[54] **PORTABLE COMPUTER AND DOCKING STATION HAVING AN ELECTROMECHANICAL DOCKING/ UNDOCKING MECHANISM AND A PLURALITY OF COOPERATIVELY INTERACTING FAILSAFE MECHANISMS**

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[51] **Int. Cl.^{6}** **G06F 1/16; G06F 3/00; G06F 13/00; H05K 7/12**

[52] **U.S. Cl.** **361/686; 395/282; 395/500**

[58] **Field of Search** 364/708.1; 312/223.1, 312/223.2; 361/606–609, 679, 683–686, 725–727, 754, 759, 798

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Primary Examiner—Michael W. Phillips
Attorney, Agent, or Firm—Beyer & Weaver, LLP.

[57]   **ABSTRACT**

A first embodiment of the present invention comprises a fully functional portable computer with central processing unit, hard disk drive data storage, and liquid crystal display and a docking station having at least a floppy disk drive, video random access memory and video controller. A motorized docking/undocking mechanism automatically docks and undocks the portable computer and docking station after the user has inserted the portable computer into the docking station or after the user has requested that the units be undocked. Numerous mechanical and electrical safeguards prevent the docking or undocking of the units if such docking or undocking is likely to lead to the loss of data or damage to the components of either unit. The internal mechanical construction of the docking station allows the user to place a large cathode ray tube display monitor directly atop the docking station without hindering the docking or undocking of the portable computer.
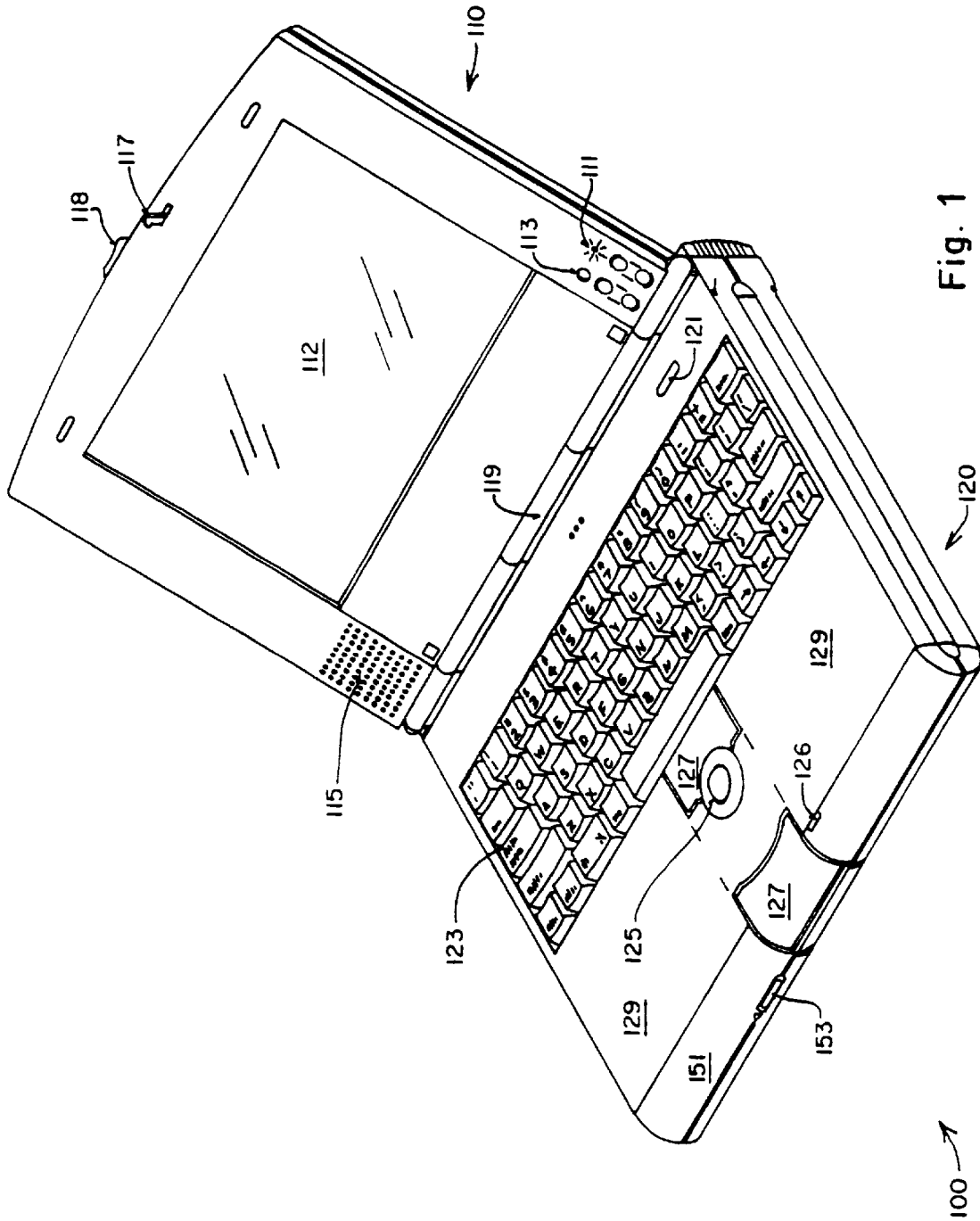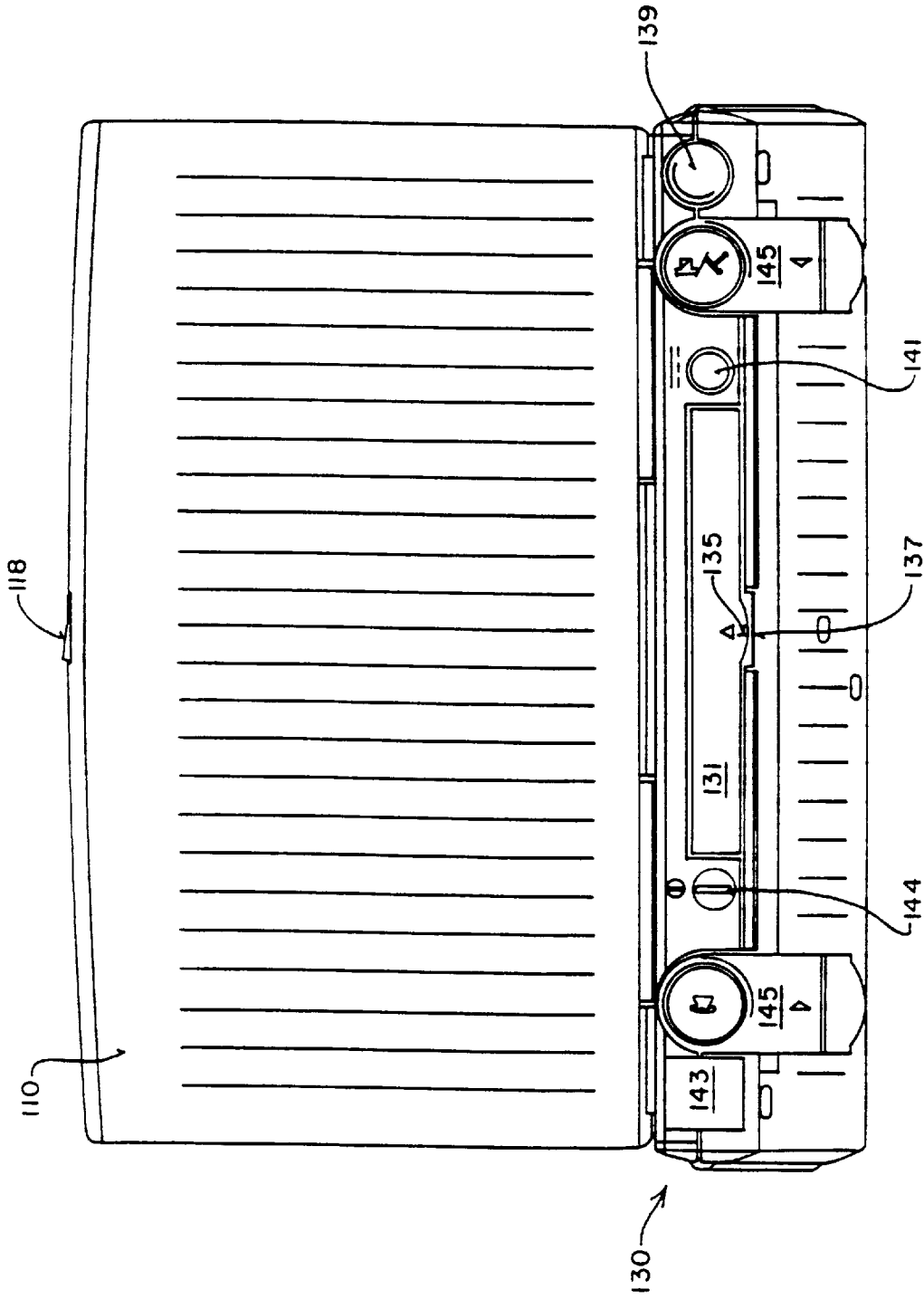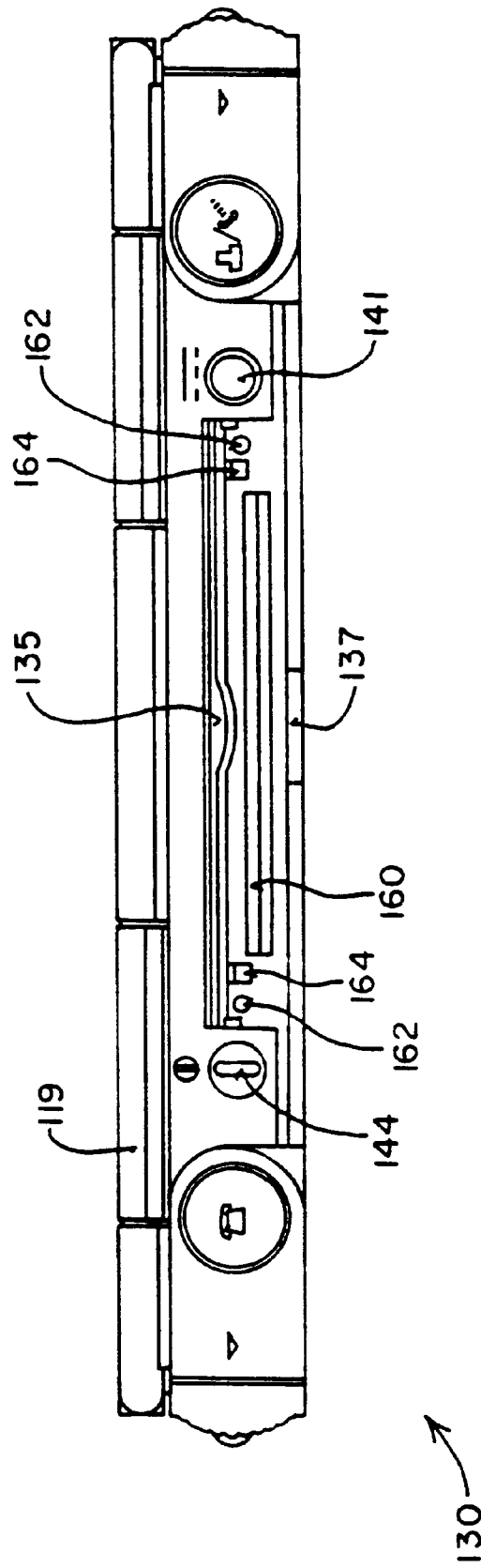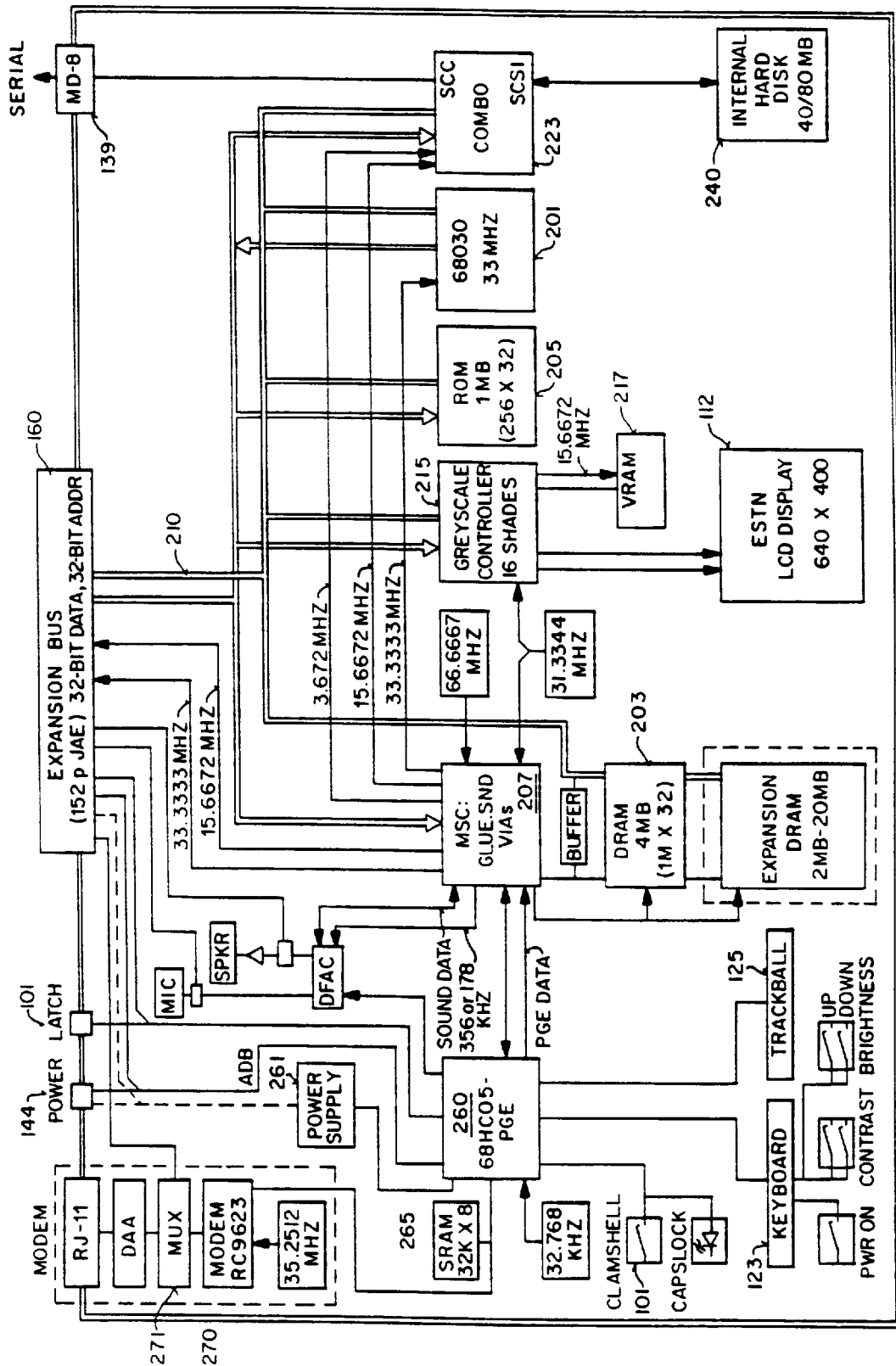
56 Claims, 20 Drawing Sheets
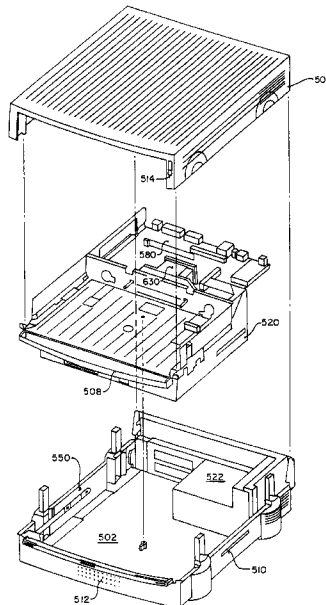
Fig. 1

Fig. 2

Fig. 3

Fig. 4

Fig. 5

Fig. 6

504

514

580

630

520

508

550

522
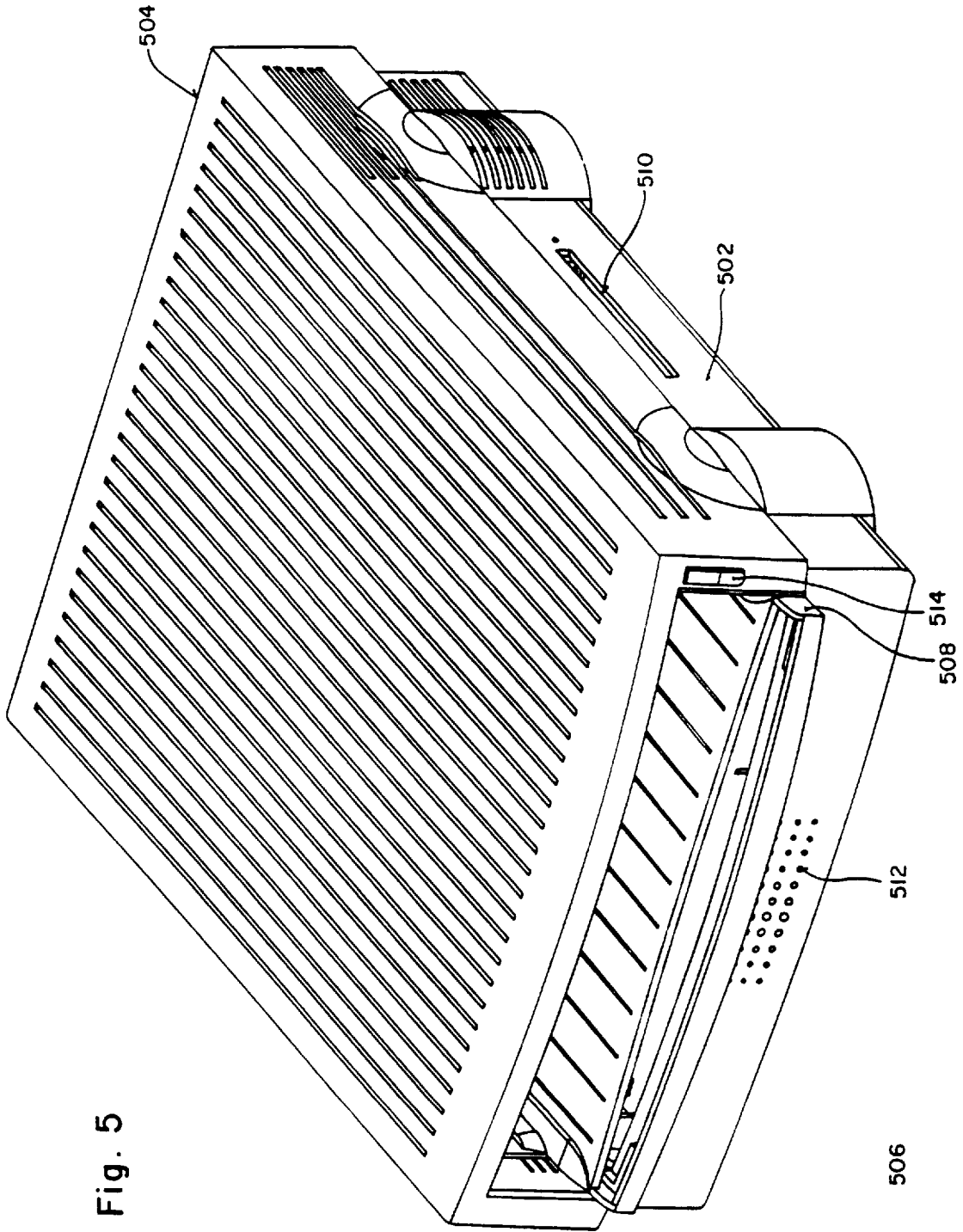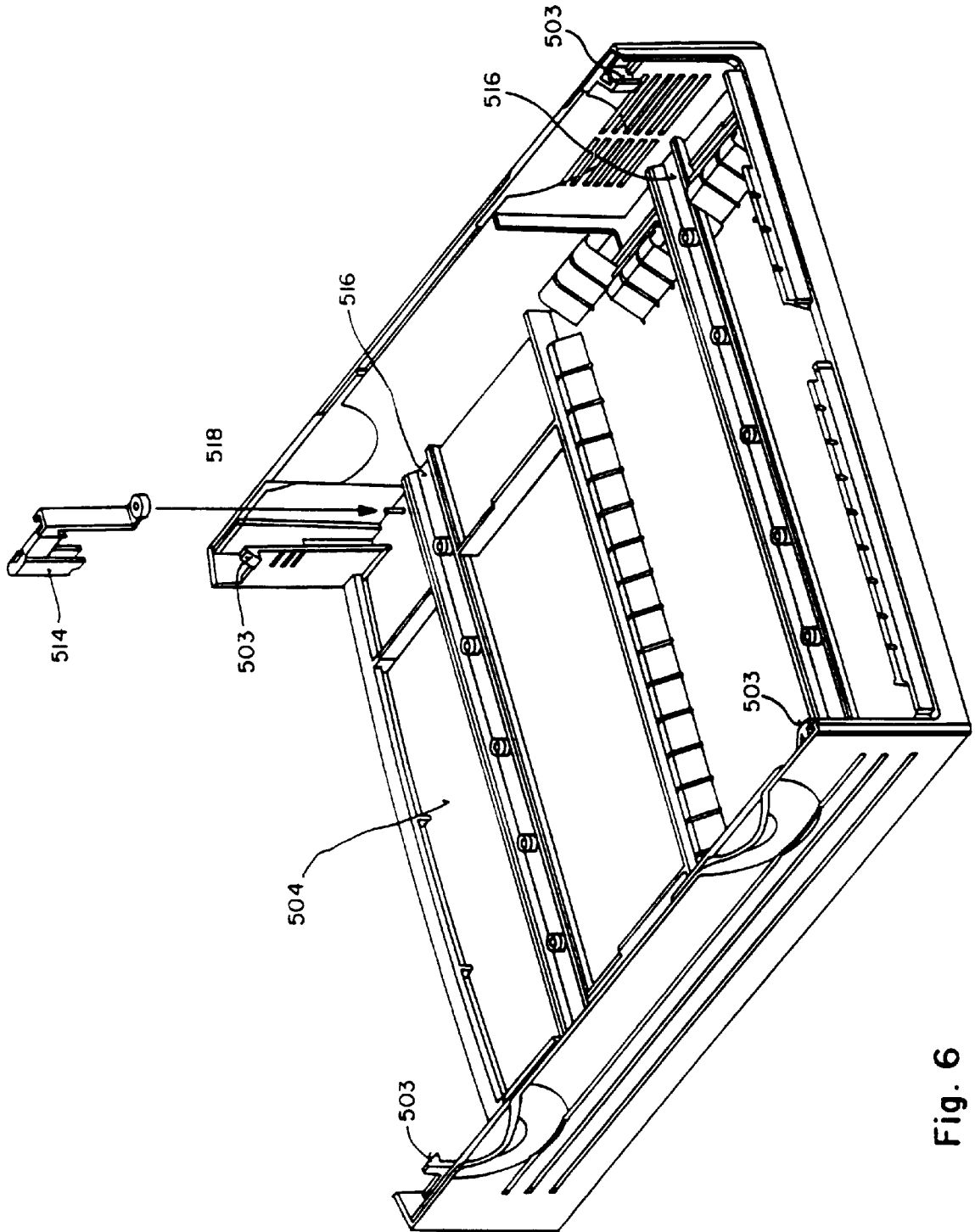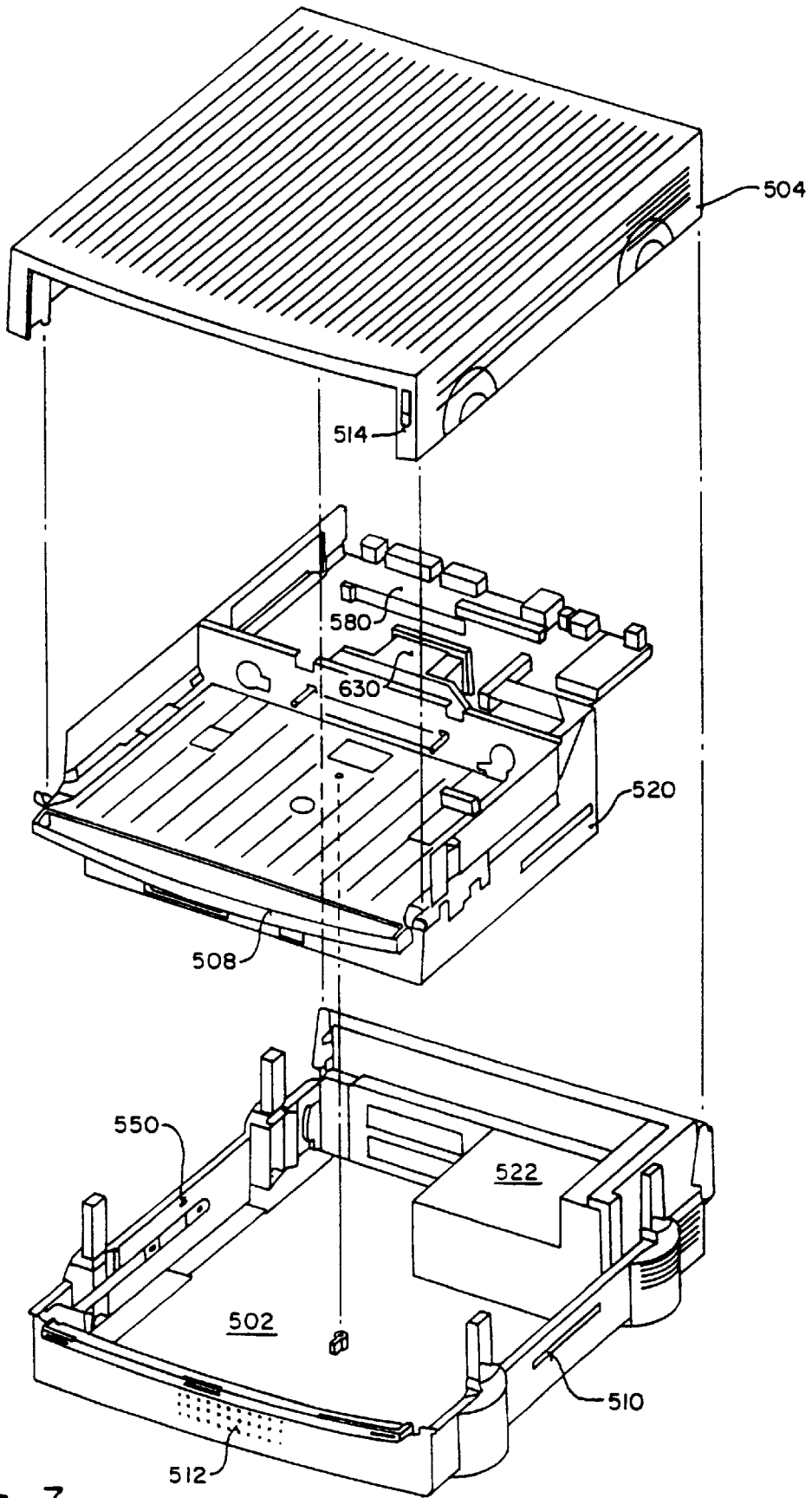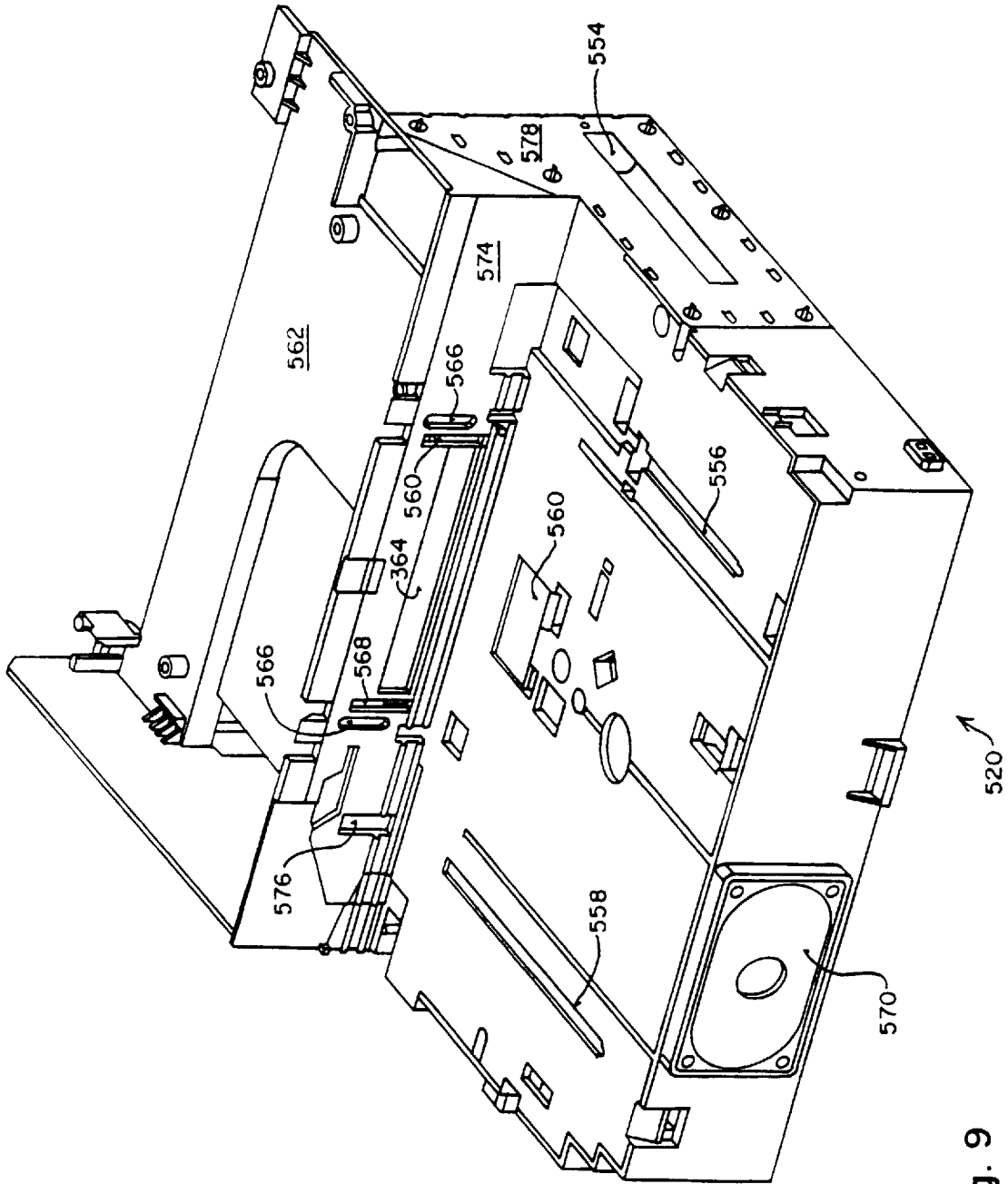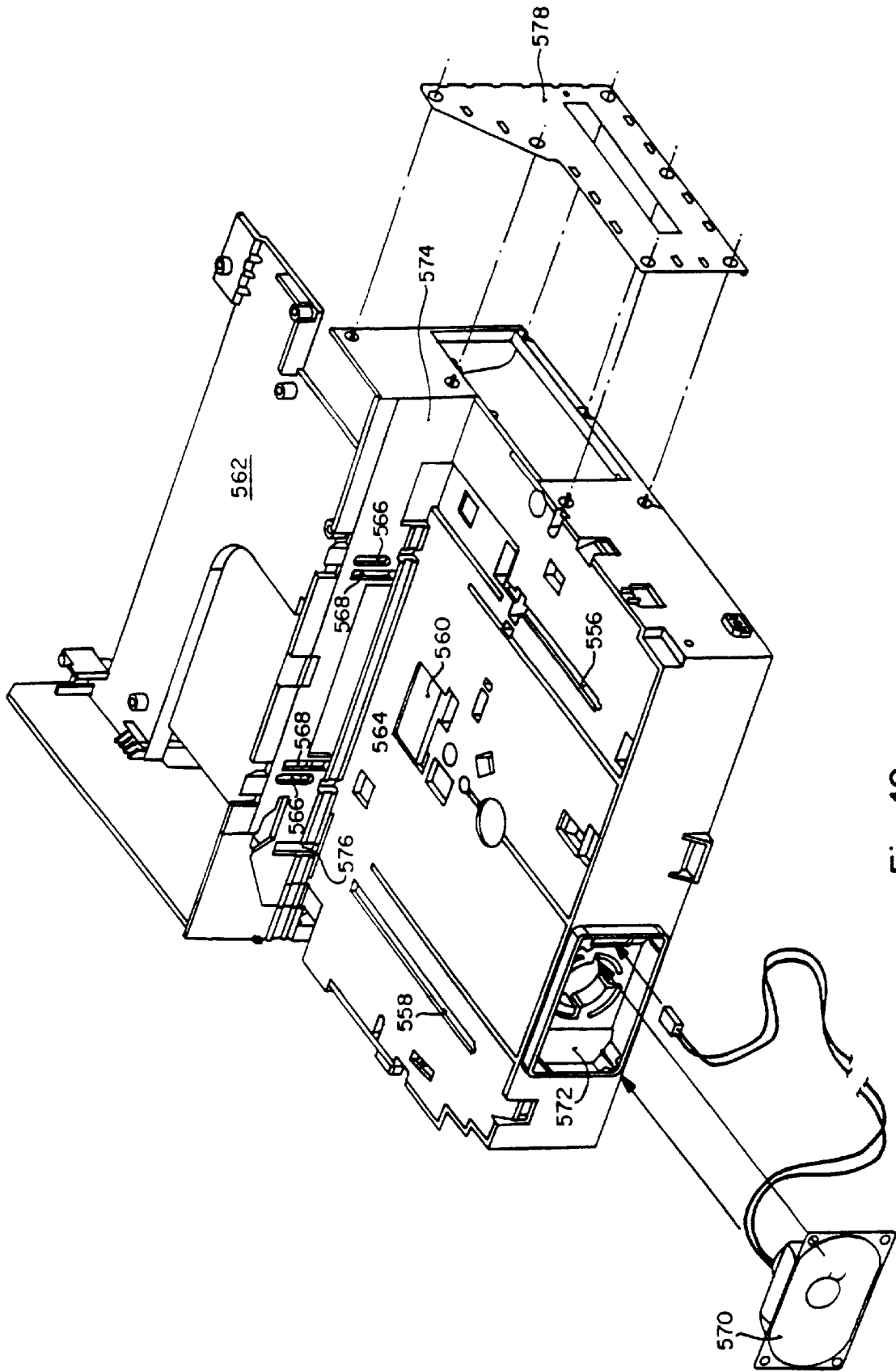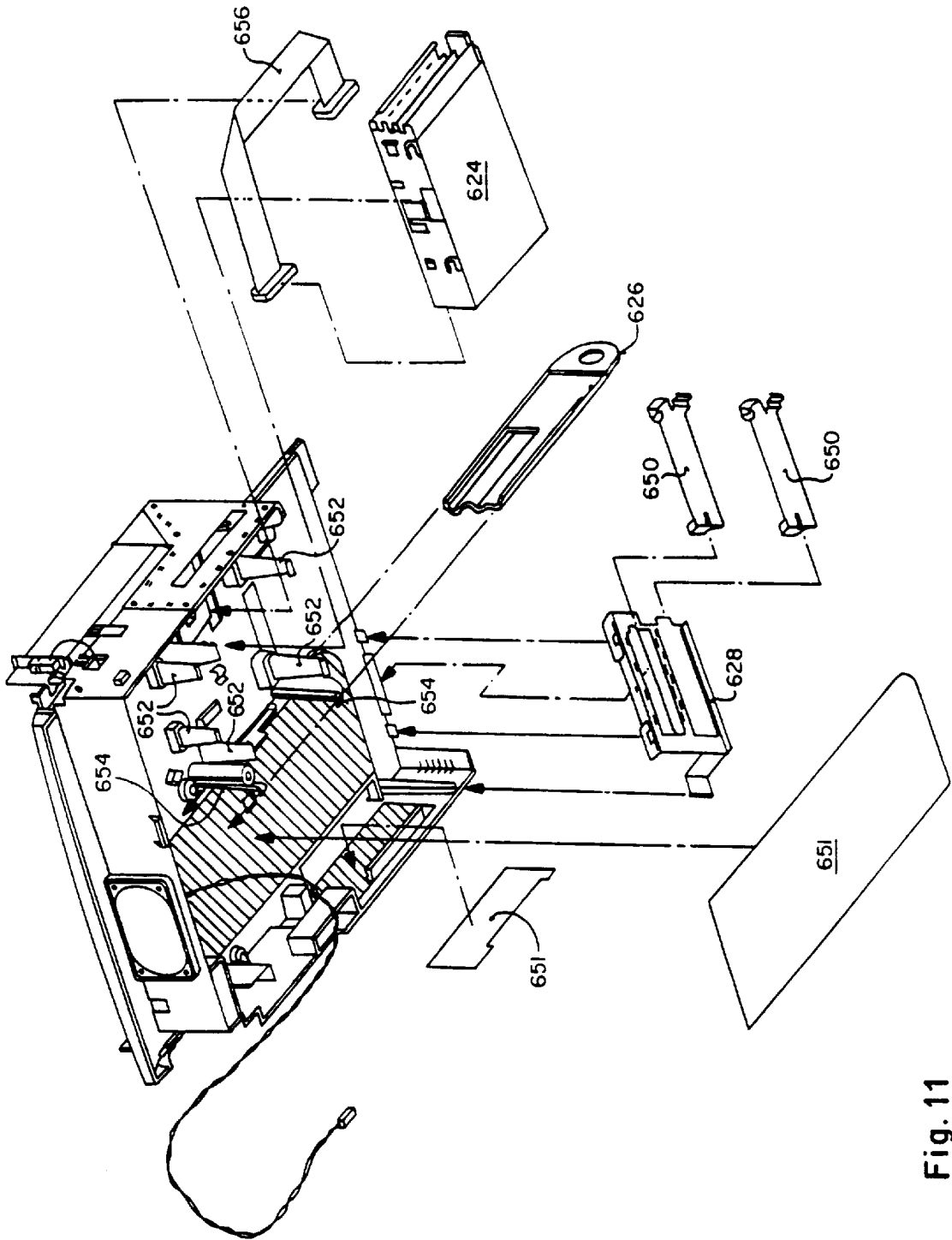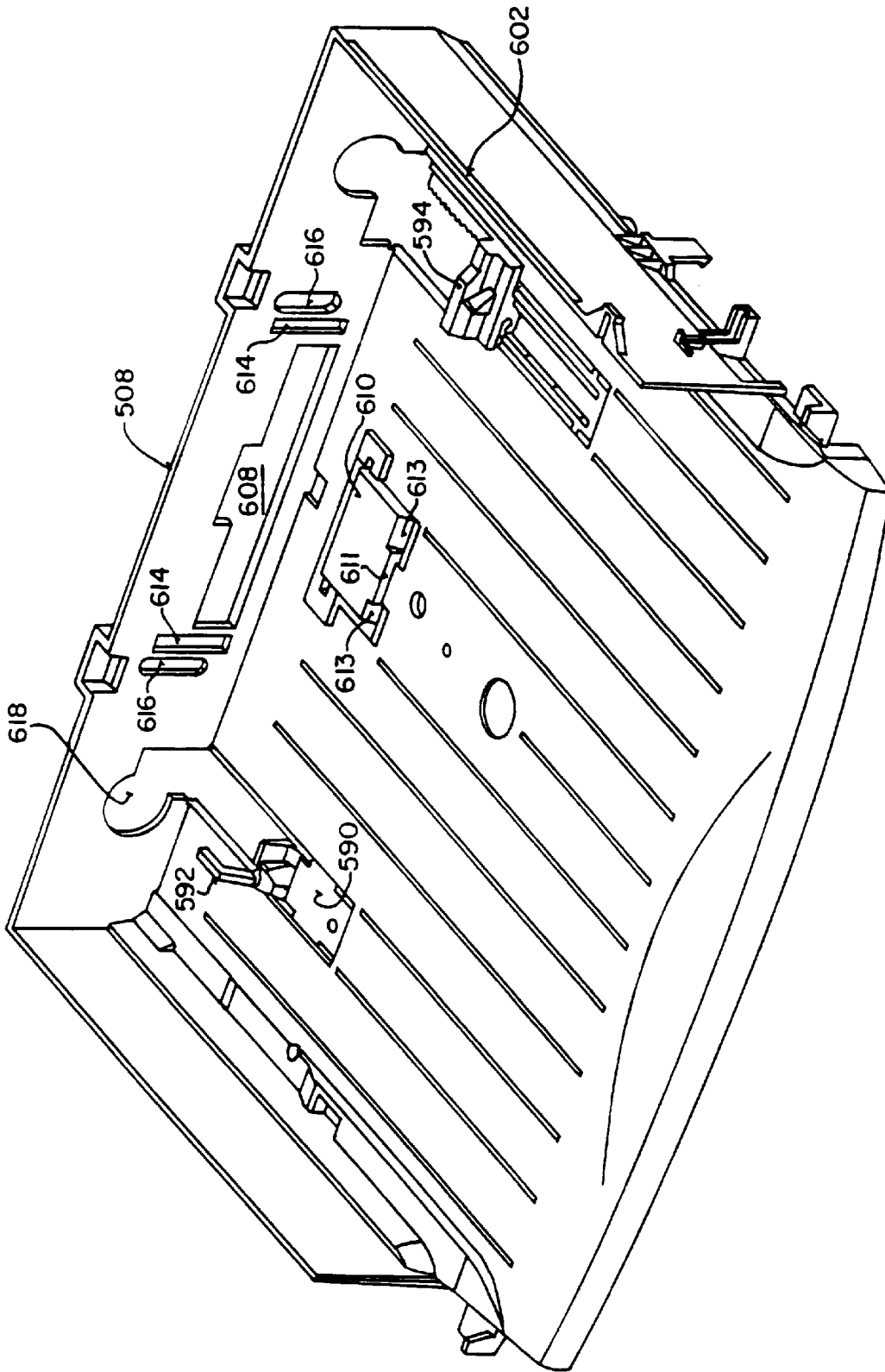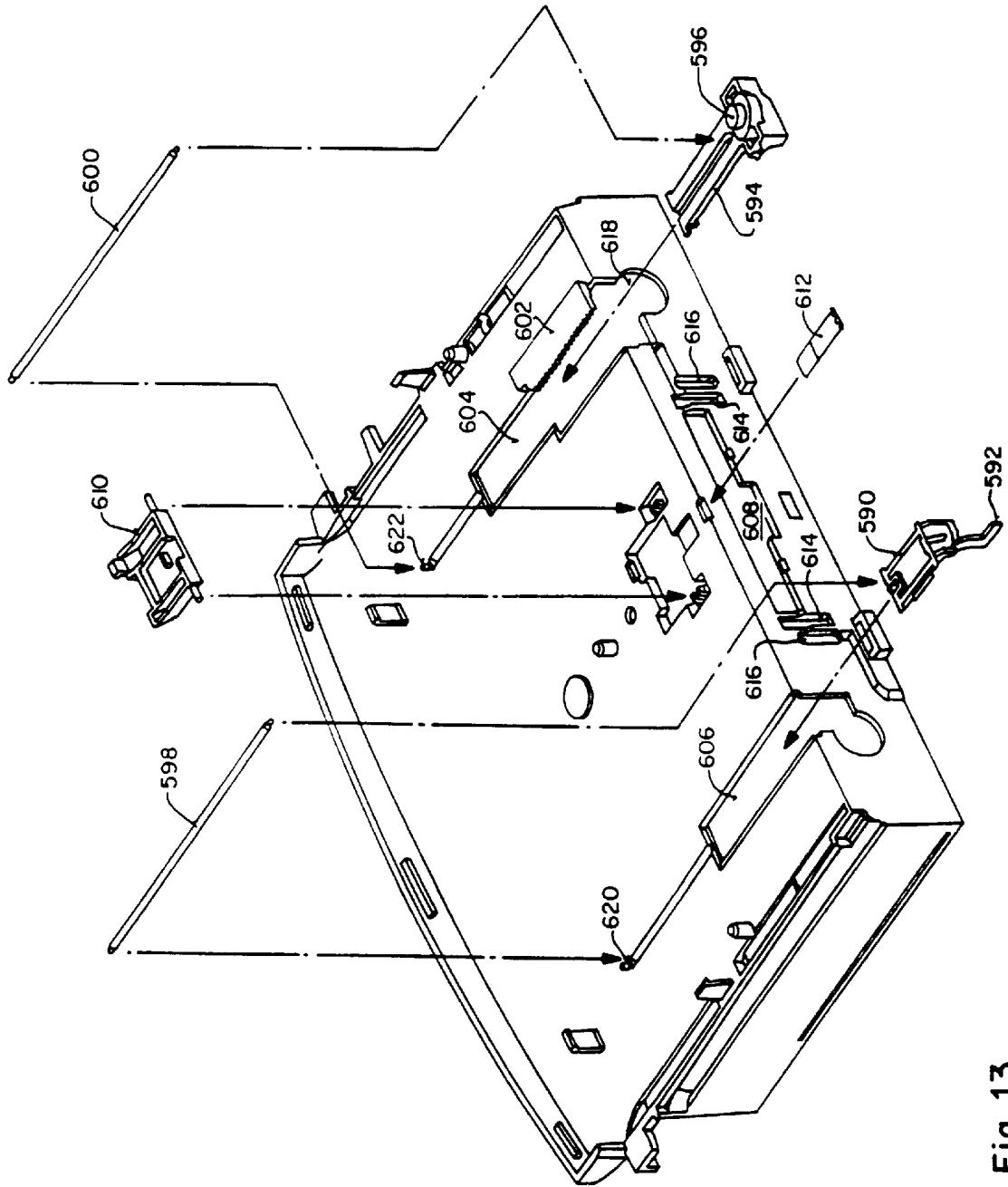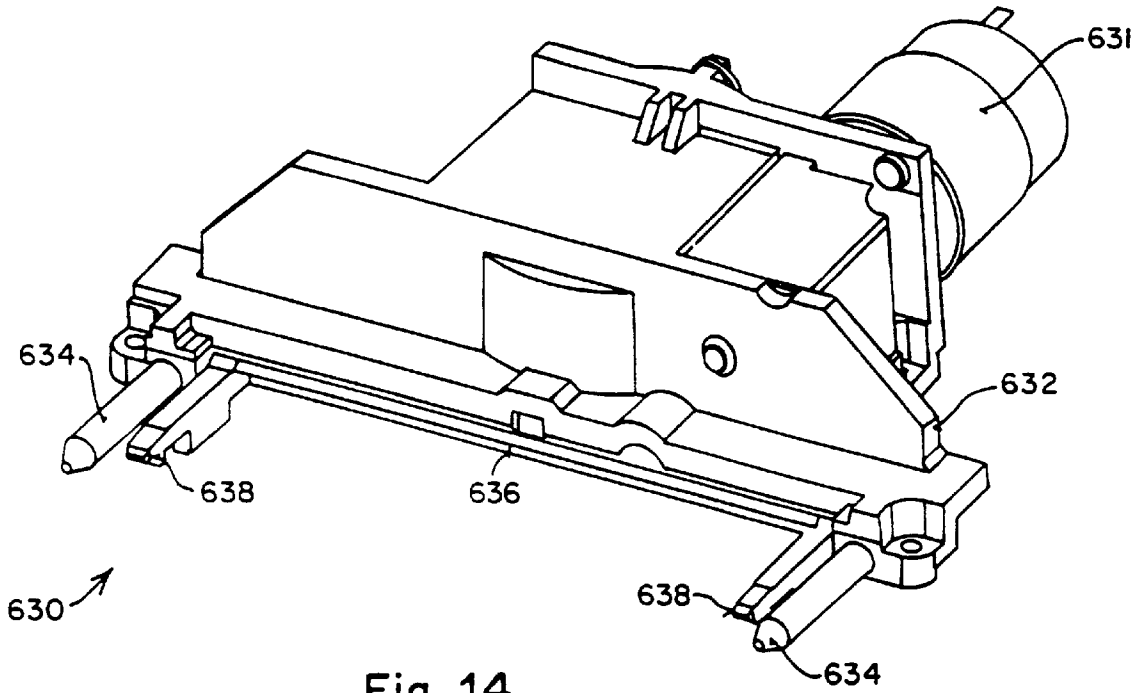
502

510

512

Fig. 7

Fig. 8

Fig. 9

Fig. 10

Fig. 11

Fig. 12

Fig. 13

Fig. 14

Fig. 15

Fig. 16

Fig. 17

Fig. 18

Fig. 19

Fig. 20

TO MANUAL
EJECTION
SLOT 550
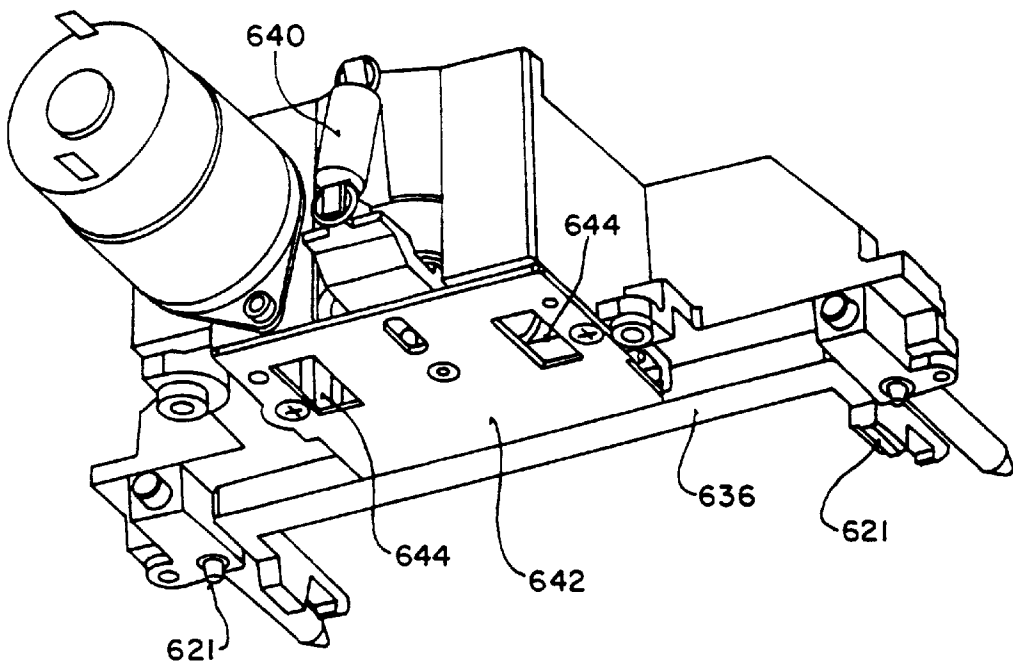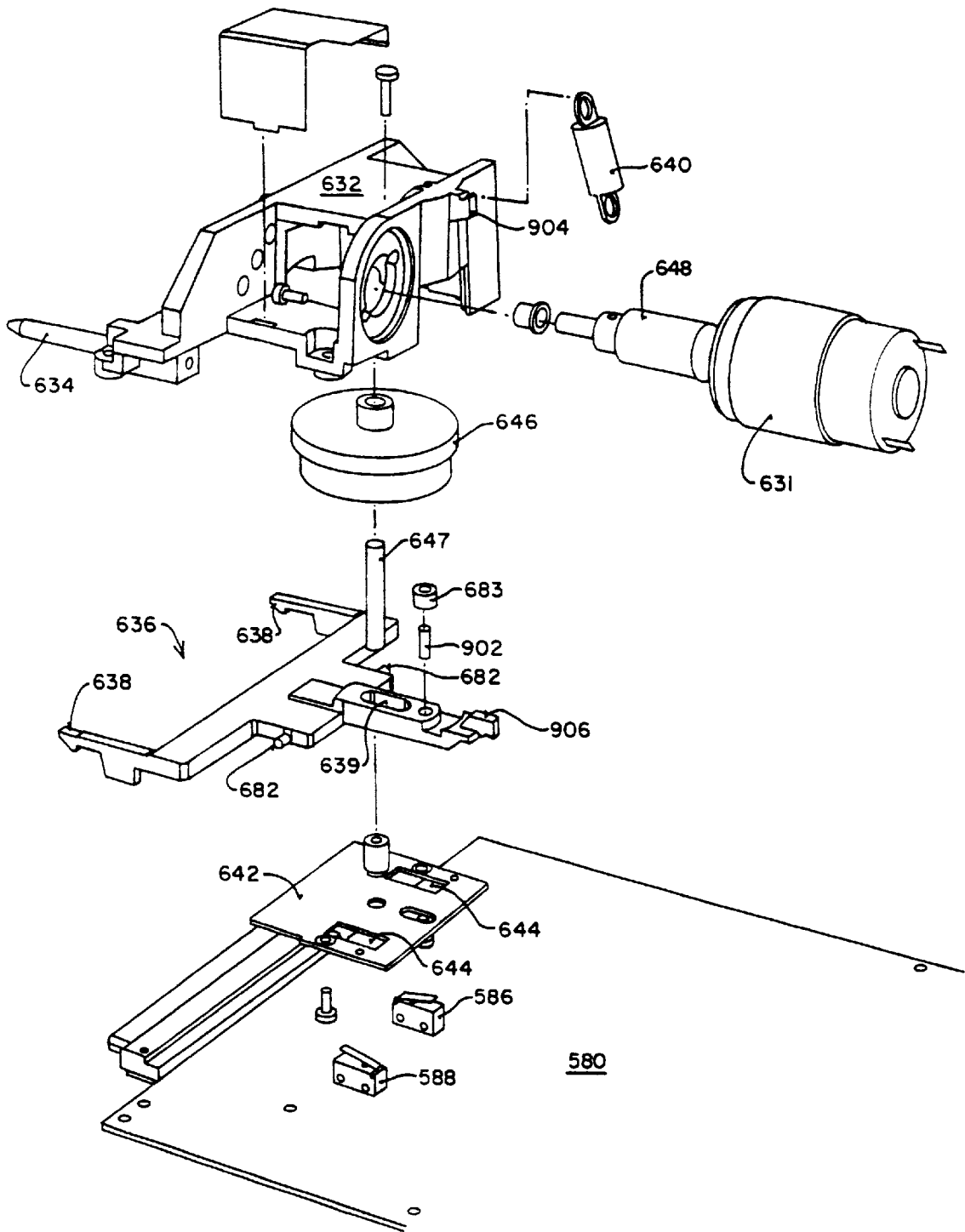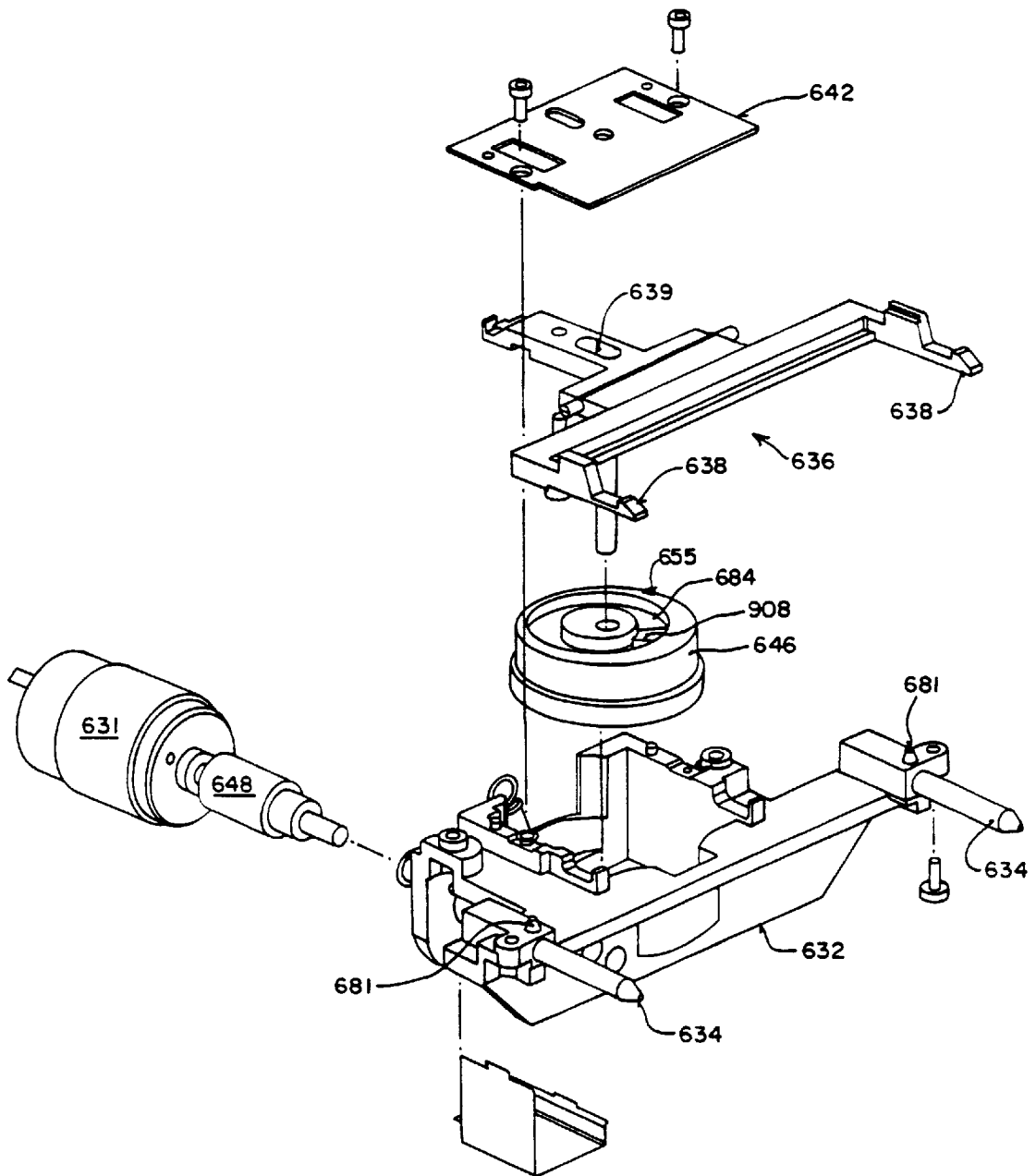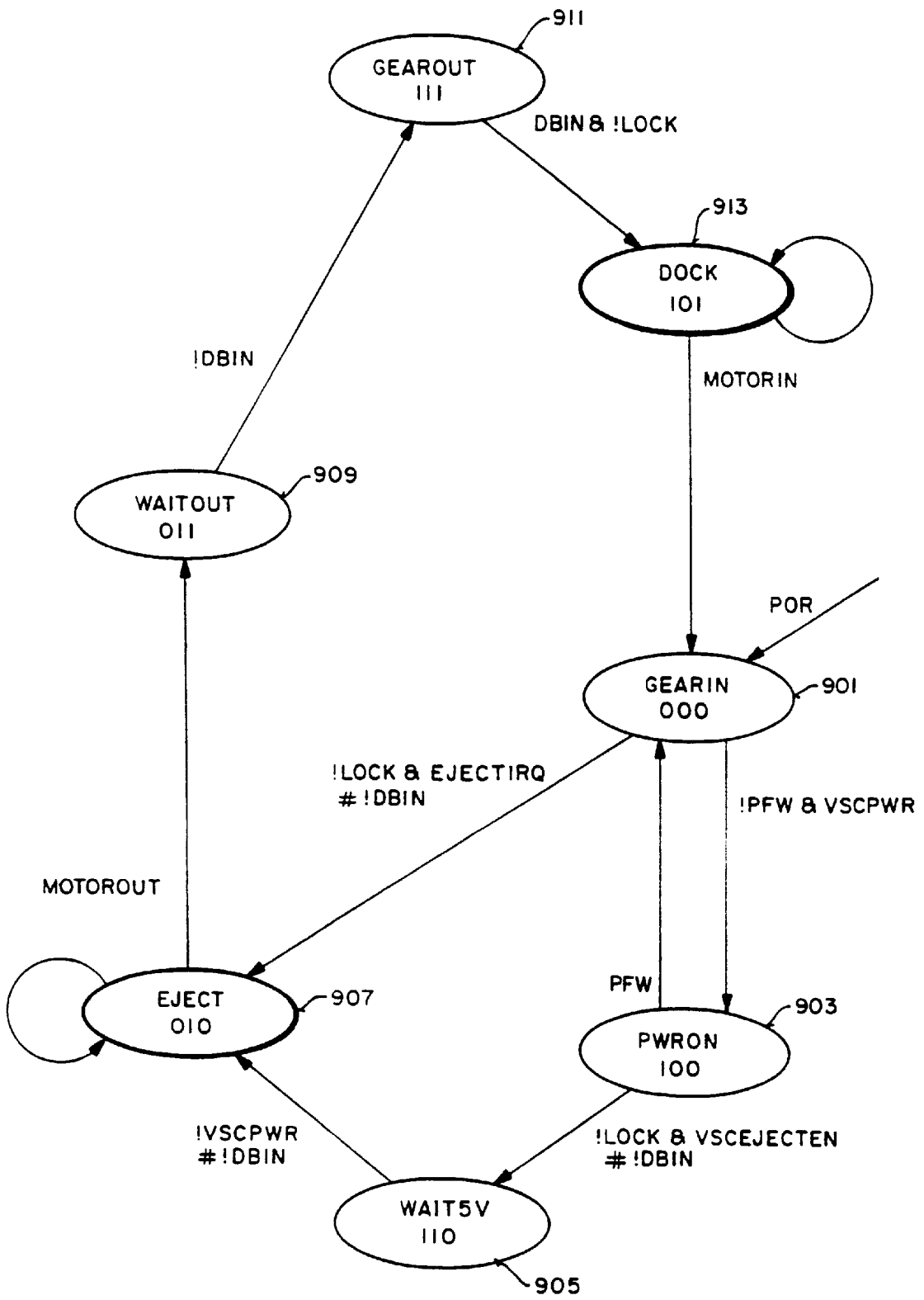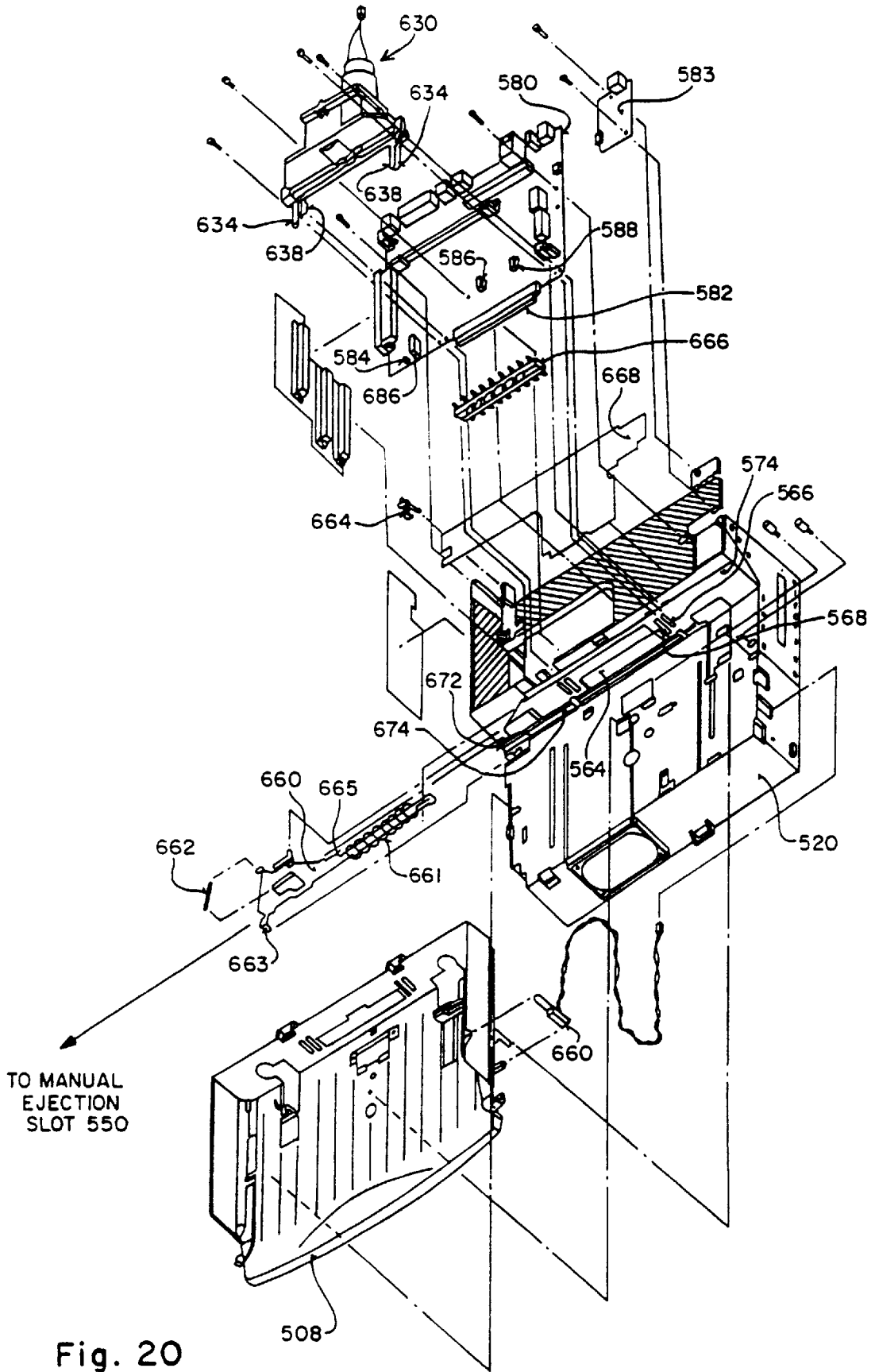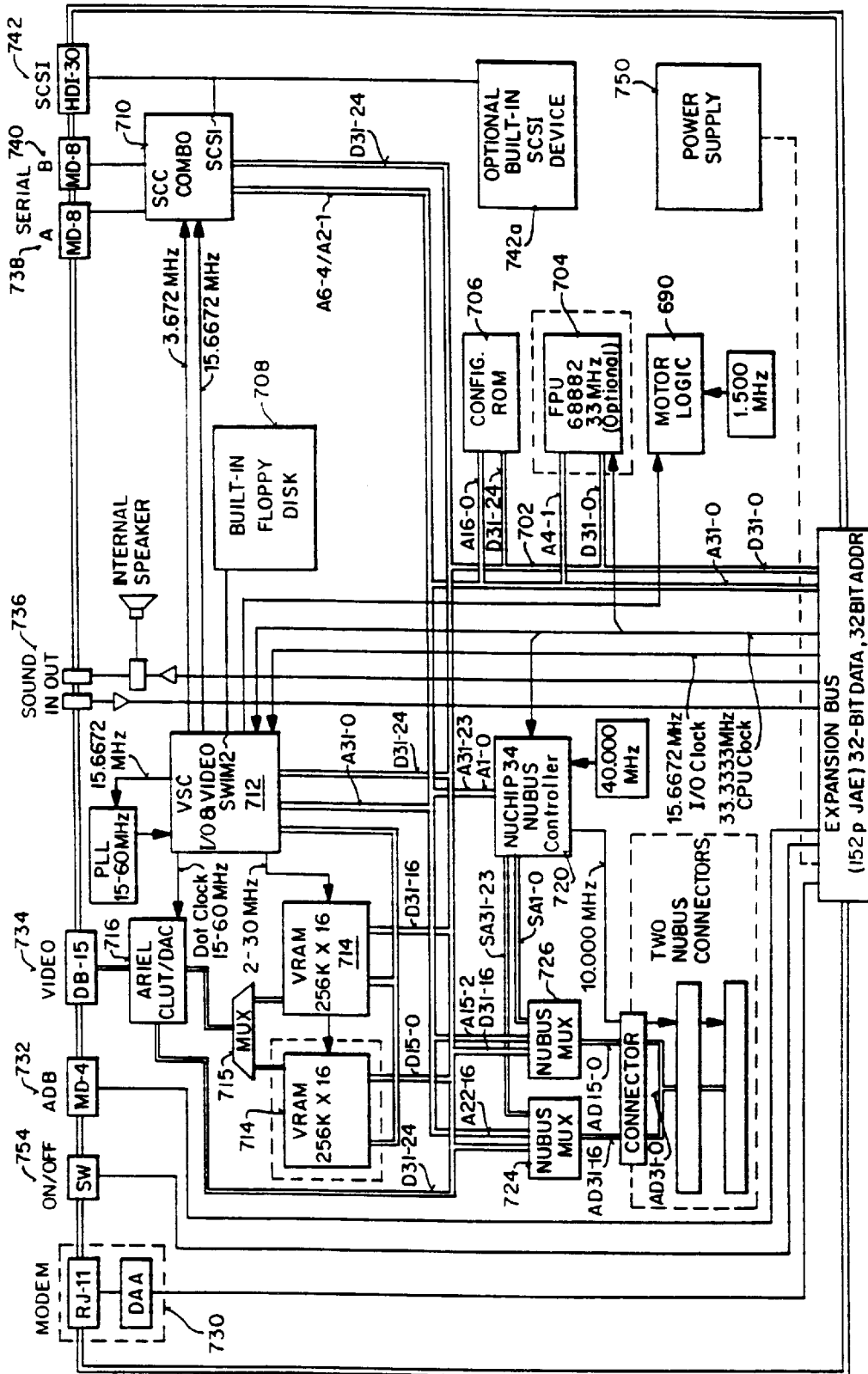
Fig. 21

PORTABLE COMPUTER AND DOCKING STATION HAVING AN ELECTROMECHANICAL DOCKING/ UNDOCKING MECHANISM AND A PLURALITY OF COOPERATIVELY INTERACTING FAILSAFE MECHANISMS

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.

BACKGROUND OF THE INVENTION

This invention is in the field of portable computers and docking stations for portable computers.

Portable computers are known. Indeed, they comprise the fastest growing segment of the computer market, as more and more people, having come to rely on the capabilities of their desktop computer to increase their productivity, desire the same capabilities when they travel as they do when they are at work.

Although the capabilities of many portable computers closely match those of larger desktop machines, the expense of purchasing a second computer in addition to a desktop machine is difficult for many people to justify. Indeed, there is something inherently wasteful in having two different machines, each functionally nearly identical. In particular, most owners use only one of the machines at any given time. The other machine sits idle. In effect, the user owns two central processing units ("CPU"s), only one of which is operating at a time.

The dilemma posed to a consumer who desires the portability of a notebook computer and the full functionality of a desktop computer without the need of purchasing two separate systems has been recognized by the computer industry. One known solution is to offer a fully capable portable notebook computer which can be coupled to a separate stationary unit, the stationary unit frequently having additional data storage such as disk drives and additional display capabilities. These stationary units are commonly known as "docking stations".

Although the concept of a portable computer/docking station is an excellent one, as it eliminates the duplication of the CPU and greatly increases the ease with which data can be transferred from the portable computer to the desktop environment and vice versa, known embodiments of this concept have suffered from very poor implementation.

In some known portable computer/docking station systems, the method of coupling the portable computer to the docking station uses an extremely clumsy mechanical system which relies on user knowledge and skill to mate the computer and docking station successfully. Examples include latch systems where the computer owner must carefully align the connectors before mating the computer to the docking station. Even after the machines have been coupled together, the security of the latching mechanism is suspect. Also, these systems do not appear to be sufficiently durable to last for an acceptable period of time.

The manner that screen displays integrate with known docking stations is also less than ideal. Typically the screen must remain separate from the docking station, as the portable computer itself forms the top surface of the two units when they are docked together. This increase in the "footprint" of the system is certainly undesirable.

Most importantly, the electrical interface between the docking station and the portable computer is usually very

crude. Unless the user follows a carefully prescribed set of instructions, the system crashes during either docking or undocking, resulting in a loss of data and possible damage to the components of either the docking station, the computer, or both. Even if the user carefully follows the instructions and completes a successful docking, the units must still be coupled to all external networks, peripherals and a power supply. Completing such connections is time consuming and prone to error.

In these systems, if undocking is commanded while in an application, the undocking occurs, but the system crashes and data is lost.

There thus remains a need for a fully functional portable computer that can be easily coupled to a docking station, the docking station offering increased data storage and increased video capabilities. The docking process itself should be completely transparent to the system's user, allowing docking and undocking to proceed with a minimum of user input and with many safeguards protecting the data and components in both units from accidental or even intentional misuse. It should also be possible for owners of a portable computer/docking station to use their portable computer with other docking stations without the need for extensive system reconfiguration.

SUMMARY OF THE INVENTION

In its first embodiment, the present invention comprises a portable computer with a liquid crystal display ("LCD"), hard disk drive storage, CPU and other supporting electronics and a docking station to which the portable computer can be coupled. Docking is accomplished by an electromechanical mating system which ensures reliable interconnection through a plurality of mechanical and electrical interlocks which prevent docking or undocking if certain conditions do not exist and which insure that docking will be accomplished in a simple and repeatable fashion if these prerequisites do exist.

The docking station is configured so that a large CRT display may be rested thereon without damaging the docking station or in any way impeding its functioning. The docking station initially comprises at least additional video-memory and a floppy disk drive, as well as such input/output ("I/O") resources as video, sound, SCSI, etc. Providing these resources in the docking station allows the construction of a very small and lightweight portable computer. A floating point arithmetic co-processor can also be added to the docking station. Additional subsystems such as I/O bus subsystems compatible with the NUBUS® bus architecture and protocol established by Texas instruments. (NUBUS is a registered trademark owned by Texas Instruments) cards having a plurality of different functions and a hard disk drive storage unit can be added.

As the docking station is usually kept in one location, it remains coupled to local area networks, the telephone system, peripherals and an AC power source. As soon as docking is complete, the user can instantly access any of these resources without additional user configuration or effort.

Security systems are provided which permit the user to lock the portable computer in or out of the docking station and to lock the docking station in place.

The present invention will now be described in detail with reference to the figures which are listed and described below.

BRIEF DESCRIPTION OF THE ILLUSTRATIONS

FIG. **1** is a front perspective of the portable computer;

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FIG. **2** is a back perspective of the portable computer, with its docking connector covered and feet in the open position;

FIG. **3** is a back perspective of the portable computer, showing the portable computer in a closed position with its feet in their closed position and with the docking connector uncovered;

FIG. **4** is a block diagram of the circuitry of the portable computer;

FIG. **5** is a front perspective of the docking station;

FIG. **6** is a perspective drawing of the underside of the top case of the docking station;

FIG. **7** is an exploded isometric drawing of the docking station;

FIG. **8** is an exploded isometric drawing of the base of the docking station;

FIG. **9** is a perspective of the skeleton of the docking station;

FIG. **10** is an exploded isometric drawing showing the top side of the skeleton;

FIG. **11** is an exploded isometric drawing of the bottom side of the skeleton;

FIG. **12** is a perspective drawing of the assembled frying pan;

FIG. **13** is an exploded isometric drawing showing the construction of the frying pan;

FIG. **14** is a top perspective drawing of the docking motor assembly;

FIG. **15** is a bottom perspective drawing of the docking motor assembly;

FIG. **16** is an exploded isometric drawing of the docking motor assembly;

FIG. **17** is an exploded isometric drawing of the docking motor assembly, viewed from beneath the assembly;

FIG. **18** is a schematic of the braking circuit used with the docking motor assembly;

FIG. **19** is a state table diagram illustrating the operation of the docking motor assembly;

FIG. **20** is an exploded isometric drawing of the frying pan/skeleton; and

FIG. **21** is a block diagram of the docking station's electronics.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

A first preferred embodiment of the present invention comprises at least a portable computer **100** and a docking station **500**. These will first be described separately in detail. Then those aspects of both the computer and docking station which relate to their operating as a unit will be described.

PORTABLE COMPUTER

Portable computer **100** is shown in a front perspective in FIG. **1** and in a rear perspective in FIGS. **2** and **3**. In this embodiment, computer **100** comprises display assembly **110** and base assembly **120**. Display assembly **110** further comprises liquid crystal display ("LCD") panel **112**, brightness controls **111** and contrast controls **113**, and speaker **115**. Latch **117** along the upper edge of display assembly **110**, activated by latch button **118**, is used to lock computer **100** in its closed position. Additionally, when display assembly **110** is in its closed position, latch **117** triggers a clamshell switch **101** (see FIG. **4**) on the internal circuitry of computer **100**, the switch signal indicating to the computer that it

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should place itself in a sleep state. Hinge assembly **119** allows display assembly **110** to open and close, as well as holding the display assembly open to the position chosen by the user.

Base assembly **120** contains the logic circuitry and memory of computer **100**. Its exterior is comprised of keyboard assembly **123**, power switch **121**, trackball **125**, select switches **127** and palmrest areas **129**. Latching slot **126** receives latch **117** and permits access to clamshell switch **101** triggered by latch **117**.

The front edge of base assembly **120** is partially comprised of battery compartment door **151**. By pressing battery door button **153**, the panel can be moved sideways, allowing the removal of computer **100**'s battery pack (not shown), door **151** being mechanically attached to the battery pack.

Rear panel **130** of computer **100** is shown in FIGS. **2** and **3**. Connector door **131** is in the center of the rear panel and covers **152**-pin connector **160**. Door **131** opens upwards along a hinge line and retracts into the interior of computer **100**. In so doing, panel cutout **137** is exposed. When door **131** is closed, cutout **137** is filled with door tab **135**. Also exposed by opening door **131** are guide holes **162** and hook openings **164**. The function of these will be described later. Rear panel **130** also has an serial (modem/printer/network) port **139**, a power port **141**, a modem port **143** and on/off button **144**. Feet **145** are shown in their open position in FIG. **2** and in their closed position in FIG. **3**. It should be noted that in their closed position, one of the legs covers serial port **139** and the other covers modem port **143**.

The internal mechanical construction of portable computer **100** is shown and discussed in a related pending patent application entitled "Structural Frame for Portable Computer", filed Jun. 5, 1992, Ser. No. 07/893,853, now U.S. Pat. No. 5,237,486. That disclosure is incorporated herein for all purposes. With reference to the internal frame that comprises the mechanical backbone of portable computer **100**, the frame has two holes for receiving guide pins from the electromechanical docking mechanism (described below) and two openings to receive and lock with mating hooks from the same mechanism.

FIG. **4** is a block diagram of the circuitry of portable computer **100**. Computer **100**'s CPU **201** comprises a Motorola 68030 microprocessor with a clock speed of either 25 or 33 MHz. As this microprocessor is known and commercially available, it requires no further description here.

CPU **201** is coupled to both random access memory ("RAM") **203** and ROM **205** by means of bus **210**. Main system controller ("MSC") **207** is also coupled to bus **210** and controls memory reading/writing as well as power control, I/O state machines and other support functions. Gray scale controller **215** is coupled to bus **210**, video RAM ("VRAM") **217** and LCD panel **112**. Input/output ("I/O") support chip **223** is coupled to bus **210**, serial port **139** and hard disk storage **240**. I/O support chip **223** facilitates data transfer to and from external sources and the internal hard disk drive storage. Finally, 152-pin connector **160** is coupled to bus **210**.

EverWatch microcontroller **260** performs many functions relating to power management and the computer's operation, including reducing power consumption during periods of reduced computer use by placing the computer in a "sleep" mode, recharging the computer's internal battery, etc. EverWatch microcontroller **260** is coupled to MSC **207**, power supply **261**, on/off button **144**, clamshell switch **101**, keyboard **123** and trackball **125**.

Modem 270 is coupled to both EverWatch microcontroller 260 and, through Mux 271, to 152-pin connector 160. Static RAM ("SRAM") 265 is also coupled to modem 270 and EverWatch microcontroller 260.

Various aspects of the construction and operation of portable computer 100 have been described in related patent applications. These include "Power Management System for Battery Powered Computers", Ser. No. 770,193, filed Oct. 1, 1991, now U.S. Pat. No. 5,254,928; "An Increased Efficiency Power Supply For Portable Computers", Ser. No. 802,810, filed Dec. 6, 1991, "Method and Apparatus For Variable Frame Rate Control", Ser. No. 819,169, filed Jan. 8, 1992, "Glichless High Speed Clock Mux", Ser. No. 893,635, filed Jun. 5, 1992, "Method and Apparatus For Reducing Transitions On Computer Signal Lines", Ser. No. 904,735, filed Jun. 26, 1992, and "Method and Apparatus for Battery Pack Testing", Ser. No. 893,863, filed Jun. 5, 1992. These disclosures are incorporated herein for all purposes. Other features of portable computer 100 which relate to the mechanical and electrical interface with docking station 500 will be described below.

DOCKING STATION

A front perspective of docking station 500 is shown in FIG. 5. As shown in FIG. 5, docking station 500 is comprised of base 502 and top 504. Portable computer insertion slot 506 is defined by top 504 and the front lip of frying pan 508. Also visible in FIG. 5 are speaker grill 512, floppy disk insertion slot 510 and electrical ejection button 514.

As shown in FIG. 6, top 504 has two structural cross beam supports 516 mounted thereon. When the present invention is in its operating configuration, these two cross beams help support the weight of a cathode ray tube ("CRT") monitor which is placed on the top of the docking station. The cross beams can be attached to the internal top surface of top 504 in any one of several known manners including adhesives and plastic rivets. Electrical ejection button 514 is mounted in top 504 by means of stud 518 and is used to trigger the electrical eject cycle if certain conditions are met. These conditions are fully described later. Top 504 attaches to base 502 by means of clips 503.

FIG. 7 illustrates how the various components of docking station 500 are assembled together. These major components and assemblies center about base 502, frying pan 508 and skeleton 520, and top 504. The construction of each of these major assemblies will now be described in detail.

FIG. 8 is an exploded isometric drawing of base 502 and the components assembled thereon. Power supply assembly 522, which has an integral cooling fan, is mounted as a unit into base 502 and provides a continuous 75 watts of power which is supplied to the circuitry of both docking station 500 and portable computer 100, when that computer is docked with the station and powered on. During docked operations, whenever AC power is supplied, power supply 522 provides two non-switched voltages: +19 V at 1 amp and +5 V at 80 milliamps. The +19 V voltage charges portable computer 100's, internal battery automatically under the control of EverWatch microcontroller 260 (see FIG. 4) whether or not the system is turned on. Motor assembly 630 (see FIG. 14) is also coupled to the +19 V voltage, which allows docking and undocking to occur at any time AC is present, even when docking station 500 is turned off. The +5 V voltage powers the motor control circuitry, which also allows docking and undocking to occur even if docking station 500 is turned off. The motor control circuitry comprises at least programmed array logic ("PAL") 690 (see FIG. 21), photodetector 584

(see FIG. 20), microswitches 586 and 588 (see FIG. 16) and eject button 514 (see FIG. 5) in this first embodiment. In successive embodiments it would be possible to use the +5 V voltage to power a LED which would indicate whether or not the docking station is locked. Alternatively, the same voltage source could power a small piezoelectric speaker which would indicate to the user when an attempt was made to remove or insert the portable computer from or into a locked docking station. Fan shroud 524 mounts atop and around power supply 522 and helps direct the cooling air supplied by the power supply's integral cooling fan. The rear of base 502 also has two openings designed to accept I/O bus subsystem cards compatible with NUBUS® I/O bus architecture and protocol promulgated by Texas Instruments, Dallas, Tex. (NUBUS is a registered trademark owned by Texas Instruments). Such I/O expansion cards which comply with and operate under the NUBUS standard are hereinafter referred to as NUBUS cards 552 which permit the installation of one 25 W or two standard 15 W NUBUS card(s).

Columns 526 mount in base 502. They are spaced along the side edges of base 502 and clip into position. Once mounted, and with top 504 in its proper position, these columns are located respectively underneath the four ends of cross beams 516 (see FIG. 6), which rest directly on top of the columns when station 500 is completely assembled. When a CRT monitor (up to 50 lb. in weight in this first embodiment) is then placed on top 504, its weight is supported by the cross beams and the load is transmitted through them into the columns and thence into the desk or table that supports station 500. The use of this internal structural framework increases the size and weight of the monitor that the station can support and also eliminates loading either portable computer 100 when it is inserted into the docking station or the docking station's internal skeleton 520 (see FIG. 9) or both. Feet 530 are adhesively mounted with pads 528 on the outer bottom surface of base 502 in recesses (not shown) in the base underneath each of the four columns. They help prevent damaging the surface that the docking station is placed upon and provide the necessary friction to keep the docking station stationary when portable computer 100 is inserted into the station.

Lock 532 is mounted through the side of base 502 in lock hole 534 which extends through the sidewall of base 502. Door bar lock 542 is mounted and pivots on the interior of the same sidewall through which lock 532 extends using door bar retainer 546 to attach door bar lock 542 to base pivot 544. Door bar lock 542 is coupled to rear rotating stud 536 of lock 532 by means of lock linkage plate 538, which has a first opening cut to fit stud 536 and a second opening cut to fit the end of door lock bar 542. Bracket 540 locks lock linkage plate 538 to both stud 536 and door bar lock 542. When lock 532 is turned to lock docking station 500, door bar lock 542 pivots about base pivot 544 and covers manual eject slot 550, which extends through the same sidewall of base 502 as does lock hole 534. Ejection slot block 548 is attached to the end of door bar lock 542 and blocks slot 550 as the key is turned. As door bar lock 542 moves, it also interacts with manual ejection linkage 662 (see FIG. 20) to release lock switch 686 on logic board 580. Releasing lock switch 686 provides a signal to PAL 690 which controls the operation of motor 631, the release signal preventing motor 631 from running.

Lock 532, when locked, prevents the removal of portable computer 100 by causing the blockage of manual ejection slot 540 in base 502 and by preventing docking motor 631 (see FIG. 14) from turning on. Thus, if the system is locked, a user cannot eject computer 100 manually or electrically.

Any forceful attempt to do so might damage computer **100**. If docking station **500** is locked when no portable computer **100** is docked to the station, no computer can be inserted because motor **631** will not turn on to begin docking. Even if someone attempts to force a portable computer **100** into the docking station, hooks **638** of motor assembly **630** will be in their raised position and would strike the frame of computer **100**, preventing further insertion, before the connectors in the docking station and computer were close enough to be mated.

Slot **531** in the rear of base **502** and lock plate **533** allow the user of the docking station to insert a locking fixture which can secure the docking station to the desk upon which it is resting.

FIG. 9 shows a front perspective of skeleton **520**. Most of the internal mechanical components, as well as the circuit boards comprising the electrical systems of docking station **500** mount in or on skeleton **520**. Skeleton floppy disk insertion slot **554** is cut into floppy disk panel **578** which attaches to the right sidewall of skeleton **520** (see FIG. 10). Speaker **570** mounts in enclosure **572** in the front of skeleton **520**. Logic board mounting area **562** provides support for mounting logic board **580**, modem DAA card **583** (see FIG. 20) and motor assembly **630** (see FIG. 14). Docking slot **564** allows the 152-pin connector **160** in computer **100** to mate with 152-pin connector **582** on logic board **580**. Guide pin slots **566** allow guide pins **634** on motor frame **632** to extend from logic board mounting area **562** through docking wall **574**. Hook slots **568** permit the same extension through wall **574** for hooks **638** on motor carriage **636**. Door block opening **560** permits the installation of gate **610** (see FIG. 12). Right CPU pushout slot **556** and left CPU pushout slot **558** permit the installation of a damped spring ejection mechanism for portable computer **100** (see FIG. 13). Docking indicator slot **576** in docking wall **574** allows a docking indicator flag **592** on left CPU pushout **590** to extend through docking wall **574** to a photodetector unit **584** (see FIG. 20) mounted on logic board **580**.

FIG. 10 is an exploded isometric drawing of the upper portion of skeleton **520**. As stated earlier, speaker **570** mounts in speaker enclosure **572** and floppy disk panel **578** mounts on the right side of skeleton **520**.

FIG. 11 is an exploded isometric drawing of the underside of skeleton **520**. Floppy disk drive **624** is held in position by a plurality of floppy disk drive clips **652**. NUBUS card guide support **626** is held in position by card guide clips **654**. NUBUS connector bracket **628** clips onto the rear of skeleton **520** and helps support optional NUBUS cards. Bracket **628** can also have connector covers **650** attached thereto. Floppy disk drive cable **656** couples floppy disk drive **624** to logic board **580**. Insulation sheets **651** are applied as indicated in the figure.

Frying pan **508** is shown assembled in FIG. 12 and in an exploded isometric view, looking at the bottom of frying pan **508**, in FIG. 13. Gate **610** prevents the insertion of portable computer **100** if the computer's rear connector door **131** (see FIGS. 2 and 3) is in its closed, lowered position. When door **131** is closed and computer **100** inserted into docking station **500**, tab **135** of door **131** contacts the center area **611** of gate **610**. As gate **610** is mounted in frying pan **508** using a gate spring (not shown) which biases gate **610** in an upwards position so that it rises above the planar surface defined by frying pan **508**, contact between tab **135** and gate center **611** jams gate **610** in its upwards biased position, blocking further motion of computer **100** into docking station **500**. As CPU pushout springs **598** and **600** were stretched by insert-

ing computer **100** until it hit gate **610**, releasing computer **100** after it hits gate **610** results in the computer being spring ejected from the docking station. Alternatively, if door **131** is open, the edges of panel cutout **137** ride up the ramped side portions **613** of gate **610**, pushing the gate down and allowing computer **100** to be fully inserted into the docking station.

Left CPU pushout **590** mounts in left frying pan CPU pushout slot **606** in frying pan **508**. Spring **598** attaches to left frying pan stud **620** and provides part of the necessary spring force to eject computer **100**. Left CPU pushout **590** rides in slot **558** in skeleton **520** (see FIG. 10) when the frying pan is properly mounted atop the skeleton. Part of left CPU pushout **590** has been shaped as a flat vertically oriented panel, herein called docking indicator flag **592**. When computer **100** is inserted into docking station **500**, both the left and right CPU pushouts and their related springs are stretched. When computer **100** has been inserted to a point where hooks **638** of motor assembly **630** (see FIG. 14) can properly capture the frame of computer **100**, docking indicator flag **592** extends through frying pan insertion indicator slot **618** and skeleton insertion indicator slot **576** (see FIG. 10) into photodetector unit **584** on logic board **580** (see FIG. 20). Breaking the light path of photodetector unit **584** indicates to PAL **690** (see FIG. 21) controlling motor assembly **630** that docking motor **631** should be started to begin the electromechanical docking of computer **100**, unless lock switch **686** (see FIG. 20) indicates that the docking station is locked. Once portable computer **100** has been docked, a subsequent transmission of light in photodetector **584**, which would occur when flag **592** is removed from the photodetector, turns on motor **631** and returns it to its ready position. This automatic resetting of the motor is critical for proper operation after a manual ejection occurs, whether or not there has been an interruption of AC power.

Right CPU pushout **594** mounts in right frying pan CPU pushout slot **604**. One side of right CPU pushout slot **604** is lined with linear gear teeth **602**. The lower portion of right CPU pushout **594** comprises a damping unit **596**. Although not shown, damping unit **596** has pinion gear teeth which mesh with linear gear teeth **602**. During ejection, the contraction of right and left CPU pushout springs **598** and **600** is slowed by the interaction of the pinion gear teeth of damping unit **596** and linear gear teeth **602**. Right ejection spring **600** provides a second part of the needed spring force to help eject computer **100** and attaches to right CPU pushout **594** and right spring stud **622**. Right CPU pushout slot **604** aligns with skeleton **520**'s right CPU pushout slot **556** when the frying pan is properly mounted on the skeleton.

Assembled docking motor assembly **630** is shown in both FIG. 14 and **15**. FIGS. 16 and 17 are exploded isometric drawings of the motor assembly, showing the relationship of the parts to one another. Motor frame **632** provides the plastic structure which supports the other components of the assembly. Frame **632** has two guide pins **634** which insert into holes in the internal frame of computer **100**. The proper insertion of the pins into the frame of the portable computer insures that the connector shells of connectors **160** and **582** (see FIGS. 3 and 20, respectively) are properly aligned for mating. Motor carriage **636** has two docking hooks **638** which insert through the frame of computer **100** and lock onto it. These hooks apply the force generated by the motor assembly to the computer. Bore **639** in carriage **636** allows the carriage to move through a 5 mm docking/ejection stroke.

In order to mate the portable computer to the docking station, a total of 30 lb. of force is needed, that force to be

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generated over a distance of 4.7 mm. Of that total force, 26 lbs. is needed to mate connectors **160** and **582** and 4 lbs. is needed to overcome the spring resistance of CPU pushouts **590** and **594** (see FIG. **13**).

Motor **631** is an inexpensive D.C. motor which turns at a high RPM rate but which generates little torque In order to generate the needed torque, motor **631** drives a gearing system comprised of worm **648** and wormgear **646**. The worm/wormgear combination provide a gear ratio reduction of 100:1. An additional 12.5:1 gear ratio reduction is achieved by the nature of the offset cam which forms part of the wormgear. Together, the worm/wormgear/cam combination provides a 1250:1 total gear ratio reduction and generates 30 lbs. of force Wormgear axle **647**, which is used to mount wormgear **646** to frame **632**, passes through bore **639** in carriage **636**. Worm **648** meshes with wormgear **646**, the wormgear rotating once for every 100 revolutions of worm **648**. As shown in FIG. **17**, the undersurface of wormgear **646** has a ramped eccentric slot **684** cut therein, the eccentric offset being 2.5 mm from the true center of the wormgear and the ramp having a single high point, oriented along the gear's axle. Spring **640** is attached at one end to hook **904** on carriage **632** and at the other end to hook **906** on carriage **636**. Cam follower **683**, mounted on motor carriage **636** by means of axle **902**, rides in ramped slot **684** and is held in this position by motor spring **640**, which normally biases carriage **636** to its lowered position, the position it has when engaged with the frame of the portable computer. As wormgear **646** rotates with cam follower **683** held in ramped eccentric slot **684** by spring **640**, the ramp profile of slot **684** gradually forces carriage **636** to pivot on pivots **682** into a raised position, where hooks **638** release from the frame of computer **100**, allowing the computer to be ejected, provided the power stroke of motor assembly **630** has already decoupled the connectors. Carriage **636** is only placed in this raised position once every full rotation of wormgear **646**. A small resting "ledge" **908** in slot **684** supports cam follower **683** when wormgear **646** has reached the point where the hooks should release. The hooks remain in this raised position until docking indicator flag **592** (see FIG. **13**) triggers photodetector unit **584** (see FIG. **20**), indicating that a portable computer has been inserted, and locking switch **686** indicates that a computer can be inserted. Once motor **631** begins to turn, cam follower **683** moves off this lip in slot **684**, whereupon spring **640** returns carriage **636** to its lowered position, allowing hooks **638** to latch onto the frame of the portable computer. When hooks **638** are latched onto the frame of computer **100**, the reciprocating motion of carriage **636** pulls computer **100** to its fully docked position. For every 180° of rotation of wormgear **646**, a power stroke of 5 mm is generated.

During both docking and ejection, it is critical that the motor assembly stop in a particular point. For example, if the motor continued to spin after the computer had been fully docked, the connectors might be disconnected. Similarly, if the motor continued to spin after the computer was fully ejected, hooks **638** might capture the frame of the computer again before the user could remove it. As the motor runs at slightly different speeds as it ages and under different load and temperature condition, an electronic braking system has been provided to insure that the motor stops as quickly as possible after current flow to the motor has been stopped. This brake system absorbs the momentum of the motor by electronically converting the motor into a generator with a direct current path to ground. Braking system **800** is shown in FIG. **18**.

The signal to turn off motor **631**, MOTON, turns off transistor **807**. Motor **631** still has a certain voltage across it.

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With transistor **807** off and diode **809** reverse biased, transistor **801** turns on, providing a current path to ground which very rapidly drains off the remaining voltage on motor **631**, braking it to a complete stop in a very short time interval.

Ejecting computer **100** from docking station **500** first requires a power stroke from motor assembly **630** to disconnect the connectors. After the power stroke, hooks **638** must be released from the frame of computer **100**. Once the hooks are released, CPU pushouts **590** and **594** eject the computer as springs **598** and **600** return to their relaxed, contracted state. As stated, the motion of cam follower **683** in ramped eccentric slot **684** forces hooks **638** of carriage **639** into this raised position once every full rotation of wormgear **646**. This deflecting motion occurs after a sufficient amount of linear reciprocating motion has occurred to disconnect the 152-pin connectors. Hooks **638** remain in this raised position as long as cam follower **683** rests on the lip in slot **684**.

To activate and control the insertion and ejection process, docking station **500** is provided with several sensors and switches. Attached to left CPU pushout **590** is a small docking indicator flag **592** (see FIG. **13**). As computer **100** is inserted into docking station **500**, it contacts the CPU pushouts and begins to extend them. At the point where hooks **638** can properly engage with the frame of the portable computer, flag **592** projects through frying pan docking slot **608** and skeleton docking slot **576** into a photodetector unit **584** on logic board **580** (see FIG. **20**), breaking the light, which causes photodetector unit **584** to generate a first "insertion beginning" signal. This signal triggers the start of motor **631**, if lock switch **686** indicates that the docking station is unlocked.

The lower surface of wormgear **646** has a small projection **655** (see FIG. **17**) extending therefrom. Mounted on logic board **580** are two small switches **586** and **588** (see FIG. **16**). As wormgear **646** rotates, switches **586** and **588** are turned on momentarily in sequence, one switch being triggered by each 180° of wormgear **646**'s rotation. It should be noted that wormgear **646** only rotates in one direction. Given this unidirectional motion, it takes a combination of signals from lock switch **686** and switches **586** and **588** to indicate whether portable computer **100** has been successfully docked or not A signal from switch **586** and photodetector **584** indicates that the computer has been successfully docked. A signal from switch **588** and a low signal from photodetector **584** (light being transmitted in the photodetector) indicates that the portable computer has been ejected successfully.

The signals from switches **586** and **588** are debounced by an RC filter network and then applied to a Schmitt trigger inverter before being used by PAL **690**. Photodetector **584**s signal is applied to a Schmitt trigger inverter for hysteresis before being used by the PAL. Together, the signals from switches **586** and **588**, photodetector **584**, eject button **514** and lock switch **686** feed a gray code state machine which allows synchronous PAL **690** to function properly in response to asynchronous human and mechanical docking/undocking indicators.

FIG. **19** is a state table diagram which illustrates the different states that motor assembly **630** can be in. Although it is not possible to designate any one state as the "starting position" of the present invention, a logical place to begin this description of the state machine is at state **901**, Gearin. State **901** can be reached in any one of three ways. First, initial AC powering of docking station **500** or any other "power-on-reset" signal places the machine in state **901**.

Additionally, a power fail warning signal or a "motorin" signal can place the machine in state **901**, depending on the previous state. In state **901**, hooks **638** are in their fully retracted position. If the portable computer has not been inserted or if the system is not locked and an ejection request has been received, then the system moves to state **907**, Eject. The system remains in state **907** until microswitch **588** provides a "motorout" signal, indicating that hooks **638** are in their fully extended position. Upon receiving the "motorout" signal, the system moves to state **909**, Waitout. State **909** provides a waiting period of variable length which lasts until a clear indication is received from the photodetector unit that the portable computer has been fully ejected. Upon receipt of that signal from the photodetector unit, the system moves to state **911**, Gearout, where hooks **638** are in their fully extended, raised position. Upon receipt from the photodetector of the signal indicating that a portable computer **100** has been inserted and receipt of a signal indicating that the docking station has not been locked, the system moves to state **913**, Dock. In state **913**, the motor assembly turns on and remains on until a signal from microswitch **586** indicates that motor **631** has rotated the correct amount. The system then returns to state **901**. State **903**, Pwron, is reached from state **901** if a power failure warning is not received and VSC **712** has power. In state **903**, a power fail warning signal returns the system to state **901**. If the system is not locked and VSC **712** provides an ejection enable signal or the photodetector signals that the portable computer is not in the docking system, then the system moves to state **905**, Wait 5 V. The system waits in state **905** until either VSC **712** indicates that power is off or the photodetector continues to indicate that there is no portable computer in the docking station. If either signal is received, the system goes to state **907**. It should be noted that the motor is on only when looping in states **907** and **913** and that the motor continues to run until the appropriate microswitch generates a signal that the motor's rotation has carried it to that switch.

FIG. **20** is an exploded isometric drawing showing how frying pan **508**, skeleton **520** and their related components are mated together. Motor assembly **630** is aligned to logic board **580** by means of several plastic studs **681** (see FIG. **17**) which extend through the logic board into skeleton **520**. When the logic board is attached to the skeleton, hooks **638** extend through hook slots **568**, guide pins **634** extend through guide pin slots **566**, and 152-pin connector **582** extends into docking slot **564**. Electromagnetic interference ("EMI") shield **666** surrounds connector **582** and mounts in docking slot **564**. Logic board **580** is attached to logic board mounting area **562** by means of a plurality of metal screws. Logic board insulator sheet **668** is placed between logic board **580** and logic board mounting area **562**. Modem card **583** is electronically coupled to logic board **580** using a 10-pin connector and is also mounted on logic board mounting area **562** in the same manner as the logic board.

Manual ejection linkage **662** mounts along docking wall **574** of skeleton **520**. As shown, linkage **662** mounts on manual ejection stud **672** and slides laterally in manual ejection linkage track **674**. Manual ejection spring **661** biases the linkage to its inactive state, with ejection plate **663** abutting manual ejection slot **550** in base **502**. During use of the docking station, if a complete power failure occurs, or if for any other reason electrical ejection cannot be accomplished, a key, thin blade screwdriver, key, or similar tool may be inserted into slot **550** to contact and push against ejection plate **663**. Pushing on ejection plate **663** pushes linkage **662** laterally across skeleton **520**. Eventually, a ramped edge **665** of linkage **662** contacts motor assembly

630 and deflects hooks **638** upwards. Immediately after hooks **638** are pushed upwards, they release from the frame of portable computer **100**. The user of the system can then manually release the computer from the 152-pin connector and remove the computer from the docking system. When power is returned to the system, PAL **690** (see FIG. **21**) detects the low signal from photodetector **584**, which indicates that the computer has been removed. As the state of the docking station in this situation is not a valid operating state, PAL **690** turns on motor **631**. As the motor rotates, linkage **662** is released and pops out again. Lock switch **686**, which was released by pushing ejection plate **663**, is then depressed. PAL **690** continues to drive motor **631** until switch **588** is actuated and hooks **638** are in their raised position again.

If motor assembly **630** jams, a resettable thermal fuse blows to prevent overheating and possible damage to the docking station. Once the jam condition is corrected, the fuse automatically resets. If the motor is not in a valid docked state (the photodetector does not indicate that portable computer **100** is in the docking station) or in a valid undocked state, with the hooks fully extended and raised, PAL **690** will return the system to a correct position based on the previously discussed state table diagram (see FIG. **19**). This safeguard is also necessary to insure that hooks **638** are moved to their proper position when the docking station is first powered up.

Electronic ejection switch **660** attaches to the side of frying pan **508**. This switch is triggered by pressing on electronic ejection button **514** mounted in top **504** (see FIG. **5**). When pressed, the switch triggers an electronic eject of computer **100** if the requisite conditions exist. On/off button **664**, which extends through the rear of base **502** when the docking station is completely assembled, provides a reset signal to the system when pressed.

FIG. **21** is a block diagram of the electronic components of docking station **500**. As stated earlier, the purpose of the docking station is to add display, I/O, video random access memory ("VRAM"), NUBUS expansion possibilities, and, optionally, computational power to portable computer **100**.

The backbone of docking station electronics **700** is system bus **702**, which provides a 32-bit address and data path. Configuration ROM **706** is coupled to bus **702** and provides docking station configuration information to CPU **201** in portable computer **100** when the computer and the station are docked. If desired, a floating point unit ("FPU") **704**, also known as an arithmetic co-processor can be coupled to bus **702**. FPU **704** performs arithmetic calculations faster than CPU **201**, allowing math-intensive applications to run much more quickly.

Video controller **712** is coupled to bus **702** and controls video data and display for the docking station. VRAM **714** is also coupled to bus **702**, as well as to video controller **712**. VRAM **714** provides storage for video information prior to its display. VRAM **714** is coupled through Mux **715** to video digital/analog converter/color look-up table ("VDAC/CLUT") **716** which generates the red, green, and blue analog signals needed to drive a video monitor. Display video signals are then transmitted to a monitor through video port **734**.

Floppy disk drive **708** is coupled through a floppy disk controller integrated into video controller **712** to bus **702**.

One of the ways to expand the capabilities of docking station **500** is to add one or more NUBUS cards. The capabilities of a NUBUS card can include acceleration, expanded video capabilities, tape drive memory access, and

networking. Provisions are made in this first embodiment of the present invention to couple up to two NUBUS cards to system bus **702**. Two NUBUS Muxes **724** and **726** provide the necessary gateways between the bus and the NUBUS cards. NUBUS controller **720** with 40 Mhz clock **722** controls the flow of information to and from the NUBUS cards.

Additional I/O capabilities and memory expansion is available in the docking station. I/O controller **710** is coupled to serial ports **738** and **740**, as well as SCSI port **742**. Controller **710** permits the installation of optional SCSI devices **742**a that could include a hard disk drive in the hard disk drive bay, which would then be coupled to system bus **702** through the controller **710**. External devices such as a hard disk drive, a CD drive or a scanner would also be coupled to the docking station through controller **710**. Power supply **750** supplies power to both docking station **500** and portable computer **100**, as well as providing power to a switched AC convenience output source for the monitor. It should be noted that power supply **750** supplies +19 V to drive motor assembly **630** and to charge the batteries in portable computer **100**, this voltage being available whenever AC power is supplied to the docking station. Additionally, a special, low current 5 V is also available whenever AC power is supplied to the docking station to provide power for photodetector **584** and the other motor control circuitry. The availability of this low current +5 V source, separate from the main +5 V source, and control logic in PAL **690** allow the possibility in a second embodiment of the present invention of powering a speaker or LED which would indicate that lock **532** is in its locked position. Motor logic, also known as PAL **690**, controls the operation of motor assembly **630**. Finally, docking station has sound in and out ports **736**, an ADB port **732**, on/off button **754** and modem port **730**.

DOCKING AND UNDOCKING

In the present invention, the computer and the docking station are coupled together using a mechanically triggered electromechanical docking/undocking mechanism. If this docking were to occur while either one of the docking station or the computer is in an active "on" condition, transient signals and voltages could destroy components and data could be corrupted and lost. The present invention incorporates numerous safety features which either prevent the docking/undocking of active units or, if such active docking/undocking can not be prevented, minimize the chances of damaging components and/or losing data.

The normal sequence for inserting the portable computer into the docking station begins with the portable computer off and the docking station off. When the portable computer is inserted, its EverWatch microcontroller **260** detects the attempted docking by means of a sense pin in the 152-pin connector. Once it detects docking, controller **260** waits for the on/off button on the docking station or the 'on' key on the keyboard to be pressed. Once an 'on' signal is received, the computer is first powered up but MSC **207** is held in a reset mode, which in turn maintains the expansion bus in a quiescent state and keeps CPU **201** powered off. The EverWatch microcontroller **260** drives a power fail warning signal high, which turns on power supply **522** in the docking station. Microcontroller **260** waits until a +5 V Ext_Sense line goes high, which indicates that power has stabilized in docking station **500**. Microcontroller **260** then takes MSC **207** out of its reset mode, allowing CPU **201** to be powered up. During this normal docking, the signal provided by clamshell switch **101** (see FIG. 4) is ignored by microcon-

troller **260**. It should be noted that whenever motor **631** is running, PAL **690** generates a power failure warning signal which shuts off power supply **522**. This guarantees that the docking station will be powered down during any docking attempt. Normal computer operations follow this initial power-up stage.

A request to eject portable computer **100** from docking station **500** can be received at any time. In the most complex case, the computer and docking station are both operating and performing some task such as word processing. If the user presses the eject button while the system is in this state, the button causes a level 2 interrupt to be sent to CPU **201**. The interrupt service routine which occurs in response to the interrupt calls the "docking manager" in ROM **205** which uses control and status calls from the configuration ROM **706** in the docking station to determine the validity of the eject request by reading MSC **207** and VSC **712**. The docking manager also checks VSC **712** to determine if the docking station is locked. If it is locked, a dialog box is displayed on the video monitor indicating that ejection cannot take place because the system is locked. If the system is not locked, the docking manager, along with configuration ROM **706**, clears the interrupt request, issues a software request to the operating system to shutdown, and sets the eject enable bit in VSC **712**, VSC **712** being coupled to PAL **690**. Once the eject enable bit is on, the state machine in PAL **690** waits until power to the docking station goes off before ejecting the computer. Next, the operating system requests that application programs quit because of the ejection request. The user is provided with a dialog box if data or changes might be lost so that they can be saved, following which the application program quits. The operating system then signals EverWatch microcontroller **260** to perform a shut down. Microcontroller **260** resets MSC **207** which turns off CPU **201** and then turns off docking station **500** and computer **100** in sequence. PAL **690** detects that power has been shut off and signals motor assembly **630** to turn on and eject the computer.

If a manual ejection is performed when docking station **500** is still on, PAL **690** turns off the docking station's power before the connectors between the docking station and the portable computer can be disengaged. The mechanism used in the mechanical ejection raises hooks **638** to allow the user to manually separate the units. As this method of ejection can occur at any time and in an "uncontrollable" manner, orderly closing of applications and saving data cannot take place. However, by insuring that power is properly shut off, the present invention prevents damage to either the docking station or the portable computer. Once the hooks have been raised and the portable computer manually removed, PAL **690** turns on motor assembly **630** until the motor assembly returns to its ready state.

When the docking station is not locked, the worst scenario would be if an active computer **100** were to be docked to the docking station, regardless of whether or not the station was on. If this was allowed to occur, both the data in computer **100**, as well as its circuitry could be damaged by voltage transients.

A first failsafe mechanism is latch switch **101** activated by latch **117** in computer **100**. Anytime computer **100** is closed, latch switch **101** provides a signal to EverWatch microcontroller **260**, which signal allows EverWatch microcontroller **260** and MSC **207** to begin and complete the process of placing the computer in a sleep mode. Docking operations are permitted in sleep mode because power to the CPU and other delicate circuits is cut off. In general, it is very difficult if not impossible to insert portable computer **100** into

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docking station **500** without computer **100** being completely closed and therefore in a sleep state.

If the user attempts to insert computer **100** into docking station **500** while computer **100** is in a sleep state, no damage occurs to the computer, but the system is inoperable. Once inserted and an 'on' signal received, computer **100** will power up both CPU **210** and docking station **500** as previously described. Although the hardware used in this first embodiment permits full operation of the system with the portable computer coming out of a sleep state, the first embodiment's operating software cannot compensate for the change in display screens. Therefore, once computer **100** detects that it has been coupled to a docking station and that it has just come from a sleep state, it immediately returns to sleep, saving data, turning off the docking station and immediately ejecting the computer from the docking station. Once ejected, when computer **100**'s "on" is pressed. LCD **110** will display a message requesting that the user order a full shutdown before attempting to dock the computer again.

In the extremely unlikely event that closing computer **100** did not result in switch **101** providing the proper signal to EverWatch microcontroller **260** to place computer **100** in sleep mode, the present invention has an extraordinary response to attempted insertions while the portable computer is still in a run mode. 152-pin **160** in computer **100** has several long pins, including a "sense" pin, a +19 V power pin, and a ground pin, which make contact with sockets in docking station **500**'s 152-pin connector **582** before the remaining short pins, which include the other power pins, are connected. The long sense pin informs MSC **207** that docking is occuring. If computer **100** is still on, MSC **207** immediately cuts power to CPU **201**. Although this results in data stored in RAM **203** being lost, this is preferable to allowing transient voltages and currents to be applied to the circuitry of computer **100**, which circuitry might be damaged. This loss of data would occur in any event, as the system could not continue to function when connected to a powered down docking station. After MSC **207** has cut power to CPU **201**, EverWatch microcontroller **260** completes a graceful shutdown of computer **100**. This shutdown process insures that computer **100** is in a known state prior to any attempt to restart or use the system. It should also be noted that one of the short pins in the 152-pin connector also acts as a sense pin, providing to computer **100** a reliable indication that the connectors have been completely mated. Only after EverWatch microcontroller **260** receives this signal will the power planes be turned on. This eliminates the arcing and pitting of the connectors that can occur when an unpowered line is mated with a powered one.

Although the present invention has now been explained with reference to a particular embodiment, it should be apparent to one skilled in the art that numerous changes and modifications may be made thereto without departing from the scope or spirit of the invention. Dynamic changes of the monitors, even if the portable computer is in a sleep mode, will be permitted in later embodiments of the present invention. For example, it is inherent in the described embodiment that the docking station can be expanded in numerous ways. These include providing the docking station with a hard disk storage unit or a CD-ROM drive. It is not inconceivable that the docking station could be equipped with a separate CPU for special situations. The portable computer in other embodiments will be powered by different types of batteries, necessitating changes in the EverWatch microcontroller. Other changes, modifications and applications of the invention will become apparent to one skilled in the art in view of this disclosure. Thus, the invention should be limited only in accordance with the appended claims.

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What is claimed is:

1. A computing system comprising:

a portable computer comprising at least a central processing unit, *and* a system address/data bus coupled to the central processing unit[, random access memory coupled to the system bus, hard disk data storage coupled to the system bus, a liquid crystal display coupled to the system bus, a power controller coupled to the system bus, and a battery coupled to the power controller]; and

a docking station detachably coupled [via electrical connector means] to the portable computer [to provide increased video display capability and increased data storage], the docking station comprising at least an electromechanical docking/undocking means including an electric motor assembly for mechanically and electrically docking and undocking the portable computer to and from the docking station[, floppy disk data storage means coupled through the electrical connector means to the system address/data bus for providing additional data storage when the portable computer is docked to the docking station, the electrical connector means coupled to the system address/data bus for displaying data from the portable computer on a cathode ray tube display when said portable computer is docked to the docking station,] and [a plurality of failsafe mechanisms] *means* disposed within the portable computer and the docking station and cooperatively interacting for protecting the portable computer and docking station from damage as docking and undocking occurs.

2. The computing system of claim 1 *wherein the docking station is detachably coupled to the portable computer via electrical connector means, and* wherein the electrical connector means comprises a docking connector allowing access to the portable computer's system address/data bus and a docking connector cover having a first position covering the docking connector and a second position uncovering the docking connector, the docking station further comprising a door block for detecting whether the docking connector cover is in the first position, said door block not permitting the portable computer to be docked to the docking station if the docking connector cover is in the first position, the door block permitting docking if the docking connector cover is in the second position.

3. The computing system of claim 2 wherein the docking station further comprises a lock means having an unlocked and locked position, the lock means preventing the portable computer from being removed from the docking station if it is docked to the station and the lock is in its locked position and the lock means preventing the portable computer from being docked to the docking station if lock is in locked position by turning off the electromechanical docking/undocking means.

4. The computing system of claim 1, wherein the [failsafe mechanisms include] *means includes* a first switch disposed internal to the portable computer and a latch disposed in a top cover assembly hingedly coupled to the portable computer, wherein when said top cover assembly is rotated to bear against said portable computer, said latch engages said first switch to signal a power management controller coupled to a main system controller further coupled to said system address/data bus that said central processor must enter a sleep state, thereby preventing transient voltages and currents on said system address/data bus when said portable computer is inserted into said docking station.

5. The computing system of claim 4, wherein the [failsafe mechanisms] *means* further [comprise] *includes* at least one

elongated contact pin disposed within the docking connector of the portable computer for contacting at least one corresponding elongated socket disposed within the electromechanical docking/undocking means of the docking station, wherein said elongated contact pins contact the corresponding elongated sockets before a plurality of shorter contact pins contact a plurality of short sockets.

6. The computing system of claim **5**, wherein the elongated contact pins comprise a first sense pin, a power pin, and a ground pin; if said portable computer is "on" when said first sense pin contacts the corresponding elongated socket, said sense pin causing the main system controller to turn off power to the central processing unit to prevent transient voltages and currents to exist within said portable computer.

7. The computing system of claim **4**, wherein the [failsafe mechanisms] *means* further [comprise] *comprises* a second sense contact pin to provide a confirming signal that the portable computer is firmly docked within the docking station, said second sense pin being shorter that said first sense pin, whereafter said power management controller applies power to said main system controller and said central processing unit.

8. The computing system of claim **1** further comprising electronic docking/undocking initiation and reset means and electronic braking means coupled to the electric motor assembly within the electromechanical docking/undocking means for accurately positioning the portable computer within the docking station when the portable computer is docked and undocked.

9. The computing system of claim **8**, wherein the electronic docking/undocking initiation and reset means comprises a photodetector unit mounted within a receiving opening interior to said docking station and electrically coupled to said electric motor assembly; when said portable computer is inserted beyond a first, begin-docking position in the receiving opening, the photocell unit signaling the electric motor assembly to start and move the portable computer to a second, finish-docking position.

10. The computing system of claim **8**, wherein the electronic braking means comprises first, second, and third transistors and a diode coupled to the electric motor assembly to rapidly stop a rotating shaft within the electric motor assembly thereby stopping the portable computer substantially at the second, finish-docking position.

11. The computing system of claim **10**, wherein first and second transistors comprise metal-oxide-semiconductor field effect transistors (MOSFETs) coupled source to gate and said third transistor comprises a bipolar transistor having its emitter coupled to the drain of said second MOSFET and its collector coupled to a ground reference, there being further a motor drive voltage applied to the source of said second MOSFET and a diode coupled between said drain of second MOSFET and the ground reference, wherein applying a stop-motor voltage to the gate of said first MOSFET turns off the second MOSFET thereby electrically decoupling the electric motor assembly from the motor drive voltage, whereafter residual motor drive voltage present in said motor assembly causes said bipolar transistor to discharge said residual voltage to ground and substantially stopping the rotating shaft.

12. The computing system of claim **8**, wherein when said portable computer is ejected the docking/undocking initiation and reset means signals the electric motor assembly to start and move the portable computer from said second, finish-docking position to a third, finish-ejecting position substantially coincident with said first begin-docking position.

13. The computing system of claim **12**, wherein when the portable computer reaches the third, finish-ejecting position, the photocell unit sends a motor-reset signal that causes electric motor assembly to reset to a ready state.

14. A computing system comprising:
a portable computer comprising at least a central processing unit, a system address/data bus coupled to the central processing unit, random access memory coupled to the system bus, hard disk data storage coupled to the system bus, a liquid crystal display coupled to the system bus, a power controller coupled to the system bus, and a battery coupled to the power controller; and
a docking station detachably coupled via electrical connector means to the portable computer to provide increased video display capability and increased data storage;
the electrical connector means comprising:
a docking connector allowing access to the portable computer's system address/data bus and a docking connector cover having a first position covering the docking connector and a second position uncovering the docking connector, the docking station further comprising a door block for detecting whether the docking connector cover is in the first position, said door block not permitting the portable computer to be docked to the docking station if the docking connector cover is in the first position, the door block permitting docking if the docking connector cover is in the second position;
the docking station comprising:
at least an electromechanical docking/undocking means including an electric motor assembly for mechanically and electrically docking and undocking the portable computer to and from the docking station,
floppy disk data storage means coupled through the electrical connector means to the system address/data bus for providing additional data storage when the portable computer is docked to the docking station,
the electrical connector means coupled to the system address/data bus for displaying data from the portable computer on a cathode ray tube display when said portable computer is docked to the docking station,
[a plurality of failsafe mechanisms] *means* disposed within the portable computer and the docking station and cooperatively interacting for protecting the portable computer and docking station from damage as docking and undocking occurs, and
lock means disposed within said docking station for cooperatively securing insertion and removal of said portable computer from said docking station, said lock means having an unlocked position and a locked position, the lock means preventing the portable computer from being removed from the docking station if the portable computer is docked to the station and the lock means is in the locked position, said lock means further preventing the portable computer from being docked on the docking station when the portable computer is not docked to the station and said lock means is in the locked position by turning off the electromechanical docking/undocking means.

15. A portable computer and docking station wherein the portable computer is usable without being docked to the

docking station and when docked to the docking station has increased data storage capabilities and increased video display capabilities, the portable computer comprising

a central processing unit;

a system bus for transmitting data and instructions coupled to the central processing unit;

random access memory coupled to the system bus;

liquid crystal display coupled to the system bus;

main system controller coupled to the system bus;

power controller coupled to the main system controller for controlling power usage in the portable computer and for controlling battery charging;

keyboard coupled to the power controller;

read only memory for storing system instructions coupled to the system bus; and

first docking connector coupled to the system bus and power controller; and the docking station comprising:

second docking connector for connecting to the first docking connector and allowing access to the portable computer's system bus;

electromechanical docking/undocking means including an electric motor assembly for electrically and mechanically coupling the first and second docking connectors together once the portable computer has been placed into the docking station;

docking station address and data bus coupled to the second docking connector;

video display system coupled to the docking station bus for display data processed in the portable computer on a cathode ray tube display;

on input/output (I/O) bus subsystem and protocol controller coupled to the docking station bus for allowing installation and use of I/O bus subsystem extension cards in the docking station;

floppy disk drive coupled to the docking station bus for allowing access to data stored on floppy disks by the portable computer when the portable computer is docked to the docking station; and

a plurality of electromechanical docking/undocking safety interlocks disposed within the portable computer and the docking station and cooperatively interacting for preventing the docking and undocking of the portable computer to and from the docking station if such docking and undocking would damage components in the docking station and the portable computer and cause the loss of data stored in the portable computer and the docking station.

16. The portable computer and docking station of claim 15 wherein the portable computer further comprises a docking connector door which has a first position covering the first docking connector and a second position uncovering the first docking connector and the docking station further comprises a door block that prevents docking of the portable computer when the door is in its first position and permits docking when the door is in its second position.

17. The portable computer and docking station of claim 16 wherein the docking station further comprises a locking means having a locked and unlocked position, the locking means preventing the portable computer from being docked to the docking station if the locking means is in its locked position by preventing the electromechanical docking/undocking means from turning on to dock the portable computer and the locking means preventing the portable computer from being removed from the docking station ashen the locking means is in its locked position.

18. The docking station of claim 15, wherein the safety interlocks include a first switch disposed internal to the portable computer and a latch disposed in a top cover assembly hingedly coupled to the portable computer, wherein when said top cover assembly is rotated to bear against said portable computer, said latch engages said first switch to signal the power controller coupled to said system address/data bus that said central processor must enter a sleep state, thereby preventing transient voltages and currents on said system address/data bus when said portable computer is inserted into said docking station.

19. The computing system of claim 18, wherein the safety interlocks further comprise at least one elongated contact pin disposed within the docking connector of the portable computer for contacting at least one corresponding elongated socket disposed within the electromechanical docking/undocking means of the docking station, wherein said elongated contact pins contact the corresponding elongated sockets before a plurality of shorter contact pins contact a plurality of short sockets.

20. The computing system of claim 19, wherein the elongated contact pins comprise a first sense pin, a power pin, and a ground pin; when said first sense pin contacts the corresponding elongated socket said sense pin informing the main system controller terminating power to the central processing unit to prevent transient voltages and currents to exist within said portable computer.

21. The computing system of claim 19, wherein the safety interlocks further comprise a second sense contact pin to provide to the power management controller a confirming signal that the portable computer is firmly docked within the docking station, said second sense pin being shorter that said first sense pin, whereafter said power management controller applies power to said main system controller and said central processing unit.

22. The computing system of claim 15 further comprising electronic docking/undocking initiation and reset means and electronic braking means coupled to the electric motor assembly within the electromechanical docking/undocking means for accurately positioning the portable computer within the docking station when the portable computer is docked and undocked.

23. The computing system of claim 22, wherein the electronic docking/undocking initiation and reset means comprises a photodetector unit mounted within a receiving opening interior to said docking station and electrically coupled to said electric motor assembly; when said portable computer is inserted beyond a first, begin-docking position in the receiving opening, the photocell unit signaling the electric motor assembly to start and move the portable computer to a second, finish-docking position.

24. The computing system of claim 22, wherein the electronic braking means comprises first, second, and third transistors and a diode coupled to the electric motor assembly to rapidly stop a rotating shaft within the electric motor assembly thereby stopping the portable computer substantially at the second, finish-docking position.

25. The computing system of claim 24, wherein first and second transistors comprise metal-oxide-semiconductor field effect transistors (MOSFETs) coupled source to gate and said third transistor comprises a bipolar transistor having its emitter coupled to the drain of said second MOSFET and Its collector coupled to a ground reference, there being further a motor drive voltage applied to the source of said second MOSFET and a diode coupled between said drain of second MOSFET and the ground reference, wherein applying a stop-motor voltage to the gate of said first MOSFET

turns the second MOSFET off thereby electrically decoupling the electric motor assembly from the motor drive voltage, whereafter residual motor drive voltage present in said motor assembly causes said bipolar transistor to discharge said residual voltage to ground and stopping the rotating shaft.

26. The computing system of claim **22**, wherein when said portable computer is ejected the docking/undocking initiation and reset means signals the electric motor assembly to start and move the portable computer from said second, finish-docking position to a third, finish-ejecting position substantially coincident with said first begin-docking position.

27. The computing system of claim **26**, wherein when the portable computer reaches the third, finish-ejecting position, the photocell unit sends a motor-reset signal that causes the electric motor assembly to reset to a ready state.

28. A portable computer and docking station wherein the portable computer is usable without being docked to the docking station and when docked to the docking station has increased data storage capabilities and increased video display capabilities;

the portable computer comprising:

a central processing unit;

a system bus for transmitting data and instructions coupled to the central processing unit;

a random access memory coupled to the system bus;

a liquid crystal display coupled to the system bus;

a main system controller coupled to the system bus;

a power controller coupled to the main system controller for controlling power usage in the portable computer and for controlling battery charging;

a keyboard coupled to the power controller;

a read only memory for storing system instructions coupled to the system bus;

a first docking connector coupled to the system bus and power controller;

a docking connector door having a first position covering the first docking connector and a second position uncovering the first docking connector;

the docking station comprising:

a second docking connector for connecting to the first docking connector and allowing access to the portable computer's system bus;

a docking connector door block disposed on said docking station for preventing docking of the portable computer when the docking connector door is in the first position, said docking connector door block further permitting docking of the portable computer when the docking connector door is in the second position;

electromechanical docking/undocking means including an electric motor assembly for electrically and mechanically coupling the first and second docking connectors together after the portable computer has been placed into the docking station:

a docking station address and data bus coupled to the second docking connector;

video display system coupled to the docking station bus for display data processed in the portable computer on a cathode ray tube display;

an input/output (I/O) bus subsystem and protocol controller coupled to the docking station address and data bus for allowing installation and use of I/O bus subsystem expansion cards in the docking station;

a floppy disk drive coupled to the docking station address and data bus for allowing access to data

stored on floppy disks by the portable computer when the portable computer is docked to the docking station;

a plurality of electromechanical docking/undocking safety interlocks disposed within the portable computer and the docking station and cooperatively interacting for preventing the docking and undocking of the portable computer to and from the docking station if such docking and undocking would damage components in the docking station and the portable computer and cause loss of data stored in the portable computer and the docking station, and

locking means for cooperatively securing insertion and removal of said portable computer from said docking station, the locking means preventing the portable computer from being docked to the docking station if the locking means is in the locked position by preventing the electromechanical docking/undocking means from turning on to dock the portable computer, said locking means further preventing the portable computer from being removed from the docking station when the portable computer is docked to the station and said lock means is in the locked position.

29. A computer system comprising:

a portable computer comprising at least a central processing unit, and a system address/data bus coupled to the central processing unit;

a docking station detachably coupled via at least one electrical connector to the portable computer, the docking station comprising at least an electromechanical docking/undocking means including an electric motor assembly for mechanically and electrically docking and undocking the portable computer to and from the docking station; and

cooperative means disposed in the docking station cooperatively interacting with the portable computer for protecting the portable computer and the docking station from electrical damage as docking and undocking occurs.

30. The computer system of claim 29 wherein the cooperative means includes a first sense contact adapted for correspondingly mating with a second sense contact disposed in the portable computer for providing a confirming signal that the portable computer is firmly docked to the docking station.

31. The computer system of claim 30 wherein the cooperative means further includes a third sense contact adapted for correspondingly mating with a fourth sense contact disposed in the portable computer for providing an electrical connection between the portable computer and the docking station; as docking occurs, this electrical connection is made earlier than the electrical connection made between the first and the second sense contacts.

32. The computer system of claim 31 wherein the first sense contact includes at least one electrical socket for matingly receiving the second sense contact, wherein the second sense contact includes at least one contact pin.

33. The computer system of claim 32 wherein the third sense contact includes at least one electrical socket for matingly receiving the fourth sense contact, wherein the fourth sense contact includes at least one contact pin longer in length than that of the at least one contact pin of the second sense contact.

34. The computer system of claim 31 wherein the third sense contact makes the electrical connection with the fourth sense contact as the portable computer docks with the

docking station; if the portable computer is "on" when the electrical connection is made, the electrical connection causing power to at least a portion of the portable computer be turned off to prevent electrical damage.

35. A docking station comprising:

a computer receiving area capable of receiving a personal computer;

electromechanical docking/undocking means for mechanically and electrically docking and undocking the portable computer to and from the computer receiving area of the docking station; and

cooperative means disposed in the docking station cooperatively interacting with the portable computer for protecting the portable computer and the docking station from electrical damage as docking and undocking occurs.

36. The docking station of claim 35 wherein the electromechanical docking/undocking means includes an electric motor assembly.

37. The docking station of claim 36 wherein the electromechanical docking/undocking means comprises a sensor assembly being electrically coupled to the electric motor assembly; when the portable computer is moved into the computer receiving area of the docking station beyond a begin-docking position, the sensor assembly signaling the electric motor assembly to start and move the portable computer to a finish-docking position for operative engagement with the docking station.

38. The docking station of claim 37 wherein the electromechanical docking/undocking means in response of a eject signal causes the electric motor assembly to start and move the portable computer from the finish-docking position to a finish-ejecting position substantially coincident with the begin-docking position.

39. The docking station of claim 38 further comprising electronic braking means coupled to the electric motor assembly to rapidly stop a rotating shaft within the electric motor assembly whereby stopping the portable computer substantially at the begin-docking position.

40. The docking station of claim 38 wherein the sensor assembly sends a motor-reset signal that causes the electric motor assembly to operate to return the portable computer to the begin-docking position after the portable computer is ejected from the docking station and has reached the finish-ejecting position.

41. The docking station of claim 35 being coupleable via electrical connector means to the portable computer, wherein the electrical connector means comprising a docking connector allowing electrical access to the potable computer and a docking connector cover having a first position covering the docking connector and a second position uncovering the docking connector the docking station further comprising a door position, sensor for detecting whether the docking connector cover is in the first position, the door position sensor not permitting the portable computer to be docked to the docking station if the docking connector cover is in the first position, the door position sensor permitting docking if the docking connector cover is in the second position.

42. The docking station of claim 35 further comprising lock means having an unlocked and locked position, the lock means preventing the portable computer from being removed from the docking station if the portable computer is docked to the docking station and the lock means is in its locked position and the lock means preventing the portable computer from being docked to the docking station if the lock means is in the locked position.

43. The docking station of claim 42 wherein the lock means causes the electromechanical docking/undocking means to be turned off when the portable computer is attempting to dock the docking station while the lock means is in the locked position.

44. The docking station of claim 35 being adapted for removably coupling the portable computer to peripheral devices external to the portable computer, the docking station further comprising data I/O controller means for interacting and cooperating with the portable computer.

45. The docking station of claim 44 wherein the data I/O controller means includes video display controller means operating cooperatively with the portable computer.

46. The docking station of claim 45 wherein the video display controller means supports at least one display device for displaying data received from the portable computer while the portable computer is docked to the docking station.

47. The docking station of claim 44 wherein the data I/O controller means includes data storage controller means operating cooperatively with the portable computer.

48. The docking station of claim 47 wherein the data storage controller means supports at least one data storage unit.

49. The docking station of claim 48 wherein the at least one data storage unit operates on a magnetic medium.

50. The docking station of claim 49 wherein the at least one data storage unit includes a floppy disk drive internal to the docking station, the floppy disk drive being coupled to the portable computer for providing additional data storage for the portable computer while the portable computer is docked to the docking station.

51. The docking station of claim 44 wherein the data I/O controller means includes data communications controller means operating cooperatively with the portable computer.

52. The docking station of claim 51 wherein the data communications controller means supports at least a communications protocol used for data transmission and data reception while the portable computer is docked to the docking station.

53. A method for operatively coupling a portable computer to a peripheral device external to the portable computer, the method comprising:

providing a docking station including the peripheral device and at least one electromechanical docking/ undocking means having an electric motor assembly for mechanically and electrically docking and undocking the portable computer to and from the docking station, and a receiving area structure adapted for receiving the portable computer for docking;

manually positioning the portable computer beyond a begin-docking position in the receiving area structure;

operating the electromechanical docking/undocking means to drive the manually positioned portable computer for operative engagement with the peripheral device in the docking station, said operating including sensing whether the portable computer is "on" as docking occurs, and controlling the portable computer to ensure no electrical damage occurring as the portable computer docks with the docking station.

54. The method of claim 53 wherein the controlling includes turning off the power to at least a portion of the portable computer if the portable computer is "on" when docking occurs.

55. The method of claim 54 wherein the at least a portion of the portable computer includes a central processing unit.

56. A method for operatively coupling a portable computer to a peripheral device external to the portable computer, the method comprising:

providing a docking station including the peripheral device and at least one electromechanical docking/undocking means having an electric motor assembly for mechanically and electrically docking and undocking the portable computer to and from to the docking station, and a receiving area structure adapted for receiving the portable computer for docking;

manually positioning the portable computer beyond a begin-docking position in the receiving area structure; and

operating the electromechanical docking/undocking means to drive the manually positioned portable computer for operative engagement with the peripheral device in the docking station, said operating including sensing whether the portable computer is firmly docked to the docking station, and turning on the power to the portable computer when the portable computer is firmly docked to the docking station.

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