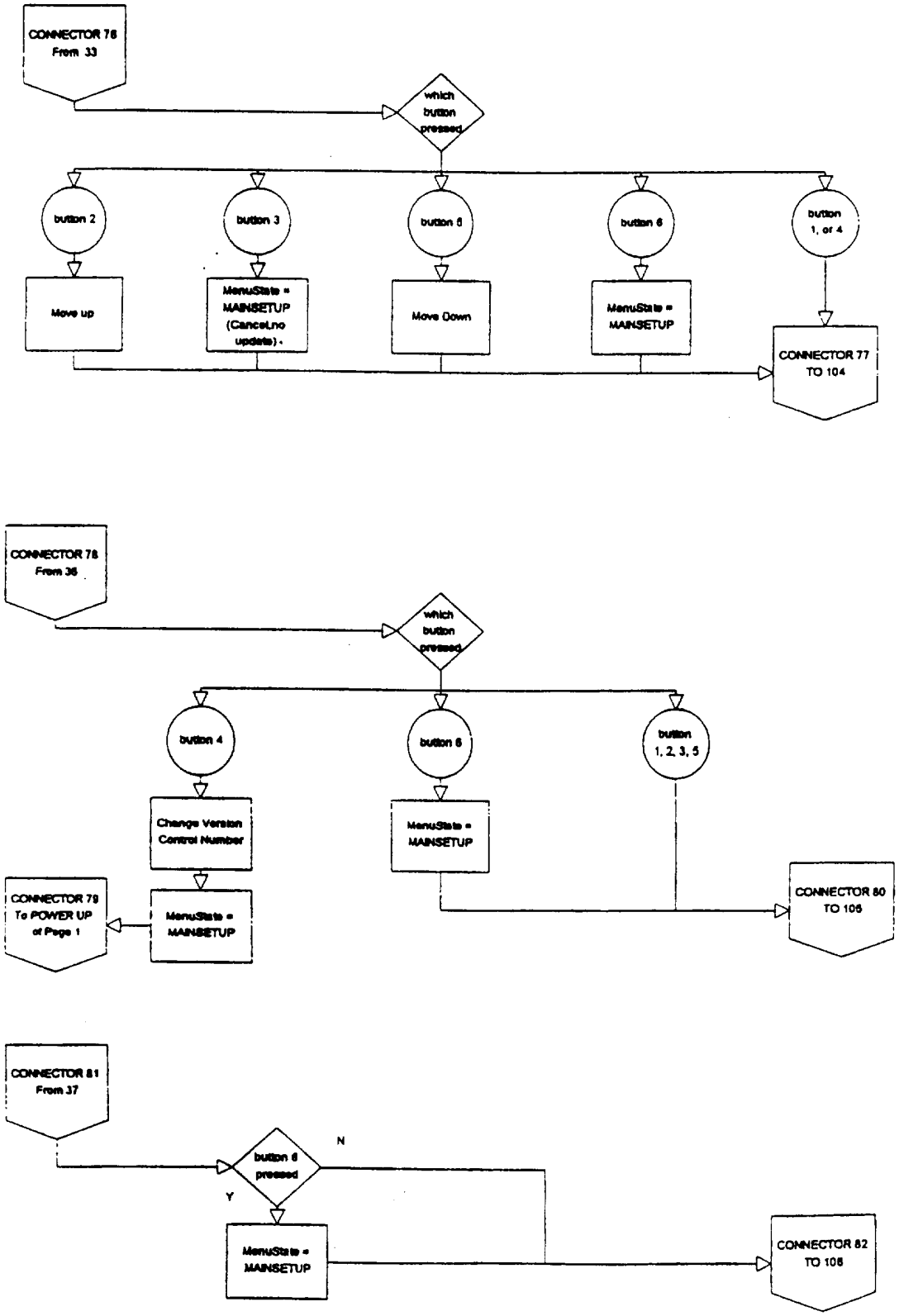

Figure 51S

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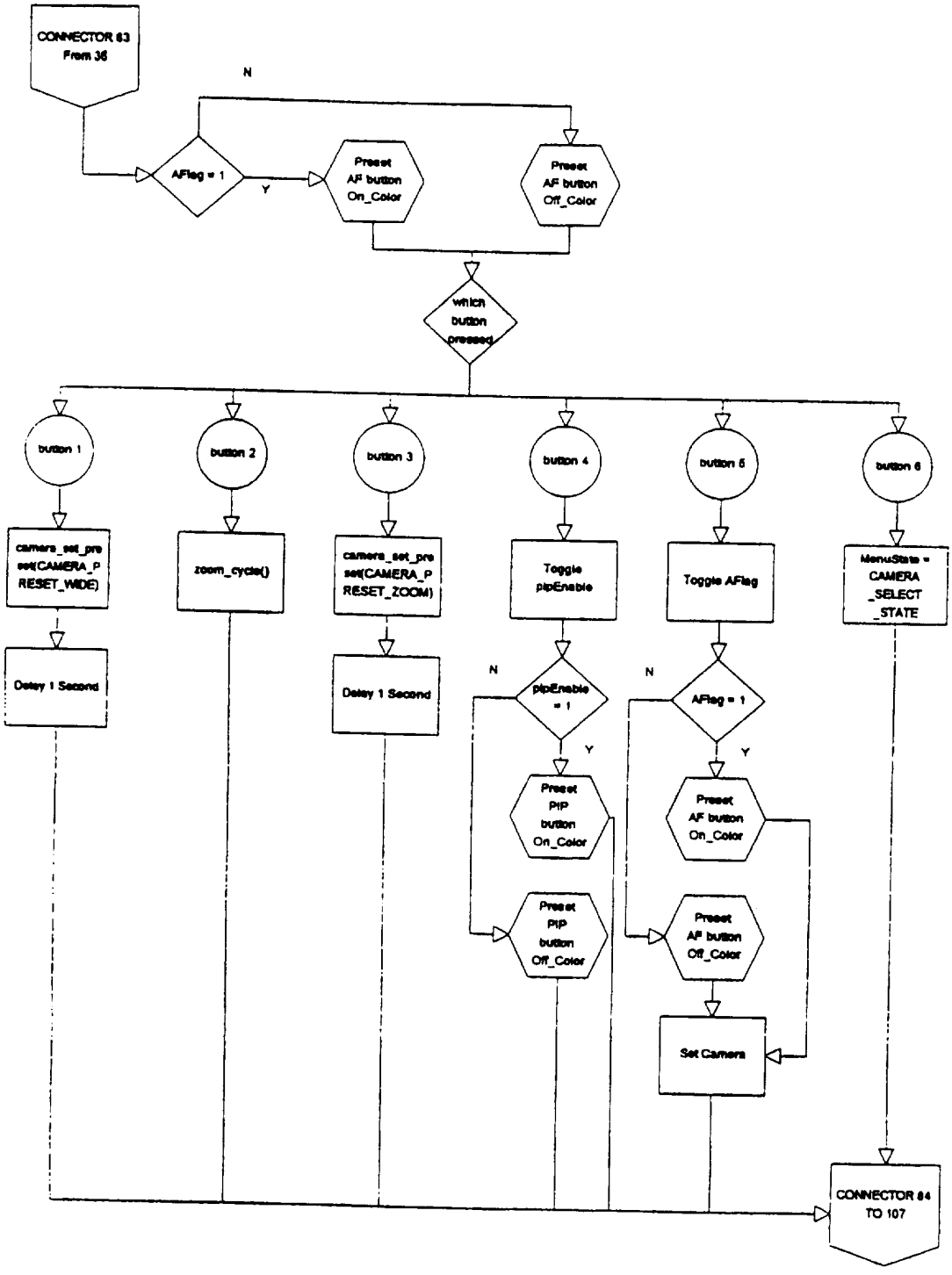

Figure 51T

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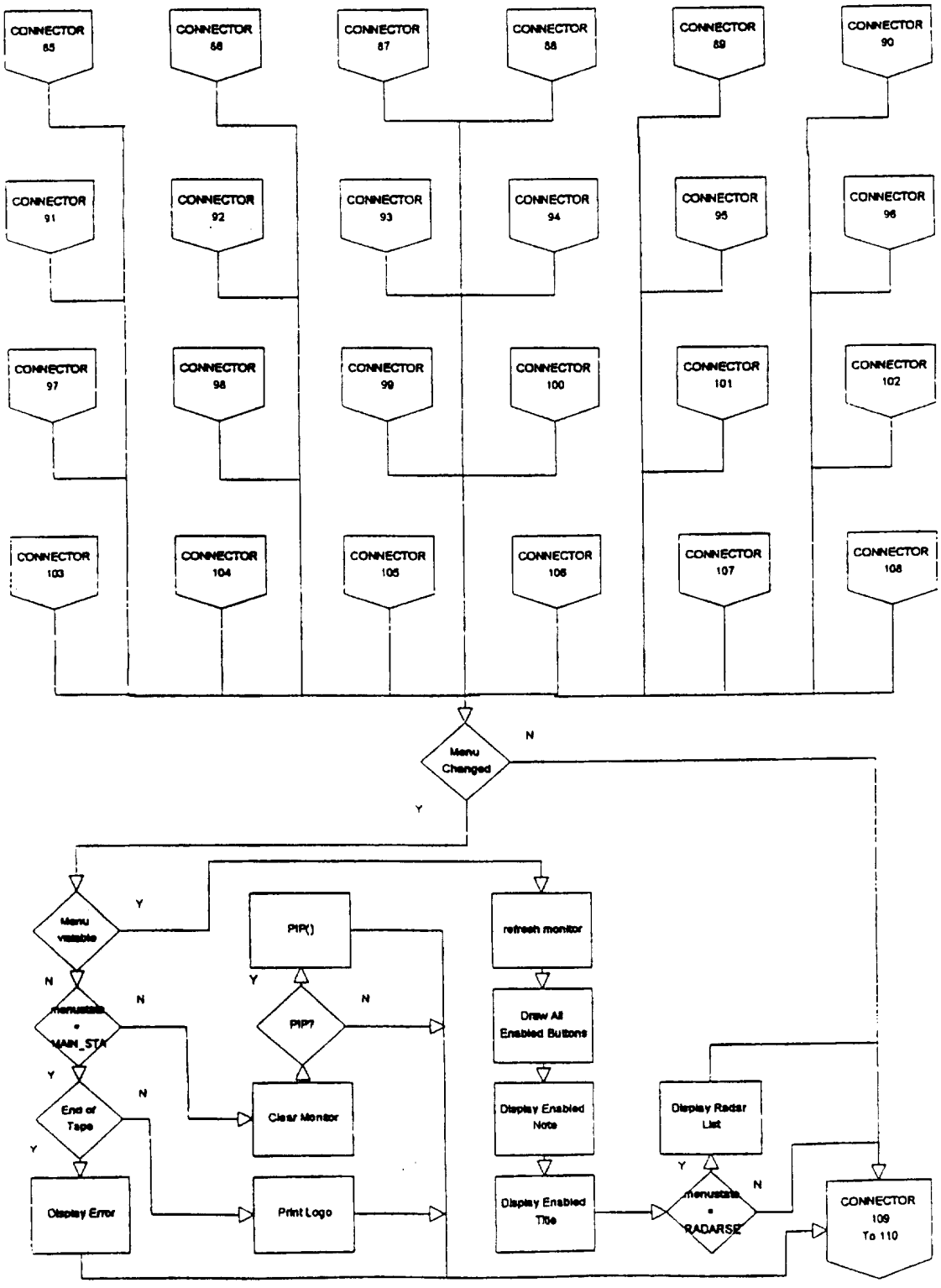

Figure 51U

77/109

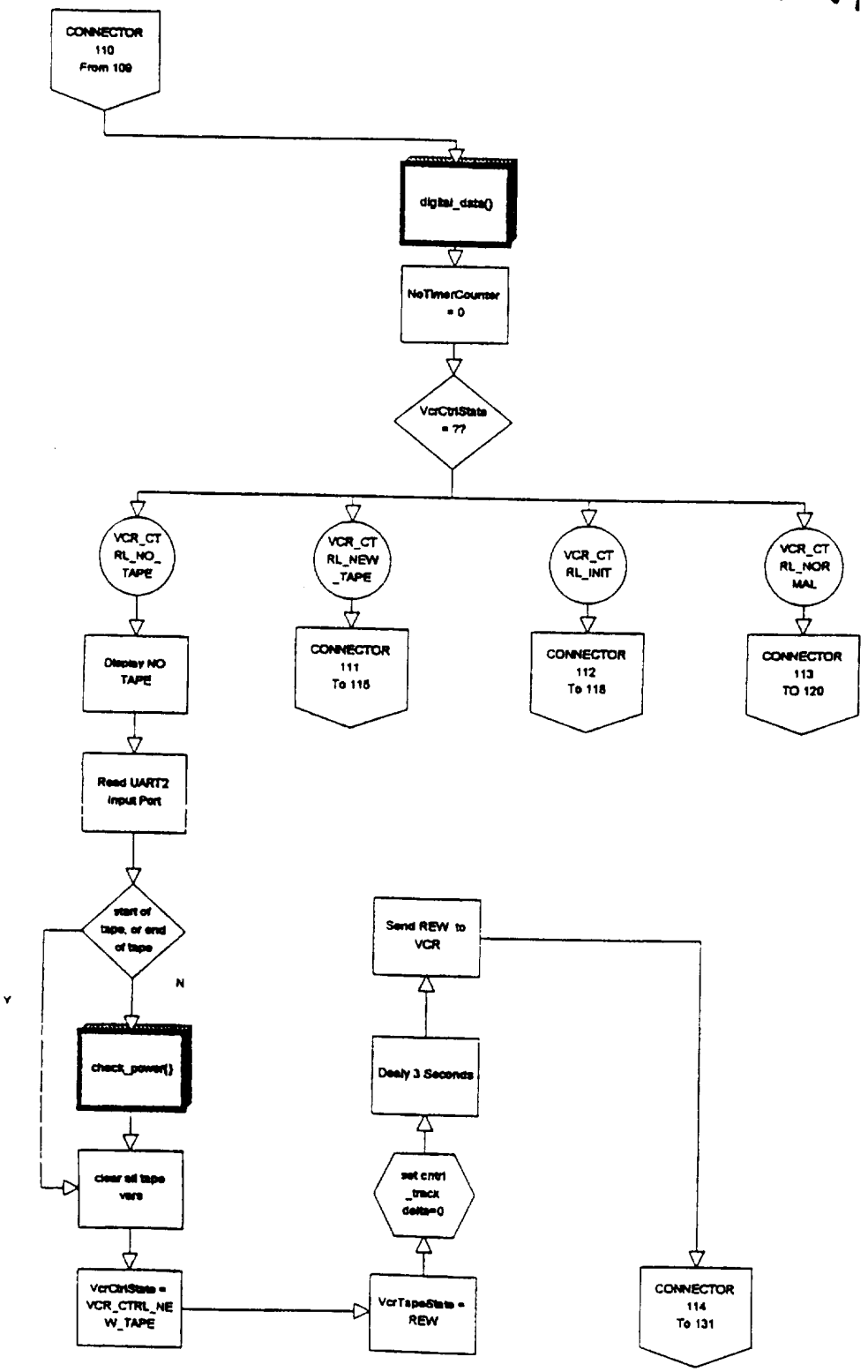

Figure 51V

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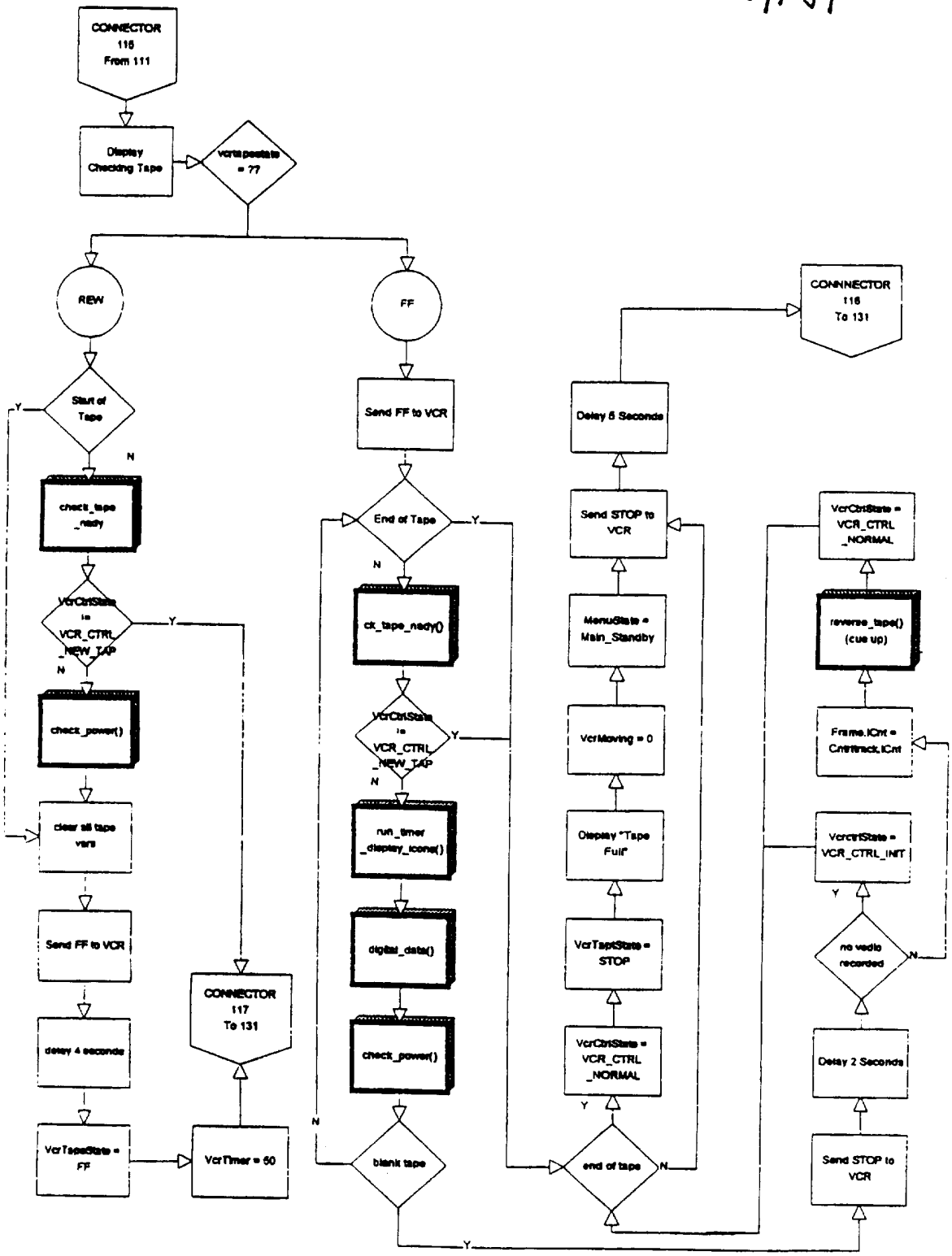

Figure 51W

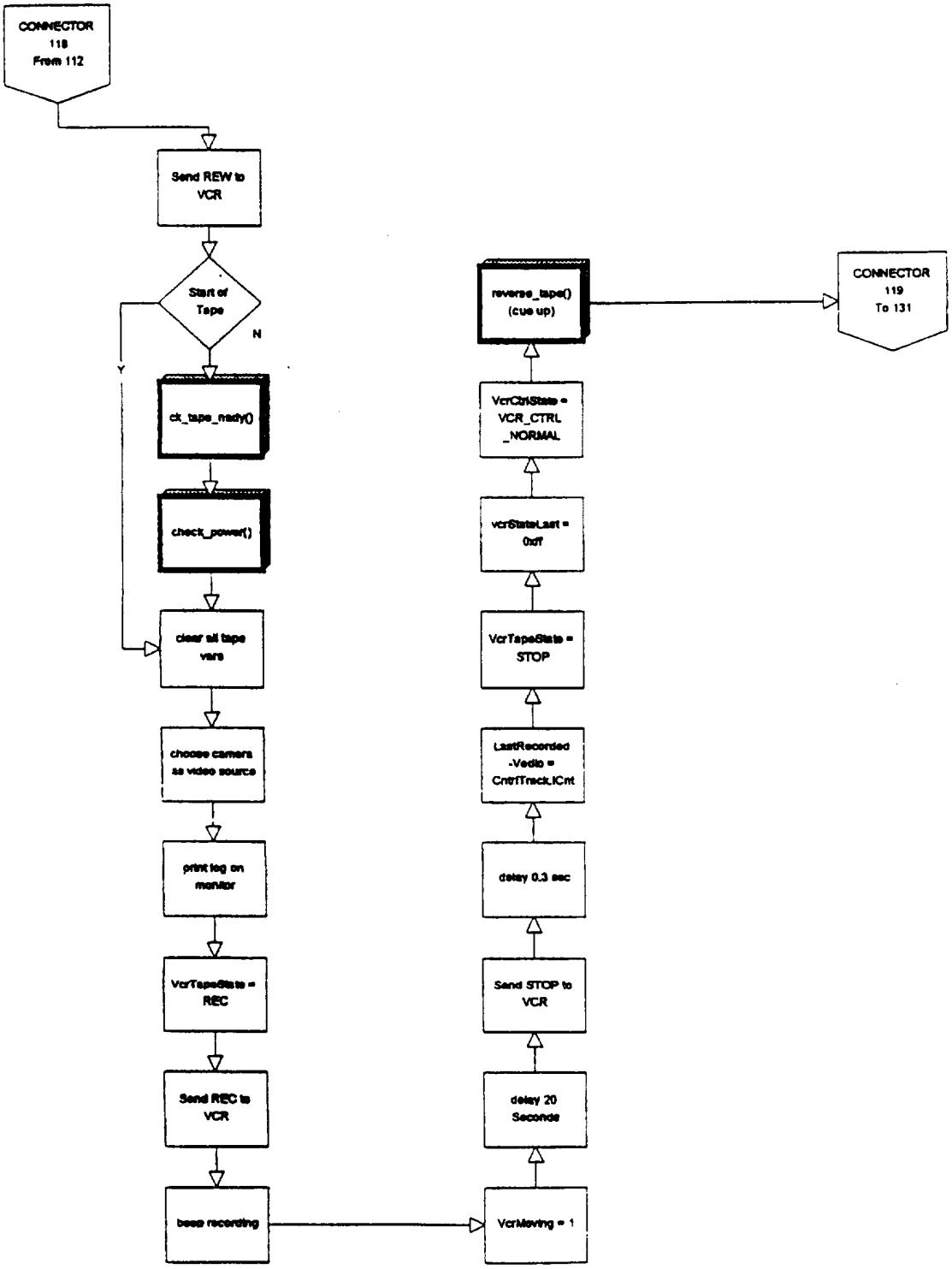
CONNECTOR
118
From 112
Send REW to VCR
Start of Tape
N
Y
ck_tape_ready()
check_power()
clear all tape vars
choose camera as video source
print log on monitor
VcrTapeState = REC
Send REC to VCR
beep recording
VcrMoving = 1
delay 20 Seconds
Send STOP to VCR
delay 0.3 sec
LastRecorded -Vedio = CntrlTrack.ICnt
VcrTapeState = STOP
vcrStateLast = 0xff
VcrCtrlState = VCR_CTRL _NORMAL
reverse_tape() (cue up)
CONNECTOR
119
To 131

Figure 51X

80/109

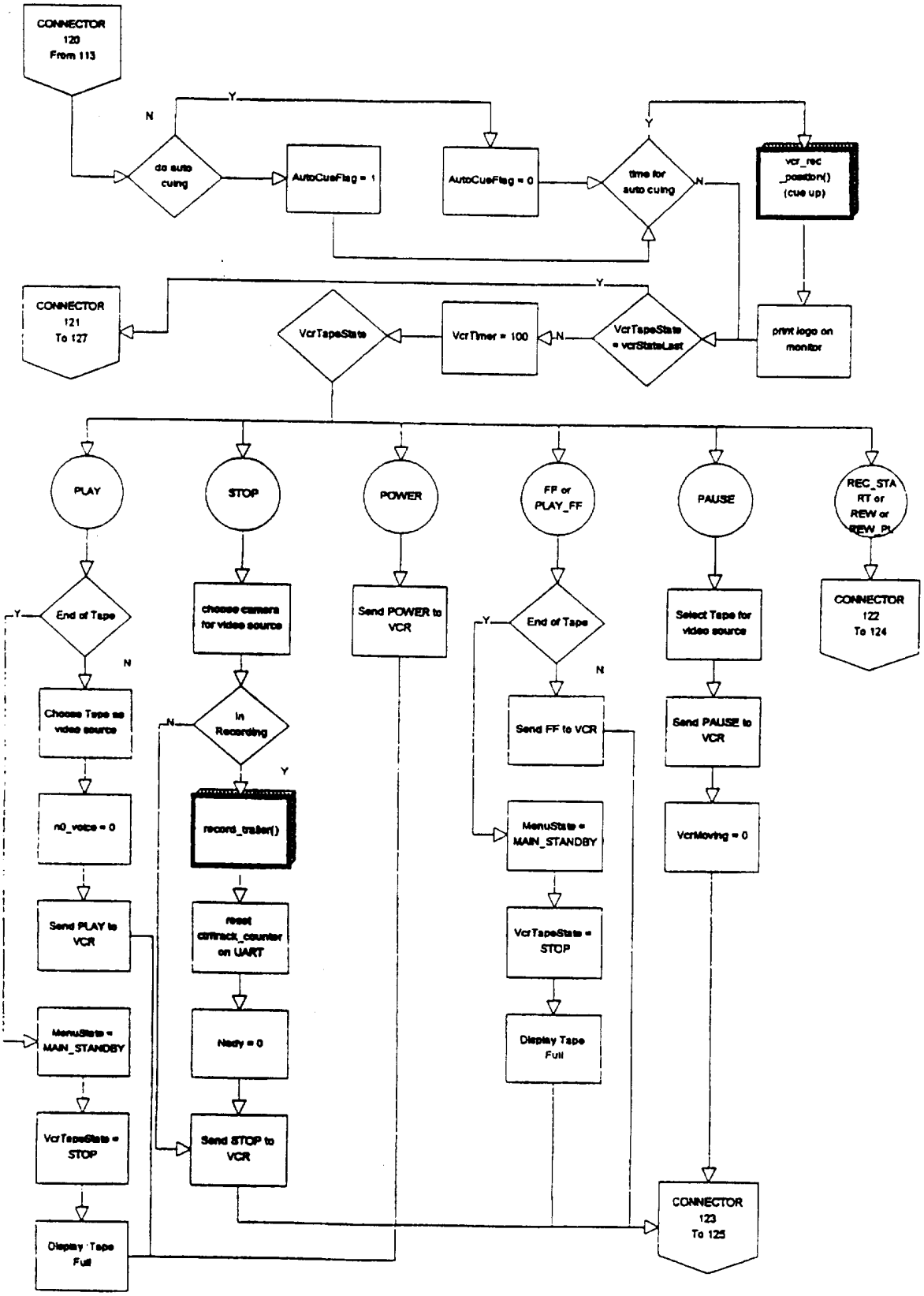

Figure 51Y

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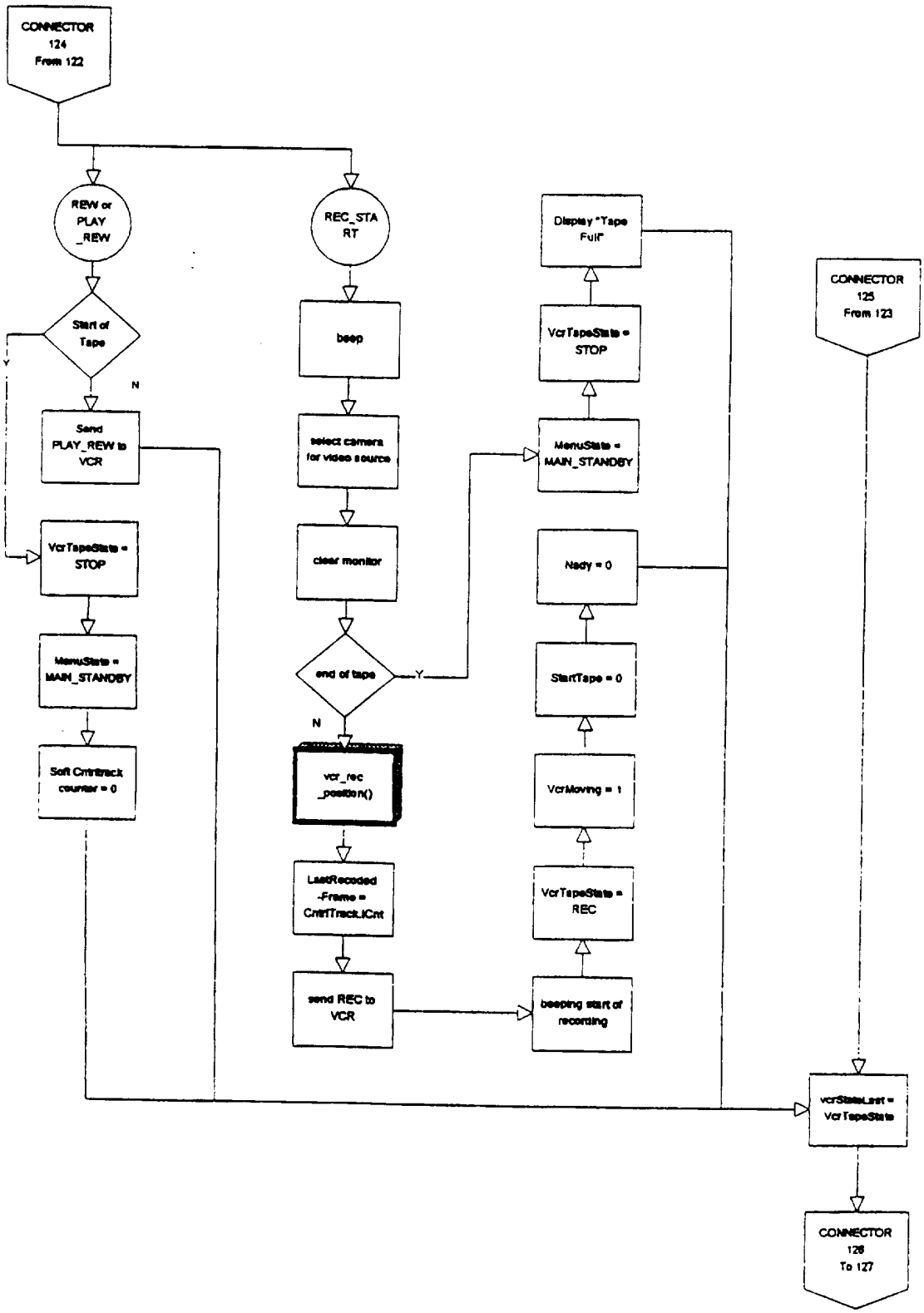

Figure 51Z

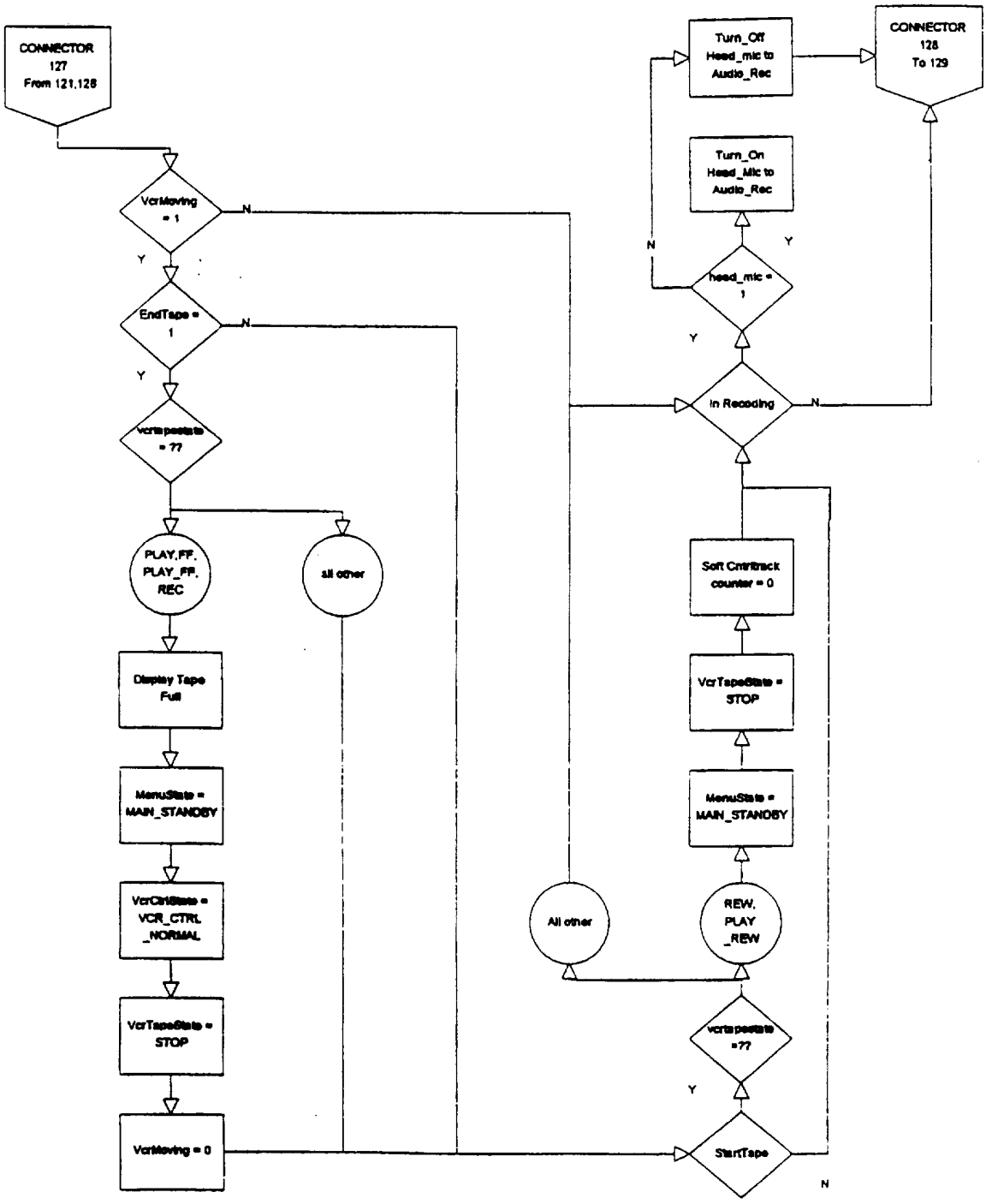
CONNECTOR 127 From 121,128
VcrMoving = 1
N
Y
EndTape = 1
N
Y
vcrtapestate = 77
PLAY,FF, PLAY_FF, REC
all other
Display Tape Full
MenuState = MAIN_STANDBY
VcrCtrlState = VCR_CTRL _NORMAL
VcrTapeState = STOP
VcrMoving = 0
Turn_Off Head_mic to Audio_Rec
CONNECTOR 128 To 129
Turn_On Head_Mic to Audio_Rec
N
Y
head_mic = 1
Y
In Recoding
N
Soft Cntrtrack counter = 0
VcrTapeState = STOP
MenuState = MAIN_STANDBY
All other
REW, PLAY _REW
vcrtapestate =77
Y
StartTape
N

Figure 51AA

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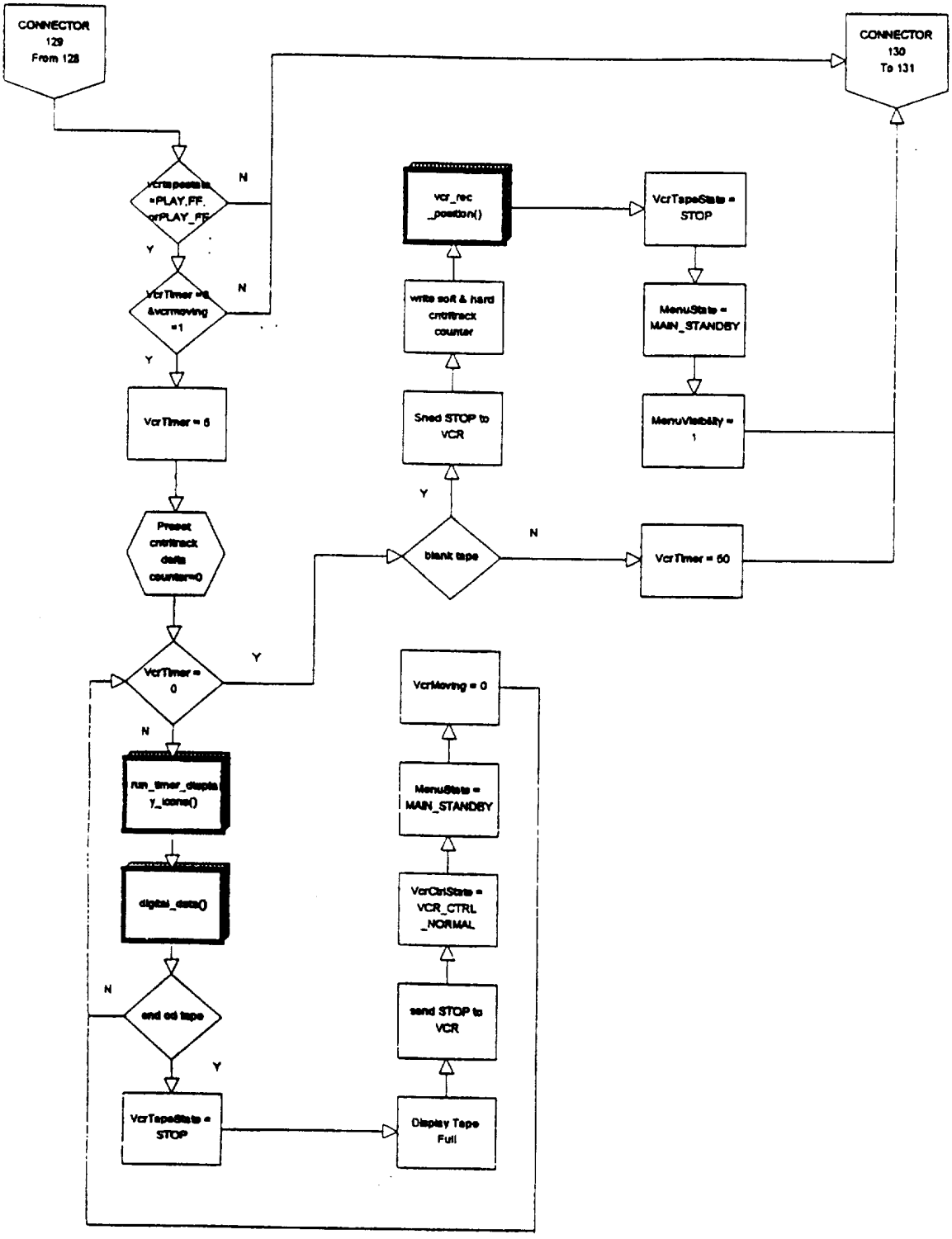

Figure 51BB

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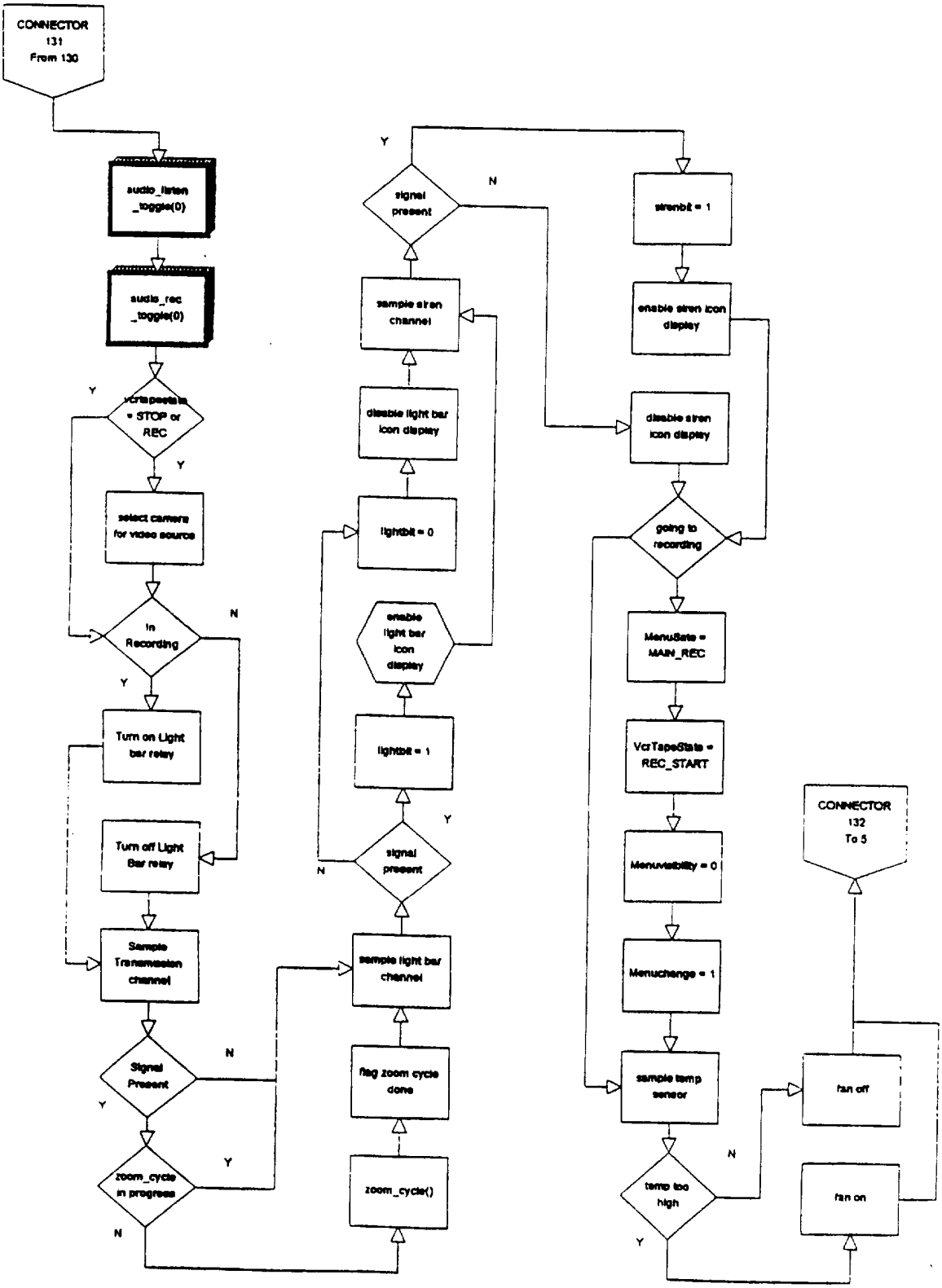

Figure 51CC

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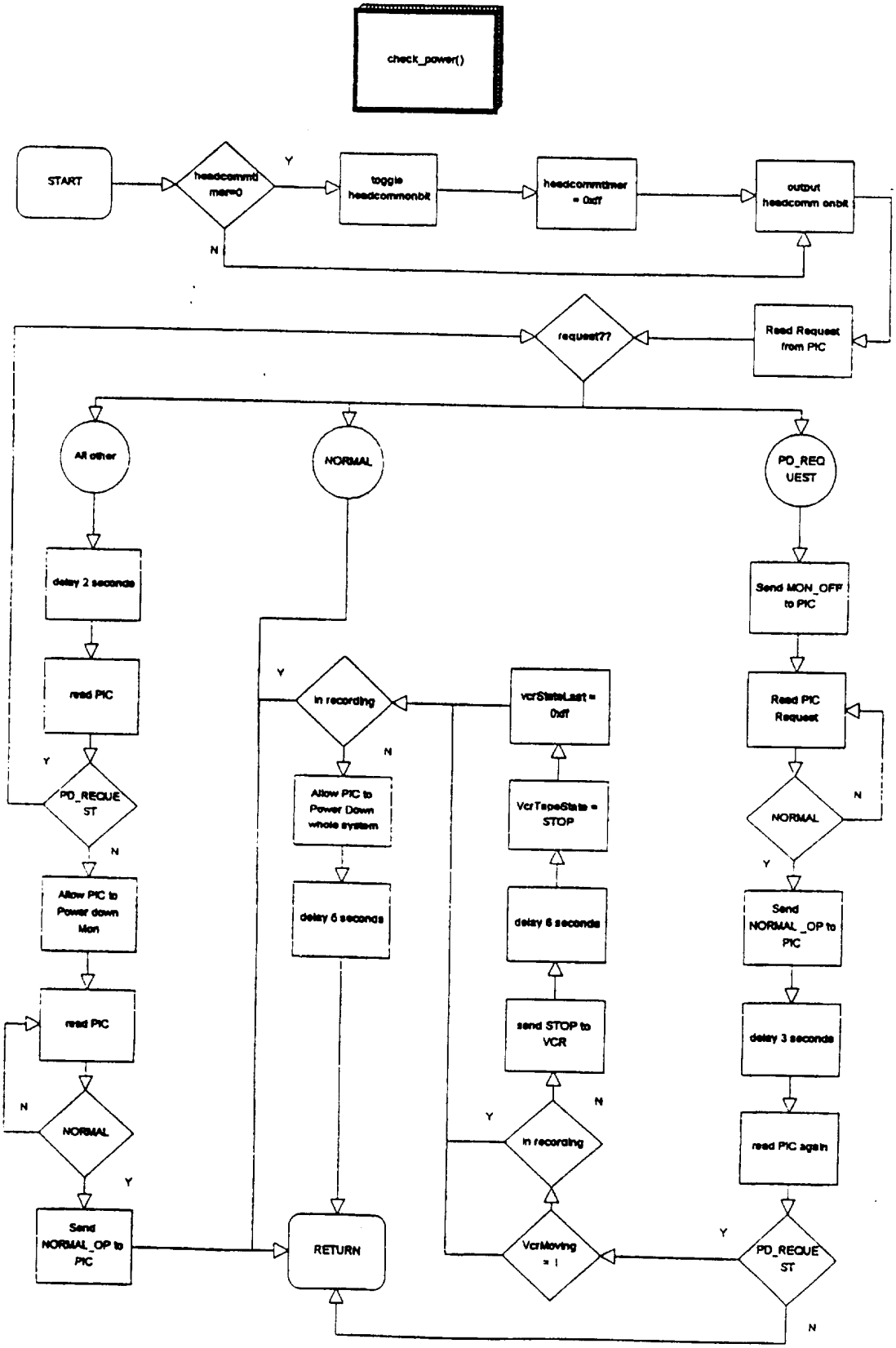

Figure 51DD

86/109

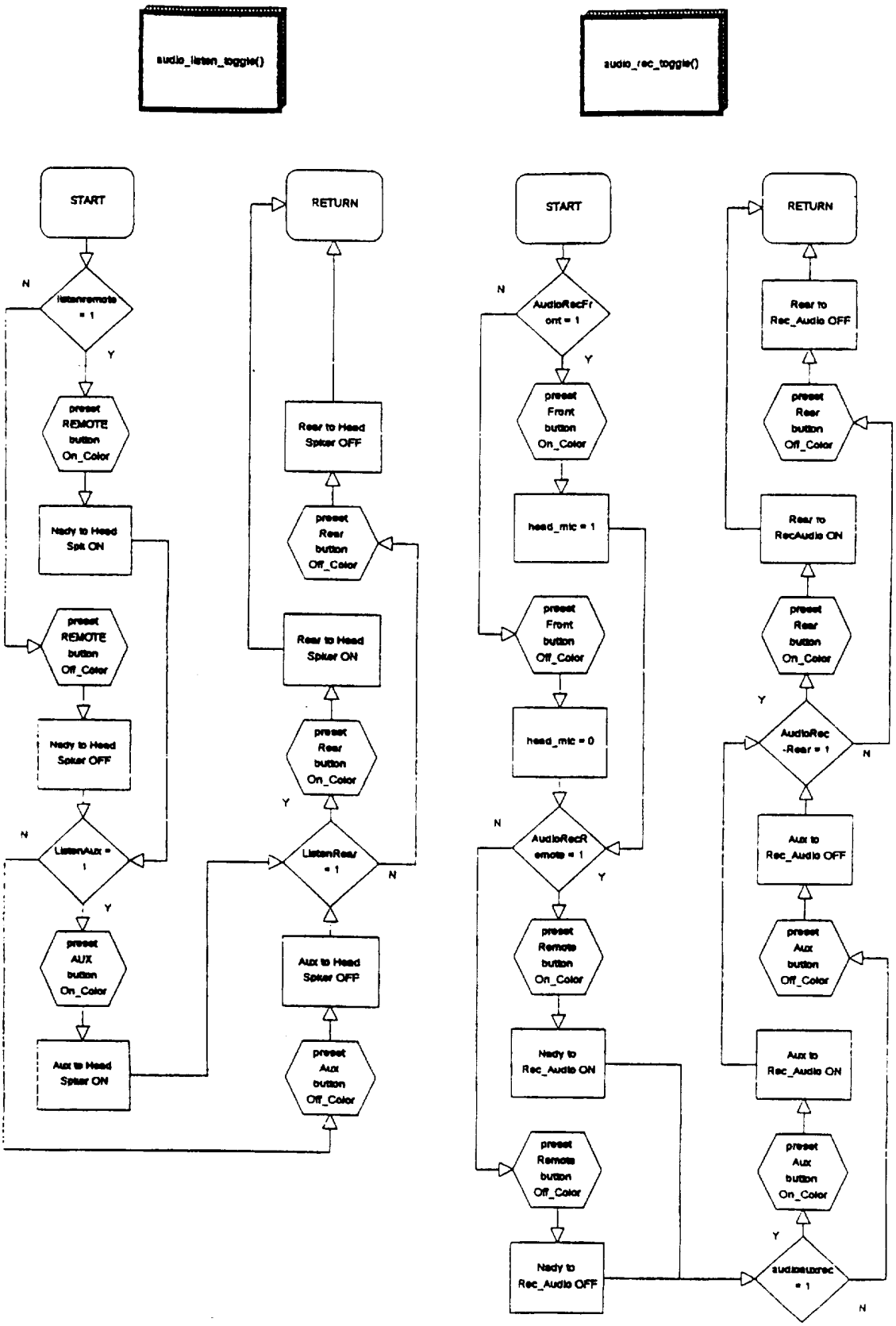

Figure 51EE

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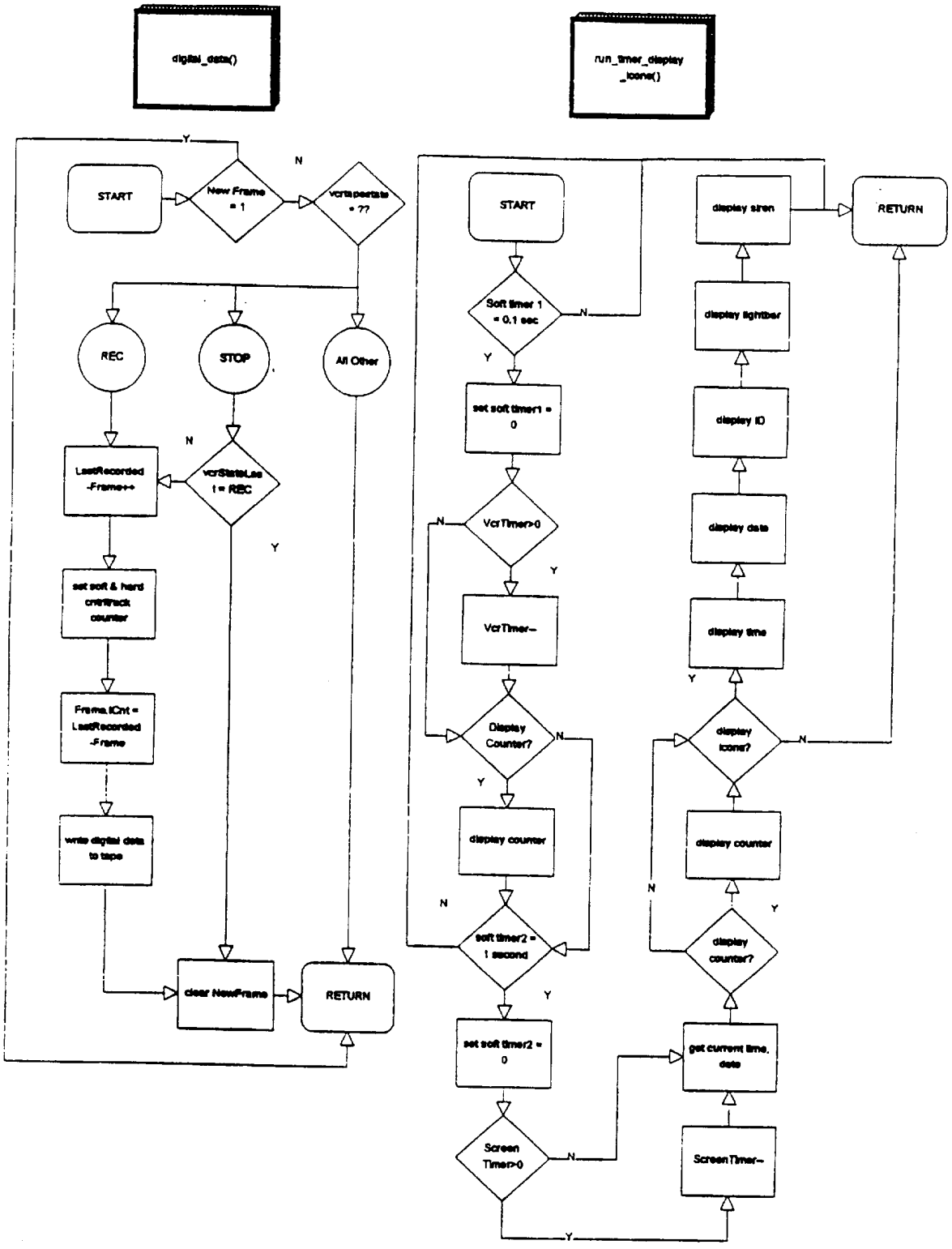

Figure 51FF

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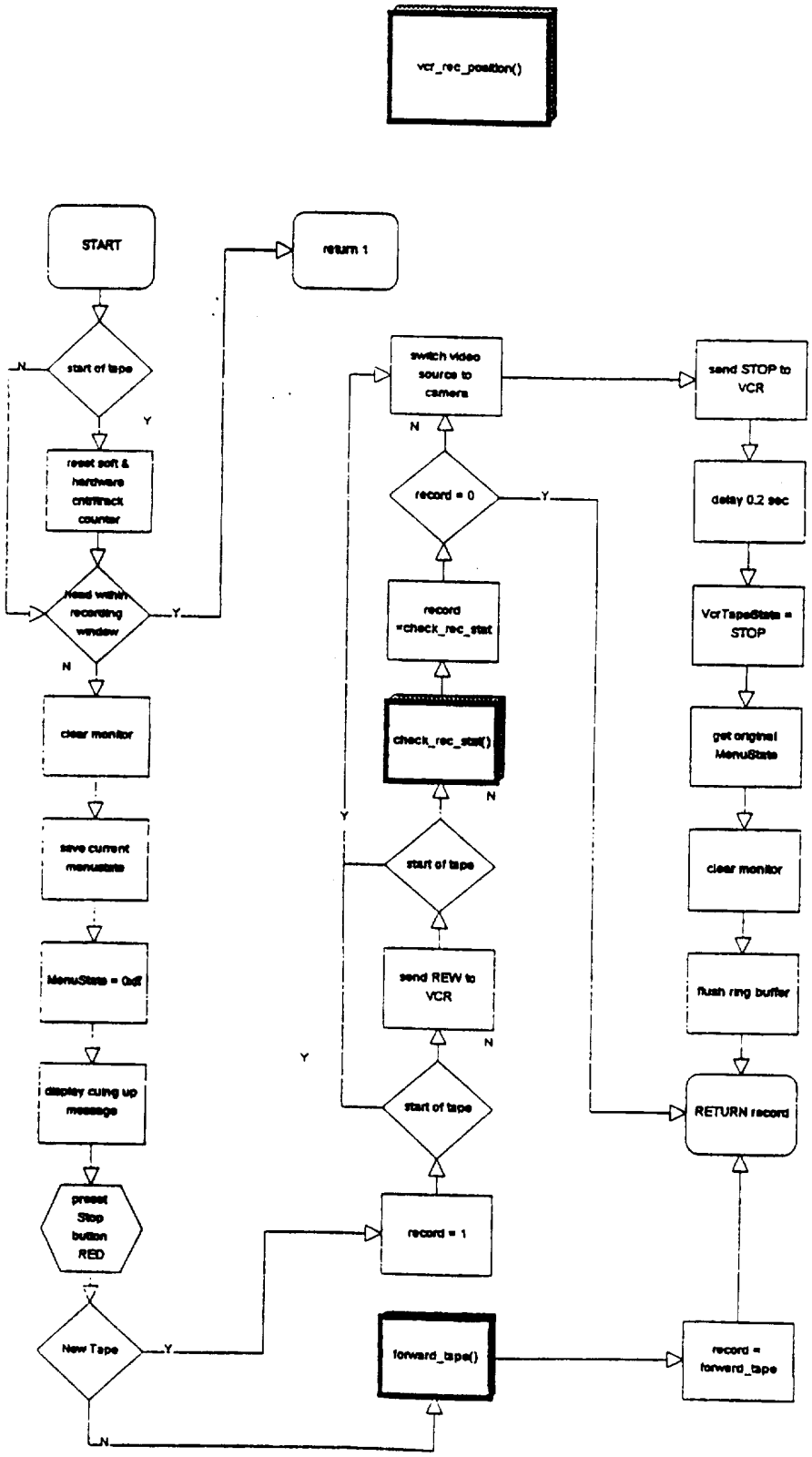

Figure 51GG

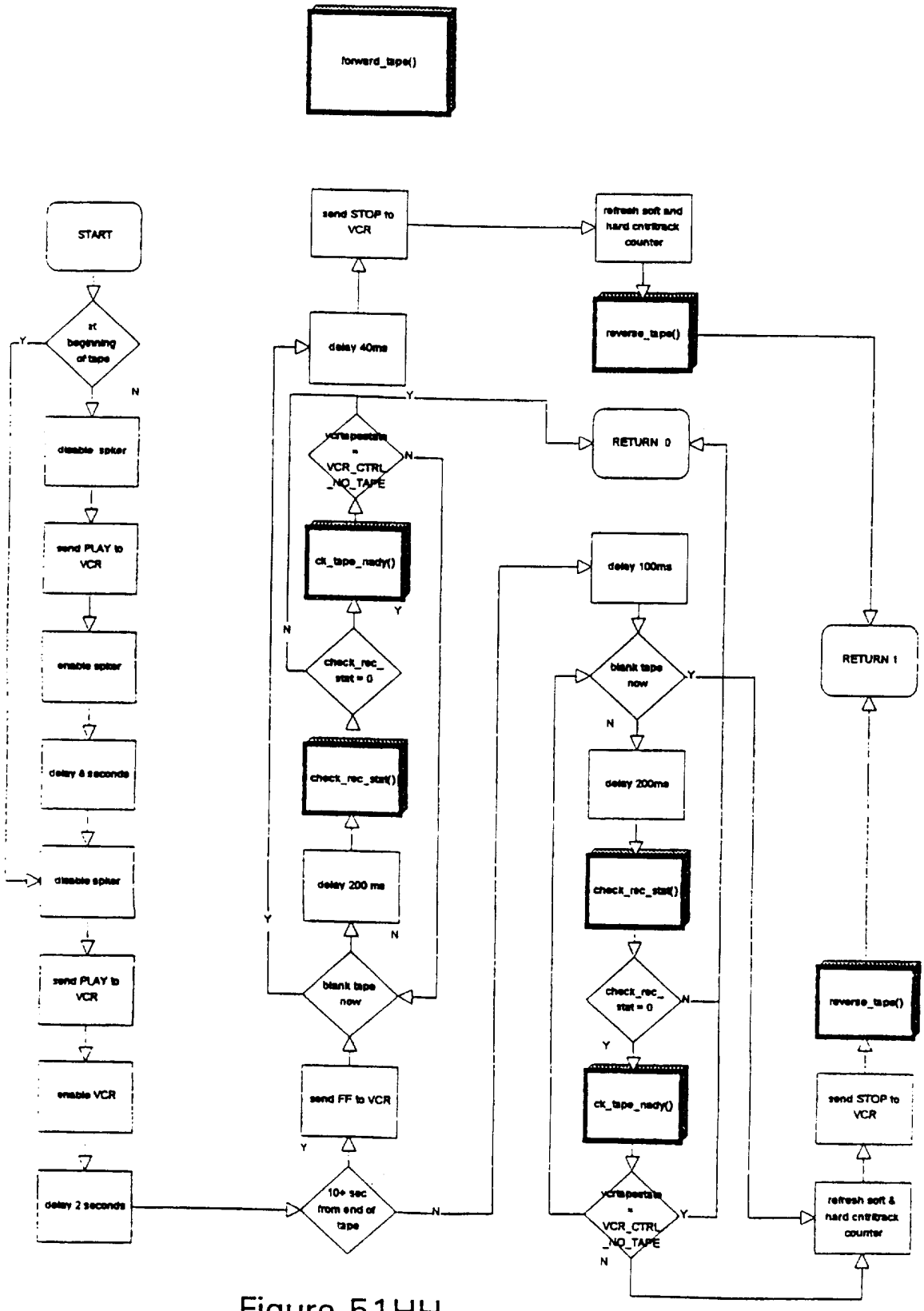
forward_tape()
START
at beginning of tape
Y
N
disable spkr
send PLAY to VCR
enable spkr
delay 5 seconds
disable spkr
send PLAY to VCR
enable VCR
delay 2 seconds
send STOP to VCR
delay 40ms
vcrispresent = VCR_CTRL_NO_TAPE
N
Y
ck_tape_ready()
Y
check_rec_stat = 0
N
check_rec_stat()
delay 200 ms
N
Y
blank tape now
send FF to VCR
Y
10+ sec from end of tape
N
refresh soft and hard cnttrack counter
reverse_tape()
RETURN 0
delay 100ms
blank tape now
Y
N
delay 200ms
check_rec_stat()
check_rec_stat = 0
N
Y
ck_tape_ready()
vcrispresent = VCR_CTRL_NO_TAPE
Y
N
RETURN 1
reverse_tape()
send STOP to VCR
refresh soft & hard cnttrack counter

Figure 51HH

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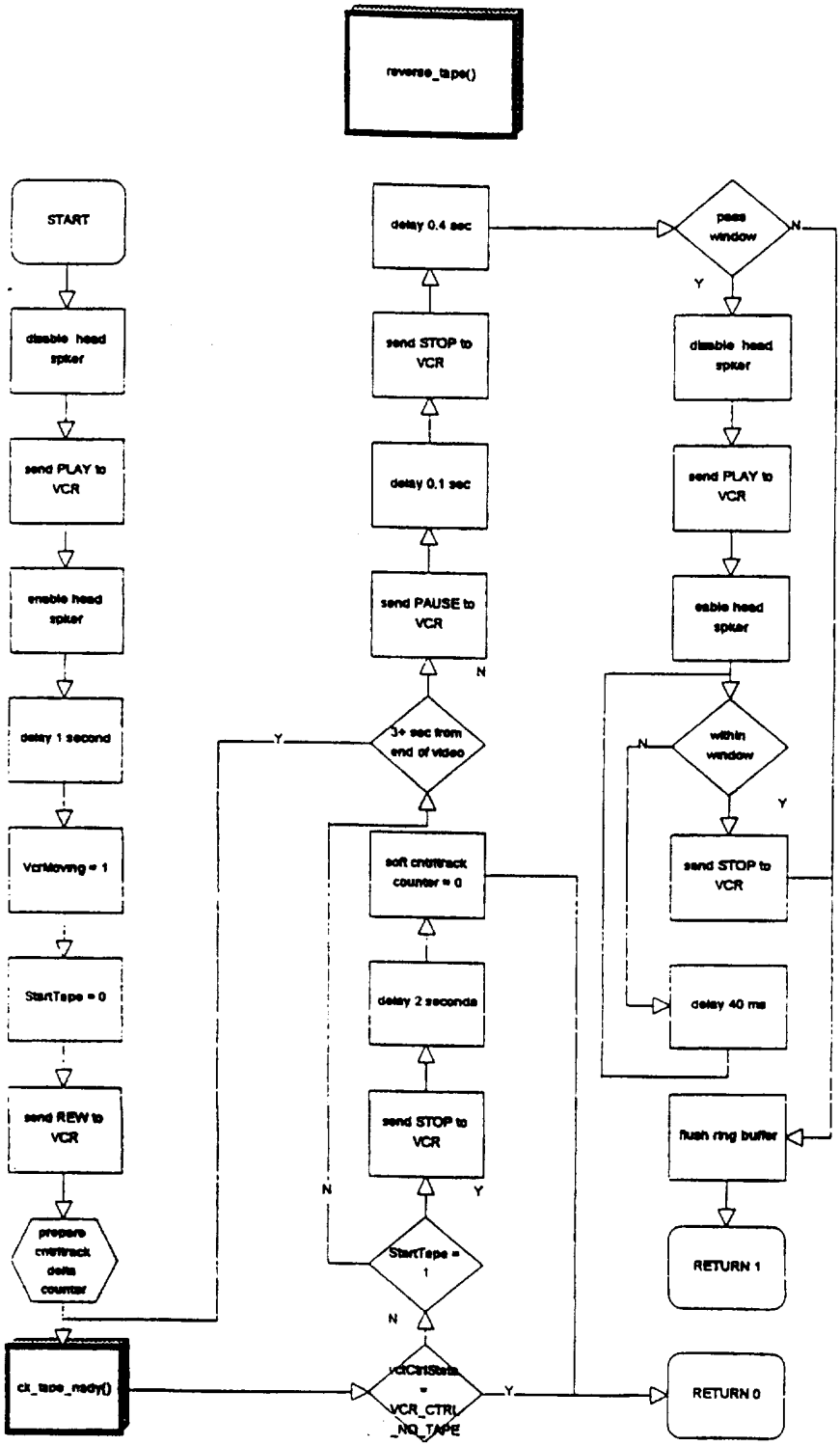

Figure 51II

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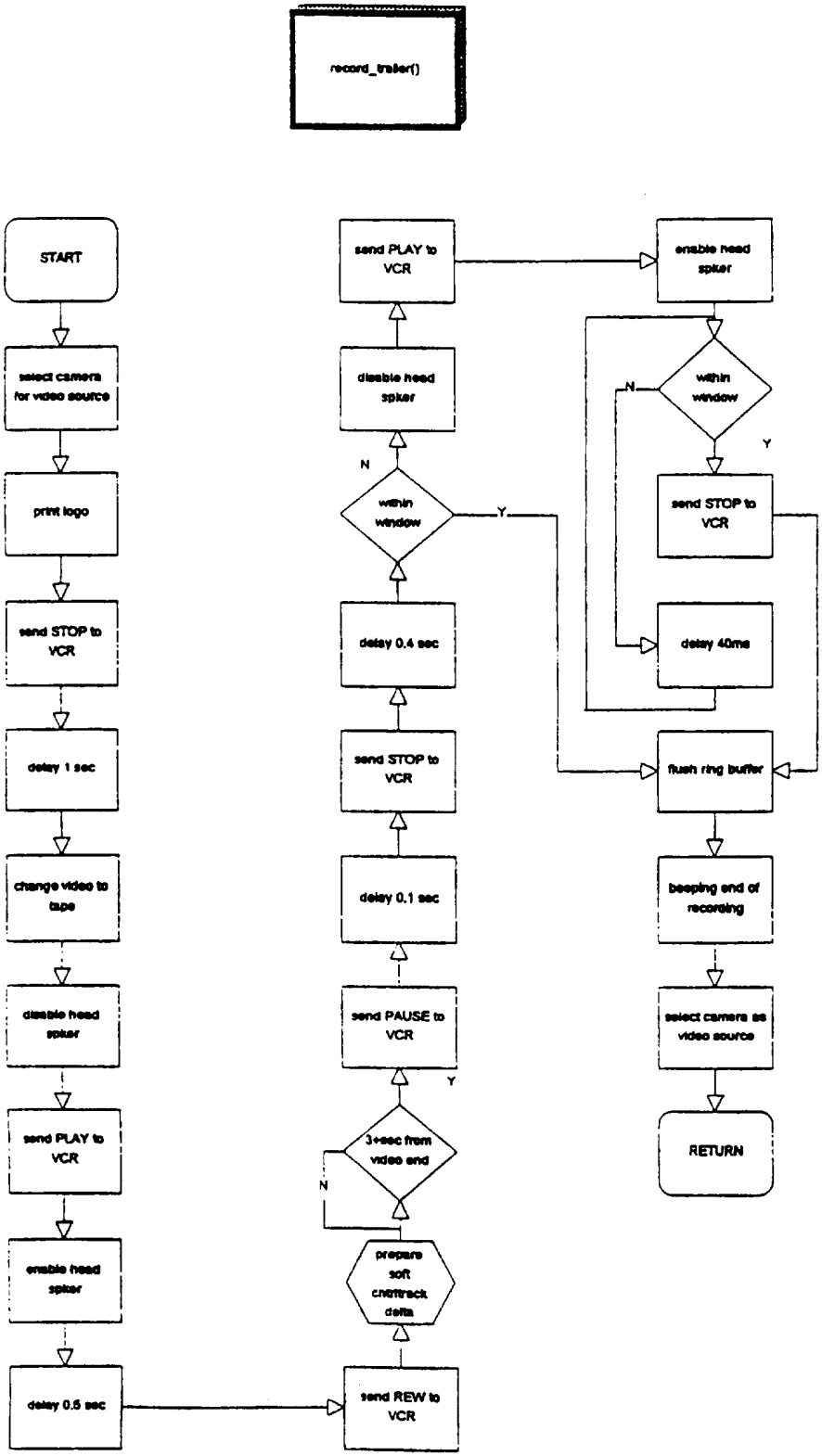

Figure 51JJ

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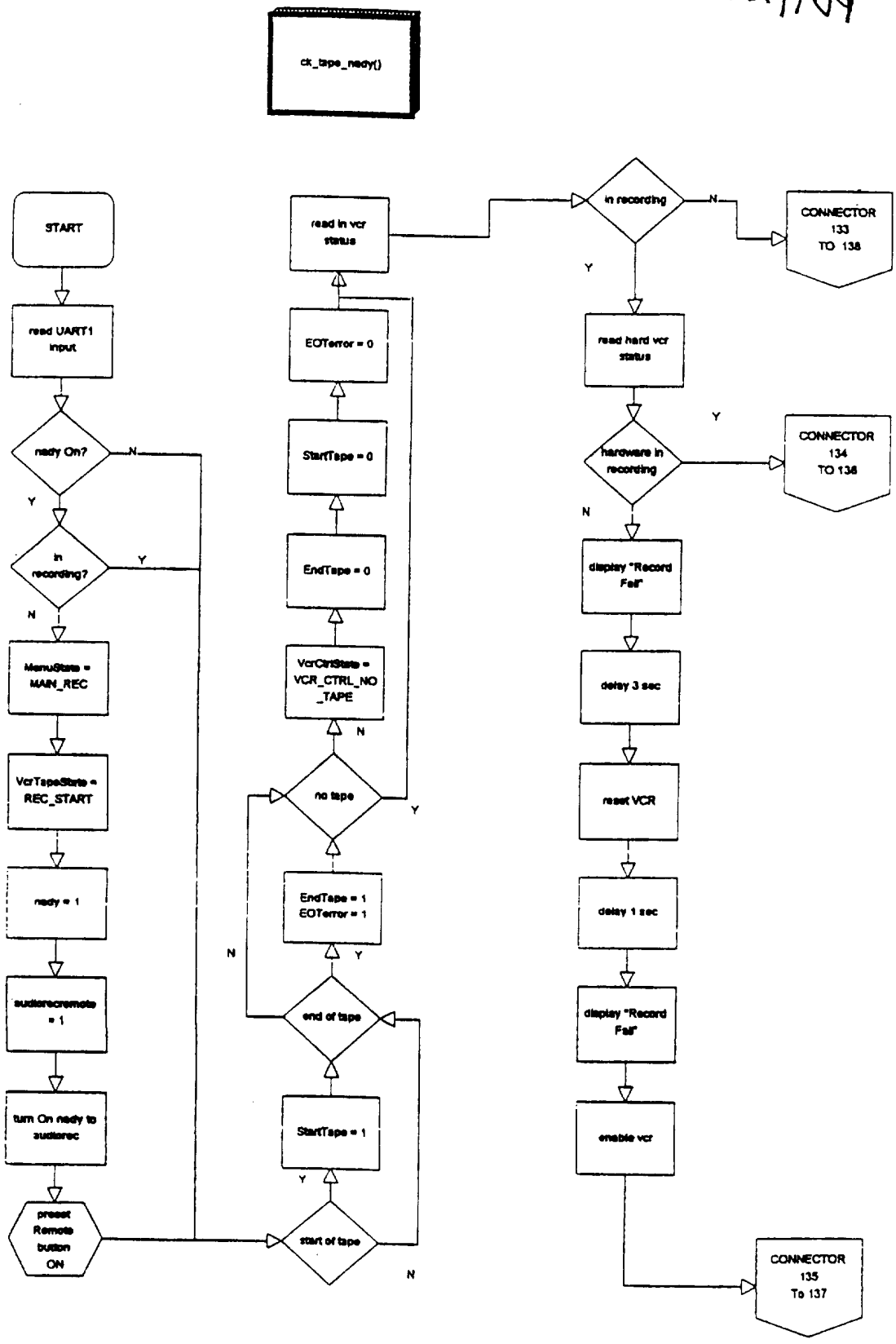

Figure 51KK

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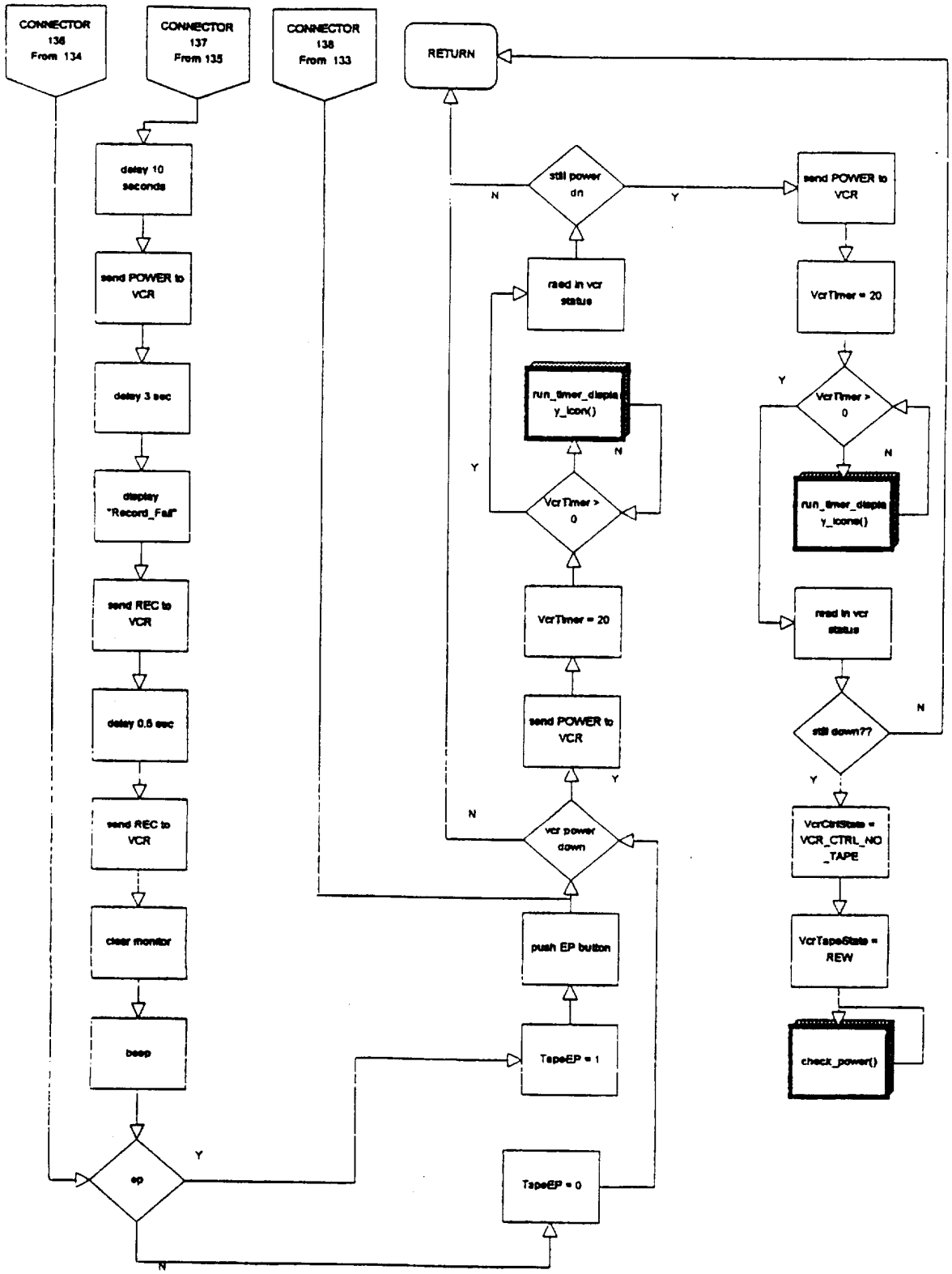

Figure 51LL

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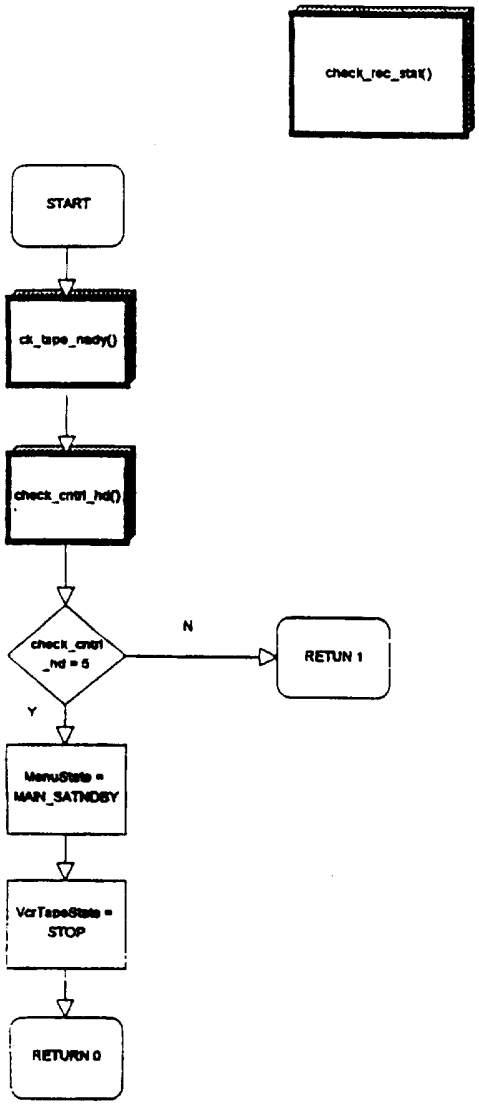

Figure 51MM

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VP3000 INTERRUPT SERVICE ROUTINE FLOW CHART

INTERRUPT 0—EXTERNAL INTERRUPT
(Generating Flag for Frame Counter)

INTERRUPT 1—TIMER0
(Generating 20ms Timing Base)

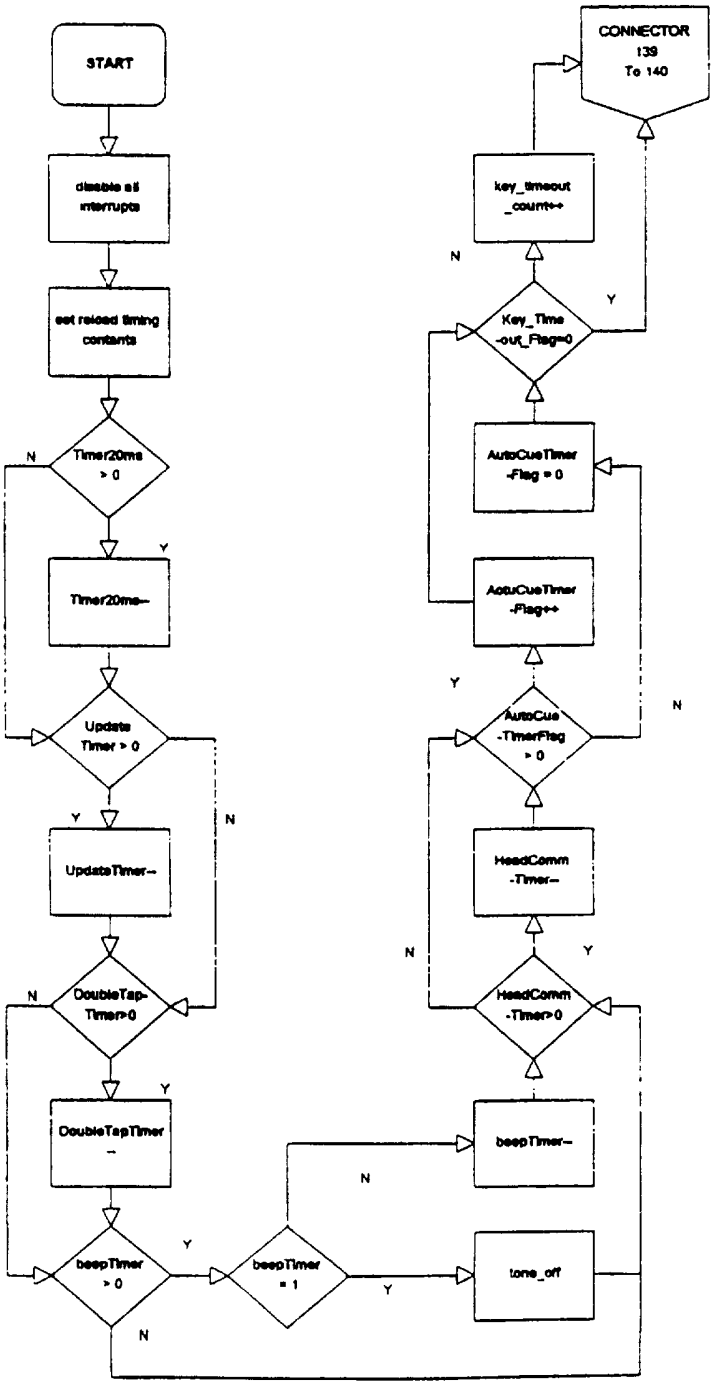

Figure 51NN

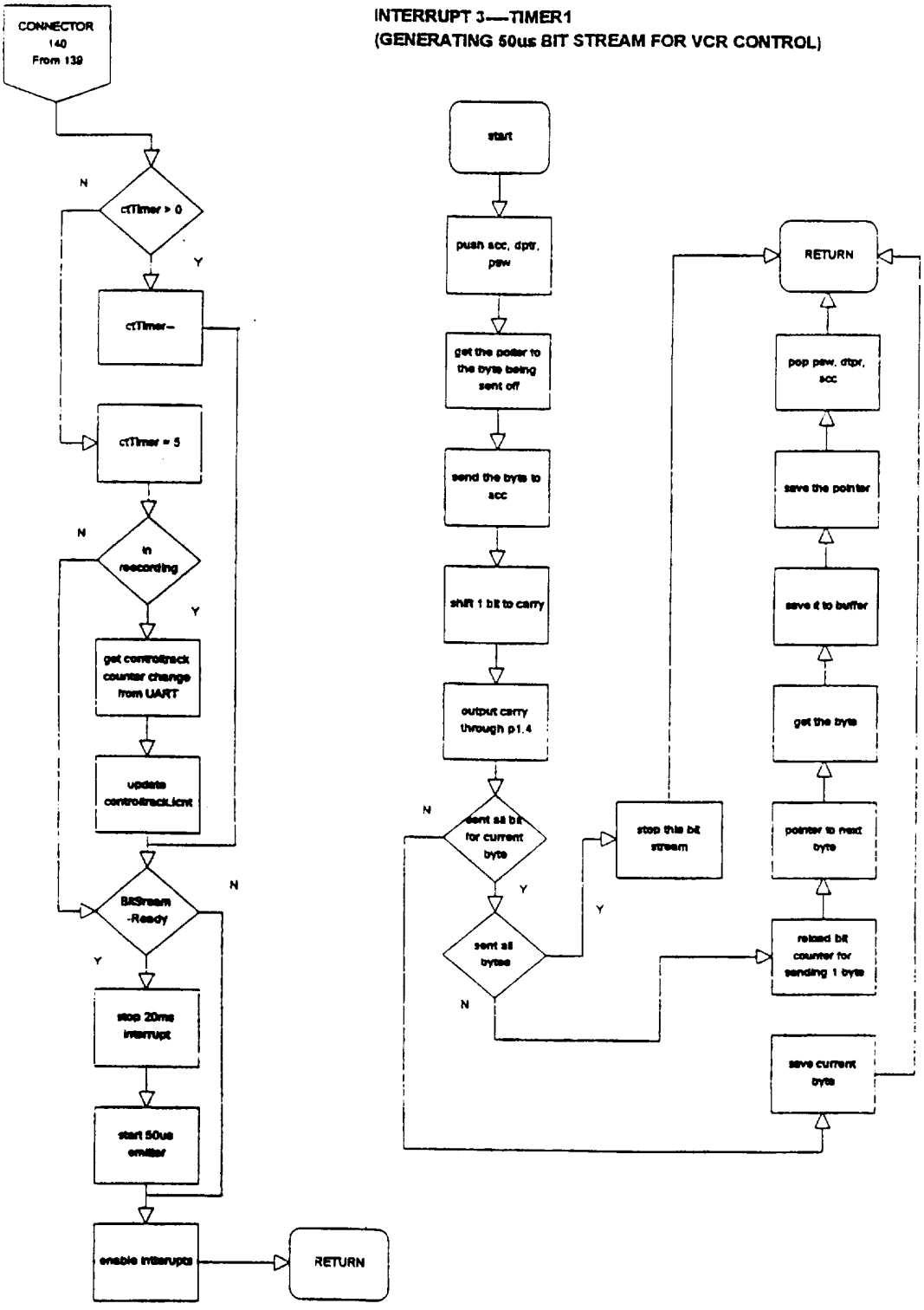
INTERRUPT 3—TIMER1
(GENERATING 50us BIT STREAM FOR VCR CONTROL)
CONNECTOR 140 From 139
ctTimer > 0
N
Y
ctTimer--
ctTimer = 5
In recording
N
Y
get controltrack counter change from UART
update controltrack.lcnt
BitStream -Ready
N
Y
stop 20ms interrupt
start 50us emitter
enable interrupts
RETURN
start
push acc, dptr, psw
get the poiter to the byte being sent off
send the byte to acc
shift 1 bit to carry
output carry through p1.4
sent all bit for current byte
N
Y
stop this bit stream
sent all bytes
Y
N
reload bit counter for sending 1 byte
pointer to next byte
get the byte
save it to buffer
save the pointer
pop psw, dptr, acc
RETURN
save current byte

Figure 5100

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INTERRUPT 4—SERIAL PORT
(CONTROL HEAD COMMUNICATION)

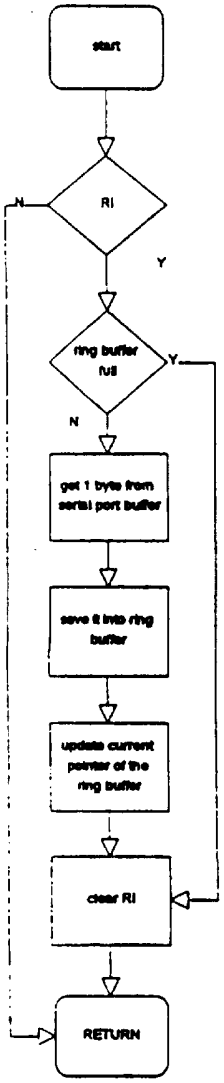


Figure 51PP

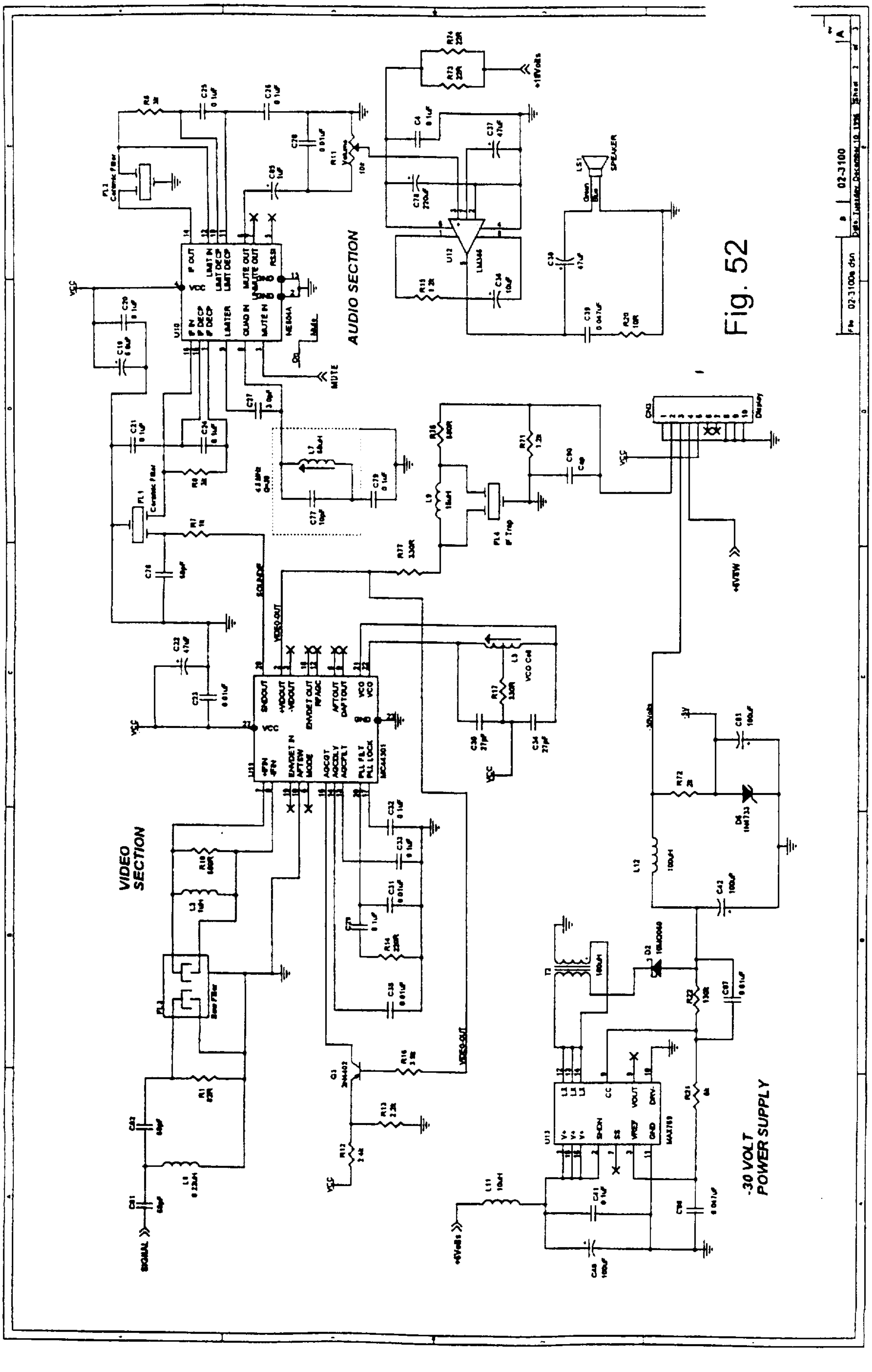

AUDIO SECTION
VIDEO SECTION
-30 VOLT POWER SUPPLY
SPEAKER
MUTE
SIGNAL
VIDEO OUT
Display

Fig. 52

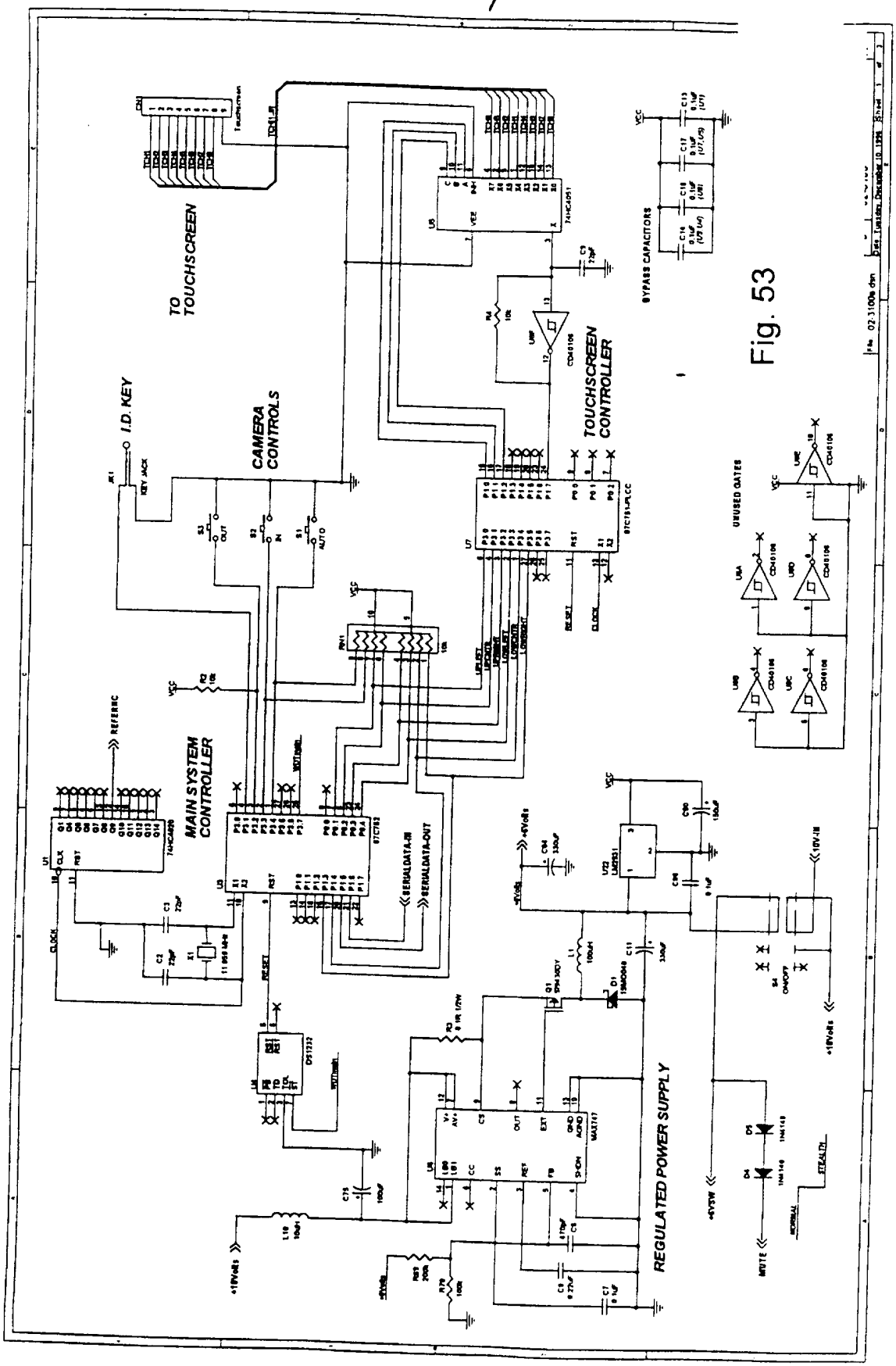

TO TOUCHSCREEN
I.D. KEY
CAMERA CONTROLS
TOUCHSCREEN CONTROLLER
BYPASS CAPACITORS
UNUSED GATES
MAIN SYSTEM CONTROLLER
REGULATED POWER SUPPLY

Fig. 53

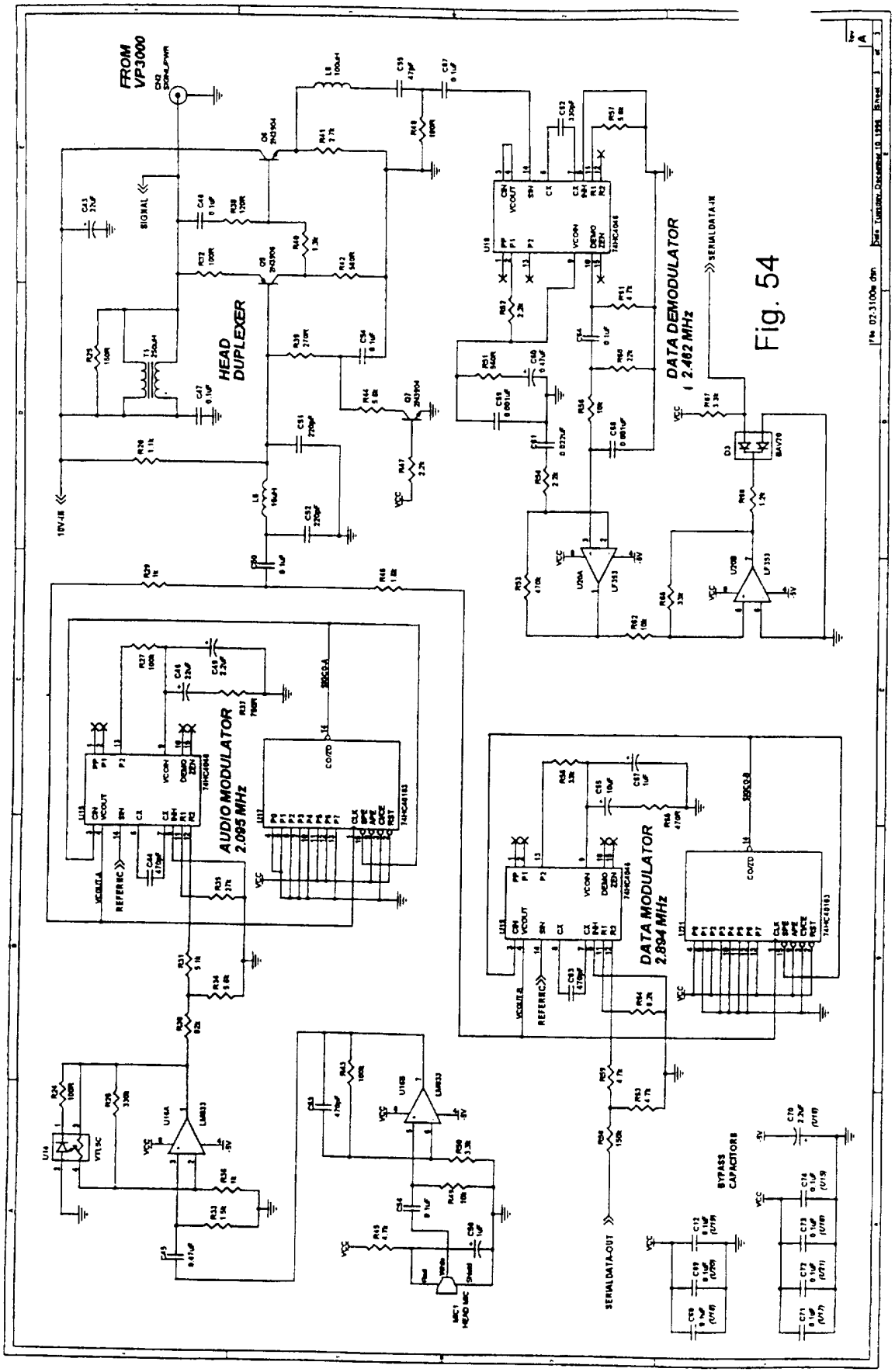

FROM VP3000
HEAD DUPLEXER
DATA DEMODULATOR @ 2.462 MHz
AUDIO MODULATOR 2.085 MHz
DATA MODULATOR 2.894 MHz
SERIAL DATA-OUT
BYPASS CAPACITORS

Fig. 54

CONTROL HEAD KEY READ PROGRAM

Figure 55

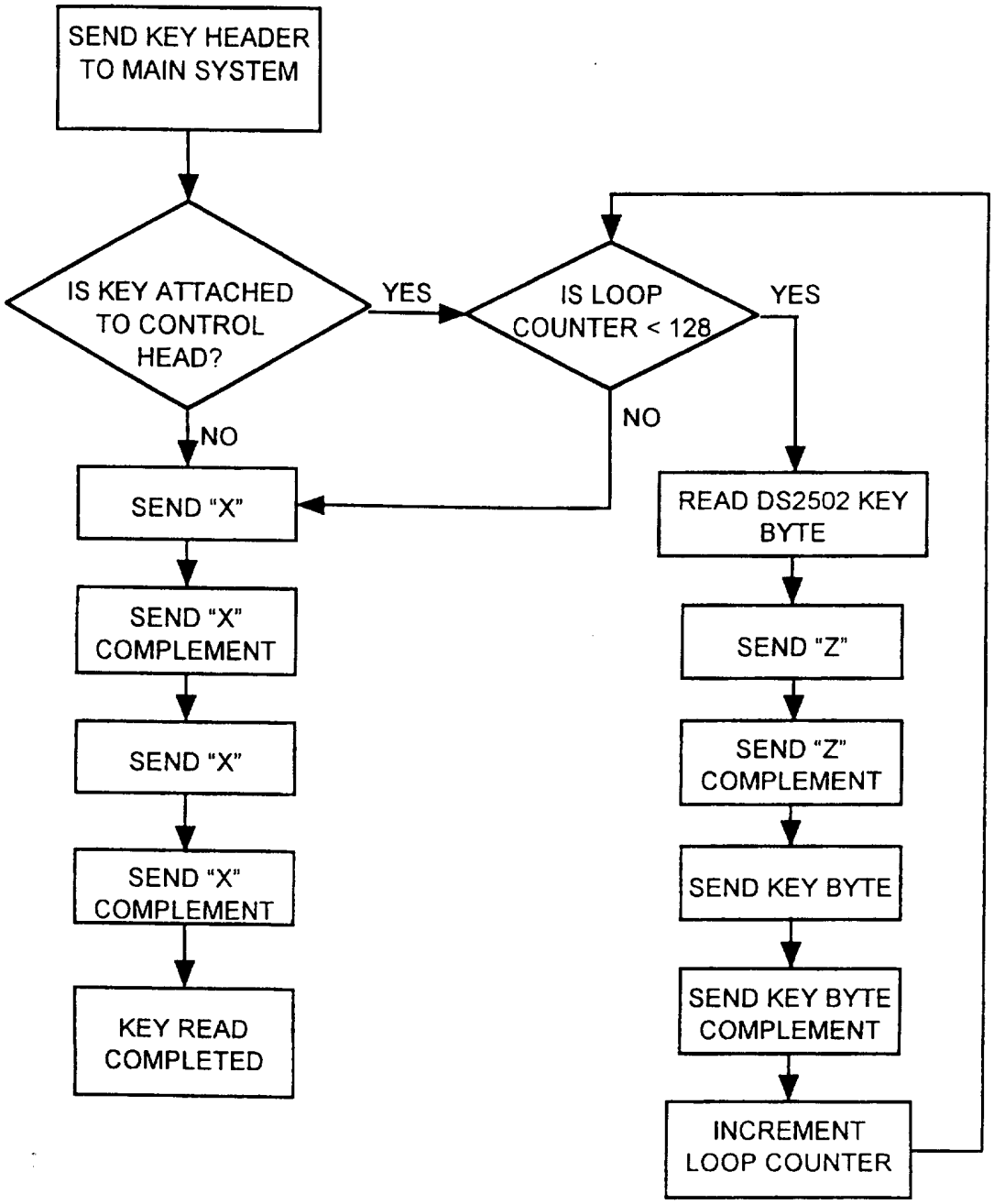
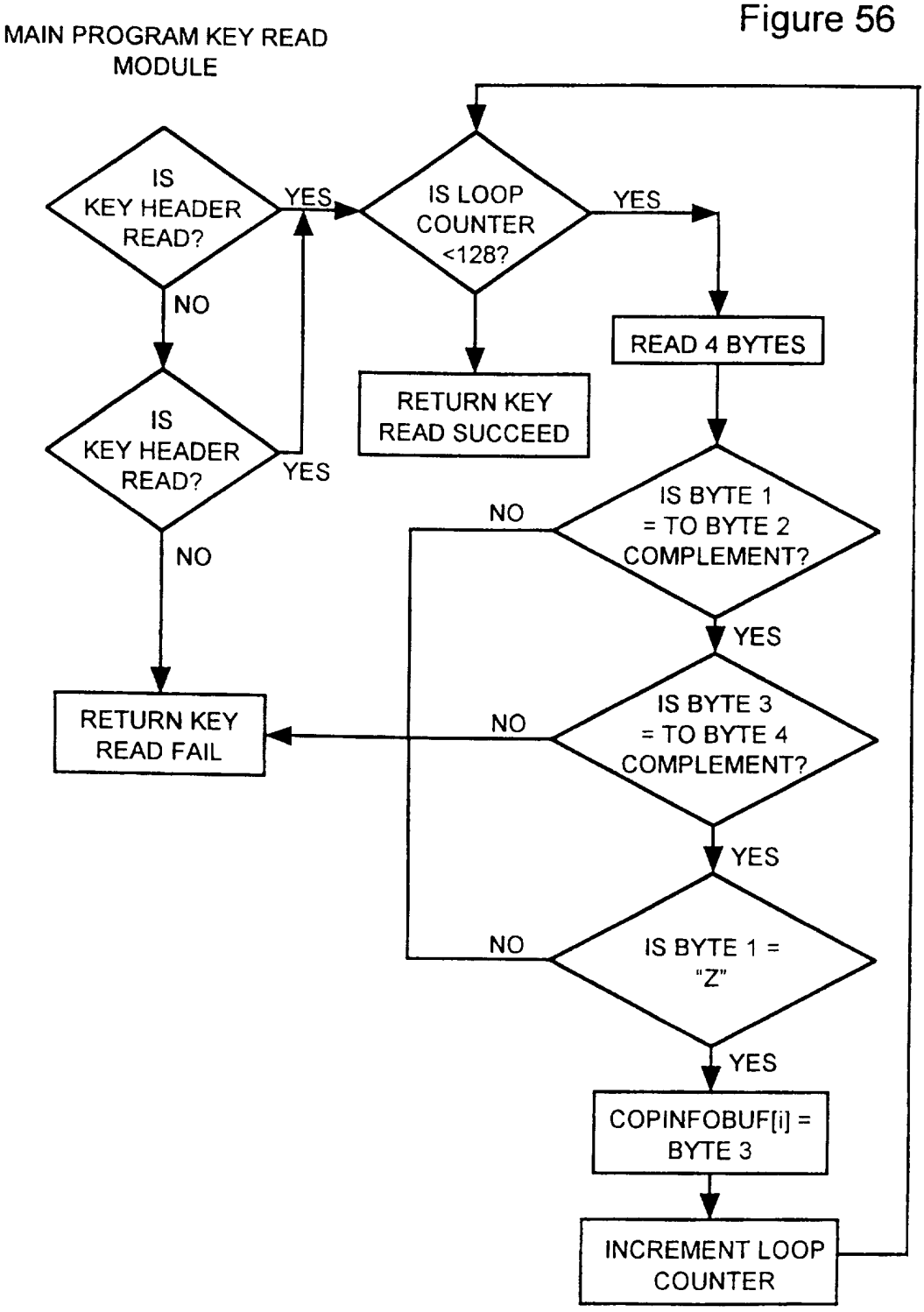


Figure 56


MAIN PROGRAM KEY READ MODULE
IS KEY HEADER READ?
YES
NO
IS LOOP COUNTER <128?
YES
RETURN KEY READ SUCCEED
READ 4 BYTES
IS KEY HEADER READ?
YES
NO
RETURN KEY READ FAIL
IS BYTE 1 = TO BYTE 2 COMPLEMENT?
NO
YES
IS BYTE 3 = TO BYTE 4 COMPLEMENT?
NO
YES
IS BYTE 1 = "Z"
NO
YES
COPINFOBUF[i] = BYTE 3
INCREMENT LOOP COUNTER

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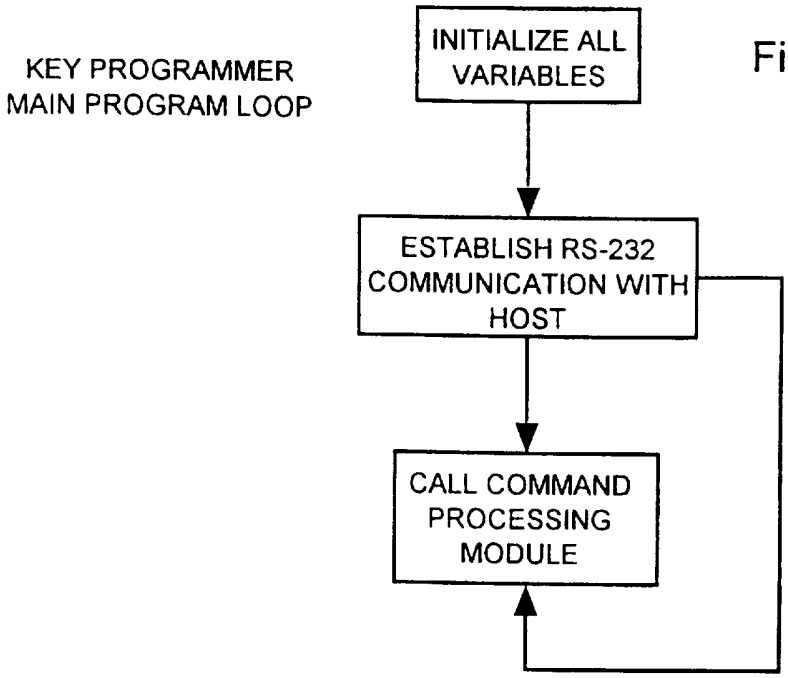

Figure 57

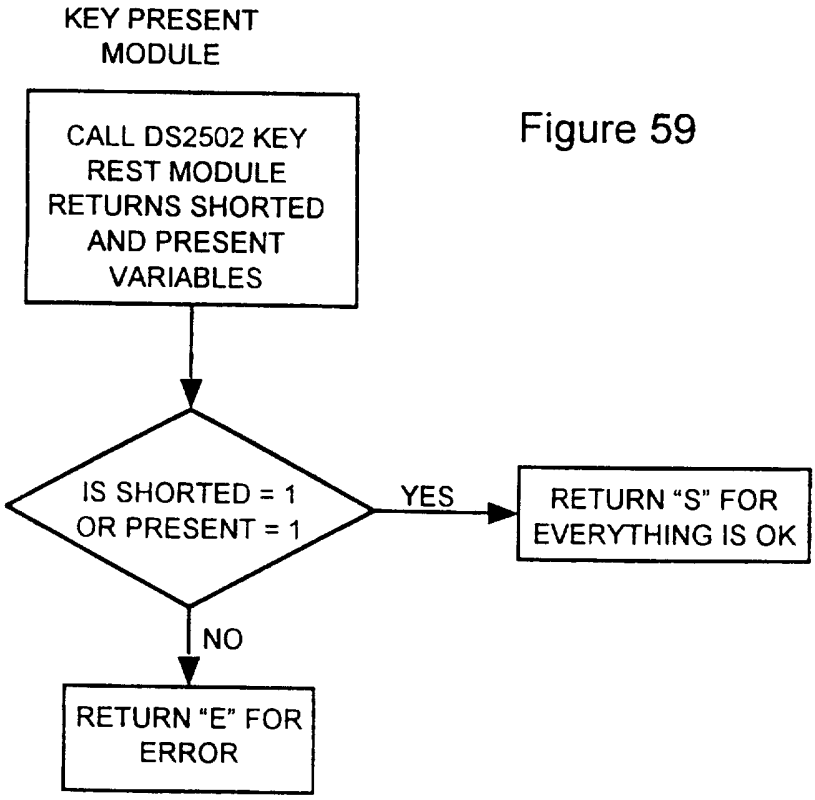

Figure 59

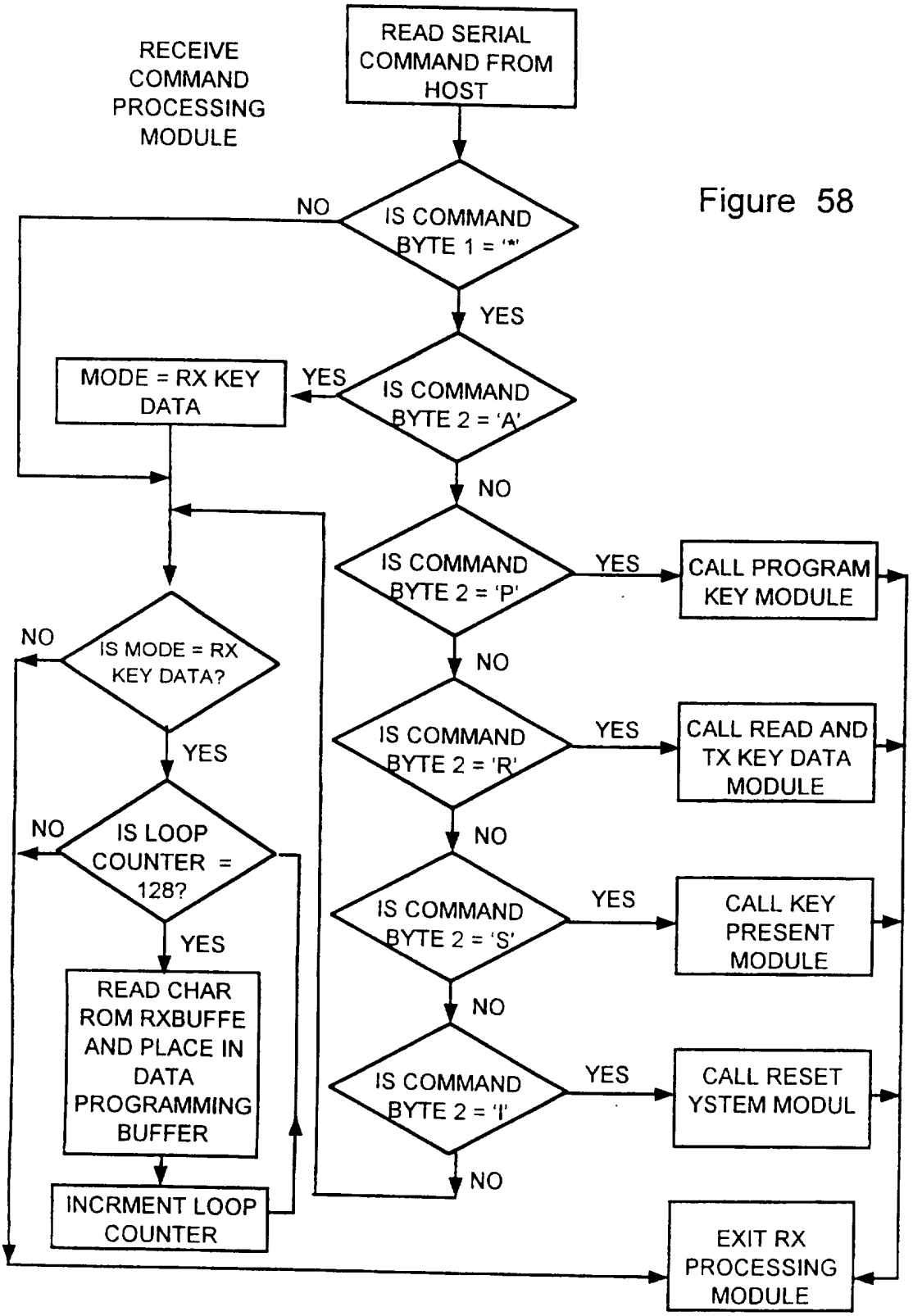
RECEIVE COMMAND PROCESSING MODULE
READ SERIAL COMMAND FROM HOST
IS COMMAND BYTE 1 = '*'
NO
YES
IS COMMAND BYTE 2 = 'A'
YES
MODE = RX KEY DATA
NO
IS COMMAND BYTE 2 = 'P'
YES
CALL PROGRAM KEY MODULE
NO
IS COMMAND BYTE 2 = 'R'
YES
CALL READ AND TX KEY DATA MODULE
NO
IS COMMAND BYTE 2 = 'S'
YES
CALL KEY PRESENT MODULE
NO
IS COMMAND BYTE 2 = 'I'
YES
CALL RESET YSTEM MODUL
NO
IS MODE = RX KEY DATA?
NO
YES
IS LOOP COUNTER = 128?
NO
YES
READ CHAR ROM RXBUFFE AND PLACE IN DATA PROGRAMMING BUFFER
INCRMENT LOOP COUNTER
EXIT RX PROCESSING MODULE

Figure 58

Figure 60

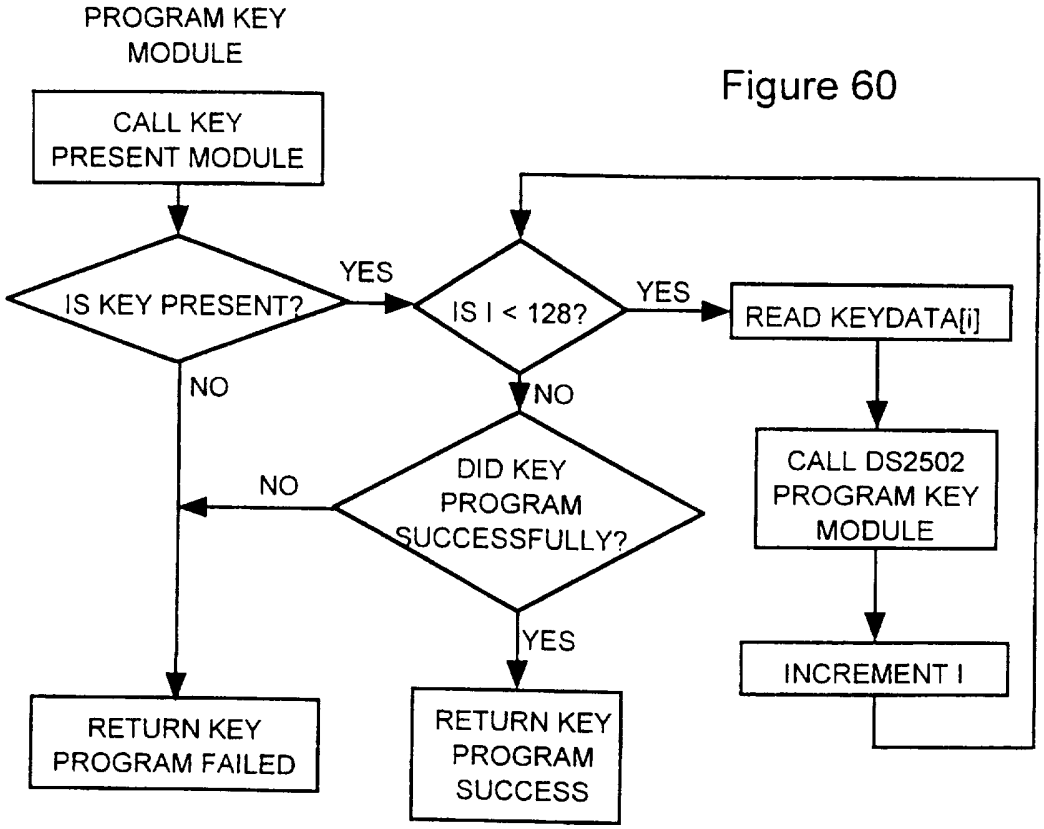

Figure 62

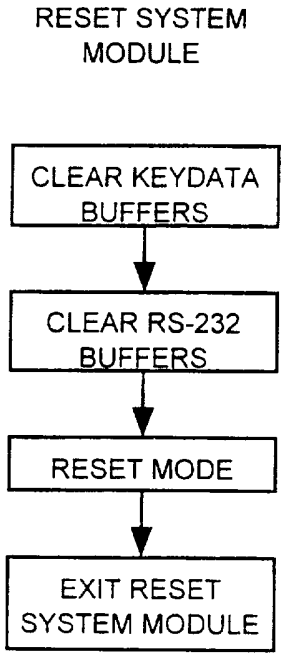

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Figure 61

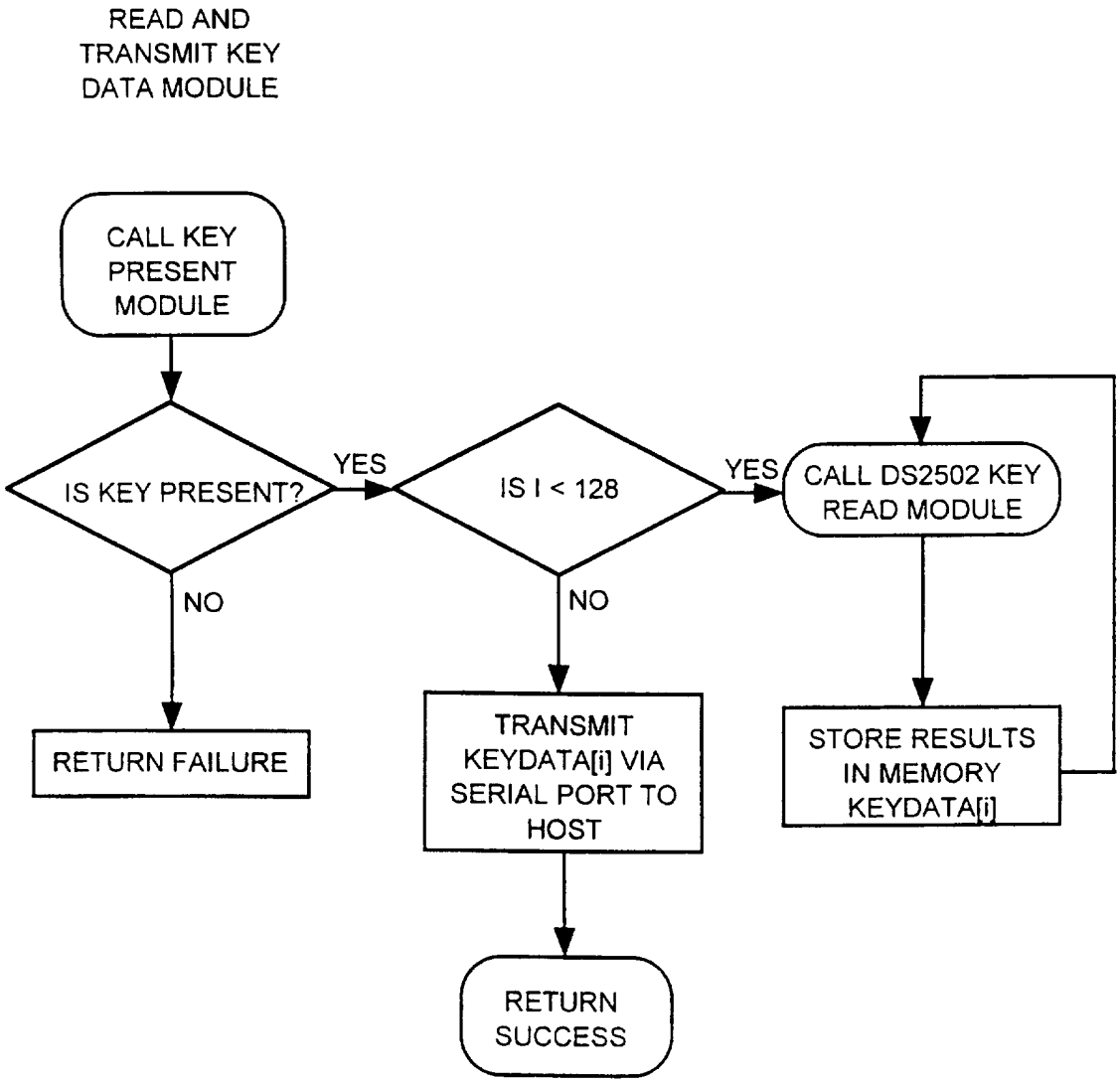


Figure 63

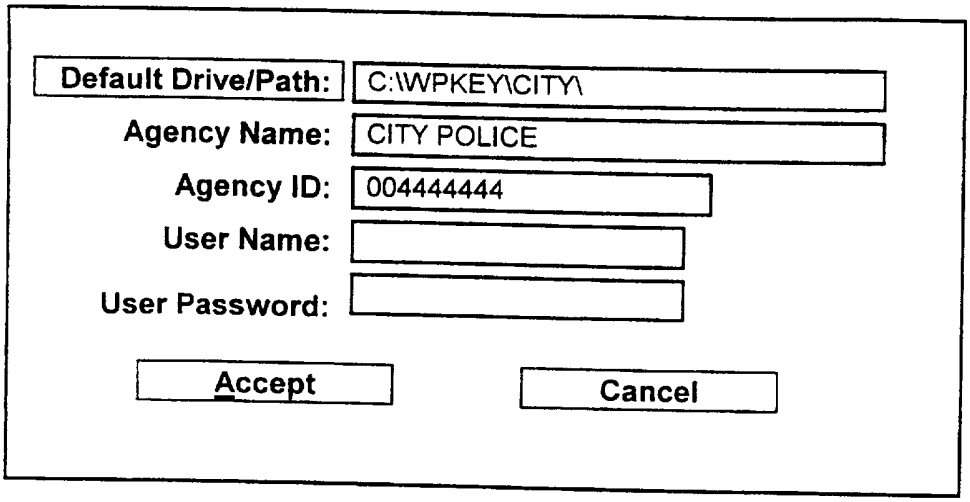
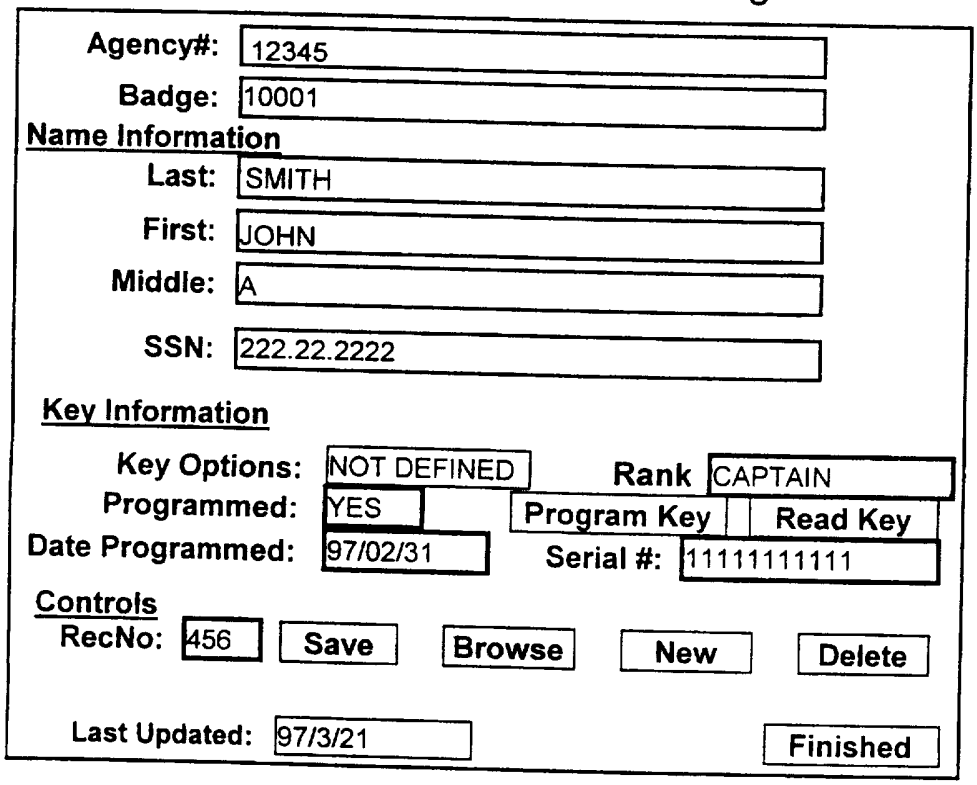


Figure 64



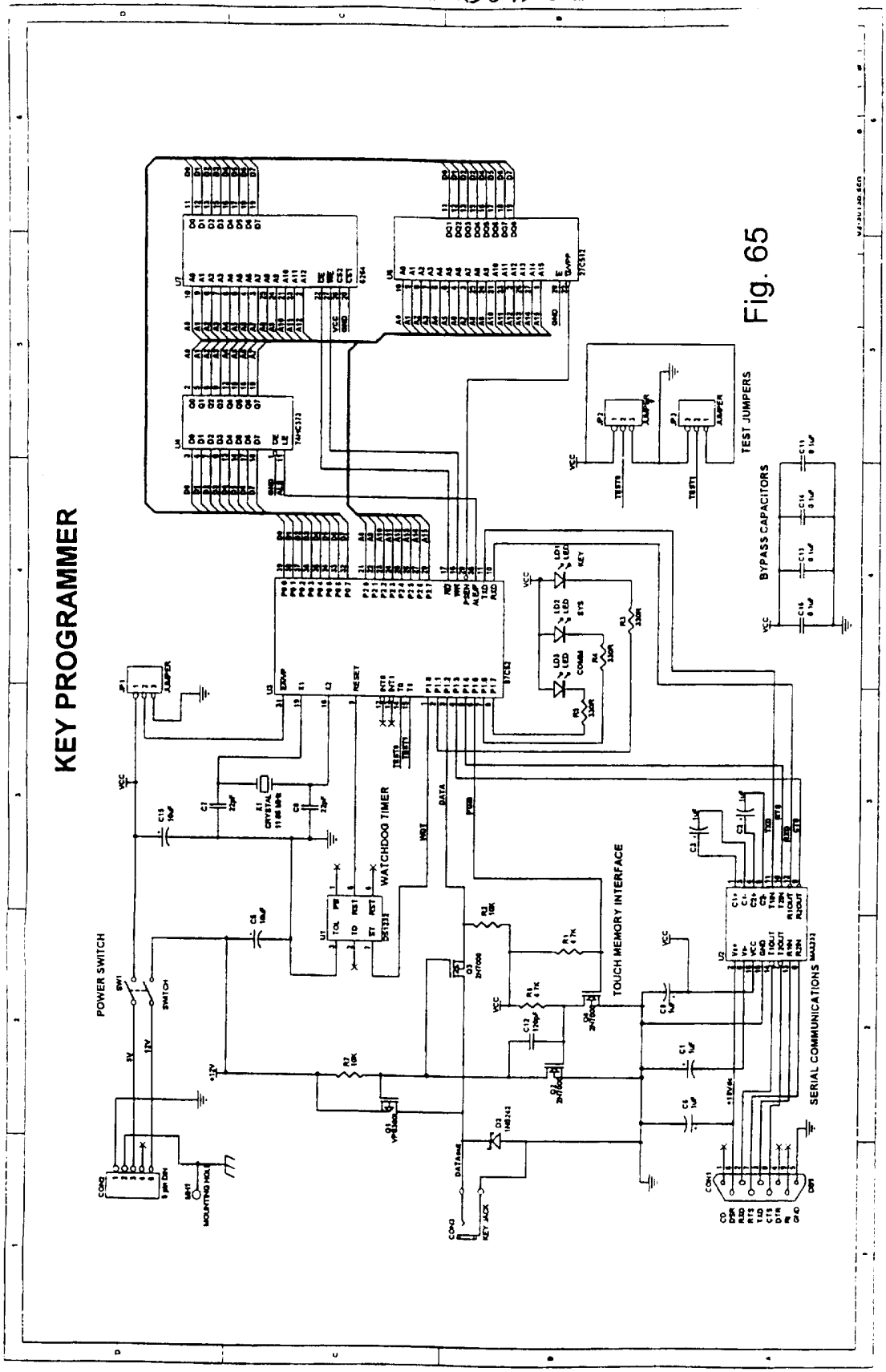

KEY PROGRAMMER
TEST JUMPERS
BYPASS CAPACITORS
WATCHDOG TIMER
TOUCH MEMORY INTERFACE
SERIAL COMMUNICATIONS
POWER SWITCH
KEY JACK

Fig. 65

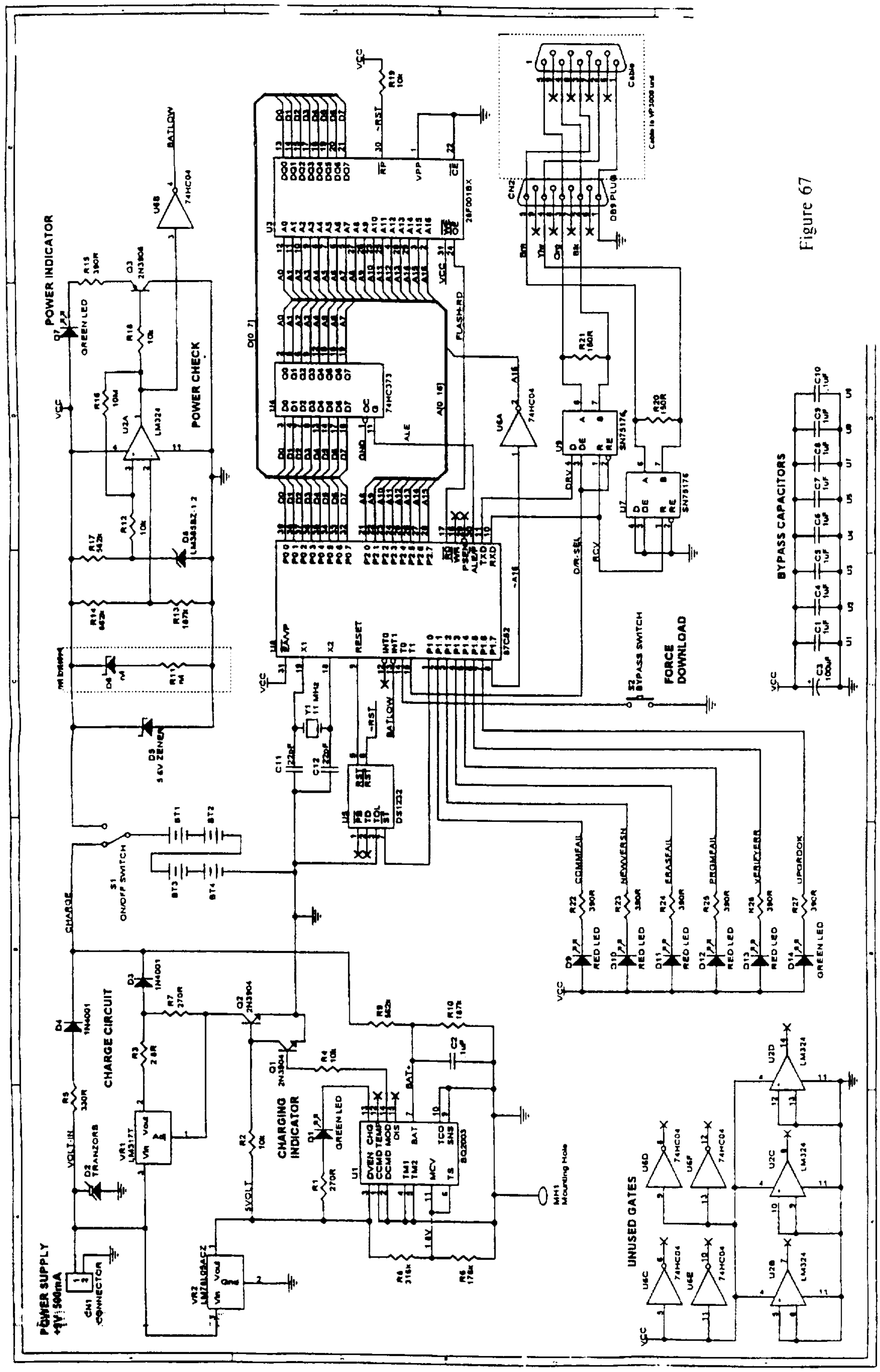

POWER INDICATOR
POWER CHECK
CHARGE CIRCUIT
CHARGING INDICATOR
BYPASS CAPACITORS
UNUSED GATES
BYPASS SWITCH
FORCE DOWNLOAD
POWER SUPPLY +9V 500mA
ON/OFF SWITCH
CHARGE
BATLOW
COMMFAIL
NEWVERSN
ERASEFAIL
PROGMFAIL
VERIFYERR
UPGRDOK
87C52
28F001BX
74HC373
SN75176
DS1232
BQ2003
LM324
74HC04
DB9 PLUG

Figure 67

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US97/05507

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :H04N 5/76
US CL :386/46
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : Please See Extra Sheet.

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

None

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

None

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X ----- Y	US 5,144,661 A (SHAMOSH et al) 01 September 1992, Fig. 1.	29-31 ---------- 1- 19 and 25-26
Y	US 5,289,280 A (NOMURA et al) 22 February 1994, Fig. 1.	1-19
X ----- Y	US 5,414,567 A (AMADA et al) 09 May 1995, Figs. 2A-2B.	20-24 and 27-29 ---------- 25-26
X	US 5,491,464 A (CARTER et al) 13 February 1996, Fig. 1 and Fig. 4.	32

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

*	Special categories of cited documents:	"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
"A"	document defining the general state of the art which is not considered to be part of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E"	earlier document published on or after the international filing date	"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
"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)	"&"	document member of the same patent family
"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		

Date of the actual completion of the international search 07 JULY 1997	Date of mailing of the international search report 22 AUG 1997
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer THAI TRAN Telephone No. (703) 305-4725

Form PCT/ISA/210 (second sheet)(July 1992)*

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US97/05507

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4,789,904 A (PETERSON) 06 December 1988, Fig. 1.	32
A	US 5,289,321 A (SECOR) 22 February 1994, Fig. 1.	32
A	US 4,511,886 A (RODRIGUEZ) 16 April 1985, Fig. 1.	1-31
A	US 4,989,081 A (MIYAGAWA et al) 29 January 1991, Fig. 2.	1-19

B. FIELDS SEARCHED
Minimum documentation searched
Classification System: U.S.

U.S.: 386/46, 1, 26, 29, 39, 96, 104; 360/5; 348/143, 148, 149, 159, 161, 461, 462, 484, 723, 724; 340/425.5, 937, 933, 471, 472, 473
IPC(6): H04N 5/76, 5/92, 7/18, 9/47, 7/00, 11/00, 7/08, 7/084, 7/087, 5/38, 5/40