IN THE UNITED STATES DISTRICT COURT

FOR THE DISTRICT OF DELAWARE

INTERMEC TECHNOLOGIES CORP., a Delaware corporation,	)	
Plaintiff,	)	
v.	)	C.A. No. _____
PALM, INC., a Delaware corporation,	)	**DEMAND FOR JURY TRIAL**
Defendant.	)	

COMPLAINT FOR PATENT INFRINGEMENT

Plaintiff, Intermec Technologies Corp. ("Intermec"), for its Complaint against Defendant Palm, Inc. ("Palm"), hereby alleges:

JURISDICTION AND VENUE

1. This action arises under the patent laws of the United States, 35 U.S.C. § 101 et seq. This Court has jurisdiction under 28 U.S.C. § 1338(a).

2. Venue is proper in this judicial district pursuant to 28 U.S.C. §§ 1391(c) and 1400(b).

THE PARTIES

3. Plaintiff Intermec is incorporated under the laws of the State of Delaware, and has its principal place of business at 6001 36th Avenue West, Everett, WA 98203.

4. On information and belief, Defendant Palm is incorporated under the laws of the State of Delaware, and has its principal place of business at 950 West Maude Avenue, Sunnyvale, CA 94085.

ASSERTED PATENTS

5. On September 20, 1994, the United States Patent and Trademark Office ("PTO") issued U.S. Patent No. 5,349,678 ("the '678 Patent") to Michael D. Morris and Lyle L. Zumbach for their invention entitled "Versatile RF Data Capture System." Intermec owns all right and title to the '678 Patent. A copy of the '678 Patent is attached hereto as Exhibit A.

6. On October 22, 1996, the PTO issued U.S. Patent No. 5,568,645 ("the '645 Patent") to Michael D. Morris and Lyle L. Zumbach for their invention entitled "Versatile RF Data Capture System." Intermec owns all right and title to the '645 Patent. A copy of the '645 Patent is attached hereto as Exhibit B.

7. On November 16, 1999, the PTO issued U.S. Patent No. 5,987,499 ("the '499 Patent") to Michael D. Morris and Lyle L. Zumbach for their invention entitled "Versatile RF Data Capture System." Intermec owns all right and title to the '499 Patent. A copy of the '499 Patent is attached hereto as Exhibit C.

8. On November 21, 1995, the PTO issued U.S. Patent No. 5,468,947 ("the '947 Patent") to Arvin D. Danielson and Dennis A. Durbin for their invention entitled "Pocket Size Data Capture Unit With Processor And Shell Modules." Intermec owns all right and title to the '947 Patent. A copy of the '947 Patent is attached hereto as Exhibit D.

9. On April 6, 1999, the PTO issued U.S. Patent No. 5,892,971 ("the '971 Patent") to Arvin D. Danielson and Dennis A. Durbin for their invention entitled "Portable Data Processing Device Having An Indicia Reader And A Multi-Tasking Operating System Capable Of Executing Battery Monitoring Instructions While Concurrently Executing Application Programs." Intermec owns all right and title to the '971 Patent. A copy of the '971 Patent is

attached hereto as Exhibit E. (The '678, '645, '499, '947 and '971 Patents are referred to collectively as the "patents-in-suit.")

ACCUSED PRODUCTS

10. Palm makes, uses, sells and/or offers for sale products that infringe the patents-in-suit. These products include, but are not limited to, Palm's Treo™ 700w, Treo™ 700wx and Treo™ 750 smartphones. (These products are collectively referred to as the "Accused Products.")

FIRST CLAIM FOR RELIEF
(INFRINGEMENT OF THE '678 PATENT)

11. Intermec incorporates paragraphs 1 through 10 by reference as though fully set forth herein.

12. By virtue of its manufacture, use, sale, offer for sale and/or encouragement of others to use the Accused Products, Palm has been and still is infringing, inducing the infringement of and/or contributing to the infringement of the '678 Patent.

13. Palm's infringement of the '678 Patent has caused Intermec substantial injury for which Intermec is entitled to receive adequate compensation. As a result of Palm's infringement of the '678 Patent, and Intermec's compliance with the requirements of 35 U.S.C. § 287(a), Intermec is entitled to damages adequate to compensate it for the infringement, but in no event less than a reasonable royalty.

14. Upon information and belief, Palm's infringement of the '678 patent has been willful and deliberate.

15. Unless enjoined by the Court, Palm's infringement will continue to cause Intermec irreparable injury.

SECOND CLAIM FOR RELIEF
(INFRINGEMENT OF THE '645 PATENT)

16. Intermec incorporates paragraphs 1 through 10 by reference as though fully set forth herein.

17. By virtue of its manufacture, use, sale, offer for sale and/or encouragement of others to use the Accused Products, Palm has been and still is infringing, inducing the infringement of and/or contributing to the infringement of the '645 Patent.

18. Palm's infringement of the '645 Patent has caused Intermec substantial injury for which Intermec is entitled to receive adequate compensation. As a result of Palm's infringement of the '645 Patent, and Intermec's compliance with the requirements of 35 U.S.C. § 287(a), Intermec is entitled to damages adequate to compensate it for the infringement, but in no event less than a reasonable royalty.

19. Upon information and belief, Palm's infringement of the '645 patent has been willful and deliberate.

20. Unless enjoined by the Court, Palm's infringement will continue to cause Intermec irreparable injury.

THIRD CLAIM FOR RELIEF
(INFRINGEMENT OF THE '499 PATENT)

21. Intermec incorporates paragraphs 1 through 10 by reference as though fully set forth herein.

22. By virtue of its manufacture, use, sale, offer for sale and/or encouragement of others to use the Accused Products, Palm has been and still is infringing, inducing the infringement of and/or contributing to the infringement of the '499 Patent.

23. Palm's infringement of the '499 Patent has caused Intermec substantial injury for which Intermec is entitled to receive adequate compensation. As a result of the infringement of the '499 Patent, and Intermec's compliance with the requirements of 35 U.S.C. § 287(a), Intermec is entitled to damages adequate to compensate it for the infringement, but in no event less than a reasonable royalty.

24. Upon information and belief, Palm's induced infringement of the '499 patent has been willful and deliberate.

25. Unless enjoined by the Court, Palm's infringement will continue to cause Intermec irreparable injury.

FOURTH CLAIM FOR RELIEF
(INFRINGEMENT OF THE '947 PATENT)

26. Intermec incorporates paragraphs 1 through 10 by reference as though fully set forth herein.

27. By virtue of its manufacture, use, sale, offer for sale and/or encouragement of others to use the Accused Products, Palm has been and still is infringing, inducing the infringement of and/or contributing to the infringement of the '947 Patent.

28. Palm's infringement of the '947 Patent has caused Intermec substantial injury for which Intermec is entitled to receive adequate compensation. As a result of Palm's infringement of the '947 Patent, and Intermec's compliance with the requirements of 35 U.S.C. § 287(a), Intermec is entitled to damages adequate to compensate it for the infringement, but in no event less than a reasonable royalty.

29. Upon information and belief, Palm's infringement of the '947 patent has been willful and deliberate.

30. Unless enjoined by the Court, Palm's infringement will continue to cause Intermec irreparable injury.

FIFTH CLAIM FOR RELIEF
(INFRINGEMENT OF THE '971 PATENT)

31. Intermec incorporates paragraphs 1 through 10 by reference as though fully set forth herein.

32. By virtue of its manufacture, use, sale, offer for sale and/or encouragement of others to use the Accused Products, Palm has been and still is infringing, inducing the infringement of and/or contributing to the infringement of the '971 Patent.

33. Palm's infringement of the '971 Patent has caused Intermec substantial injury for which Intermec is entitled to receive adequate compensation. As a result of Palm's infringement of the '971 Patent, and Intermec's compliance with the requirements of 35 U.S.C. § 287(a), Intermec is entitled to damages adequate to compensate it for the infringement, but in no event less than a reasonable royalty.

34. Upon information and belief, Palm's infringement of the '971 patent has been willful and deliberate.

35. Unless enjoined by the Court, Palm's infringement will continue to cause Intermec irreparable injury.

DEMAND FOR RELIEF

WHEREFORE, Intermec prays that this Court:

A. Grant injunctive relief prohibiting Palm, its officers, agents, servants, employees and attorneys, and those persons in active concert or participation with it, from further infringement of the patents-in-suit;

B. Award Intermec damages adequate to compensate it for Palm's infringement, together with interest as fixed by the Court;

C. Award Intermec treble damages for Defendant's willful infringement.

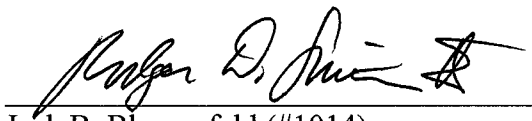
D. Declare this case exceptional pursuant to 35 U.S.C. § 285 and award Intermec its costs and reasonable attorneys' fees; and

E. Grant Intermec such other and further relief as the Court deems just and proper.

DEMAND FOR JURY TRIAL

Pursuant to Fed. R. Civ. P. 38, Intermec demands trial by jury of all issues triable of right by a jury.

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May 18, 2007

815740

EXHIBIT A

US005349678A

United States Patent [19]

Morris et al.

[11] Patent Number: 5,349,678

[45] Date of Patent: Sep. 20, 1994

[54] VERSATILE RF DATA CAPTURE SYSTEM

[75] Inventors: Michael D. Morris; Lyle L. Zumbach, both of Cedar Rapids, Iowa

[73] Assignee: Norand Corporation, Cedar Rapids, Iowa

[21] Appl. No.: 748,150

[22] Filed: Aug. 21, 1991

[51] Int. Cl.[5] G06F 15/21

[52] U.S. Cl. 395/800; 364/DIG. 2; 364/920; 364/927; 364/919.2

[58] Field of Search ..... 395/325, 600, 800; 364/DIG. 2 MS File

[56] References Cited

U.S. PATENT DOCUMENTS

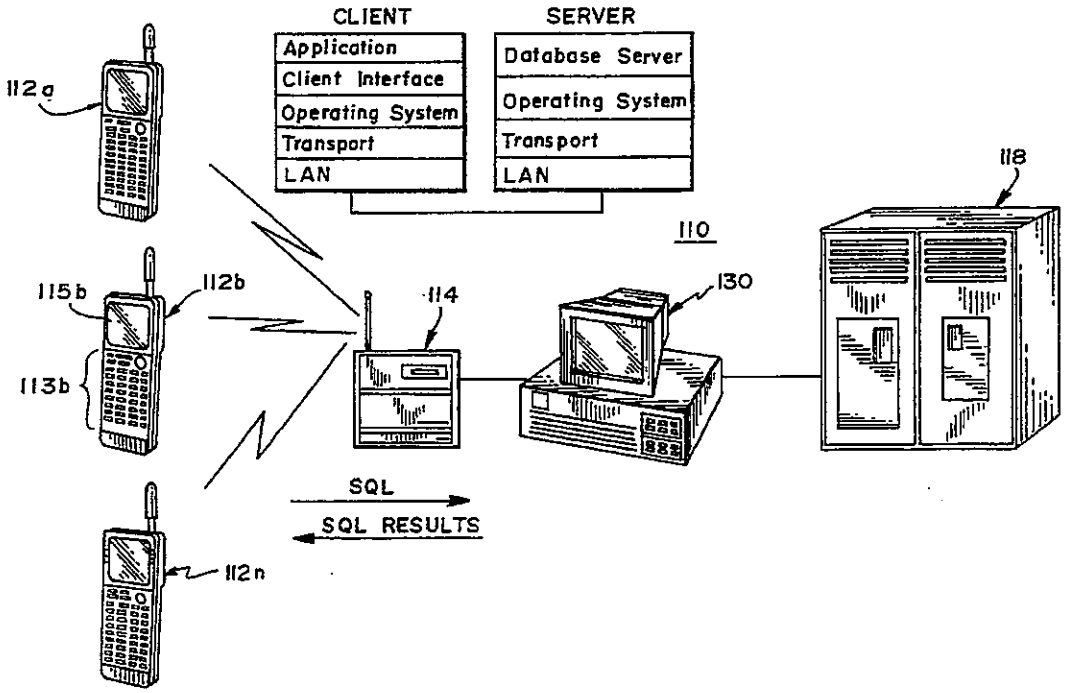
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4,839,854	6/1989	Sakami et al.	364/DIG. 2
4,905,186	2/1990	Fukui	364/DIG. 2
4,910,794	3/1990	Mahany .	
4,924,462	5/1990	Sojka .	
4,940,974	7/1990	Sojka .	

Primary Examiner—Thomas M. Heckler
Attorney, Agent, or Firm—McAndrews, Held & Malloy, Ltd.

[57] ABSTRACT

A data capture system is disclosed as comprising a plurality of client data collection terminals, and a server station. Each terminal including a mechanism for collecting data, a dynamic addressable memory and a first controller operating on data formatted in a first style. The server station comprises mass memory, which is larger than the dynamic addressable memory of a terminal for storing data to be used by the data collection terminals, an addresser responsive to a memory altering request for addressing the mass memory and a second controller operating on data formatted in a second style different from said first style. The data stored in the dynamic addressable memory is formatted in the second style. A communication system interconnects the server station and each of the plurality of client data collection terminals. The first controller of each client data collection terminal is responsive to a need for further data to generate a memory altering request and for actuating the communication system to transmit the generated request to the server station. The request is generated to identify its terminal and the particular needed data. The second controller of the server station is responsive to the transmitted request to address and retrieve the needed data from the mass memory before actuating the communication system to transmit the needed data back to the requesting terminal as identified by the request.

27 Claims, 9 Drawing Sheets



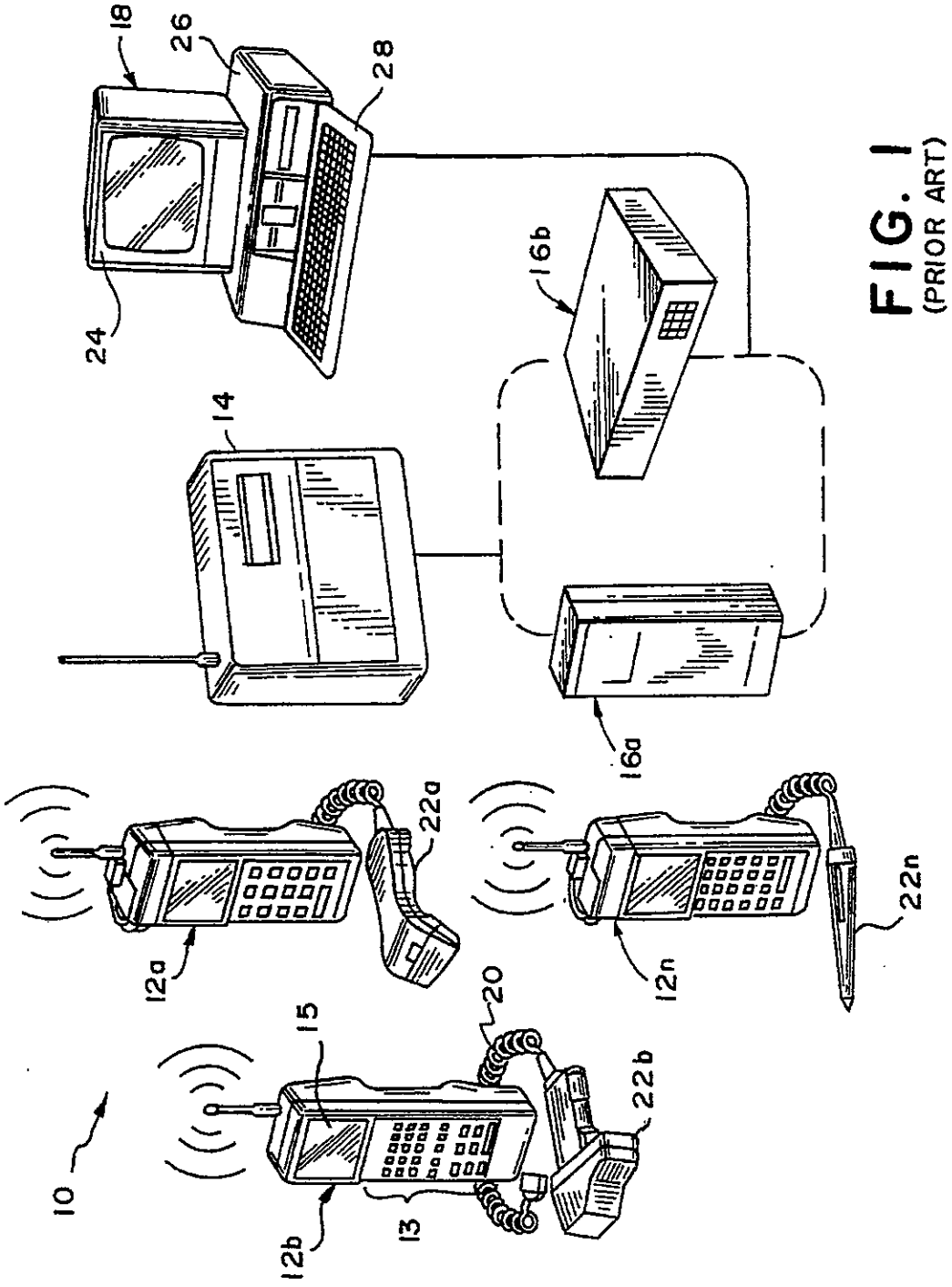


FIG. 1
(PRIOR ART)

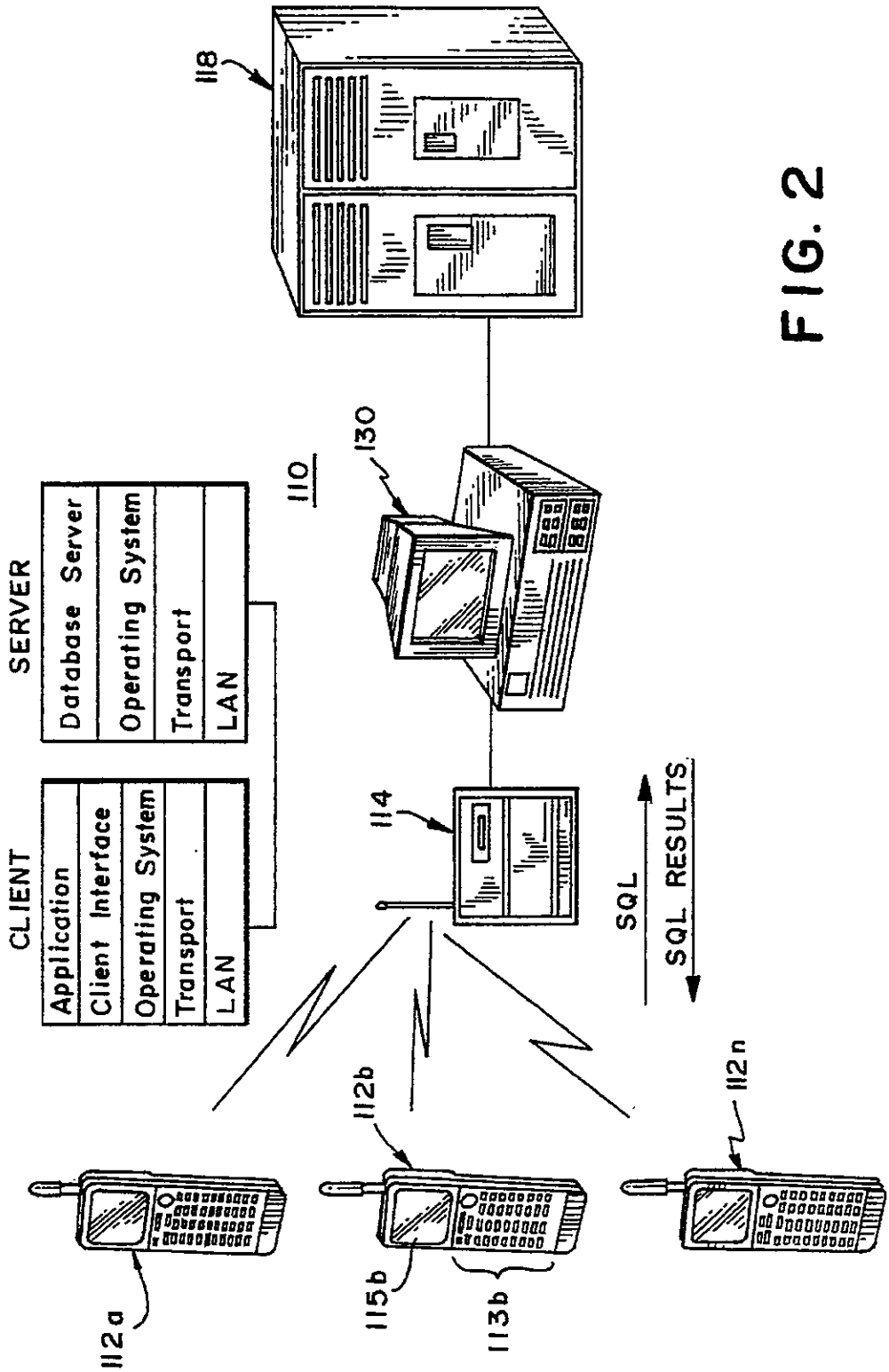

118
110
130
SERVER
Database Server
Operating System
Transport
LAN
CLIENT
Application
Client Interface
Operating System
Transport
LAN
114
SQL
SQL RESULTS
112b
112n
112a
115b
113b

FIG. 2

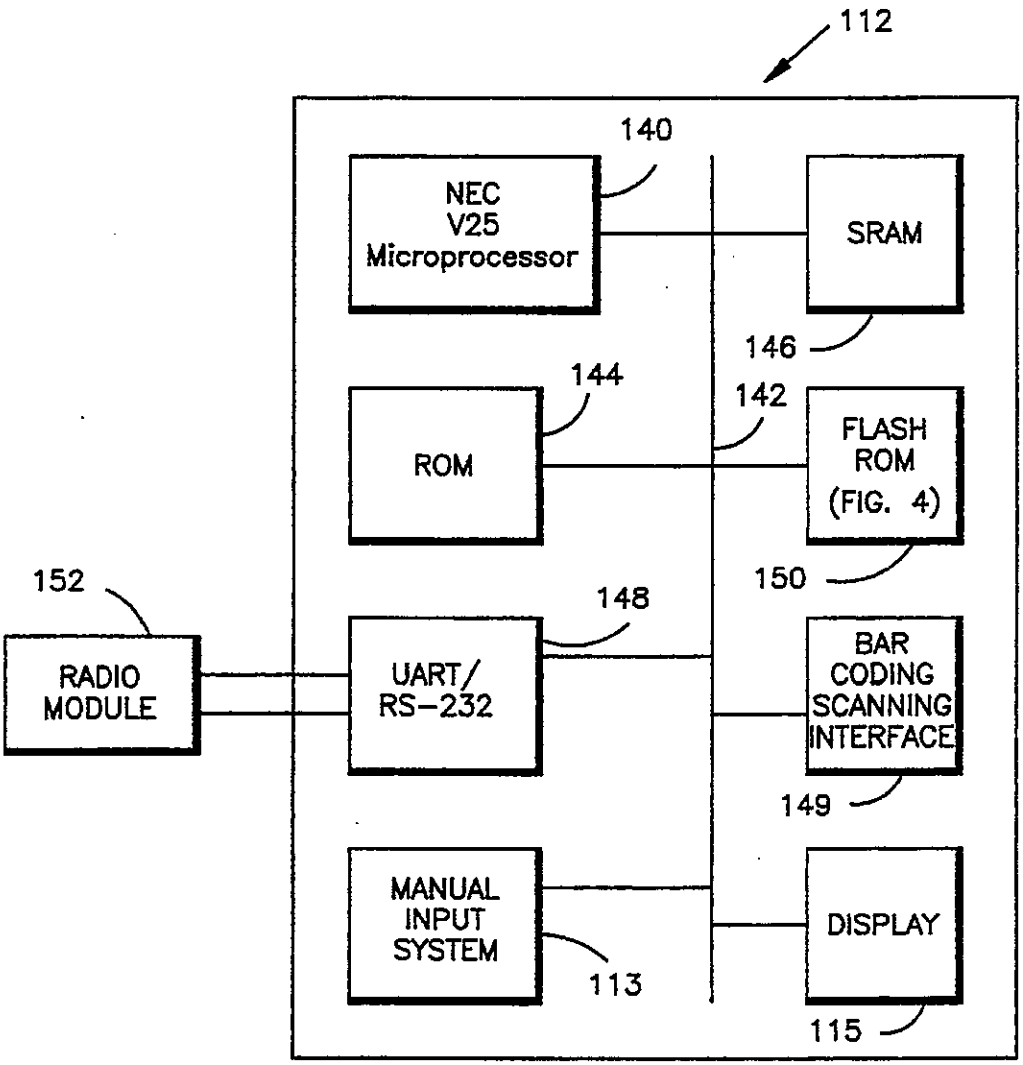

112
140
NEC V25 Microprocessor
SRAM
146
144
142
ROM
FLASH ROM (FIG. 4)
150
152
148
RADIO MODULE
UART/ RS-232
BAR CODING SCANNING INTERFACE
149
MANUAL INPUT SYSTEM
113
DISPLAY
115

FIG. 3

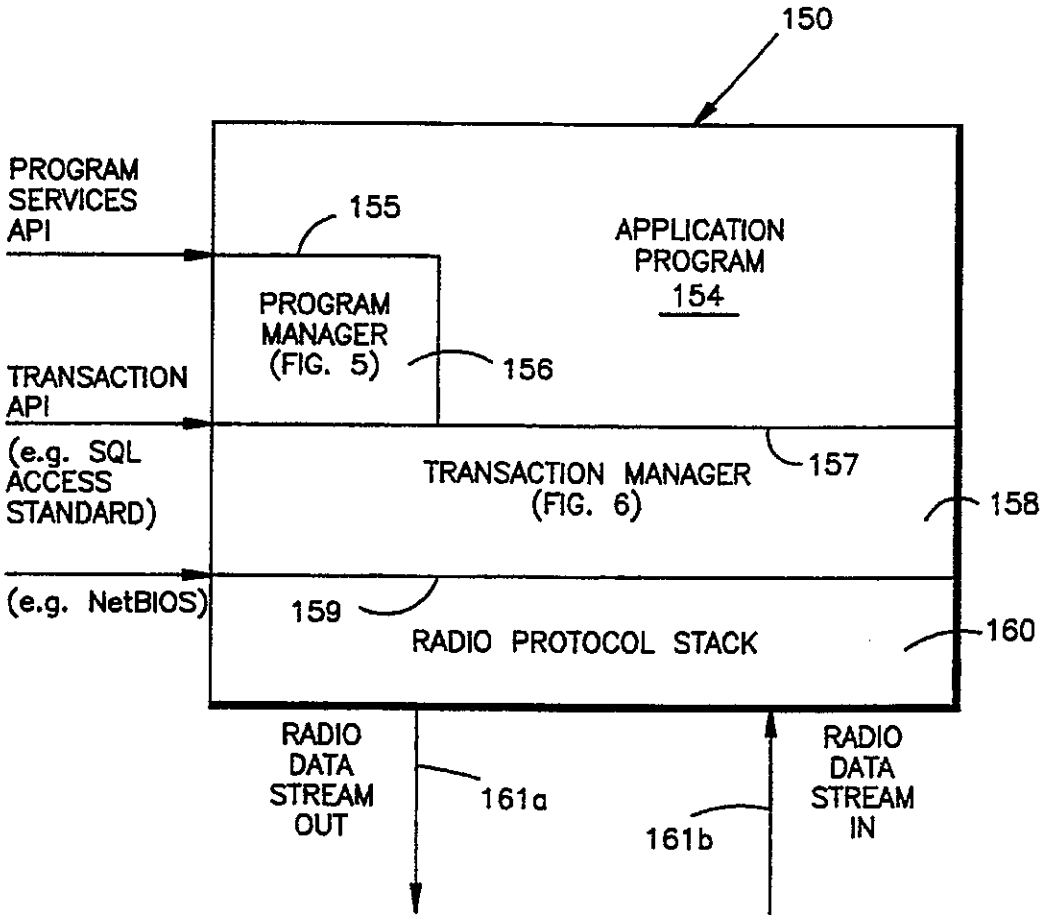
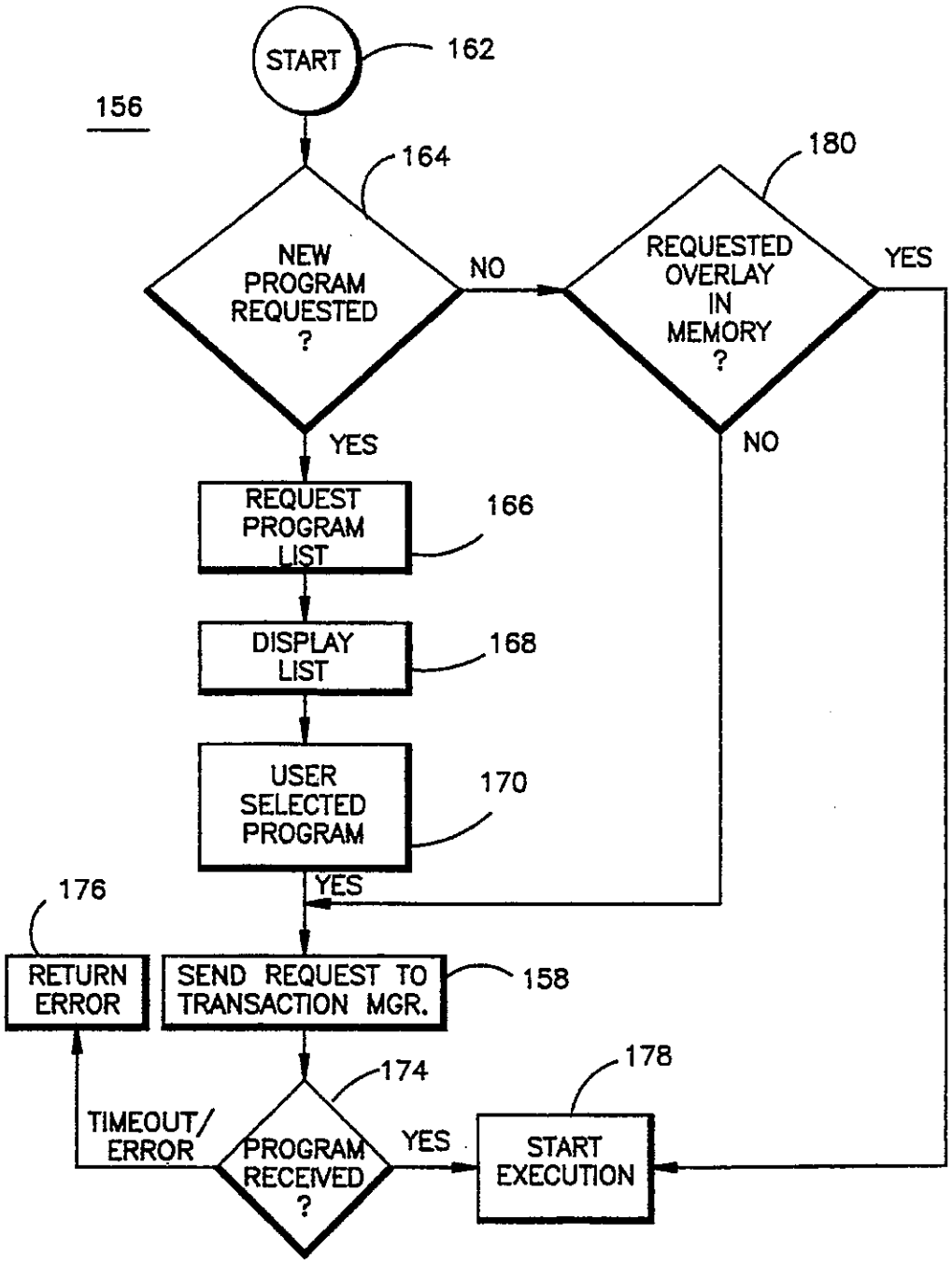

150
PROGRAM SERVICES API
155
APPLICATION PROGRAM 154
PROGRAM MANAGER (FIG. 5)
156
TRANSACTION API
(e.g. SQL ACCESS STANDARD)
TRANSACTION MANAGER (FIG. 6)
157
158
(e.g. NetBIOS)
159
RADIO PROTOCOL STACK
160
RADIO DATA STREAM OUT
161a
161b
RADIO DATA STREAM IN

FIG. 4

FIG. 5


START
162
156
164
NEW PROGRAM REQUESTED ?
NO
180
REQUESTED OVERLAY IN MEMORY ?
YES
YES
NO
REQUEST PROGRAM LIST
166
DISPLAY LIST
168
USER SELECTED PROGRAM
170
YES
176
RETURN ERROR
SEND REQUEST TO TRANSACTION MGR.
158
174
178
TIMEOUT/ ERROR
PROGRAM RECEIVED ?
YES
START EXECUTION

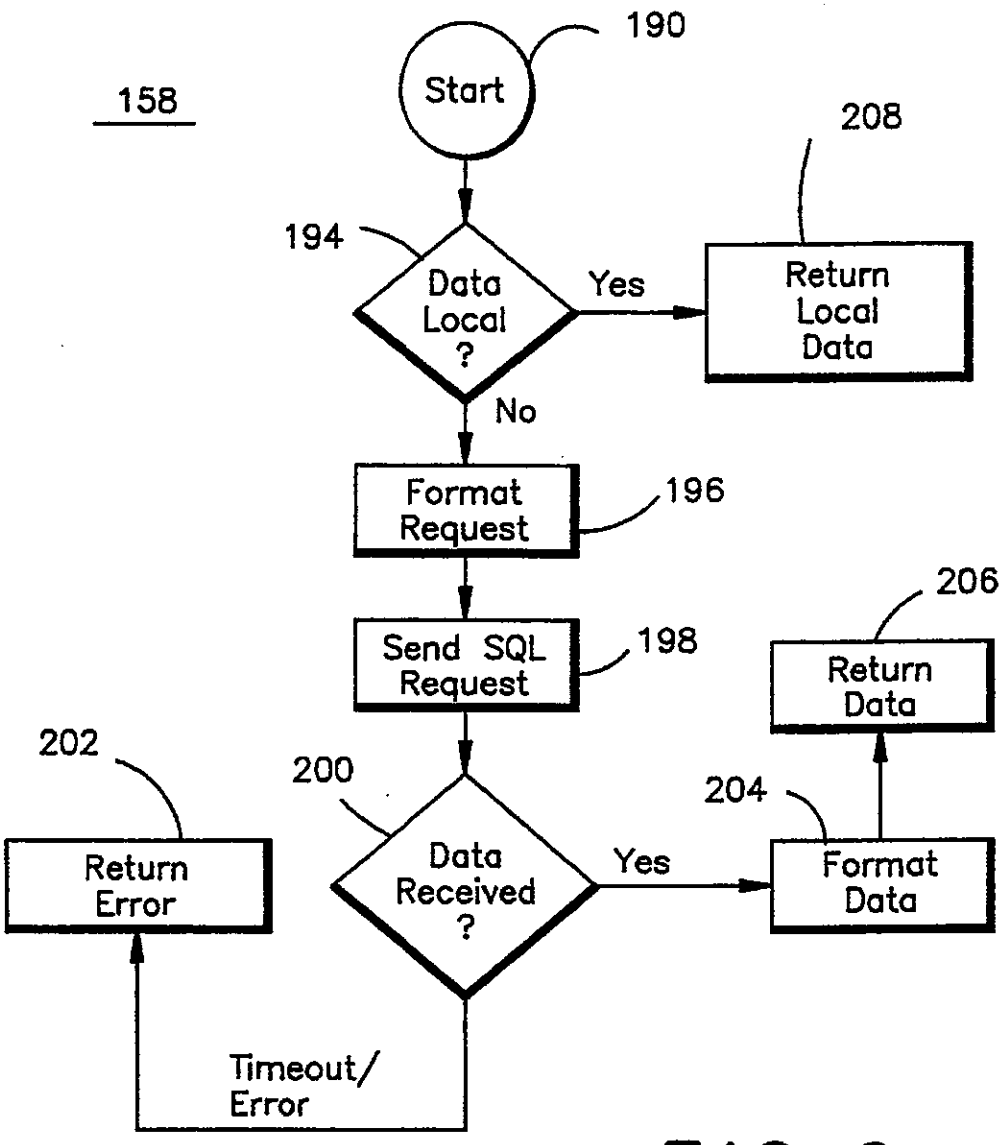

158
Start
190
208
194
Data Local ?
Yes
Return Local Data
No
Format Request
196
Send SQL Request
198
206
Return Data
202
200
204
Return Error
Data Received ?
Yes
Format Data
Timeout/ Error

FIG. 6

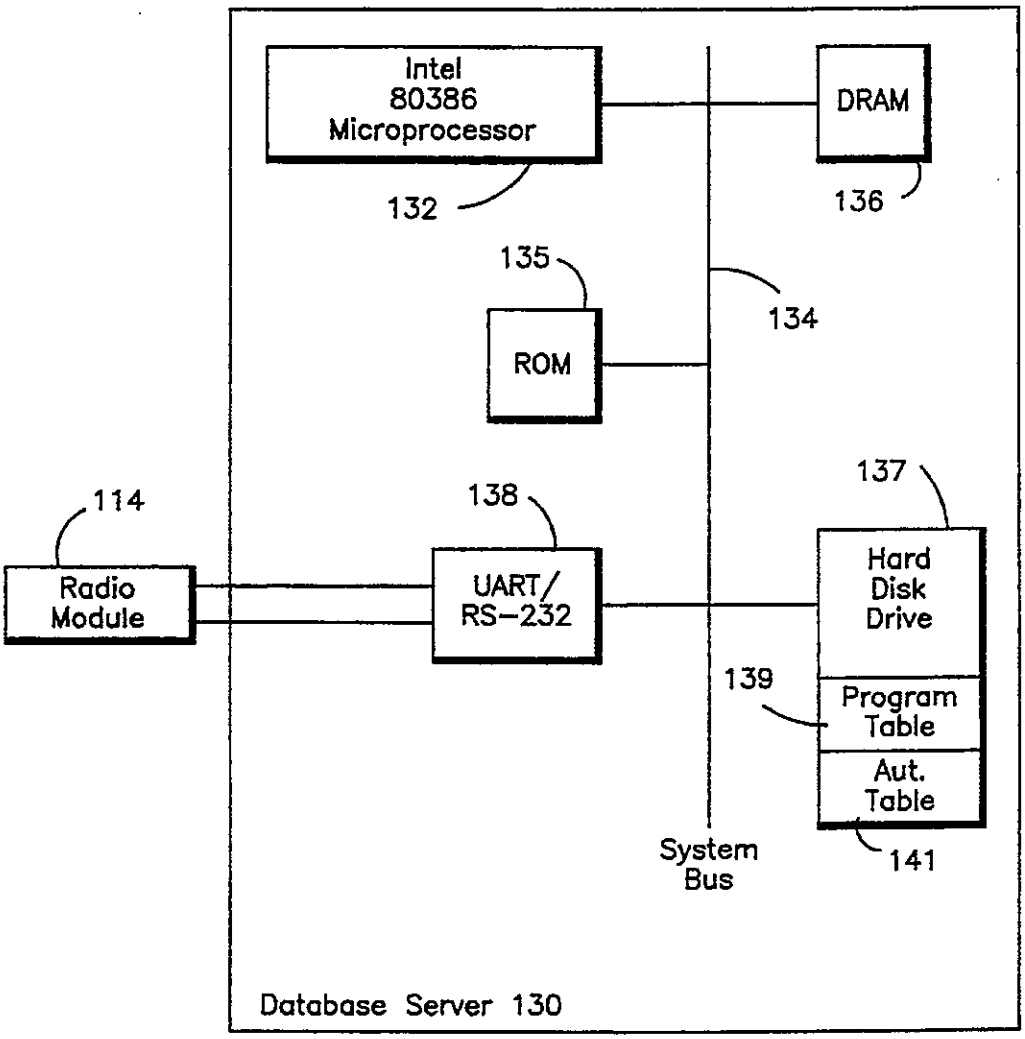

Intel
80386
Microprocessor
132
DRAM
136
135
ROM
134
114
Radio
Module
138
UART/
RS-232
137
Hard
Disk
Drive
139
Program
Table
Aut.
Table
141
System
Bus
Database Server 130

FIG. 7

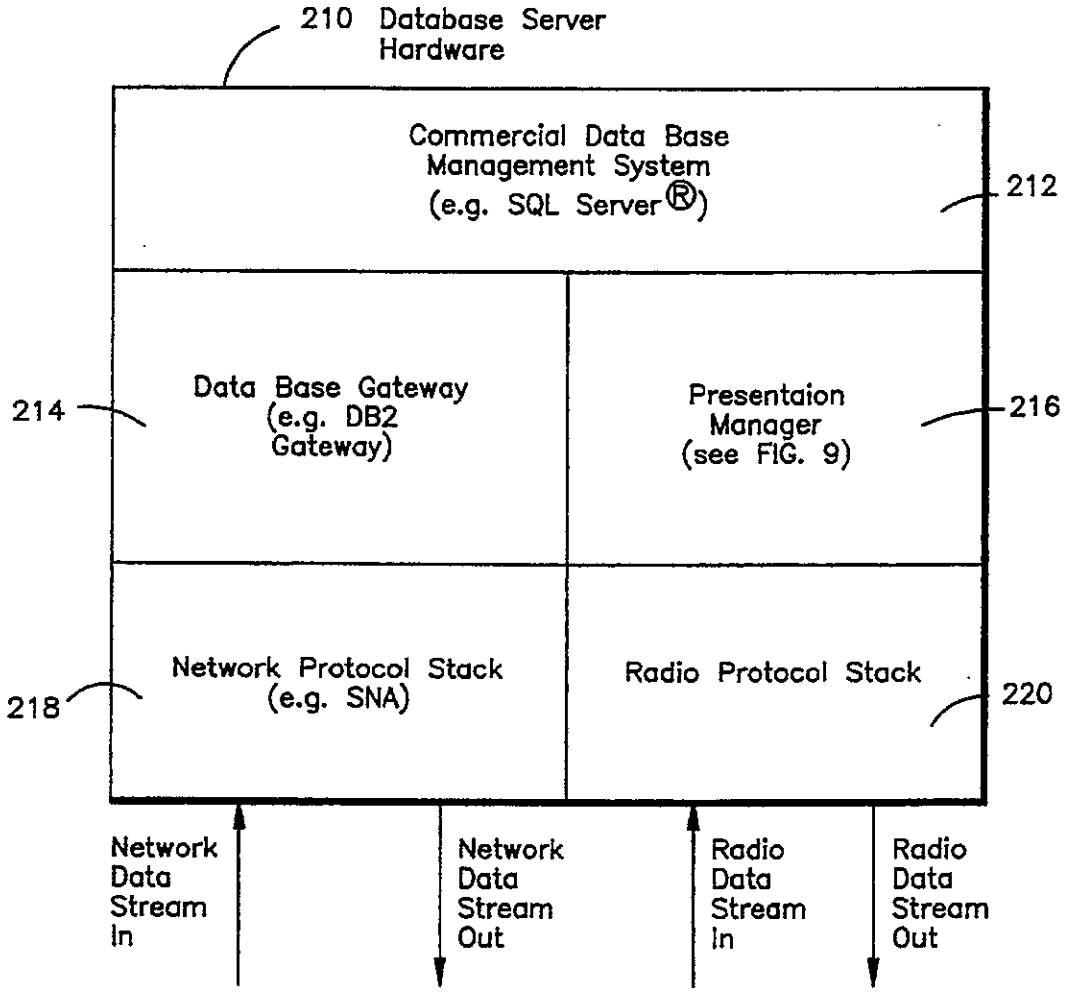

210 Database Server Hardware
Commercial Data Base Management System (e.g. SQL Server®)
212
214
Data Base Gateway (e.g. DB2 Gateway)
Presentaion Manager (see FIG. 9)
216
218
Network Protocol Stack (e.g. SNA)
Radio Protocol Stack
220
Network Data Stream In
Network Data Stream Out
Radio Data Stream In
Radio Data Stream Out

FIG. 8

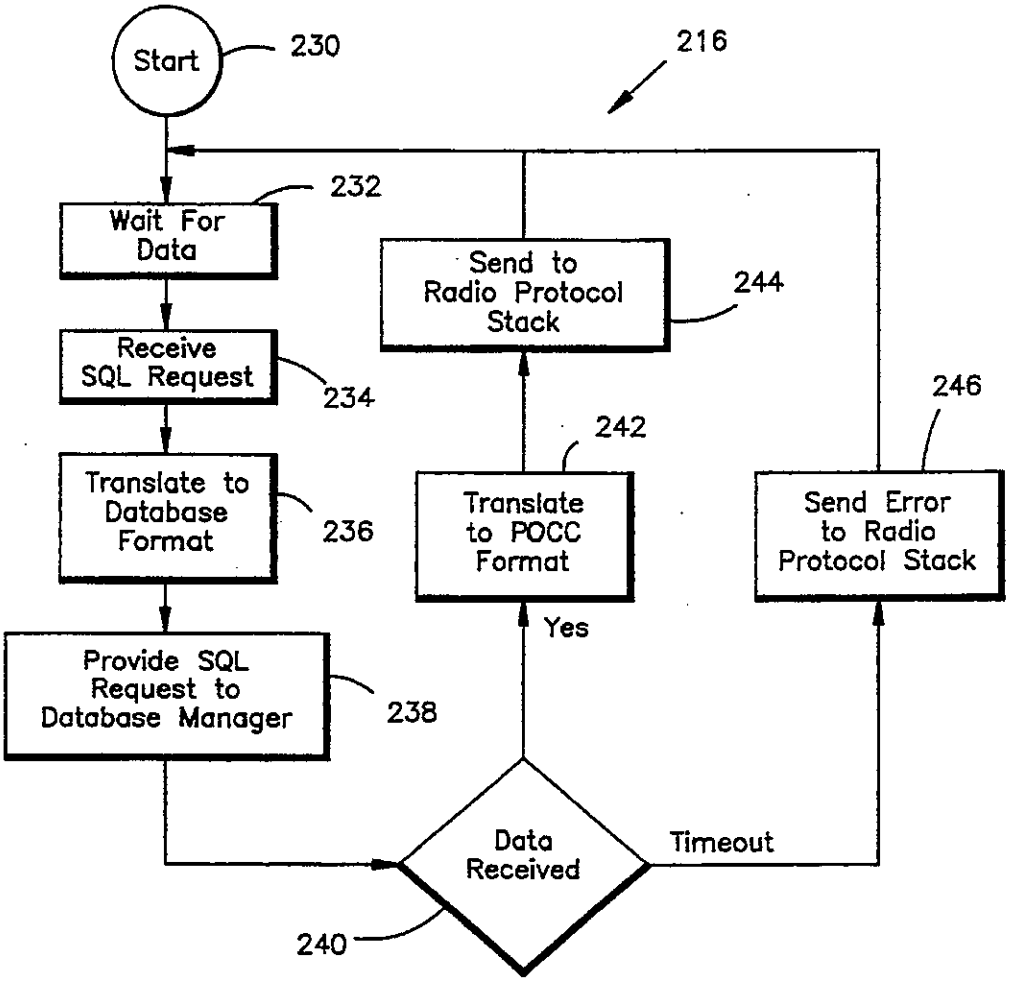

Start
230
216
232
Wait For Data
Receive SQL Request
234
Translate to Database Format
236
Provide SQL Request to Database Manager
238
Data Received
240
Yes
Timeout
Translate to POCC Format
242
Send to Radio Protocol Stack
244
Send Error to Radio Protocol Stack
246

FIG. 9

VERSATILE RF DATA CAPTURE SYSTEM

AUTHORIZATION PURSUANT TO 37 CFR 1.71(d) AND (e)

A portion of the disclosure of this patent document contains material which is subject to copyright protection. The copyright owner has no objection to the facsimile reproduction by anyone of the patent document or the patent disclosure, as it appears in the Patent and Trademark Office patent file or records, but otherwise reserves all copyright rights whatsoever.

REFERENCE TO RELATED, CO-PENDING PATENT APPLICATIONS

The following, co-pending applications are all assigned to assignee of this invention and are incorporated herein by reference:

1. U.S. Ser. No. **700704** (Express Mail Label No.: FB 537 394 682US), entitled "SYSTEM FOR COUPLING A MULTIPLICITY OF RF DATA COLLECTION TERMINALS WITH HOST COMPUTER MEANS" filed on May 14, 1991 in the names of Gollnick et al. now abandoned in favor of U.S. Ser. No. 07/857,603, filed Mar. 30, 1992, now abandoned in favor of U.S. Ser. No. 07/947,102, filed Sep. 14, 1992 and
2. U.S. Ser. No. 660618 (Express Mail mailing Label No.: FB 537 394 671US), entitled "SYSTEM FOR PROCESSING COMMUNICATIONS WITH MULTIPLE PORTABLE RF DATA COLLECTION TERMINALS", filed Feb. 25, 1991 in the name of P. Miller, now abandoned in favor of U.S. Ser. No. 07/830,561, filed Jan. 30, 1992.

BACKGROUND OF THE INVENTION

The present invention relates to a data capture system **10** illustrated in FIG. **1** for entering data at a plurality of remote locations using means such as a plurality of portable data collection terminals **12***a, b-n*. The data capture system **10** is applicable to receive and collect a wide variety of data and has found particular application in warehouses or retail store where a data capture system **10** would be used to keep an up-to-date record of the products to be marketed. Typically, the system **10** would be capable of updating on a real time basis the inventory count of products, and to use stock locator data to identify where each product of the remaining inventory is stored, when a product is moved from one place to another, and which employee has current charge of that product. In addition, when a product is sold, the price and sales person who sold the product are recorded.

Such data may be inputted into a terminal **12** by means of its keyboard **13**. For example, a terminal user could count the number of one type of product and enter that number via the terminal's keyboard **13**. Alternatively, data could be entered to the terminal **10** via a CCD bar code scanner **22**, which is electrically coupled by a cable **20** to its terminal **12**. In an illustrative embodiment of this invention, the scanner as illustratively identified in FIG. **1** by the numeral **22***a* and its terminal **12***a* could take the form of that modular scanner/terminal described in PCT international application W090/16033 published Dec. 27, 1990. Differing types of scanners **22***b* and **22***n* could also be used with the terminals **12** and may illustratively take the form of those scanners described in U.S. Pat. Nos. 4,970,379 of Danstrom, 4,882,476 of White, 4,894,523 of Chadima, 4,877,949 of Danielson et al., 5,019,669 of Adams et al. and 4,924,462 of Sojka; International Application No. PCT/US90/03282 of Koenck et al.; and European Patent Publication No. 0 353 759 of Mahany et al.

The data capture system **10** utilizes illustratively RF transmission to bilaterally transmit data between each of the plurality of terminals **12***a, b-n* and a base radio transceiver **14**. By way of example, the base radio transceiver may illustratively take the form of that model RB3000 base radio transceiver manufactured by Norand Corporation, Cedar Rapids of Iowa. In turn, the base radio transceiver **14** is connected via a communications multiplexer **16***a* or a communications controller **16***b* to a host computer **18**. Illustratively, the multiplexer **16***a* could take the form of that model RM3200 as manufactured by Norand Corporation and the controller **16***b* could take the form of that controller identified as model RC2250 of Norand Corporation. The host computer **18** may illustratively be an International Business Machines Corporation of AT class or higher. As illustrated in FIG. **1**, the host computer **18** includes a keyboard **28**, a display **24** and a system unit **26**.

Each of the portable data collection terminals **12***a, b-n* includes a transceiver (not shown in FIG. **1**) for transmitting RF messages to and from the base radio transceiver **14**. A transmitted message comprises an initialization sequence, an address indicative of the particular terminal **12***a, b*-or *n* from or to which the message is directed, a message identifier and system information, the message data and/or control commands, error control, and an end of message indication. U.S. Pat. Nos. 4,910,794; 4,924,462; and 4,940,974, each assigned to the assignee of this invention and incorporated herein by reference, provide further information on RF data collection terminals and systems.

In a RF data capture system similar to that shown in FIG. **1** known as the RT1200 system of Norand Corporation, controlled RF transmission between a plurality of terminals and a radio base is established using a communications multiplexer similar to that of the multiplexer **16***a* shown in FIG. **1** to provide access to a particular one of the terminals **12***a,b-n*. The RT1200 system utilizes time division multiplexing on a single frequency channel. The RT1200 communications protocol is based on a sequential polling method that transmits a query addressed to each portable terminal in succession, and allows a specified amount of time for the addressed terminal to respond when the addressed terminal has a data message ready for transmission. U.S. Pat. No. 4,940,974 describes an improved, adaptive data communications system wherein the base radio transceiver **14** transmits a multi-terminal polling signal to each of its terminals **12***a, b-n*. That multi-terminal polling signal defines a series of successive response time slots in which the terminals **12** may randomly select to respond. A terminal **12** having a message to be transmitted to the host computer **18** via the base radio transceiver **14** transmits a brief response burst in the selected time slot giving its own unique identification address. After receiving the responses from the ready terminals **12**, the base radio transceiver **14** polls each of the responding terminals **12**, ignoring those terminals without messages to be transmitted. This system is adaptive in that the number of time slots may be changed depending upon the number of active terminals ready to transmit data messages.

The present invention is particularly related to adapting such data capture system **10** as shown in FIG. **1** to employ distributed processing concepts. Each of the portable data collection terminals **12** has a computer processing capability in the illustrative form of a microprocessor, whereby the entire system's processing capability may be distributed between the host computer **18** and the portable terminals **12**. The system **10** is structured in accordance with a client/server architecture whereby the host computer **18** acts as a server to each of the plurality of client terminals **12**, whereby programs may be dynamically loaded across that RF (or any serial) data link established between the host computer **18** and its terminals **12**.

The use of distributed processing is enhanced by relational database technology and the use of Structured Query Language (SQL) developed by the International Business Machines Company to provide access to relational databases. The use of relational database technology depends on organizing data in tables (or relations); each row of the table represents a record and each column represents an attribute. Various operations may be performed on these relations and, since the mathematics of these operations is very well understood, the results are predictable. An example of these operations is the "join" where two or more relations may be put together based on some common attribute. The advantage of this organization is that data may be easily retrieved in a form not envisioned by the designers; that is, ad hoc retrievals are quite easy to perform.

A further concept of distributed processing is to partition the system so that data is available to all network users but the data physically resides where it is most likely to be processed. This provides universal access without incurring severe communication overhead penalties. In the context of the data capture system **10** illustrated in FIG. **1**, data is made available to each of the terminals **12** and to the host computer **18** by the use of the RF transmission between each of terminals **12** and the base radio transceiver **14**. However, employing the concept of distributed processing would direct that more data and application programs be stored within each of the terminals **12**, where such data is used or such programs executed. As a result, overhead penalties, primarily in terms of delays as would occur by the transmission of data between the terminals **12** and its host computer **18** are avoided.

In a client/server model, the server provides a general function to several client processes. Some of the more useful implementations of this concept are distributed databases, remote procedure calls and networked pipes. The distributed databases currently rely on some form of communication through Structured Query Language (SQL). These databases are comprised of front-end applications and a database server. The application interacts with the user. When database access is required, the application sends an SQL request to the database server which services the request across a network. This allows most of the processing to be done locally, but provides for a central data store that may be shared by many distributed users.

The remote procedure call concept allows systems to become specialized servers so that many applications may use their specialized hardware. To access these remote services, the application program makes a procedure call that is like any procedure call to the program's code. The difference is that the call results in a request to a remote system to provide the computation designated by the call.

The concept of "pipes" relates to supplying the output of one process to the input of another process. If the two processes are on different computers then this becomes a method of distributed processing. A variant of this method is the named pipe which allows select output to be input to another process over a named connection. This is the primary method of distributed interprocess communications with an OS/2 LAN Manager.

The efficient transmission of data to a remote terminal of a system is key to distributed processing. IBM's solution is their Distributed Data Management (DDM) protocols. These are a set of published IBM protocols that describe how to access files and databases on a remote system. IBM also developed a System Application Architecture (SAA) with common programming interfaces for program access to remote data on IBM SAA compliant systems. The importance of these protocols (which use LU 6.2 protocols for inter-system communication) is that a remote system such as a PC may access IBM host databases and files without having to program the host computer.

Remote data access in the non-IBM world is also becoming standard. The Network File System (NFS TM) protocols (developed by Sun Microsystems but placed in the public domain) may be used to access or create files on any system running an NFS server. Novell Corporation is also providing similar services to a wide range of systems with its portable Netware TM.

In current data capture systems employing a plurality of remote terminals **12**, the application program is run in the centrally disposed host computer **18** for real time control of the remote terminals **12**. Placing control in the host computer **18** increases significantly the hardware and software complexity forcing the host computer **18** to run multiple processes. Such application programs residing in the host computer **18** are complicated by the need to assure the concurrent control over shared data. Further, the host computer **18** must be fast enough to service all remote terminals **12** in real time. In such current data capture systems, the host computer **18** must normally validate data entry by the user and must respond to all user input, thus requiring significant amounts of data to be sent back and forth over an RF link between each of the terminals **10** and its host computer **18** as well as increasing the number of data transition session between the host computer **18** and its terminals **12**.

The present invention is related to the use of distributed processing concepts in a RF data capture system **10** as generally shown in FIG. **1** and, in particular, to improve the efficiency of such overall systems by improving the speed and efficiency of data transmission over the RF link between each of the terminals **12***a,b-n* and the base radio transceiver **14**.

SUMMARY OF THE INVENTION

It is therefore an object of this invention to decrease the response time required for a portable data collection terminal to respond to its user.

It is a further object of this invention to minimize the data transmitted typically by RF transmission between each of a plurality of terminals and its centrally disposed host computer.

It is a still further object of this invention to eliminate programming the host computer for real time control of its plurality of data collection terminals.

It is another object of this invention to provide an environment for the ready development of application programs for each of a plurality of data collection terminals.

It is a still further object of this invention to provide a new and improved scheme of distributive processing between a central or host computer and a plurality of remote terminals.

It still a further object of this invention to provide a new and improved battery operated terminal for use in a data capture system comprised of a plurality of such terminals, wherein the drain imposed by large memory and frequent use of radio modules is minimized.

In accordance with these and other objects of the invention, a data capture system comprises a plurality of client data collection terminals, and a server station. Each terminal includes a mechanism for collecting data, a dynamic addressable memory and a first controller operating on data formatted in a first style. The server station comprises a mass memory, which is larger than the dynamic addressable memory of a terminal for storing data to be used by the data collection terminals, an addresser responsive to a memory altering request for addressing the mass memory and a second controller operating on data formatted in a second style different from the first style. The data stored in the dynamic addressable memory is formatted in the second style. A communication system interconnects the server station and each of the plurality of client data collection terminals. The first controller of each client data collection terminal is responsive to a need for further data to generate a memory altering request and for actuating the communication system to transmit the generated request to the server station. The request is generated to identify its terminal and the particular needed data. The second controller of the server station is responsive to the transmitted request to address and retrieve the needed data from the mass memory before actuating the communication system to transmit the needed data back to the requesting terminal as identified by the request.

In a further aspect of this invention, each of the plurality application programs is partitioned into a root module and at least one overlay module. The first controller of each terminal includes a processor for executing a selected application of the plurality and is responsive to the execution of an application program to generate the memory altering request and for actuating the communication system to transmit the generated request to the server station. The request identifies its terminal and the particular overlay module needed to continue the execution of its application program. The second controller of the server station is responsive to transmitted request for addressing and retrieving from its mass memory the particular overlay module, before actuating the communication system to transmit the particular overlay module back to the requesting terminal.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is diagrammatic illustration of an existing prior art data capture system which may be upgraded to incorporate features of the present invention;

FIG. **2** is diagrammatic illustration of a data capture system configured in a client/server architecture to effect distributed processing in accordance with the teachings of this invention;

FIG. **3** is a functional block diagram illustrating the architecture of a portable data collection terminal as shown in FIG. **2**;

FIG. **4** is diagram of the application program architecture as stored within the ROM of the portable data collection terminal shown in FIG. **3**;

FIG. **5** is a flow diagram of the Program Manager program shown in the architecture diagram of FIG. **4**;

FIG. **6** is a flow diagram of the Transaction Manager program shown in the architecture diagram of FIG. **4**;

FIG. **7** is a functional block diagram of the database server shown in FIG. **2**;

FIG. **8** is a diagrammatic showing of the architecture of the database server memory; and

FIG. **9** is a flow diagram of the Presentation Manager program shown in the architecture diagram of FIG. **8**.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings and, in particular to FIG. **2**, there is shown a data capture system **110** in accordance with the teachings of this invention, where elements similar to those of FIG. **1** are identified by like numerals but in the **100**'s series. The data capture system **110** includes a plurality of portable data collection terminals **112***a,b-n*, which in an illustrative embodiment of this invention may take the form of that terminal RT1100 as manufactured by Norand Corporation. Each terminal **112** includes, as shown in FIG. **3**, a radio module **152** which is capable of receiving and transmitting RF signals to a base radio transceiver **114**, which may illustratively take the form of that model RB3000 base radio transceiver as manufactured by Norand Corporation. The RB3000 base radio transceiver **114** is capable of operating at multiple baud rates as described in U.S. Pat. No. 4,910,794. In turn, the received signals are transmitted to a database server **130**, which in response to the received signals applies signals to the base radio transceiver **114** to be transmitted to a selected one of the plurality of the terminals **112**. Each message transmitted between one of the terminals **112** and the transceiver **114** includes an identification number or ID indicating the originating terminal **112** or its user. In turn, the database server **130** is coupled to a host computer **118**. In an illustrative embodiment of this invention, the host computer **118** may take the form of an IBM 3090 main frame with a DB2 database engine. As will be explained in detail below, each terminal **112** is programmed to compose an SQL request that will cause the database server **130** to return an application program, a memory overlay or application specific data to the requesting terminal **112**. The host computer **118** may also access the database server **130** by generating and transmitting SQL request messages thereto.

The host computer **118** has a database, which is accessible through the database server **130** to respond to the SQL request from one of the terminals **112**, supplying to the requesting terminal **112** a computer program, memory overlays or application specific data. The host computer **118** may illustratively take the form of an IBM 3090 main frame with a DB2 database engine and would have a memory of a capacity many orders greater than that of the terminals **112**. Much of the data and software to be used by the terminals **112** need not be stored with in the terminal's memory, but rather may reside in the database of the server **130** or in the memory of the host computer **118**. Thus, when that data and/or program stored in the database server **130** is needed, the

needing terminal **112** formulates its SQL request message, transmits that message via the base radio transceiver **14** to be processed by the database server **130**, which accesses its database (or the memory of the host computer **118**) and retransmits the requested data or programs back to the requesting terminal **112**. At least two tables are defined as shown in FIG. **7** in a memory of the database server **130** including a first program table **139** and a second authorization table **141**. The program table **139** keeps track of all of the programs, the overlays and the locations where they are stored in the database of the server **130**. The programs are typically stored as a "bulk" or "binary" data type. The program table requires at a minimum the following fields or attributes:

attribute	type	description
program name	char	Name of the program
overlay	char	root or other named overlay
date	char or date	Date program was created (revision control)
program	varbinary or varchar	The actual program or overlay
size	integer	The size of the binary to be loaded

As will be explained later with respect to FIG. **7**, the first, program table **139** and the second authorization table **141** may be established within a hard disk drive **137** of the database server **130**. The SQL request includes an attribute to identify whether a new program or an overlay is to be accessed and sent by the requesting terminal **112** and the address or name of the first, program table **139**. The SQL request does not need to have the address of the requested program or overlay, but accesses the program table **139**, which provides an address within the hard disk drive **137** in accordance with the attribute. As will be explained, the database server **130** in response to the SQL request accesses a particular program or overlay and transmits it back to the requesting terminal **112**. The second authorization table **141** identifies the relationship between a particular user and each of the programs which that user is authorized to access. For example, each user has an ID and the authorization table **141** would list the program names which may be accessed by that particular user ID. Similarly, the SQL includes the ID and an address for the authorization table **141**. Thus, the SQL request accesses the authorization table **141** to see if the requesting terminal **112** or its user as identified by the ID is permitted to use a particular program or overlay. If there is a match between the ID and one of the listed programs stored in the authorization table **141**, then as will be explained, the database server **130** will access that program or overlay and transmit it back to the requesting terminal **112**. On the other hand, if the ID is not found within the authorization table **141**, the requested program or overlay is not transmitted back to the requesting terminal **112**.

FIG. **3** shows an illustrative embodiment of the hardware architecture of the elements of the portable data collection terminals **112**. Each terminal **112** includes a data bus **142** for interconnecting the elements of the terminal **112**, which may include a ROM **144** for the bootstrap loader, a flash ROM **150** for storing system and application programs, a static RAM (SRAM) **146** for storing data, programs and dynamically loadable program overlays, a microprocessor **140** which may take the form of that processor made by NEC as a model V25, the radio module **152**, a serial communication interface (UART) **148** for the radio module **152**, a bar coding scanning interface **149**, a manual input system such as a keyboard **113** and a display **115**. The serial communication interface **148** permit messages to be transmitted and received via the radio module **152**. The keyboard **113** and the bar code scanning interface **149** permit data entry respectively by the terminal user and a CCD bar code scanner similar to those identified in FIG. **1** by the numeral **22**. As is well known in the art, a scanner **22** would be moved across coded data to provide data descriptive of the item to which the bar code was attached, typically including a description of the item, its price and/or other inventory data.

Appreciating that each terminal **112** is battery operated, a plurality of memories **144**, **146** and **150** are provided therein to store various types and sizes of data and programs dependent upon their use and to the end, that battery drain be minimized. The ROM **144** stores the operating system and basic input/output system (BIOS) for the microprocessor **140**. The SRAM **146** stores the dynamically loadable program overlays and data. The flash ROM **150** stores the system operating program and the application programs to be executed by the microprocessor **140**, typically carrying out the various inventory functions for which a terminal **112** may be programmed. A portion of the SRAM **146** is partitioned into tables for application specific data, i.e., data to be used by the stored application programs. It is a significant aspect of this invention, that not all of the application programs or application specific data which may be used by a terminal **112**, should be stored in the SRAM **146**, but rather that significant portions of the application programs and specific data may be stored in the database server **130** (or even in the host computer **118**) to be accessed when needed by a particular terminal **112**.

The architecture of the software stored in the flash ROM **150** is shown in FIG. **4**. The flash ROM **150** stores a plurality of application programs **154**, e.g., inventory tracking, a program manager **156** program explained below with respect to FIG. **5** for transmitting the SQL request to the database server **130** to obtain an overlay module or a new program, a transaction manager **158** as explained below in detail with respect to FIG. **6** for opening a new session to receive or to transmit streams of data thereto, and a radio protocol stack **160** for effecting the RF transmission of a data stream out **161***a* to the database server **130** and for receiving an RF transmission via a data stream input **161***b* from the database server **130**. An application interface **155** is established between the application programs **154** and the program manager **156**, whereby any of the application programs can request the services of the program manager **156**, which may be illustratively thought of as a collection of sub-routine calls for new overlay modules or a new program as will be explained below with respect to FIG. **5**. Further, the application programs **154** have a transaction application programming interface (API) **157** with the transaction manager **158** as will be explained below with respect to FIG. **6**. The transaction API **157** permits an application to transmit a SQL request to the database server **130**. In turn, the transaction manager **158** has an interface **159** as exemplified by a NetBIOS with the radio protocol stack **160**, which effects by RF transmission the sending and receiving of data to and from the database server **130**. As indicated by the architecture of the data stored within the flash

ROM **150** shown in FIG. **4**, the radio protocol stack **160** is transparent with respect to an application program, i.e., the application program need not be programmed to effect radio transmission but only to place a call to transmit or to receive data. Either the program manager **156** or the transaction manager **158** carries out that step without any special program of the application programs **154**.

The database server **130**, as shown generally in FIG. **2**, may illustratively take the form of an IBM PS/2 model 80 computer running IBM's OS/2 Extended Edition operating system. Generally, the database server **130** responds to a SQL request transmitted by a radio module **152** of a data collection terminal **112** (see FIG. **3**), or from the host computer **118**. The response of the database server **130** to the SQL request is determined by the semantics of that SQL request, which is formatted in the ANSI standard SQL. The database server **130** need not store state information about each of the terminals **112***a,b-n*. Data relating to a particular or specific terminal **112** is assigned to its own memory table, which may be illustratively formed at its unique address within a DRAM **136** of the database server **130** as shown in FIG. **7**. That table for terminal specific data may be used at a buffer, where the addressed location within the DRAM **136** acts as a buffer memory to be addressed by a SQL request and in response thereto, to transmit the data stored in that buffer to the requesting terminal **112**. Alternatively, the terminal specific data could be stored in the hard disk drive **137** of the database server **130** and could be accessed by assigning an identifier attribute for that data to each terminal **112**, whereby the appropriate relation in the hard disk drive **137** of the database server **130** could be defined. As will be explained, each SQL request identifies a new program, an overlay or application specific data which is required by the requesting terminal **112**; the database server **130** responds to that request and transmits in turn the requested program, memory overlay or application specific data to the particular requesting terminal **112**.

FIG. **7** shows the hardware architecture of the database server **130**, including a data bus **134** for connecting the various elements thereof, a microprocessor **132** illustratively taking the form of that processor manufactured by Intel under its model No. 80386, a ROM **135** for the computer powerup program, the diagnostic programs and the BIOS program, the dynamic RAM (DRAM) **136** serving as a memory for a database server program, server data, and a "cache" memory for the database, and a mass storage in the illustrative form of the hard disk drive **137** for storing all of the partitioned application programs and application specific data to be called by the plurality of terminals **112***a,b-n*. The database server **130** may provide gateway functions to other databases, e.g., DB2. In an operational sense, a gateway function permits access to a remote database by passing and/or reformatting the request. In other words, the SQL request could be translated into a format that would correspond and be recognized by that format of the remote database.

Referring now to FIG. **3**, the SRAM **146** of a portable data collection terminal **112** is significantly smaller than the disk drive **137** of a database server **130** and may have a capacity insufficient to store all of an application program and data to be executed by its microprocessor **140**. Distributed processing is accomplished in the context of this data capture system **110** employing a plurality of terminals **112** and a database server **130**, by partitioning each application program into a plurality of parts or modules. The first program part is known as a root module and will be loaded first when a request for a new program is issued by the microprocessor **140** at power up or entered by a user through the terminal's key board **113**. There will be at least one and typically many further parts known as memory overlays or overlay modules. The root module and the overlay modules will be given unique identifiers so that they may be loaded when requested. When the microprocessor **140** is executing the last instruction of a root module or an overlay module, then it is necessary to request and retrieve the next overlay module to permit the application program to continue to be executed without interruption. As will be explained below, this data capture system **110** is capable of formatting a SQL request for that original program or root module and for the subsequent overlay modules. In the simplest embodiment of this invention, the programmer builds into the application program a request to the program manager program **156** (see FIG. **4**) to request and load an overlay module and jump to it. In a more sophisticated version, a program in the development environment determines the external function calls in program and substitutes a call to the program manager program **156**. The development in partitioning of an application program is accomplished on the database server **130** using a data collection terminal emulator system that emulates the keyboard **113**, the display **115** and other possible peripherals of the terminal **112**. The only programming to be done specific to the database server **130** is to create the database tables and load them with any application specific data.

The software architecture of the DRAM**136** is further described in FIG. **8**, as being partitioned to store a commercial database management system **212** such as the SQL Server (Microsoft), a database gateway **214**, e.g., a DB2 Gateway by IBM, a presentation manager **216** to be more fully disclosed in the flow diagram of FIG. **9**, a network protocol stack **218**, and a radio protocol stack **220**.

The program manager program **156** generally shown in the software architecture diagram of FIG. **4** is more fully shown in the flow diagram of FIG. **5**. Basically, the program manager program **156** is disposed in the next lower layer below an application program, e.g., an inventory program, and responds to its request for either a new program or a memory overlay, to configure and transmit an SQL request to the database server **130**. Upon receipt of the requested program or memory overlay, the program manager program **156** stores it in SRAM **146** before initiating its execution by the microprocessor **140**. A start **162** is initiated in a number of ways by the associated application program. At power up when typically there is no application being executed, the operating system program, which is stored in the ROM **144**, places a call to the program manager **156**. Alternatively, a new application program may be called by the operator by actuating a selected key(s) of the keyboard **113**. Appreciating that all of a particular application program need not be stored in the SRAM **146**, overlay modules of the application program presently being executed may be stored in the database of the server **130** and may be called by the program manager program **156**. The application program continues to be executed until it recognizes that the next step is not available, at which time it places a call through the start step **162** for the next section or overlay module of the

application program to be retrieved and placed in the SRAM **146** of the requesting terminal **112**.

After a start has been provided in any of these ways, step **164** determines whether a new program or memory overlay is being requested. If a new program is requested, step **166** accesses the database in the server **130** for the requested program. In particular, step **166** initiates the radio protocol stack program **160**, whereby the radio module **152** (see FIG. **3**) is activated to transmit the SQL request to the database server **130** via the transceiver **114** (see FIG. **2**). The SQL request initiated by step **166** seeks as will be described below a list of programs which are stored in the database server **130** and is available to this originating terminal **112**. Initially, step **166** calls the radio protocol stack program **160** (see FIG. **4**), whereby access is made through the UART **148** (see FIG. **3**) to the module **152**, turning module **152** "on" to transmit the SQL request to the transceiver **114**. In addition to actuating the radio module **152**, the radio protocol stack **160** provides the protocols and media access to allow the SQL request to be sent via the transceiver **114** to the database server **130**. Illustratively, the radio protocol stack **160** would include the RTC system as described in U.S. Pat. No. 4,940,974. When the radio protocol stack **160** is called to initiate transmission, a session is said to be held between the requesting terminal **112** and the database server **130**. For example, when a SQL request is generated by the transaction manager **158** (see FIG. **4**), a session is opened. Each session enjoys a logical relationship between the requesting terminal **112** and the database, e.g., the hard disk drive **137**, within the database server **130**. Each session includes one or more data packets, the data packet being the maximum byte size of the data stream appearing on the output **161***a* that may be transmitted by the radio module **152**. The radio protocol stack **160** functions to segregate a data stream out **161***a* to be transmitted to the database server **130**, into a number of data packets and, in similar fashion, to reassemble the data packets of an incoming data stream appearing at the input **161***b* into a continuous data stream. Each SQL request includes an address or ID of its originating terminal **112**. As will be explained later, the database server **130** uses a presentation manager program **216** to store the relationship (mapping) between the terminal ID and the operating system session identificer, which is stored in a known location within the DRAM **136** of the database server **130**. In this way, the database server **130** remembers to which of the plurality of terminals **112***a, b-n* that the requested data or memory overlay, should be transmitted.

The database server **130** operating as will be explained, will respond to the SQL request for a program overlay by accessing a list of programs authorized for the particular requesting terminal **112** or user and transmitting that list back via the transceiver **114** to the requesting terminal **112**. Illustratively, step **166** may format an SQL request in the following manner:

```
select distinct program_name from
authorization where user_id = "morrismd"
```

Here the SQL request is seeking a list of distinct programs, not duplicates, which have been authorized for transmission to a particular user, i.e., a particular terminal **112**. In the illustrative request, the user ID is "morrismd"; in other words, all program names having an ID attribute "morrismd" are distributed to the requesting terminal **112**. Next, step **168** displays the received list of authorized programs on the terminal's display **115**.

In step **170** of FIG. **5**, the terminal user selects from that list of available programs as displayed in step **168** and enters via the terminal keyboard **113** the selected program to be requested from the database of the server **130**. When a program is selected from the menu displayed upon the display **115** (see FIG. **2**) by user actuation of the keyboard **113**, the transaction manager **158** (see FIG. **6**) is called to format the SQL request to retrieve from the remote database the particular program selected in step **170**. An illustratively example of such a SQL request may take the form of:

```
select program from program_table where
program_name = "inventory.exe" and overlay =
"root"
```

Illustratively, the SQL request accesses the first, program table **139** (see FIG. **7**) to obtain the address in the hard disk drive **137** of the requested program, e.g. the "inventory.exe" program, which is an original program or its root overlay.

After transmission of the SQL request for a new program, step **174** waits for a returned message to the terminal **112** and will time out after a set period, e.g., 30 seconds. If no response is received by the requesting terminal **112** within this period, step **176** generates a return error message and returns it to the calling application program. On the other hand if the requested original program is received within the period, step **178** updates a mapping memory or table, which may be illustratively included within the SRAM **146** (see FIG. **3**) of the terminal **112**. A record of the application program or module thereof presently being executed by the microprocessor **140** is recorded in the mapping memory in terms of its starting address and length. When a new program is received and loaded into SRAM **146**, step **178** records its starting address and length in the mapping memory, before loading the root module of the new program into a designated location of the SRAM **146** and, thereafter, initiates execution of the received and loaded program instead of returning control to the application program. The SRAM **146** is used as a "cache" memory to receive the **140** programs and memory overlays to be executed by the microprocessor **140**. Thus, the SRAM **146** provides a local memory from which the application program may be executed, whereas the remaining sections or memory overlays of the application program and other original programs may be stored distantly in the database of the server **130**.

It is appreciated that application programs are sometimes larger than its sections or memory overlays. Therefore to efficiently use the local memory, e.g., the SRAM**146** , new programs are illustratively stored in the database of the server **130**, whereas program overlays may be stored in both the database of the server **130** and in the local memory, i.e., the SRAM **146**. Therefore, if step **164** determines that the application is not requesting a new program, but rather an overlay module, step **180** examines the SRAM **146** and if the requested overlay module is in SRAM **146**, the program moves to step **178** to initiate execution of the overlay module and control is passed to the overlay module. However, if the requested overlay module is not in the SRAM **146**, step **180** moves control moves to the transaction manager **158**, which formulates and transmits a

SQL request via the transceiver **114** to retrieve the needed overlay module from the database of the server **130**. The requested memory overlay is transmitted back via the transceiver **114** and is loaded into SRAM **146** and, thereafter, the local mapping memory in SRAM **146** is updated in terms of its starting address and length. After step **174** determines that the requested program has been timely received as explained above, step **178** initiates execution of the overlay module before returning control to the application program.

Referring now to FIG. **6**, there is shown the transaction manager program **158** which responds to a call from the application program **154** (see FIG. **4**) for data to be processed thereby and provides an application programming interface (API) **157** to the application program which allows it to access the database in the server **130**. The transaction manager program **158** also supports the program manager program **156** to access programs stored in the database of the server **130**. Thus, it is seen that the program manager program **156** of FIG. **5** accesses remote programs and overlay modules whereas the transaction manager **158** of FIG. **6** accesses any kind of data. Initially, step **194** determines whether the requested data is in the local memory, i.e., SRAM **146**, and, if so stored, step **208** returns the local data to be processed by the application program. If not, step **196** formats an SQL request for the requested data and step **198** calls the radio protocol stack program **160** (see FIG. **4**) thus actuating the radio module **152** and transmitting the SQL request via the transceiver **114** to access the requested data in the database of the server **130**. Step **200** waits while the server **130** accesses the requested data and transmits it via the transceiver **114** to the requesting terminal **112**. Step **200** times a response period, e.g., **1** minute, and if that period is exceeded indicating an error condition, step **202** returns an error message to the calling application program. If the data is received within the response period, step **204** formats the requested data in a formusable by the calling application program, before step **206** returns that data to the application program. Step **206** returns the data to the SRAM **146**, whereby control is passed to the application program which uses the returned data.

The presentation manager program **216**, shown in FIG. **9**, processes the SQL request transmitted from one of the terminals **112** (see FIG. **2**) via the transceiver **114** and a standard interface, e.g. Unix sockets or IBM NetBIOS, to the database manager program **212** (see FIG. **8**). The database manager program **212** interprets the SQL request and accesses the hard disk drive **137** accordingly (see FIG. **7**). This allows an application program being executed by the microprocessor **140** (see FIG. **3**) to establish sessions with any SQL accessible database as maybe formed within the hard disk drive **137** of the database server **130**. The principle function of the presentation manager program **216** is to translate between that format used by the transaction manager program **158** of a terminal **112** and the SQL format of the database of the hard disk drive **137**, if these formats are different. The SQL request to be applied to the database management program **212** is semantically configured in accordance with the function to be achieved. The SQL request may direct that data be inserted into the disk drive **137**, that data be accessed and retrieved, that a new program or overlay module be retrieved from the disk drive **137**, that data be added to one or more fields in a set of records stored in the disk drive **137** or that data be deleted from one or more records of the disk drive **137**. Updating involves the transmitting of new variable values from the originating terminal **112**.

Referring now to the flow diagram of FIG. **9**, the presentation manager program **216** enters through start step **230** to step **232**, which waits for a SQL request to be forwarded from the radio protocol stack **220** (see FIG. **8**). As will be described below, the SQL request is directed toward the database manager program **212**. Step **234** receives the SQL request as a sequence of bytes. Step **236** comes into play only if some reformulation of the SQL request is necessary. In a first instance, if the database manager program **212** was not adapted to support the ANSI standard SQL format or if the SQL request was compressed, then step **236** would be necessary to decompress the data or to translate the format of the SQL request into that of the particular database manager program **212** employed in the system. Next, step **236** provides the data to the database manager program **212** through an interface in the illustrative form of the IBM NetBIOS interface. The translation step **236** is identical to the formatting request **196** of the transaction manager program **158** of FIG. **6** and, ordinarily, it would be only necessary to perform the formatting or translation step once upon a particular SQL request, preferably in the presentation manager program **216**. Step **240** waits for the database manager program **212** to access the disk drive **137** for a predetermined time period. If the requested material, i.e., the application specific data, root overlay or memory overlay, is received within the time period, it is translated in step **242** to the format of the requesting terminal **112**, before calling the radio protocol stack program **220** to transmit the accessed material back to the requesting terminal **112**. On the other hand, if the SQL request is one to add or delete data from the hard disk drive **137**, step **240** generates a status message indicating that the change of the hard disk drive **137** has been completed, before step **242** translates that status message into the terminal format and the radio protocol stack **220** is called in step **244** to send that message back to the requesting terminal **112**. If the time period set in step **240** times out, without receiving the requested material, step **246** transmits an error pachet to the radio protocol stack program **220**, whereby an error message is returned to the requesting terminal **112**.

Thus, there has been described a data capture system **110** that distributes the application program between the memory of a terminal **112** and a database server **130** serving a plurality of such terminals **112**. In this fashion, the complexity of the program to be executed upon a terminal **112** is minimized by permitting the data base server **130** and its hard disk **137** to store a large variety of application programs to be served to its client terminals **112**. The above data capture system **110** permits dynamic loading of the original programs or root modules and subsequent memory overlays from the hard disk **137**, whereby the size of the SRAM **146** of a terminal **112** and the power required by a terminal **112** is minimized. Further, the amount of data transmitted via the RF link between each of the plurality of terminals **112** and the database server **130** is minimized. Further, the database server **130** provides a "user friendly" environment for the development of application programs for the terminals **112**. In particular, the database server **130** is capable of readily developing both the client and server portions of the application programs to be executed by the terminal's microprocessor **140**.

It will be apparent that many modifications and variations may be effected without departing from the scope of the teachings and concepts of the present disclosure.

We claim:

1. A data capture system comprising:

a) a plurality of portable client data collection terminals, each terminal comprising means for collecting data, dynamic addressable storage means and first control means operating on data formatted in a first style;

b) a server station comprising mass memory means which is larger than said dynamic addressable storage means of a terminal for storing data to be used by said data collection terminals, means responsive to a memory altering request for addressing said mass memory means and second control means operating on data formatted in a second style different from said first style, said data stored in said mass memory means being formatted in said second style; and

c) communication means for interconnecting said server station and each of said plurality of client data collection terminals;

d) said first control means of each client data collection terminal comprising means responsive to a need for further data for generating said memory altering request and for actuating said communication means to transmit said generated request to said server station, said generated request identifying its terminal and the particular needed data;

e) said responsive means of said server station responsive to said generated and transmitted request for addressing and retrieving said needed data from said mass memory means before actuating said communication means to transmit said needed data back to said requesting terminal as identified by said request;

f) said communication means comprises RF radio means for transmitting said memory altering request from each of said plurality of client data collection terminals to said server station and for transmitting said needed data from said server station back to said requesting terminal.

2. The data capture system as claimed in claim 1, wherein said RF radio means comprises a first radio module disposed in each of said plurality of client data collection terminals and a second radio module disposed in said server station.

3. The data capture system as claimed in claim 2, wherein said generating means of each terminal initially responds to a need for further data by accessing its dynamic addressable storage means for the needed data and, if not available therein, for then actuating its radio module to transmit said generated request to said server station.

4. The data capture system as claimed in claim 2, wherein each of said plurality of client data collection terminals comprises battery means for energizing its terminal, whereby said terminals are rendered portable.

5. The data capture system as claimed in claim 1, wherein said generating means initially responds to a need for further data by accessing its dynamic addressable storage means for the needed data and, if the needed data is not available therein, for then actuating said communication means to transmit said generated request to said server station.

6. The data capture system as claimed in claim 1, wherein said generating means generates said memory altering request in said first style, said second control means of said server station comprising means for translating said memory altering request from its first style to said second style.

7. The data capture system as claimed in claim 6, wherein there is included means coupled to said mass memory means of said server station for receiving and translating said needed data from its second style to its first style before actuating said communication means to transmit said translated, needed data back to said requesting terminal.

8. A data capture system comprising:

a) a plurality of client data collection terminals, each terminal comprising means for collecting data, first control means including processor means for executing a selected one of a plurality application programs, and dynamic addressable storage means;

b) a server station comprising mass memory means which is larger than said dynamic storage means of a terminal for storing application programs to be executed by said processor means of each of said data collection terminals, each application program being partitioned into a root module and at least one overlay module, and second control means responsive to a memory altering request for addressing said mass memory means; and

c) communication means for transmitting data between said server station and each of said plurality of client data collection terminals;

d) said first control means of each client data collection terminal further comprises means responsive to the execution of an application program by said terminal's processor means for generating a memory altering request and for actuating said communication means to transmit said generated request to said server station, said generated request identifying its terminal and a particular overlay module needed to continue the execution of its application program;

e) said second control means of said server station responsive to said generated and transmitted request for addressing and retrieving from said mass memory means said particular overlay module, before actuating said communication means to transmit said particular overlay module back to said requesting terminal as identified by said request, whereby said processor means of said requesting terminal is able to continue executing said presently executed application program.

9. The data capture system as claimed in claim 8, wherein each of said plurality of application programs is formatted in a first style.

10. The data capture system as claimed in claim 9, wherein said second control means of said database server comprises a second processor for executing its control program, said control program of said database server formatted in a second style differing from said first style, said plurality of application programs stored in said mass memory means also being formatted in said second style.

11. The data capture system as claimed in claim 10, wherein said generating means of each terminal generates its memory altering request in said first style, and said second control means of said server station further comprises first means for translating said memory altering request from its first style to said second style.

12. The data capture system as claimed in claim 11, wherein said second control means of said server station

further comprises second means for translating said addressed overlay module from its second style to said first style and, thereafter, actuating said communication means to transmit said translated overlay module to said requesting terminal.

13. The data capture system as claimed in claim 8, wherein each root module and said one overlay module of an application program is programmed with a call for the next overlay module needed to continue the execution of its application program, said processor means of a terminal executing a root module or said one overlay module to generate said call, said generating means of a terminal responsive to said generated call for generating said memory altering request identifying the next overlay module to be executed by said processor means of a terminal.

14. The data capture system as claimed in claim 13, wherein said generating means is responsive to said call for said next overlay module for addressing said dynamic addressable storage means, if said addressed next overlay module is present therein, said processor means executing said next overlay module, and if not present therein, actuating said communication means to transmit said memory altering request to said server station.

15. The data capture system as claimed in claim 14, wherein said root module and said one overlay module of each application program is programmed with calls for data needed in the execution of its application program, said generating means comprises means responsive to each of said data calls for initially addressing said dynamic addressable storage means, if said needed data is present therein, retrieving the needed data from said dynamic addressable storage means to be then processed by said executed application program, and if the needed data is not present in said dynamic addressable storage means, actuating said communication means to transmit said memory altering request from that terminal to said server station.

16. The data capture system as claimed in claim 13, wherein each of said plurality of client data collection terminal comprises battery means for energizing and rendering its terminal portable, said generating means responsive to said overlay call for the next overlay module for addressing said dynamic addressable storage means, if said next overlay module is present therein, said processor means executing said next overlay module, and if said next overlay module is not present in said dynamic addressable storage means, actuating said communication means to transmit said memory altering request to said server station, whereby the time that said communication means is energized and the drain on said battery means are minimized.

17. The data capture system as claimed in claim 16, wherein said root module and said one overlay module are programmed with calls for data needed to be executed by their application program, said generating means comprising means responsive to said data calls for addressing said dynamic addressable storage means, if said needed data is present within said dynamic addressable storage means, retrieving and immediately processing said requested data by said application program, and if said requested data is not present, actuating said communication means for transmitting said memory altering request to said server station, whereby the time that said communication means is actuated and the drain on said battery means are minimized.

18. The data capture system as claimed in claim 8, wherein said communication means comprises RF radio means for transmitting said memory altering request from each of said plurality of client data collecting terminals to said server station and for transmitting said retrieved, particular overlay module from said server station to said requesting terminal.

19. The data capture system as claimed in claim 18, wherein said RF radio means comprises a first radio module disposed in each of said plurality of client data collection terminals, and a second radio module in said server station.

20. The data capture system as claimed in claim 8, wherein each of said plurality of client data collection terminal comprises battery means for energizing its terminal, whereby said terminal is portable.

21. A data capture system comprising:

a) a plurality of battery operated data collection terminals, each terminal comprising means for collecting data including a keyboard, processor means for executing a selected one of a plurality of application programs, dynamic addressable storage means, and first radio means for transmitting and receiving radio signals; and

b) a server station comprising mass memory means which is larger than said dynamic addressable storage means of a terminal for storing said plurality of application programs to be executed by said processor means of each of said data collection terminals, each application program being partitioned into a root module and at least one overlay module, means responsive to a memory altering request for addressing said mass memory means, and second radio means for transmitting and receiving radio signals to and from said first radio means of a terminal;

c) each data collection terminal further comprising means responsive to calls originating during the execution of an application program by said processor means for data specific to said executed application program or for the next overlay module or to a call entered by a user on said keyboard for a root module of a new application program, for generating a corresponding memory altering request and for actuating said first radio means to transmit said generated request to said server station, said generated request identifying its terminal and the particular application specific data, root module or overlay module needed to continue the execution of its application program;

d) said responsive means of said server station responsive to said generated and transmitted request for addressing and retrieving from said mass memory means said particular root module, overlay module or application specific data, before actuating said second radio means to transmit same back to said requesting terminal as identified by said request.

22. The data capture system as claimed in claim 21, wherein each of said plurality of application programs is formatted in a first style.

23. The data capture system as claimed in claim 22, wherein said plurality of application programs stored in said mass memory means are formatted in a second style differing from said first style.

24. The data capture system as claimed in claim 23, wherein said generating means of each terminal generates its memory altering request in said first style, and said server station further comprises first means for translating said memory altering request from said first style to said second style.

25. A data capture system as claimed in claim 24, wherein said server station comprises second means for translating said addressed overlay module from said second style to said first style and means for actuating said second radio means to transmit said translated overlay module to said requesting terminal.

26. The data capture system as claimed in claim 21, wherein said server station comprises a first memory program table for storing unique addresses for each of said plurality of application programs, said generating means of a data collection terminal generating said memory altering request transmitted to said first memory program table, said request including said address of said first memory program table.

27. The data capture system as claimed in claim 26, wherein each of said plurality of data collection terminals has a unique ID, said server station further comprises a second memory table for storing for each application program a list of terminal ID's to be given access to a particular application program, said server station comprising means responsive to each memory altering request for comparing said ID of said request with said list of ID's for said requested application program and, only if there is a match, retrieving said requested application program from said mass memory means to be transmitted back to said authorized requesting terminal.

* * * * *

EXHIBIT B

US005568645A

United States Patent [19]

Morris et al.

[11] Patent Number: 5,568,645

[45] Date of Patent: Oct. 22, 1996

[54] **VERSATILE RF DATA CAPTURE SYSTEM**

[75] Inventors: **Michael D. Morris; Lyle L. Zumbach**, both of Cedar Rapids, Iowa

[73] Assignee: **Norand Corporation**, Cedar Rapids, Iowa

[21] Appl. No.: **267,758**

[22] Filed: **Jul. 5, 1994**

Related U.S. Application Data

[63] Continuation of Ser. No. 748,150, Aug. 21, 1991, Pat. No. 5,349,678.

[51] **Int. Cl.**[6] **G06F 17/60**

[52] **U.S. Cl.** **395/800**; 364/DIG. 2; 364/920; 364/927; 364/919.2

[58] **Field of Search** 364/403, 406; 395/800

[56] **References Cited**

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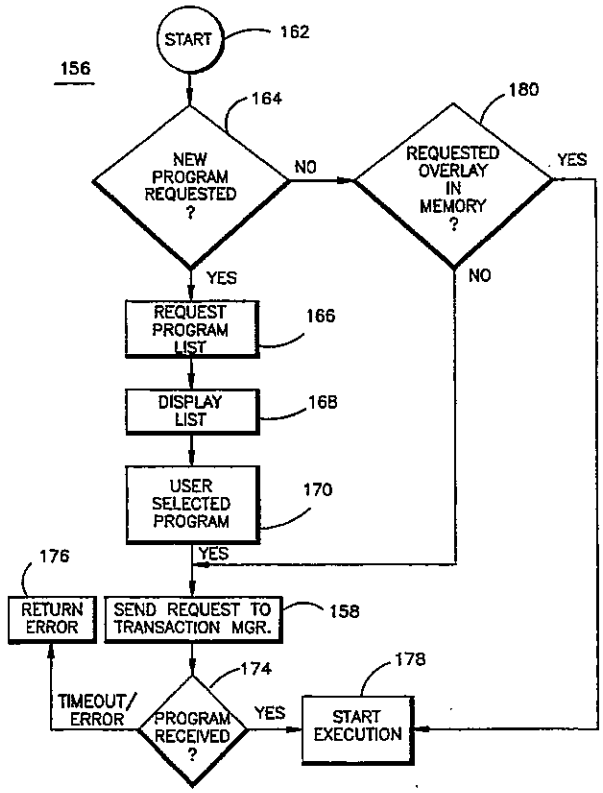
Primary Examiner—Thomas M. Heckler

Attorney, Agent, or Firm—R. Lewis Gable

[57] **ABSTRACT**

A data capture system is disclosed as comprising a plurality of client data collection terminals, and a server station. Each terminal including a mechanism for collecting data, a dynamic addressable memory and a first controller operating on data formatted in a first style. The server station comprises mass memory, which is larger than the dynamic addressable memory of a terminal for storing data to be used by the data collection terminals, an addresser responsive to a memory altering request for addressing the mass memory and a second controller operating on data formatted in a second style different from said first style. The data stored in the dynamic addressable memory is formatted in the second style. A communication system interconnects the server station and each of the plurality of client data collection terminals. The first controller of each client data collection terminal is responsive to a need for further data to generate a memory altering request and for actuating the communication system to transmit the generated request to the server station. The request is generated to identify its terminal and the particular needed data. The second controller of the server station is responsive to the transmitted request to address and retrieve the needed data from the mass memory before actuating the communication system to transmit the needed data back to the requesting terminal as identified by the request.

8 Claims, 9 Drawing Sheets



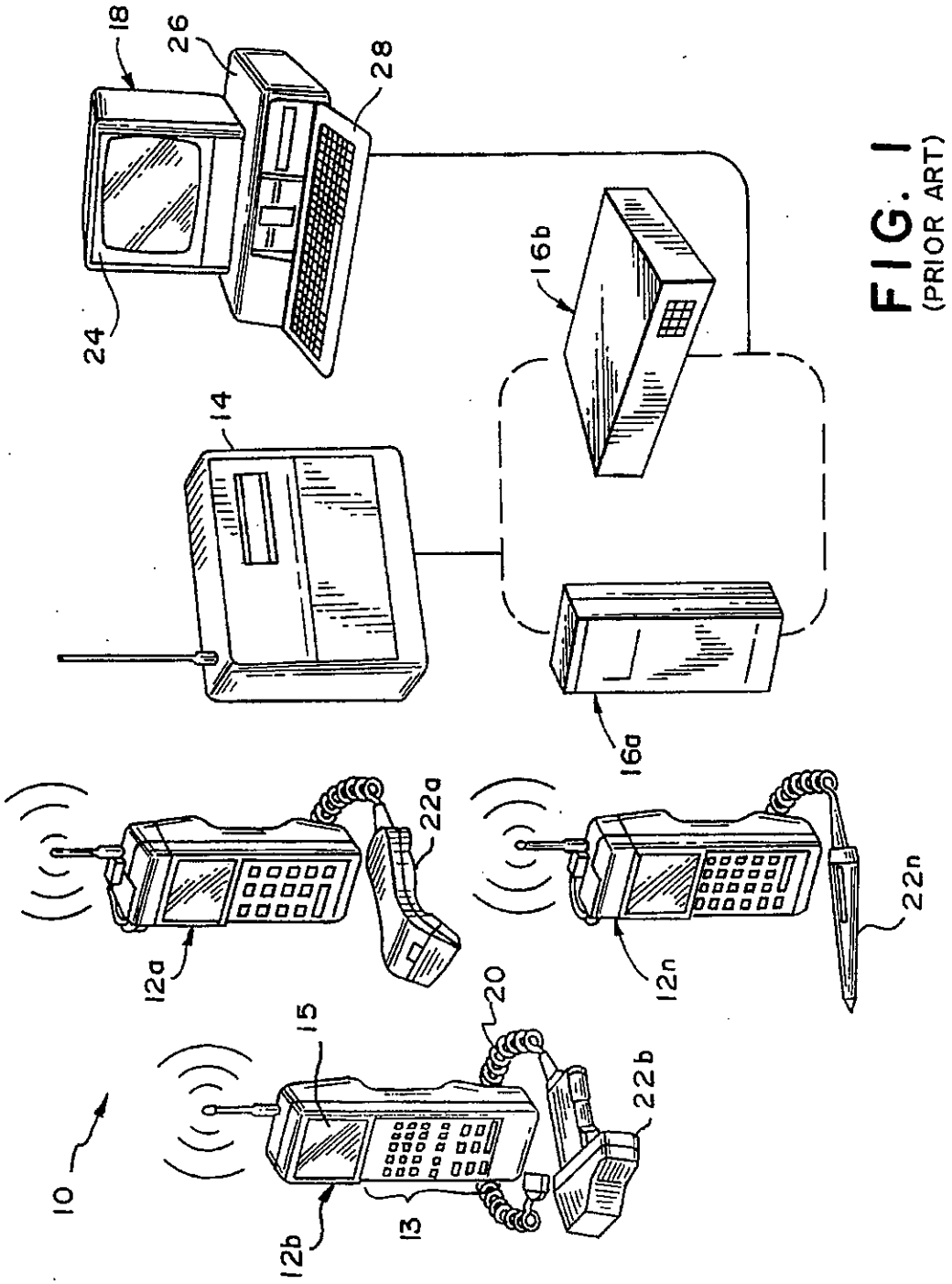


FIG. 1
(PRIOR ART)

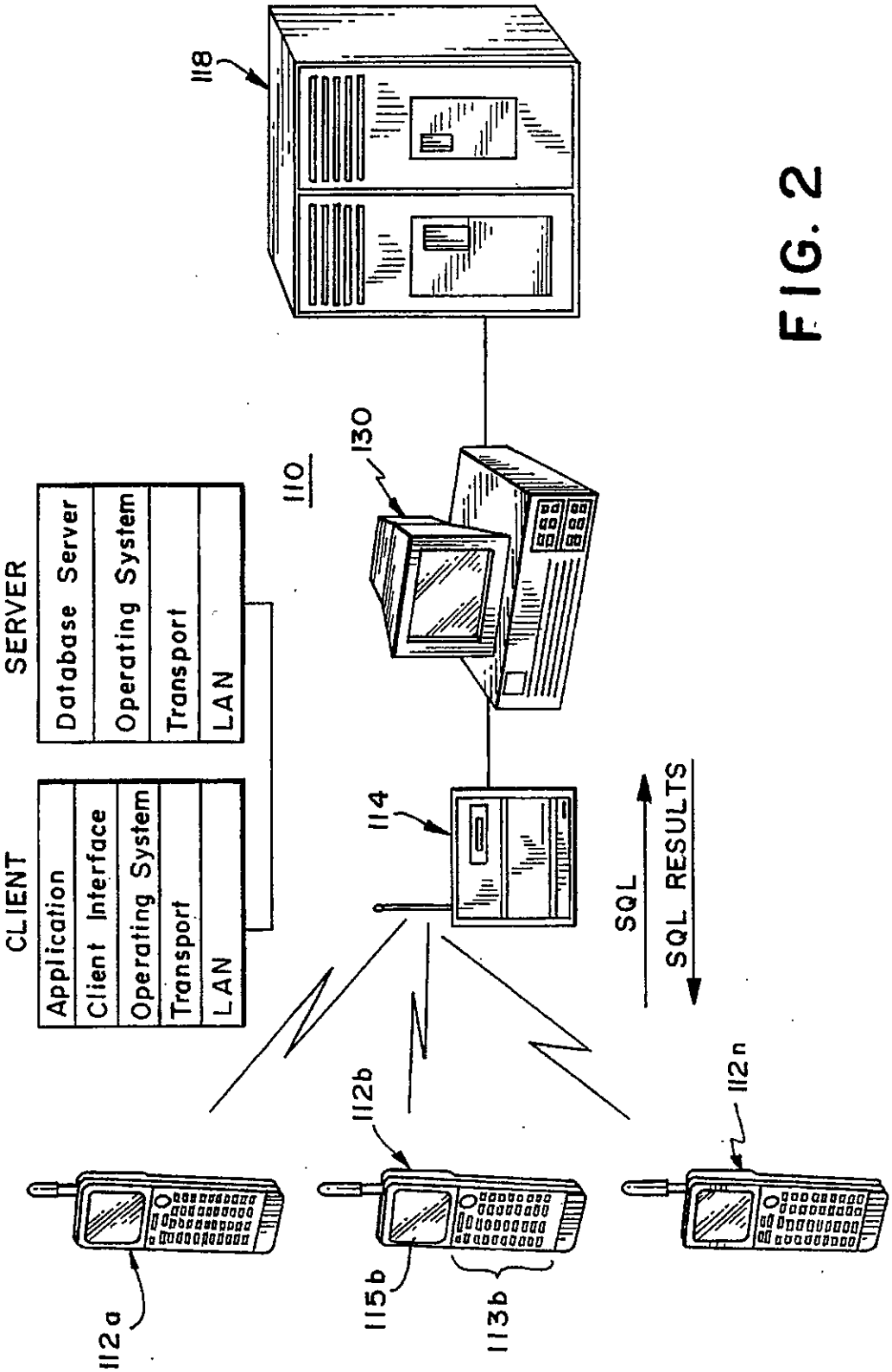

118
110
130
SERVER
Database Server
Operating System
Transport
LAN
CLIENT
Application
Client Interface
Operating System
Transport
LAN
114
SQL
SQL RESULTS
112a
112b
112n
115b
113b

FIG. 2

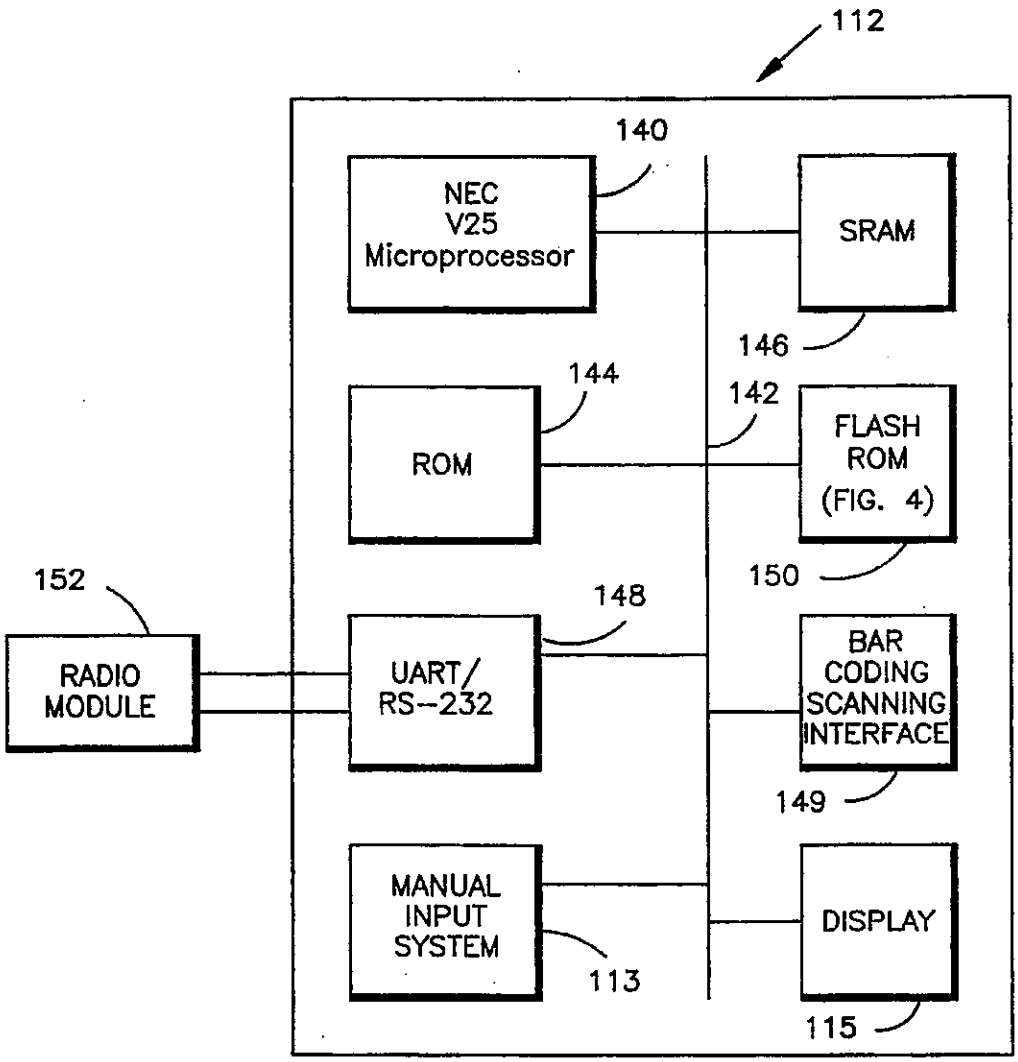

112
140
NEC V25 Microprocessor
SRAM
146
144
142
ROM
FLASH ROM (FIG. 4)
150
152
148
RADIO MODULE
UART/ RS-232
BAR CODING SCANNING INTERFACE
149
MANUAL INPUT SYSTEM
113
DISPLAY
115

FIG. 3

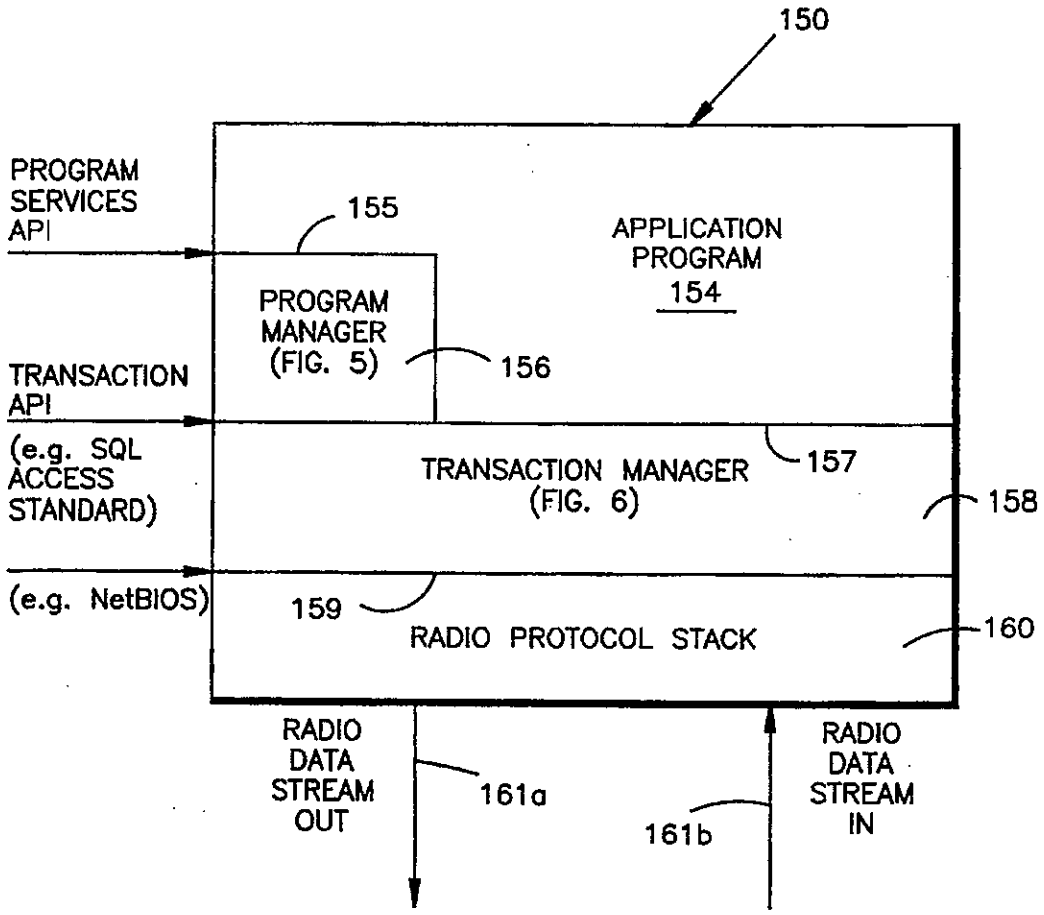
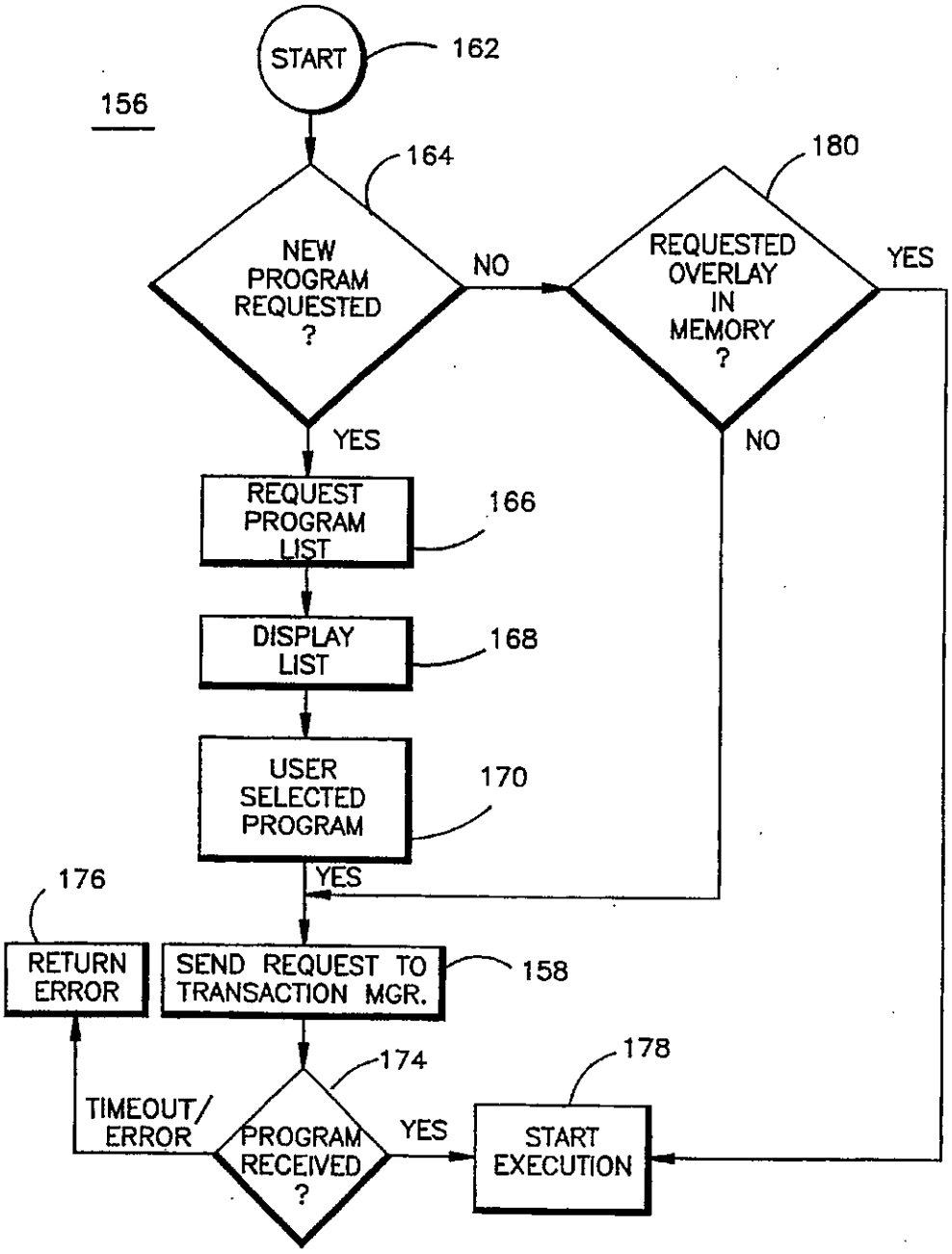

150
PROGRAM SERVICES API
155
APPLICATION PROGRAM 154
PROGRAM MANAGER (FIG. 5)
156
TRANSACTION API
(e.g. SQL ACCESS STANDARD)
TRANSACTION MANAGER (FIG. 6)
157
158
(e.g. NetBIOS)
159
RADIO PROTOCOL STACK
160
RADIO DATA STREAM OUT
161a
161b
RADIO DATA STREAM IN

FIG. 4

FIG. 5


156
START
162
164
NEW PROGRAM REQUESTED ?
NO
180
REQUESTED OVERLAY IN MEMORY ?
YES
YES
NO
REQUEST PROGRAM LIST
166
DISPLAY LIST
168
USER SELECTED PROGRAM
170
YES
176
RETURN ERROR
SEND REQUEST TO TRANSACTION MGR.
158
174
178
TIMEOUT/ ERROR
PROGRAM RECEIVED ?
YES
START EXECUTION

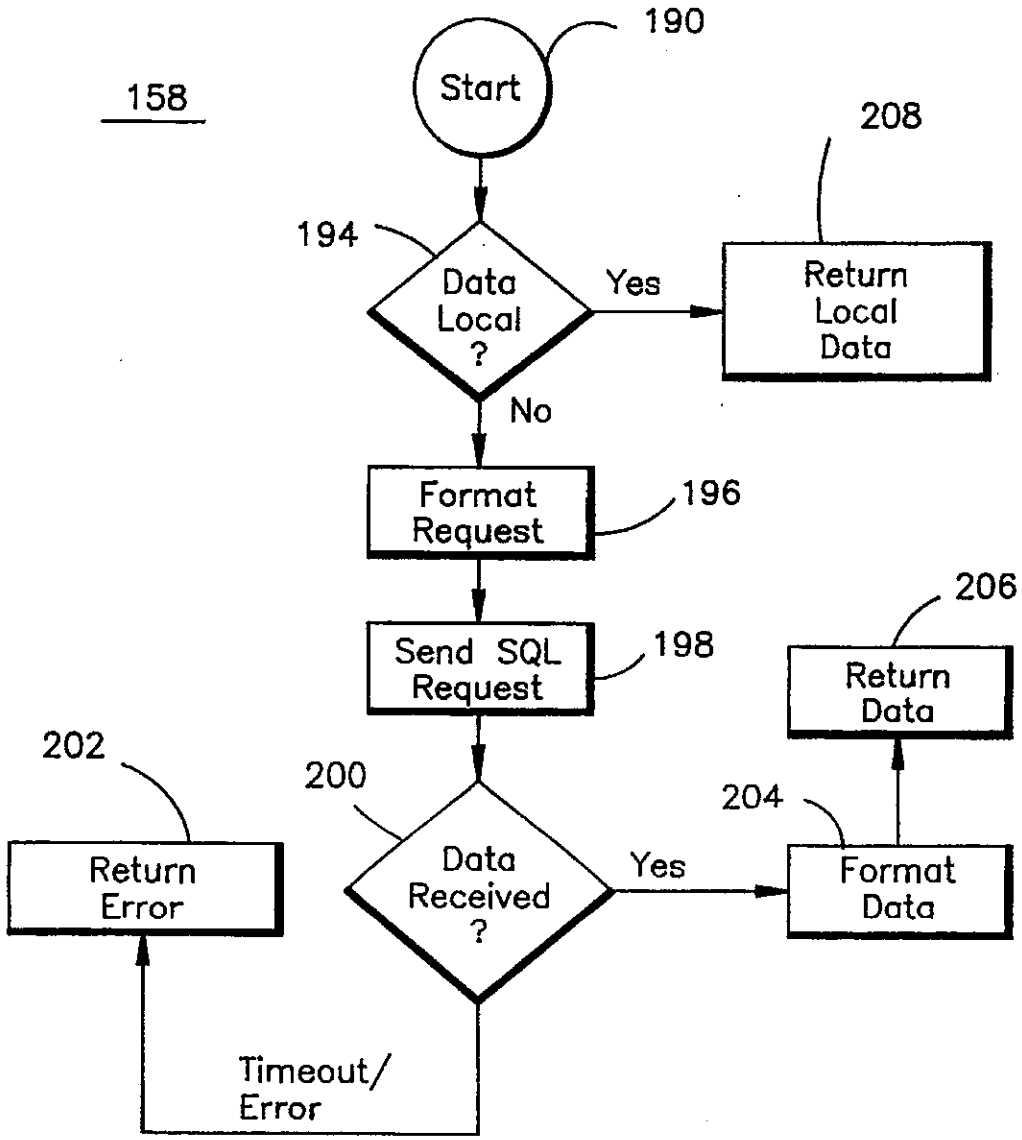

158
Start
190
208
194
Data Local ?
Yes
Return Local Data
No
Format Request
196
Send SQL Request
198
206
Return Data
202
200
204
Return Error
Data Received ?
Yes
Format Data
Timeout/ Error

FIG. 6

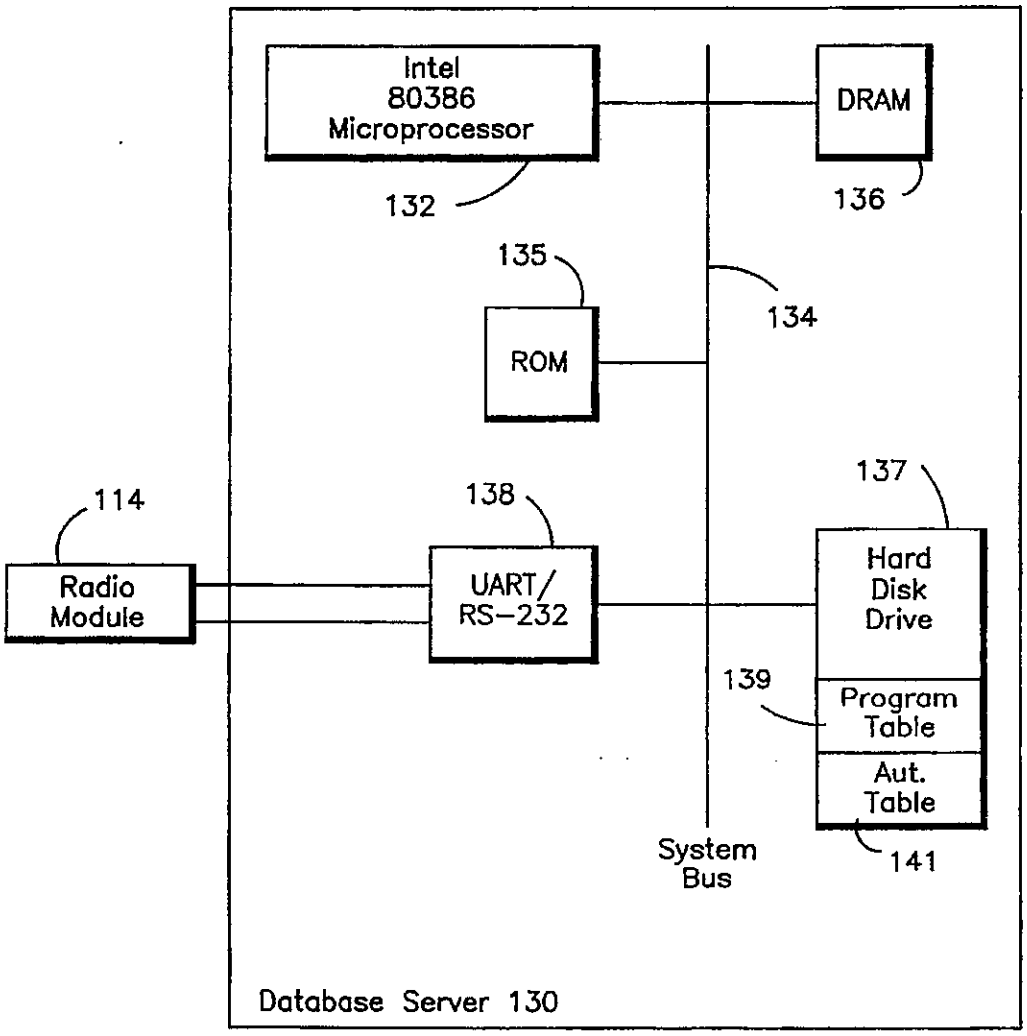

Intel
80386
Microprocessor
132
DRAM
136
135
ROM
134
114
Radio
Module
138
UART/
RS-232
137
Hard
Disk
Drive
139
Program
Table
Aut.
Table
141
System
Bus
Database Server 130

FIG. 7

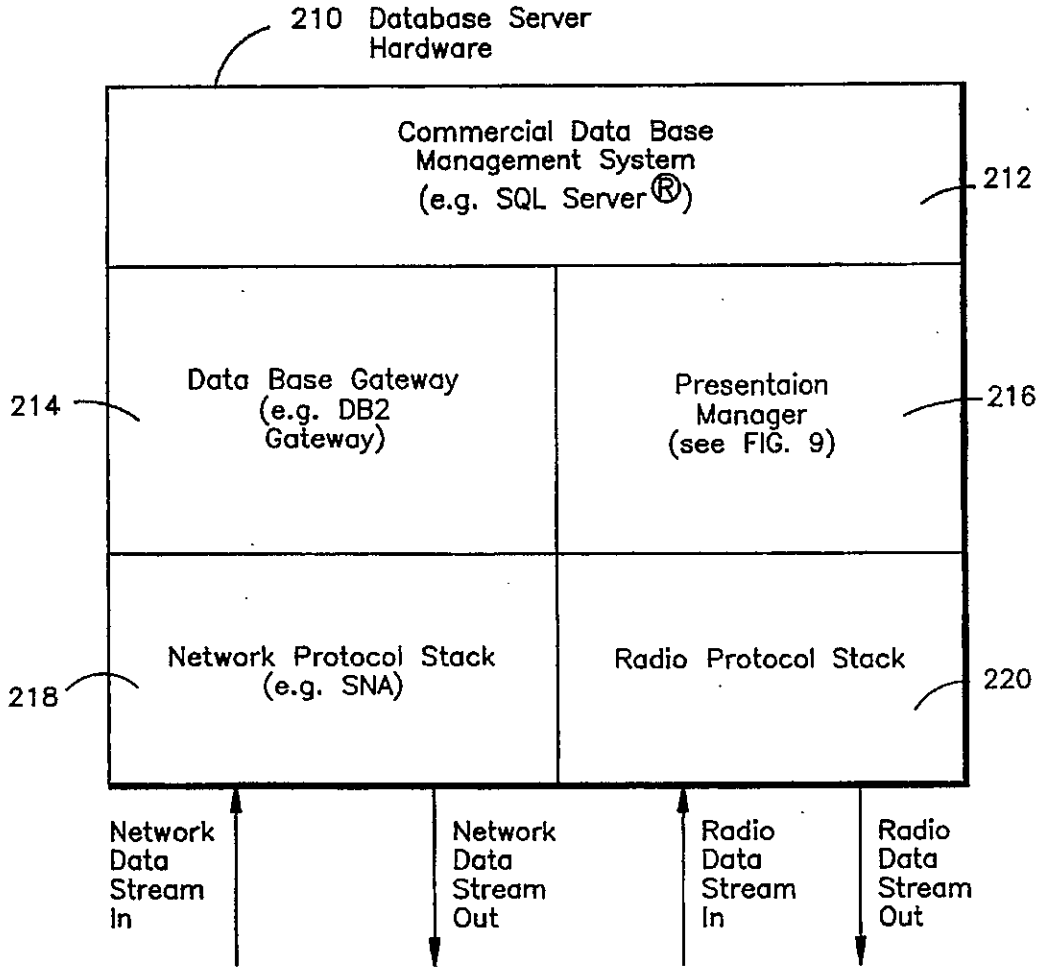

210 Database Server Hardware
Commercial Data Base Management System (e.g. SQL Server®)
212
Data Base Gateway (e.g. DB2 Gateway)
214
Presentaion Manager (see FIG. 9)
216
Network Protocol Stack (e.g. SNA)
218
Radio Protocol Stack
220
Network Data Stream In
Network Data Stream Out
Radio Data Stream In
Radio Data Stream Out

FIG. 8

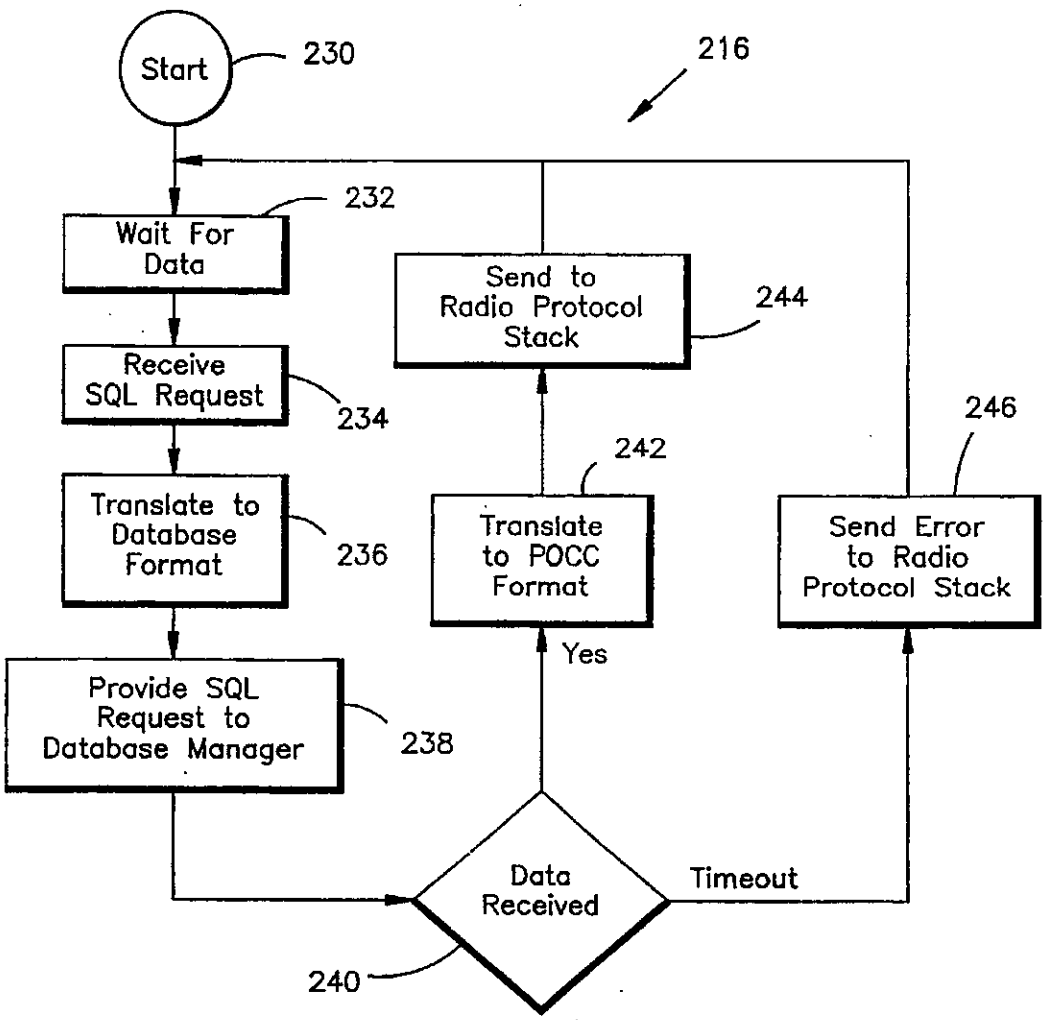

Start
230
216
232
Wait For Data
Receive SQL Request
234
Translate to Database Format
236
Provide SQL Request to Database Manager
238
Data Received
240
Yes
Timeout
Translate to POCC Format
242
Send to Radio Protocol Stack
244
Send Error to Radio Protocol Stack
246

FIG. 9

VERSATILE RF DATA CAPTURE SYSTEM

This application is a continuation of U.S. patent application Ser. No. 07/748,150, entitled "VERSATILE RF DATA CAPTURE SYSTEM", filed Aug. 21, 1991 in the names of Michael D. Morris et al. (now U.S. Pat. No. 5,349,678).

AUTHORIZATION PURSUANT TO 37 CFR 1.71(d) AND (e)

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REFERENCE TO RELATED, CO-PENDING PATENT APPLICATIONS

The following, co-pending applications are all assigned to assignee of this invention and are incorporated herein by reference:

1. U.S. Ser. No. 700,704 (Express Mail Label No.: FB 537 394 682US), entitled "SYSTEM FOR COUPLING A MULTIPLICITY OF RF DATA COLLECTION TERMINALS WITH HOST COMPUTER MEANS" filed on May 14, 1991 in the names of Gollnick et al. (Attorney Docket No. DN37834X), now abandoned in favor of U.S. Ser. No. 07/857,603, filed Mar. 30, 1992 (Attorney Docket No. DN37834XA), now abandoned in favor of U.S. Ser. No. 07/947,102, filed Sep. 14, 1992 (Attorney Docket No. DN37834XXB), now abandoned; and
2. U.S. Ser. No. 660,618 (Express Mail mailing Label No.: FB 537 394 671US), entitled "SYSTEM FOR PROCESSING COMMUNICATIONS WITH MULTIPLE PORTABLE RF DATA COLLECTION TERMINALS", filed Feb. 25, 1991 in the name of P. Miller (Attorney Docket No. 37734), now abandoned in favor of U.S. Ser. No. 07/830,561, filed Jan. 30, 1992 (Attorney Docket No. 37734A), now abandoned.

BACKGROUND OF THE INVENTION

The present invention relates to a data capture system **10** illustrated in FIG. **1** for entering data at a plurality of remote locations using means such as a plurality of portable data collection terminals **12***a, b–n*. The data capture system **10** is applicable to receive and collect a wide variety of data and has found particular application in warehouses or retail store where a data capture system **10** would be used to keep an up-to-date record of the products to be marketed. Typically, the system **10** would be capable of updating on a real time basis the inventory count of products, and to use stock locator data to identify where each product of the remaining inventory is stored, when a product is moved from one place to another, and which employee has current charge of that product. In addition, when a product is sold, the price and sales person who sold the product are recorded.

Such data may be inputted into a terminal **12** by means of its keyboard **13**. For example, a terminal user could count the number of one type of product and enter that number via the terminal's keyboard **13**. Alternatively, data could be entered to the terminal **10** via a CCD bar code scanner **22**, which is electrically coupled by a cable **20** to its terminal **12**. In an illustrative embodiment of this invention, the scanner

as illustratively identified in FIG. **1** by the numeral **22***a* and its terminal **12***a* could take the form of that modular scanner/terminal described in PCT international application W090/16033 published Dec. 27, 1990. Differing types of scanners **22***b* and **22***n* could also be used with the terminals **12** and may illustratively take the form of those scanners described in U.S. Pat. Nos. 4,970,379 of Danstrom, 4,882,476 of White, 4,894,523 of Chadima, 4,877,949 of Danielson et al., 5,019,669 of Adams et al. and 4,924,462 of Sojka; International Application No. PCT/US90/03282 of Koenck et al.; and European Patent Publication No. 0 353 759 of Mahany et al.

The data capture system **10** utilizes illustratively RF transmission to bilaterally transmit data between each of the plurality of terminals **12***a, b–n* and a base radio transceiver **14**. By way of example, the base radio transceiver may illustratively take the form of that model RB3000 base radio transceiver manufactured by Norand Corporation, Cedar Rapids of Iowa. In turn, the base radio transceiver **14** is connected via a communications multiplexer **16***a* or a communications controller **16***b* to a host computer **18**. Illustratively, the multiplexer **16***a* could take the form of that model RM3200 as manufactured by Norand Corporation and the controller **16***b* could take the form of that controller identified as model RC2250 of Norand Corporation. The host computer **18** may illustratively be an International Business Machines Corporation of AT class or higher. As illustrated in FIG. **1**, the host computer **18** includes a keyboard **28**, a display **24** and a system unit **26**.

Each of the portable data collection terminals **12***a, b–n* includes a transceiver (not shown in FIG. **1**) for transmitting RF messages to and from the base radio transceiver **14**. A transmitted message comprises an initialization sequence, an address indicative of the particular terminal **12***a, b*-or *n* from or to which the message is directed, a message identifier and system information, the message data and/or control commands, error control, and an end of message indication. U.S. Pat. Nos. 4,910,794; 4,924,462; and 4,940,974, each assigned to the assignee of this invention and incorporated herein by reference, provide further information on RF data collection terminals and systems.

In a RF data capture system similar to that shown in FIG. **1** known as the RT1200 system of Norand Corporation, controlled RF transmission between a plurality of terminals and a radio base is established using a communications multiplexer similar to that of the multiplexer **16***a* shown in FIG. **1** to provide access to a particular one of the terminals **12***a,b–n*. The RT1200 system utilizes time division multiplexing on a single frequency channel. The RT1200 communications protocol is based on a sequential polling method that transmits a query addressed to each portable terminal in succession, and allows a specified amount of time for the addressed terminal to respond when the addressed terminal has a data message ready for transmission. U.S. Pat. No. 4,940,974 describes an improved, adaptive data communications system wherein the base radio transceiver **14** transmits a multi-terminal polling signal to each of its terminals **12***a, b–n*. That multi-terminal polling signal defines a series of successive response time slots in which the terminals **12** may randomly select to respond. A terminal **12** having a message to be transmitted to the host computer **18** via the base radio transceiver **14** transmits a brief response burst in the selected time slot giving its own unique identification address. After receiving the responses from the ready terminals **12**, the base radio transceiver **14** polls each of the responding terminals **12**, ignoring those terminals without messages to be transmitted. This system is

adaptive in that the number of time slots may be changed depending upon the number of active terminals ready to transmit data messages.

The present invention is particularly related to adapting such data capture system **10** as shown in FIG. **1** to employ distributed processing concepts. Each of the portable data collection terminals **12** has a computer processing capability in the illustrative form of a microprocessor, whereby the entire system's processing capability may be distributed between the host computer **18** and the portable terminals **12**. The system **10** is structured in accordance with a client/server architecture whereby the host computer **18** acts as a server to each of the plurality of client terminals **12**, whereby programs may be dynamically loaded across that RF (or any serial) data link established between the host computer **18** and its terminals **12**.

The use of distributed processing is enhanced by relational database technology and the use of Structured Query Language (SQL) developed by the International Business Machines Company to provide access to relational databases. The use of relational database technology depends on organizing data in tables (or relations); each row of the table represents a record and each column represents an attribute. Various operations may be performed on these relations and, since the mathematics of these operations is very well understood, the results are predictable. An example of these operations is the "join", where two or more relations may be put together based on some common attribute. The advantage of this organization is that data may be easily retrieved in a form not envisioned by the designers; that is, ad hoc retrievals are quite easy to perform.

A further concept of distributed processing is to partition the system so that data is available to all network users but the data physically resides where it is most likely to be processed. This provides universal access without incurring severe communication overhead penalties. In the context of the data capture system **10** illustrated in FIG. **1**, data is made available to each of the terminals **12** and to the host computer **18** by the use of the RF transmission between each of terminals **12** and the base radio transceiver **14**. However, employing the concept of distributed processing would direct that more data and application programs be stored within each of the terminals **12**, where such data is used or such programs executed. As a result, overhead penalties, primarily in terms of delays as would occur by the transmission of data between the terminals **12** and its host computer **18** are avoided.

In a client/server model, the server provides a general function to several client processes. Some of the more useful implementations of this concept are distributed databases, remote procedure calls and networked pipes. The distributed databases currently rely on some form of communication through Structured Query Language (SQL). These databases are comprised of front-end applications and a database server. The application interacts with the user. When database access is required, the application sends an SQL request to the database server which services the request across a network. This allows most of the processing to be done locally, but provides for a central data store that may be shared by many distributed users.

The remote procedure call concept allows systems to become specialized servers so that many applications may use their specialized hardware. To access these remote services, the application program makes a procedure call that is like any procedure call to the program's code. The difference is that the call results in a request to a remote system to provide the computation designated by the call.

The concept of "pipes" relates to supplying the output of one process to the input of another process. If the two processes are on different computers then this becomes a method of distributed processing. A variant of this method is the named pipe which allows select output to be input to another process over a named connection. This is the primary method of distributed interprocess communications with an OS/2 LAN Manager.

The efficient transmission of data to a remote terminal of a system is key to distributed processing. IBM's solution is their Distributed Data Management (DDM) protocols. These are a set of published IBM protocols that describe how to access files and databases on a remote system. IBM also developed a System Application Architecture (SAA) with common programming interfaces for program access to remote data on IBM SAA compliant systems. The importance of these protocols (which use LU 6.2 protocols for inter-system communication) is that a remote system such as a PC may access IBM host databases and files without having to program the host computer.

Remote data access in the non-IBM world is also becoming standard. The Network File System (NFS™) protocols (developed by Sun Microsystems but placed in the public domain) may be used to access or create files on any system running an NFS server. Novell Corporation is also providing similar services to a wide range of systems with its portable Netware™.

In current data capture systems employing a plurality of remote terminals **12**, the application program is run in the centrally disposed host computer **18** for real time control of the remote terminals **12**. Placing control in the host computer **18** increases significantly the hardware and software complexity forcing the host computer **18** to run multiple processes. Such application programs residing in the host computer **18** are complicated by the need to assure the concurrent control over shared data. Further, the host computer **18** must be fast enough to service all remote terminals **12** in real time. In such current data capture systems, the host computer **18** must normally validate data entry by the user and must respond to all user input, thus requiring significant amounts of data to be sent back and forth over an RF link between each of the terminals **10** and its host computer **18** as well as increasing the number of data transition session between the host computer **18** and its terminals **12**.

The present invention is related to the use of distributed processing concepts in a RF data capture system **10** as generally shown in FIG. **1** and, in particularly to improve the efficiency of such overall systems by improving the speed and efficiency of data transmission over the RF link between each of the terminals **12***a,b–n* and the base radio transceiver **14**.

SUMMARY OF THE INVENTION

It is therefore an object of this invention to decrease the response time required for a portable data collection terminal to respond to its user.

It is a further object of this invention to minimize the data transmitted typically by RF transmission between each of a plurality of terminals and its centrally disposed host computer.

It is a still further object of this invention to eliminate programming the host computer for real time control of its plurality of data collection terminals.

It is another object of this invention to provide an environment for the ready development of application programs for each of a plurality of data collection terminals.

It is a still further object of this invention to provide a new and improved scheme of distributive processing between a central or host computer and a plurality of remote terminals.

It still a further object of this invention to provide a new and improved battery operated terminal for use in a data capture system comprised of a plurality of such terminals, wherein the drain imposed by large memory and frequent use of radio modules is minimized.

In accordance with these and other objects of the invention, a data capture system comprises a plurality of client data collection terminals, and a server station. Each terminal includes a mechanism for collecting data, a dynamic addressable memory and a first controller operating on data formatted in a first style. The server station comprises a mass memory, which is larger than the dynamic addressable memory of a terminal for storing data to be used by the data collection terminals, an addresser responsive to a memory altering request for addressing the mass memory and a second controller operating on data formatted in a second style different from said first style. The data stored in the dynamic addressable memory is formatted in the second style. A communication system interconnects the server station and each of the plurality of client data collection terminals. The first controller of each client data collection terminal is responsive to a need for further data to generate a memory altering request and for actuating the communication system to transmit the generated request to the server station. The request is generated to identify its terminal and the particular needed data. The second controller of the server station is responsive to the transmitted request to address and retrieve the needed data from the mass memory before actuating the communication system to transmit the needed data back to the requesting terminal as identified by the request.

In a further aspect of this invention, each of the plurality application programs is partitioned into a root module and at least one overlay module. The first controller of each terminal includes a processor for executing a selected application of the plurality and is responsive to the execution of an application program to generate the memory altering request and for actuating the communication system to transmit the generated request to the server station. The request identifies its terminal and the particular overlay module needed to continue the execution of its application program. The second controller of the server station is responsive to transmitted request for addressing and retrieving from its mass memory the particular overlay module, before actuating the communication system to transmit the particular overlay module back to the requesting terminal.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is diagrammatic illustration of an existing prior art data capture system which may be upgraded to incorporate features of the present invention;

FIG. **2** is diagrammatic illustration of a data capture system configured in a client/server architecture to effect distributed processing in accordance with the teachings of this invention;

FIG. **3** is a functional block diagram illustrating the architecture of a portable data collection terminal as shown in FIG. **2**;

FIG. **4** is diagram of the application program architecture as stored within the ROM of the portable data collection terminal shown in FIG. **3**;

FIG. **5** is a flow diagram of the Program Manager program shown in the architecture diagram of FIG. **4**;

FIG. **6** is a flow diagram of the Transaction Manager program shown in the architecture diagram of FIG. **4**;

FIG. **7** is a functional block diagram of the database server shown in FIG. **2**;

FIG. **8** is a diagrammatic showing of the architecture of the database server memory; and

FIG. **9** is a flow diagram of the Presentation Manager program shown in the architecture diagram of FIG. **8**.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings and, in particular to FIG. **2**, there is shown a data capture system **110** in accordance with the teachings of this invention, where elements similar to those of FIG. **1** are identified by like numerals but in the 100's series. The data capture system **110** includes a plurality of portable data collection terminals **112***a,b–n*, which in an illustrative embodiment of this invention may take the form of that terminal RT1100 as manufactured by Norand Corporation. Each terminal **112** includes, as shown in FIG. **3**, a radio module **152** which is capable of receiving and transmitting RF signals to a base radio transceiver **114**, which may illustratively take the form of that model RB3000 base radio transceiver as manufactured by Norand Corporation. The RB3000 base radio transceiver **114** is capable of operating at multiple baud rates as described in U.S. Pat. No. 4,910,794. In turn, the received signals are transmitted to a database server **130**, which in response to the received signals applies signals to the base radio transceiver **114** to be transmitted to a selected one of the plurality of the terminals **112**. Each message transmitted between one of the terminals **112** and the transceiver **114** includes an identification number or ID indicating the originating terminal **112** or its user. In turn, the database server **130** is coupled to a host computer **118**. In an illustrative embodiment of this invention, the host computer **118** may take the form of an IBM 3090 main frame with a DB2 database engine. As will be explained in detail below, each terminal **112** is programmed to compose an SQL request that will cause the database server **130** to return an application program, a memory overlay or application specific data to the requesting terminal **112**. The host computer **118** may also access the database server **130** by generating and transmitting SQL request messages thereto.

The host computer **118** has a database, which is accessible through the database server **130** to respond to the SQL request from one of the terminals **112**, supplying to the requesting terminal **112** a computer program, memory overlays or application specific data. The host computer **118** may illustratively take the form of an IBM 3090 main frame with a DB2 database engine and would have a memory of a capacity many orders greater than that of the terminals **112**. Much of the data and software to be used by the terminals **112** need not be stored with in the terminal's memory, but rather may reside in the database of the server **130** or in the memory of the host computer **118**. Thus, when that data and/or program stored in the database server **130** is needed, the needing terminal **112** formulates its SQL request message, transmits that message via the base radio transceiver **14** to be processed by the database server **130**, which accesses its database (or the memory of the host computer **118**) and retransmits the requested data or programs back to the requesting terminal **112**. At least two tables are defined

as shown in FIG. 7 in a memory of the database server **130** including a first program table **139** and a second authorization table **141**. The program table **139** keeps track of all of the programs, the overlays and the locations where they are stored in the database of the server **130**. The programs are typically stored as a "bulk" or "binary" data type. The program table requires at a minimum the following fields or attributes:

attribute	type	description
program name	char	Name of the program
overlay	char	root or other named overlay
date "control)"	char or date	Date program was created (revision control)
program	varbinary or varchar	The actual program or overlay
size	integer	The size of the binary to be loaded

As will be explained later with respect to FIG. 7, the first, program table **139** and the second authorization table **141** may be established within a hard disk drive **137** of the database server **130**. The SQL request includes an attribute to identify whether a new program or an overlay is to be accessed and sent by the requesting terminal **112** and the address or name of the first, program table **139**. The SQL request does not need to have the address of the requested program or overlay, but accesses the program table **139**, which provides an address within the hard disk drive **137** in accordance with the attribute. As will be explained, the database server **130** in response to the SQL request accesses a particular program or overlay and transmits it back to the requesting terminal **112**. The second authorization table **141** identifies the relationship between a particular user and each of the programs which that user is authorized to access. For example, each user has an ID and the authorization table **141** would list the program names which may be accessed by that particular user ID. Similarly, the SQL includes the ID and an address for the authorization table **141**. Thus, the SQL request accesses the authorization table **141** to see if the requesting terminal **112** or its user as identified by the ID is permitted to use a particular program or overlay. If there is a match between the ID and one of the listed programs stored in the authorization table **141**, then as will be explained, the database server **130** will access that program or overlay and transmit it back to the requesting terminal **112**. 0n the other hand, if the ID is not found within the authorization table **141**, the requested program or overlay is not transmitted back to the requesting terminal **112**.

FIG. **3** shows an illustrative embodiment of the hardware architecture of the elements of the portable data collection terminals **112**. Each terminal **112** includes a data bus **142** for interconnecting the elements of the terminal **112**, which may include a ROM **144** for the bootstrap loader, a flash ROM **150** for storing system and application programs, a static RAM (SRAM) **146** for storing data, programs and dynamically loadable program overlays, a microprocessor **140** which may take the form of that processor made by NEC as a model V25, the radio module **152**, a serial communication interface (UART) **148** for the radio module **152**, a bar coding scanning interface **149**, a manual input system such as a keyboard **113** and a display **115**. The serial communication interface **148** permit messages to be transmitted and received via the radio module **152**. The keyboard **113** and the bar code scanning interface **149** permit data entry respectively by the terminal user and a CCD bar code scanner similar to those identified in FIG. **1** by the numeral **22**. As is well known in the art, a scanner **22** would be moved across coded data to provide data descriptive of the item to which the bar code was attached, typically including a description of the item, its price and/or other inventory data.

Appreciating that each terminal **112** is battery operated, a plurality of memories **144**, **146** and **150** are provided therein to store various types and sizes of data and programs dependent upon their use and to the end, that battery drain be minimized. The ROM **44** stores the operating system and basic input/output system (BIOS) for the microprocessor **140**. The SRAM **146** stores the dynamically loadable program overlays and data. The flash ROM **150** stores the system operating program and the application programs to be executed by the microprocessor **140**, typically carrying out the various inventory functions for which a terminal **112** may be programmed. A portion of the SRAM **146** is partitioned into tables for application specific data, i.e., data to be used by the stored application programs. It is a significant aspect of this invention, that not all of the application programs or application specific data which may be used by a terminal **112**, should be stored in the SRAM **146**, but rather that significant portions of the application programs and specific data may be stored in the database server **130** (or even in the host computer **118**) to be accessed when needed by a particular terminal **112**.

The archectiture of the software stored in the flash ROM **150** is shown in FIG. **4**. The flash ROM **150** stores a plurality of application programs **154**, e.g., inventory tracking, a program manager program **156** explained below with respect to FIG. **5** for transmitting the SQL request to the database server **130** to obtain an overlay module or a new program, a transaction manager **158** as explained below in detail with respect to FIG. **6** for opening a new session to receive or to transmit streams of data thereto, and a radio protocol stack **160** for effecting the RF transmission of a data stream out **161***a* to the database server **130** and for receiving an RF transmission via a data stream input **161***b* from the database server **130**. An application interface **155** is established between the application programs **154** and the program manager **156**, whereby any of the application programs can request the services of the program manager **156**, which may be illustratively thought of as a collection of sub-routine calls for new overlay modules or a new program as will be explained below with respect to FIG. **5**. Further, the application programs **154** have a transaction application programming interface (API) **157** with the transaction manager **158** as will be explained below with respect to FIG. **6**. The transaction API **157** permits an application to transmit a SQL request to the database server **130**. In turn, the transaction manager **158** has an interface **159** as exemplified by a NetBIOS with the radio protocol stack **160**, which effects by RF transmission the sending and receiving of data to and from the database server **130**. As indicated by the archectiture of the data stored within the flash ROM **150** shown in FIG. **4**, the radio protocol stack **160** is transparent with respect to an application program, i.e., the application program need not be programmed to effect radio transmission but only to place a call to transmit or to receive data. Either the program manager **156** or the transaction manager **158** carries out that step without any special program of the application programs **154**.

The database server **130**, as shown generally in FIG. **2**, may illustratively take the form of an IBM PS/2 model 80 computer running IBM's OS/2 Extended Edition operating system. Generally, the database server **130** responds to a SQL request transmitted by a radio module **152** of a data collection terminal **112** (see FIG. **3**, or from the host computer **118**. The response of the database server **130** to the

SQL request is determined by the semantics of that SQL request, which is formatted in the ANSI standard SQL. The database server **130** need not store state information about each of the terminals **112***a,b–n*. Data relating to a particular or specific terminal **112** is assigned to its own memory table, which may be illustratively formed at its unique address within a DRAM **136** of the database server **130** as shown in FIG. **7**. That table for terminal specific data may be used at a buffer, where the addressed location within the DRAM **136** acts as a buffer memory to be addressed by a SQL request and in response thereto, to transmit the data stored in that buffer to the requesting terminal **112**. Alternatively, the terminal specific data could be stored in the hard disk drive **137** of the database server **130** and could be accessed by assigning an identifier attribute for that data to each terminal **112**, whereby the appropriate relation in the hard disk drive **137** of the database server **130** could be defined. As will be explained, each SQL request identifies a new program, an overlay or application specific data which is required by the requesting terminal **112**; the database server **130** responds to that request and transmits in turn the requested program, memory overlay or application specific data to the particular requesting terminal **112**.

FIG. **7** shows the hardware architecture of the database server **130**, including a data bus **134** for connecting the various elements thereof, a microprocessor **132** illustratively taking the form of that processor manufactured by Intel under its model No.80386, a ROM **135** for the computer powerup program, the diagnostic programs and the BIOS program, the dynamic RAM (DRAM) **136** serving as a memory for a database server program, server data, and a "cache" memory for the database, and a mass storage in the illustrative form of the hard disk drive **137** for storing all of the partitioned application programs and application specific data to be called by the plurality of terminals **112***a,b–n*. The database server **130** may provide gateway functions to other databases, e.g., DB2. In an operational sense, a gateway function permits access to a remote database by passing and/or reformatting the request. In other words, the SQL request could be translated into a format that would correspond and be recognized by that format of the remote database.

Referring now to FIG. **3**, the SRAM **146** of a portable data collection terminal **112** is significantly smaller than the disk drive **137** of a database server **130** and may have a capacity insufficient to store all of an application program and data to be executed by its microprocessor **140**. Distributed processing is accomplished in the context of this data capture system **110** employing a plurality of terminals **112** and a database server **130**, by partitioning each application program into a plurality of parts or modules. The first program part or first information portion is known as a root module and will be loaded first when a request for a new program is issued by the microprocessor **140** at power up or entered by a user through the terminal's key board **113**. There will be at least one and typically many further parts or second information portions known as memory overlays or overlay modules. The root module and the overlay modules will be given unique identifiers so that they may be loaded when requested. When the microprocessor **140** is executing the last instruction of a root module or an overlay module, then it is necessary to request and retrieve the next overlay module to permit the application program to continue to be executed without interruption. As will be explained below, this data capture system **110** is capable of formatting a SQL request for that original program or root module and for the subsequent overlay modules. In the simplest embodiment of this invention, the programmer builds into the application program a request to the program manager program **156** (see FIG. **4**) to request and load an overlay module and jump to it. In a more sophisticated version, a program in the development environment determines the external function calls in program and substitutes a call to the program manager program **156**. The development in partitioning of an application program is accomplished on the database server **130** using a data collection terminal emulator system that emulates the keyboard **113**, the display **115** and other possible peripherals of the terminal **112**. The only programming to be done specific to the database server **130** is to create the database tables and load them with any application specific data.

The software architecture of the DRAM **136** is further described in FIG. **8**, as being partitioned to store a commercial database management system **212** such as the SQL Server (Microsoft), a database gateway **214**, e.g., a DB2 Gateway by IBM, a presentation manager **216** to be more fully disclosed in the flow diagram of FIG. **9**, a network protocol stack **218**, and a radio protocol stack **220**.

The program manager program **156** generally shown in the software architecture diagram of FIG. **4** is more fully shown in the flow diagram of FIG. **5**. Basically, the program manager program **156** is disposed in the next lower layer below an application program, e.g., an inventory program, and responds to its request for either a new program or a memory overlay, to configure and transmit an SQL request to the database server **130**. Upon receipt of the requested program or memory overlay, the program manager program **156** stores it in SRAM **146** before initiating its execution by the microprocessor **140**. A start **162** is initiated in a number of ways by the associated application program. At power up when typically there is no application being executed, the operating system program, which is stored in the ROM **144**, places a call to the program manager **156**. Alternatively, a new application program may be called by the operator by actuating a selected key(s) of the keyboard **113**. Appreciating that all of a particular application program need not be stored in the SRAM **146**, overlay modules of the application program presently being executed may be stored in the database of the server **130** and may be called by the program manager program **156**. The application program continues to be executed until it recognizes that the next step is not available, at which time it places a call through the start step **162** for the next section or overlay module of the application program to be retrieved and placed in the SRAM **146** of the requesting terminal **112**.

After a start has been provided in any of these ways, step **164** determines whether a new program or memory overlay is being requested. If a new program is requested, step **166** accesses the database in the server **130** for the requested program. In particular, step **166** initiates the radio protocol stack program **160**, whereby the radio module **152** (see FIG. **3**) is activated to transmit the SQL request to the database server **130** via the transceiver **114** (see FIG. **2**). The SQL request initiated by step **166** seeks as will be described below a list of programs which are stored in the database server **130** and is available to this originating terminal **112**. Initially, step **166** calls the radio protocol stack program **160** (see FIG. **4**), whereby access is made through the UART **148** (see FIG. **3**) to the module **152**, turning module **152** "on" to transmit the SQL request to the transceiver **114**. In addition to actuating the radio module **152**, the radio protocol stack **160** provides the protocols and media access to allow the SQL request to be sent via the transceiver **114** to the database server **130**. Illustratively, the radio protocol stack **160** would

include the RTC system as described in U.S. Pat. No. 4,940,974. When the radio protocol stack **160** is called to initiate transmission, a session is said to be held between the requesting terminal **112** and the database server **130**. For example, when a SQL request is generated by the transaction manager **158** (see FIG. 4), a session is opened. Each session enjoys a logical relationship between the requesting terminal **112** and the database, e.g., the hard disk drive **137**, within the database server **130**. Each session includes one or more data packets, the data packet being the maximum byte size of the data stream appearing on the output **161***a* that may be transmitted by the radio module **152**. The radio protocol stack **160** functions to segregate a data stream out **161***a* to be transmitted to the database server **130**, into a number of data packets and, in similar fashion, to reassemble the data packets of an incoming data stream **161***b* into a continuous data stream. Each SQL request includes an address or ID of its originating terminal **112**. As will be explained later, the database server **130** uses a presentation manager program **216** to store the relationship (mapping) between the terminal ID and the operating system session identificer, which is stored in a known location within the DRAM **136** of the database server **130**. In this way, the database server **130** remembers to which of the plurality of terminals **112** *a, b–n* that the requested data or memory overlay, should be transmitted.

The database server **130** operating as will be explained, will respond to the SQL request for a program overlay by accessing a list of programs authorized for the particular requesting terminal **112** or user and transmitting that list back via the transceiver **114** to the requesting terminal **112**. Illustratively, step **166** may format an SQL request in the following manner:

```
select distinct program_name from
authorization where user_id = "morrismd"
```

Here the SQL request is seeking a list of distinct programs, not duplicates, which have been authorized for transmission to a particular user, i.e., a particular terminal **112**. In the illustrative request, the user ID is "morrismd"; in other words, all program names having an ID attribute "morrismd" are distributed to the requesting terminal **112**. Next, step **168** displays the received list of authorized programs on the terminal's display **115**.

In step **170** of FIG. **5**, the terminal user selects from that list of available programs as displayed in step **168** and enters via the terminal keyboard **113** the selected program to be requested from the database of the server **130**. When a program is selected from the menu displayed upon the display **115** (see FIG. 2) by user actuation of the keyboard **113**, the transaction manager **158** (see FIG. 6) is called to format the SQL request to retrieve from the remote database the particular program selected in step **170**. An illustratively example of such a SQL request may take the form of:

```
select program from program_table where
program_name = "inventory.exe" and overlay =
"root"
```

Illustratively, the SQL request accesses the first, program table **139** (see FIG. 7) to obtain the address in the hard disk drive **137** of the requested program, e.g. the "inventory.exe" program, which is an original program or it's root overlay.

After transmission of the SQL request for a new program, step **174** waits for a returned message to the terminal **112** and will time out after a set period, e.g., 30 seconds. If no response is received by the requesting terminal **112** within this period, step **176** generates a return error message and returns it to the calling application program. On the other hand if the requested original program is received within the period, step **178** updates a mapping memory or table, which may be illustratively included within the SRAM **146** (see FIG. 3) of the terminal **12**. A record of the application program or module thereof presently being executed by the microprocessor **140** is recorded in the mapping memory in terms of its starting address and length. When a new program is received and loaded into SRAM **146**, step **178** records its starting address and length in the mapping memory, before loading the root module of the new program into a designated location of the SRAM **146** and, thereafter, initiates execution of the received and loaded program instead of returning control to the application program. The SRAM **146** is used as a "cache" memory to receive the 140 programs and memory overlays to be executed by the microprocessor **140**. Thus, the SRAM **146** provides a local memory from which the application program may be executed, whereas the remaining sections or memory overlays of the application program and other original programs may be stored distantly in the database of the server **130**.

It is appreciated that application programs are sometimes larger than it's sections or memory overlays. Therefore to efficiently use the local memory, e.g., the SRAM **146**, new programs are illustratively stored in the database of the server **130**, whereas program overlays may be stored in both the database of the server **130** and in the local memory, i.e. the SRAM **146**. Therefore, if step **164** determines that the application is not requesting a new program, but rather an overlay module, step **180** examines the SRAM **146** and if the requested overlay module is in SRAM **146**, the program moves to step **178** to initiate execution of the overlay module commences and control is passed to the overlay module. However, if the requested overlay module is not in the SRAM **146**, step **180** moves control moves to the transaction manager **158**, which formulates and transmits a SQL request via the transceiver **114** to retrieve the needed overlay module from the database of the server **130**. The requested memory overlay is transmitted back via the transceiver **114** and is loaded into SRAM **146** and, thereafter, the local mapping memory in SRAM **146** is updated in terms of its starting address and length. After step **174** determines that the requested program has been timely received as explained above, step **178** initiates execution of the overlay module before returning control to the application program.

Referring now to FIG. **6**, there is shown the transaction manager program **158** which responds to a call from the application program **154** (see FIG. 4) for data to be processed thereby and provides an application programming interface (API) **157** to the application program which allows it to access the database in the server **130**. The transaction manager program **158** also supports the program manager program **156** to access programs stored in the database of the server **130**. Thus, it is seen that the program manager program **156** of FIG. **5** accesses second information portions such as remote programs and overlay modules whereas the transaction manager **158** of FIG. **6** accesses any kind of data. Initially, step **194** determines whether the requested data is in the local memory, i.e., SRAM **146**, and, if so stored, step **208** returns the local data to be processed by the application program. If not, step **196** formats an SQL request for the requested data and step **198** calls the radio protocol stack program **160** (see FIG. 4) thus actuating the radio module **152** and transmitting the SQL request via the transceiver **114** to access the requested data in the database of the server **130**.

Step **200** waits while the server **130** accesses the requested data and transmits it via the transceiver **114** to the requesting terminal **112**. Step **200** times a response period, e.g., 1 minute, and if that period is exceeded indicating an error condition, step **202** returns an error message to the calling application program. If the data is received within the response period, step **204** formats the requested data in a form usable by the calling application program, before step **206** returns that data to the application program. Step **206** returns the data to the SRAM **146**, whereby control is passed to the application program which uses the returned data.

The presentation manager program **216**, shown in FIG. **9**, processes the SQL request transmitted from one of the terminals **112** (see FIG. **2**) via the transceiver **114** and a standard interface, e.g. Unix sockets or IBM NetBIOS, to the database manager program **212** (see FIG. **8**). The database manager program **212** interprets the SQL request and accesses the hard disk drive **137** accordingly (see FIG. **7**). This allows an application program being executed by the microprocessor **140** (see FIG. **3**) to establish sessions with any SQL accessible database as maybe formed within the hard disk drive **137** of the database server **130**. The principle function of the presentation manager program **216** is to translate between that format used by the transaction manager program **158** of a terminal **112** and the SQL format of the database of the hard disk drive **137**, if these formats are different. The SQL request to be applied to the database management program **212** is semantically configured in accordance with the function to be achieved. The SQL request may direct that data be inserted into the disk drive **137**, that data be accessed and retrieved, that a new program or overlay module be retrieved from the disk drive **137**, that data be added to one or more fields in a set of records stored in the disk drive **137** or that data be deleted from one or more records of the disk drive **137**. Updating involves the transmitting of new variable values from the originating terminal **112**.

Referring now to the flow diagram of FIG. **9**, the presentation manager program **216** enters through start step **230** to step **232**, which waits for a SQL request to be forwarded from the radio protocol stack **220** (see FIG. **8**). As will be described below, the SQL request is directed toward the database manager program **212**. Step **234** receives the SQL request as a sequence of bytes. Step **236** comes into play only if some reformulation of the SQL request is necessary. In a first instance, if the database manager program **212** was not adapted to support the ANSI standard SQL format or if the SQL request was compressed, then step **236** would be necessary to decompress the data or to translate the format of the SQL request into that of the particular database manager program **212** employed in the system. Next, step **236** provides the data to the database manager program **212** through an interface in the illustrative form of the IBM NetBIOS interface. The translation step **236** is identical to the formatting request **196** of the transaction manager program **158** of FIG. **6** and, ordinarily, it would be only necessary to perform the formatting or translation step once upon a particular SQL request, preferably in the presentation manager program **216**. Step **240** waits for the database manager program **212** to access the disk drive **137** for a predetermined time period. If the requested material, i.e., a second information portion such as the application specific data, root overlay or memory overlay, is received within the time period, it is translated in step **242** to the format of the requesting terminal **112**, before calling the radio protocol stack program **220** to transmit the accessed material back to the requesting terminal **112**. On the other hand, if the SQL request is one to add or delete data from the hard disk drive **137**, step **240** generates a status message indicating that the change of the hard disk drive **137** has been completed, before step **242** translates that status message into the terminal format and the radio protocol stack **220** is called in step **244** to send that message back to the requesting terminal **112**. If the time period set in step **240** times out, without receiving the requested material, step **246** transmits an error pachet to the radio protocol stack program **220**, whereby an error message is returned to the requesting terminal **112**.

Thus, there has been described a data capture system **110** that distributes the application program between the memory of a terminal **112** and a database server **130** serving a plurality of such terminals **112**. In this fashion, the complexity of the program to be executed upon a terminal **112** is minimized by permitting the data base server **130** and its hard disk **137** to store a large variety of application programs to be served to its client terminals **112**. The above data capture system **110** permits dynamic loading of the original programs or root modules and subsequent memory overlays from the hard disk **137**, whereby the size of the SRAM **146** of a terminal **112** and the power required by a terminal **112** is minimized. Further, the amount of data transmitted via the RF link between each of the plurality of terminals **112** and the database server **130** is minimized. Further, the database server **130** provides a "user friendly" environment for the development of application programs for the terminals **112**. In particular, the database server **130** is capable of readily developing both the client and server portions of the application programs to be executed by the terminal's microprocessor **140**.

It will be apparent that many modifications and variations may be effected without departing from the scope of the teachings and concepts of the present disclosure.

We claim:

1. A system for collecting data from at least one remote site and transmitting the collected data to a main information center and having information distributed throughout said data collecting system, the information being partitioned into a first information portion and a second information portion, said data collection system comprising:

a) at least one terminal for collecting data at the remote site, said terminal comprising means for collecting data, a first memory for storing the first information portion, information requesting means responsive to the need for information by said terminal to generate an information call identifying the needed information, and first memory searching means responsive to the information call for searching said first memory for the presence or absence of that needed information, said first memory searching means responsive to the presence of that needed information for accessing said first memory and supplying that accessed, needed information for use by said terminal;

b) a server for said terminal; and

c) communication means for interconnecting said terminal and said server, said first memory searching means responsive to the absence of that needed information within said second memory for transmitting the information call via said communication means from said terminal to said server;

d) said server disposed at the main information center and comprising a second memory for storing the second information portion, and second memory searching means responsive to the information call transmitted via said communication means from said terminal for accessing the requested information from said second

memory means and transmitting the accessed information via said communication means from said server to said terminal.

2. The data collecting system as claimed in claim 1, wherein the information comprises a plurality of application programs, the first information portion comprises a root module and the second information portion comprises at least one overlay module, said terminal comprising a processor for executing a selected one application program, and said information requesting means responsive during the execution of the root module by said processor for generating the information call requesting a particular overlay module.

3. The data collecting system as claimed in claim 2, wherein the second information portion comprises application specific data and a request encoded within each of said application programs for the corresponding application specific data, said information requesting means responsive during the execution of one of said pluralities of the application programs by said processor for generating the information call for the corresponding application specific data.

4. The data collecting system as claimed in claim 2, wherein said terminal comprises a keyboard for user entry of a request for a root module for a new application program of said plurality thereof, said information requesting means responsive to the root module request for generating in turn the information call therefore.

5. The data collecting system as claimed in claim 1, wherein said communication means is wireless.

6. The data collecting system as claimed in claim 5, wherein said terminal comprises a first radio and said server comprises a second radio, said communication means comprises said first and second radios.

7. The data collecting system as claimed in claim 6, wherein said first memory searching means is responsive to the absence of the requested information within said first memory for actuating said first radio.

8. The data collecting system as claimed in claim 6, wherein said second memory searching means is responsive to the receipt of the information call to actuate said second radio.

* * * * *

EXHIBIT C

US005987499A

United States Patent [19]

Morris et al.

[11] Patent Number: 5,987,499

[45] Date of Patent: *Nov. 16, 1999

[54] **VERSATILE RF DATA CAPTURE SYSTEM**

[75] Inventors: **Michael D. Morris**; **Lyle L. Zumbach**, both of Cedar Rapids, Iowa

[73] Assignee: **Norand Corporation**, Cedar Rapids, Iowa

[*] Notice: This patent is subject to a terminal disclaimer.

[21] Appl. No.: **08/735,351**

[22] Filed: **Oct. 22, 1996**

Related U.S. Application Data

[63] Continuation of application No. 08/267,758, Jul. 5, 1994, Pat. No. 5,568,645, which is a continuation of application No. 07/748,150, Aug. 21, 1991, Pat. No. 5,349,678.

[51] **Int. Cl.**[6] **G06F 13/38**; G06F 15/17

[52] **U.S. Cl.** **709/203**; 709/219

[58] **Field of Search** 395/200.33, 200.47, 395/200.48, 200.49; 709/203, 217, 218, 219, 201

[56] **References Cited**

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5,568,645	10/1996	Morris et al.	395/200.33
5,586,260	12/1996	Hu	395/200.33

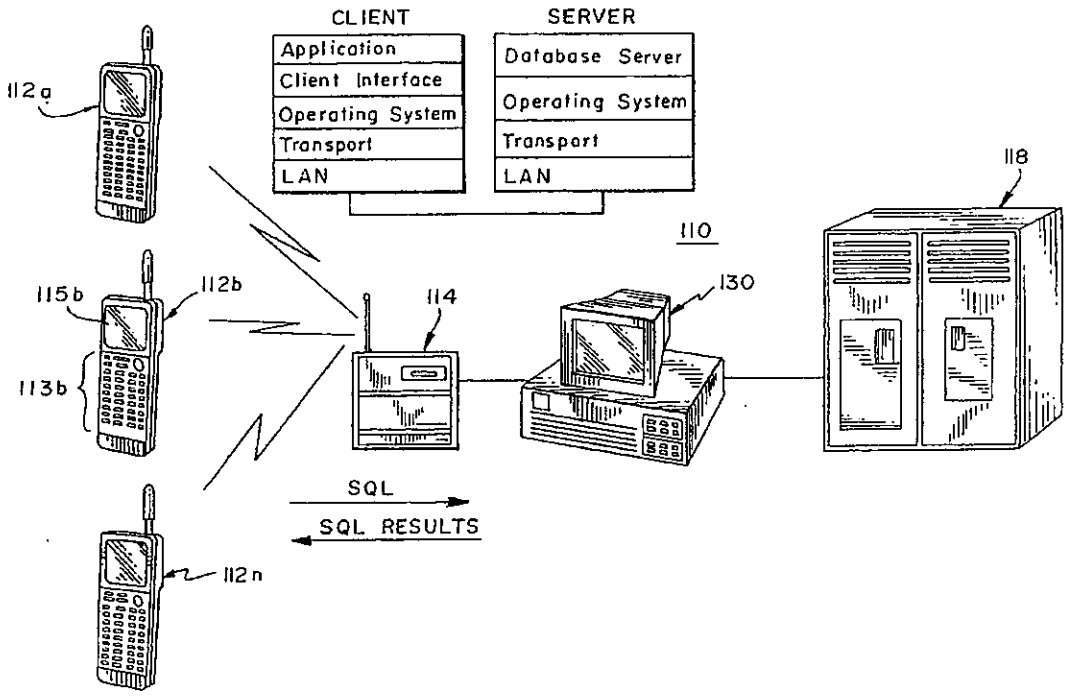
Primary Examiner—Mark H. Rinehart

Attorney, Agent, or Firm—Akin, Gump, Strauss, Hauer & Feld, LLP

[57] **ABSTRACT**

A data capture system is disclosed as comprising a plurality of client data collection terminals, and a server station. Each terminal including a mechanism for collecting data, a dynamic addressable memory and a first controller operating on data formatted in a first style. The server station comprises mass memory, which is larger than the dynamic addressable memory of a terminal for storing data to be used by the data collection terminals, an addresser responsive to a memory altering request for addressing the mass memory and a second controller operating on data formatted in a second style different from said first style. The data stored in the dynamic addressable memory is formatted in the second style. A communication system interconnects the server station and each of the plurality of client data collection terminals. The first controller of each client data collection terminal is responsive to a need for further data to generate a memory altering request and for actuating the communication system to transmit the generated request to the server station. The request is generated to identify its terminal and the particular needed data. The second controller of the server station is responsive to the transmitted request to address and retrieve the needed data from the mass memory before actuating the communication system to transmit the needed data back to the requesting terminal as identified by the request.

17 Claims, 9 Drawing Sheets



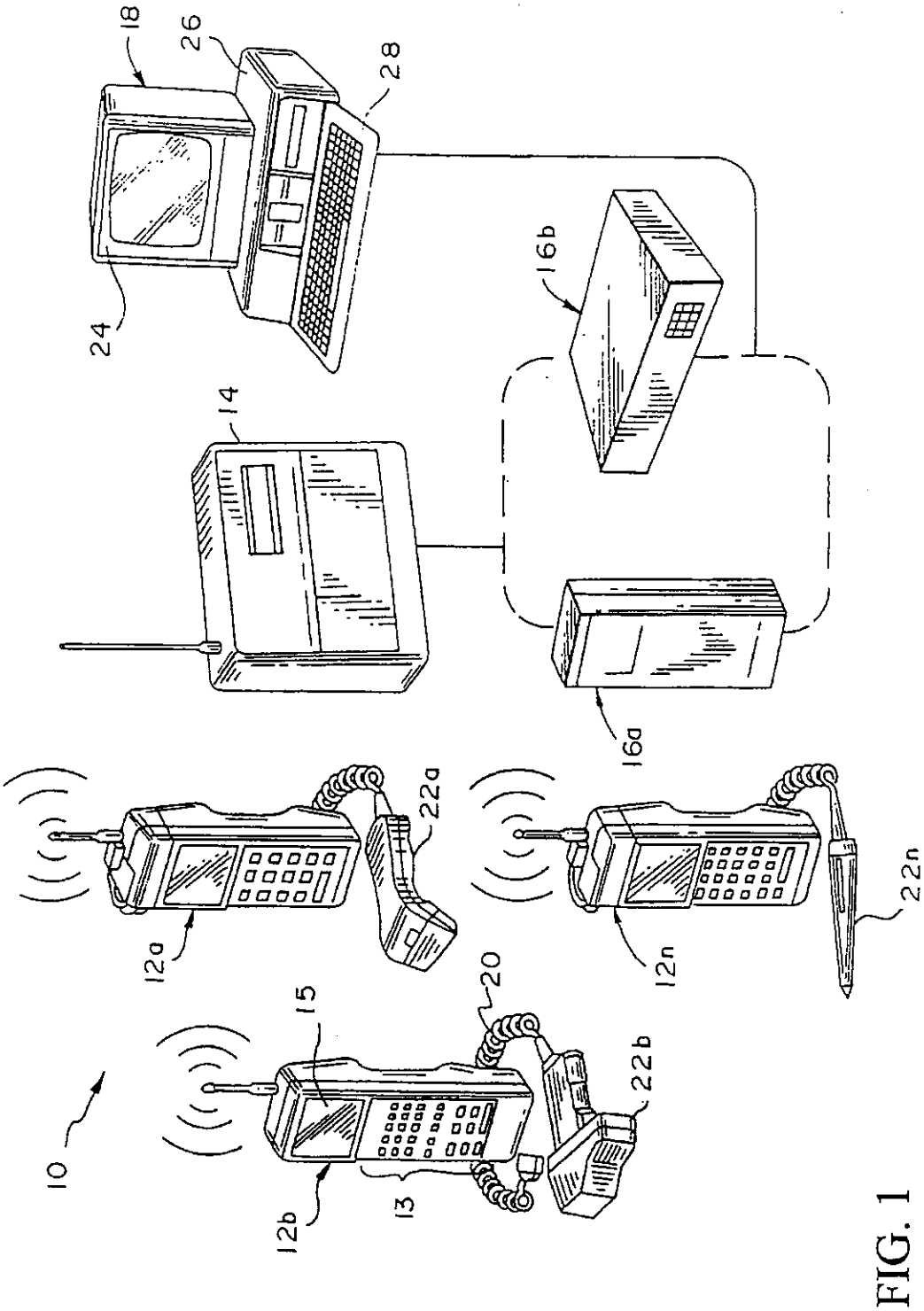


FIG. 1

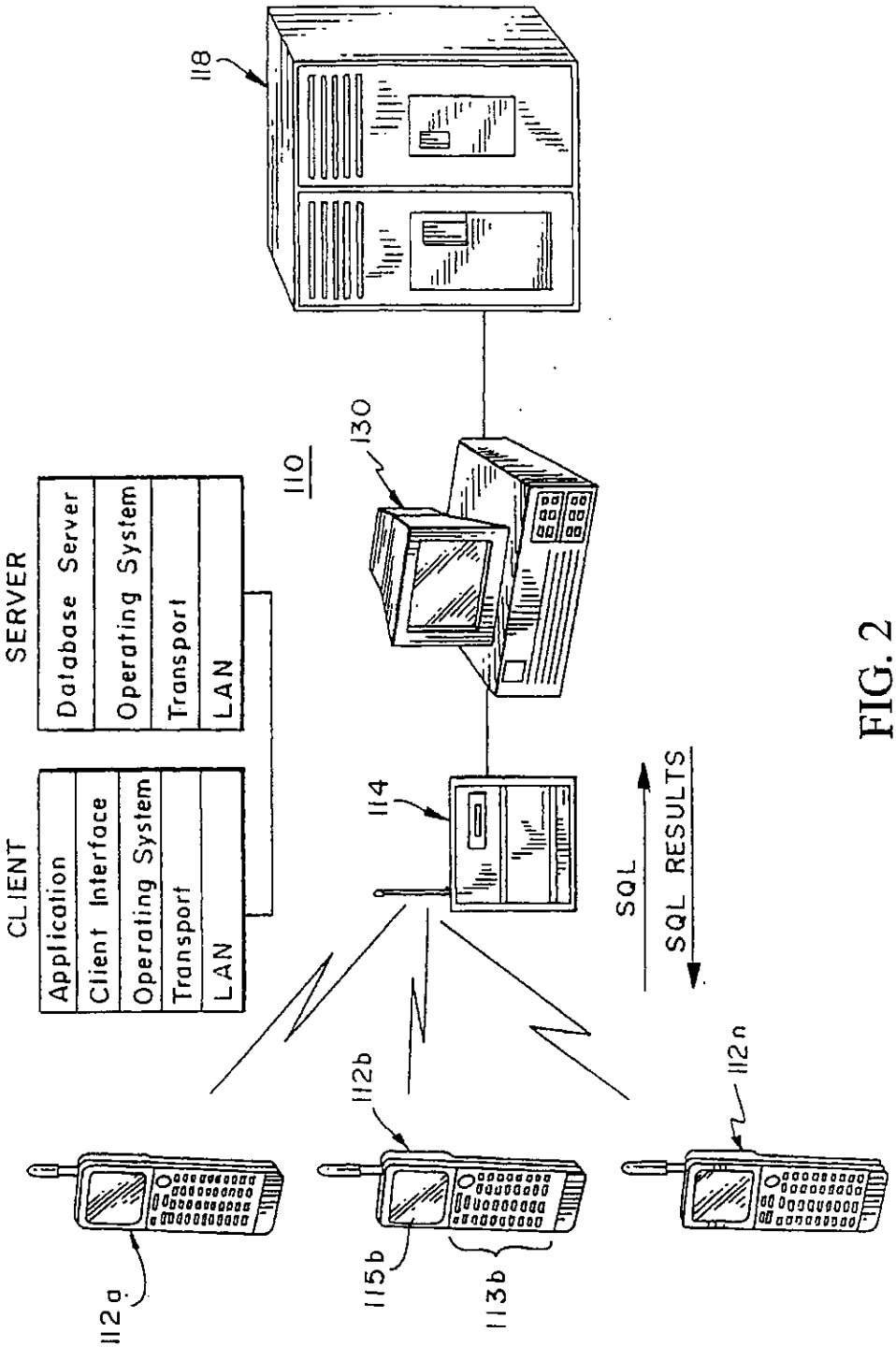

118
130
110
SERVER
Database Server
Operating System
Transport
LAN
CLIENT
Application
Client Interface
Operating System
Transport
LAN
114
SQL
SQL RESULTS
112b
112n
112a
115b
113b

FIG. 2

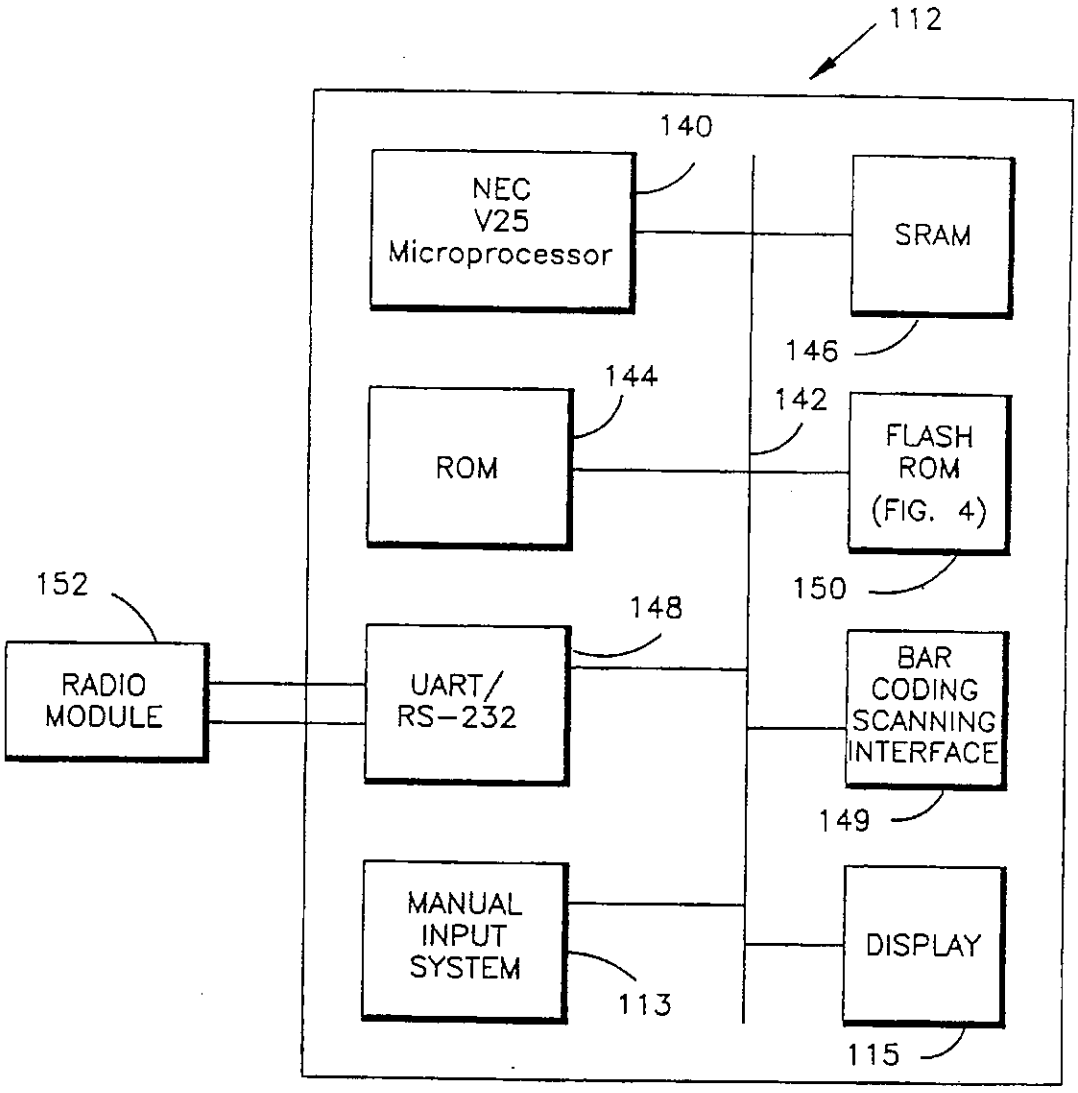

112
140
NEC
V25
Microprocessor
SRAM
146
144
142
ROM
FLASH
ROM
(FIG. 4)
150
152
148
RADIO
MODULE
UART/
RS-232
BAR
CODING
SCANNING
INTERFACE
149
MANUAL
INPUT
SYSTEM
113
DISPLAY
115

FIG. 3

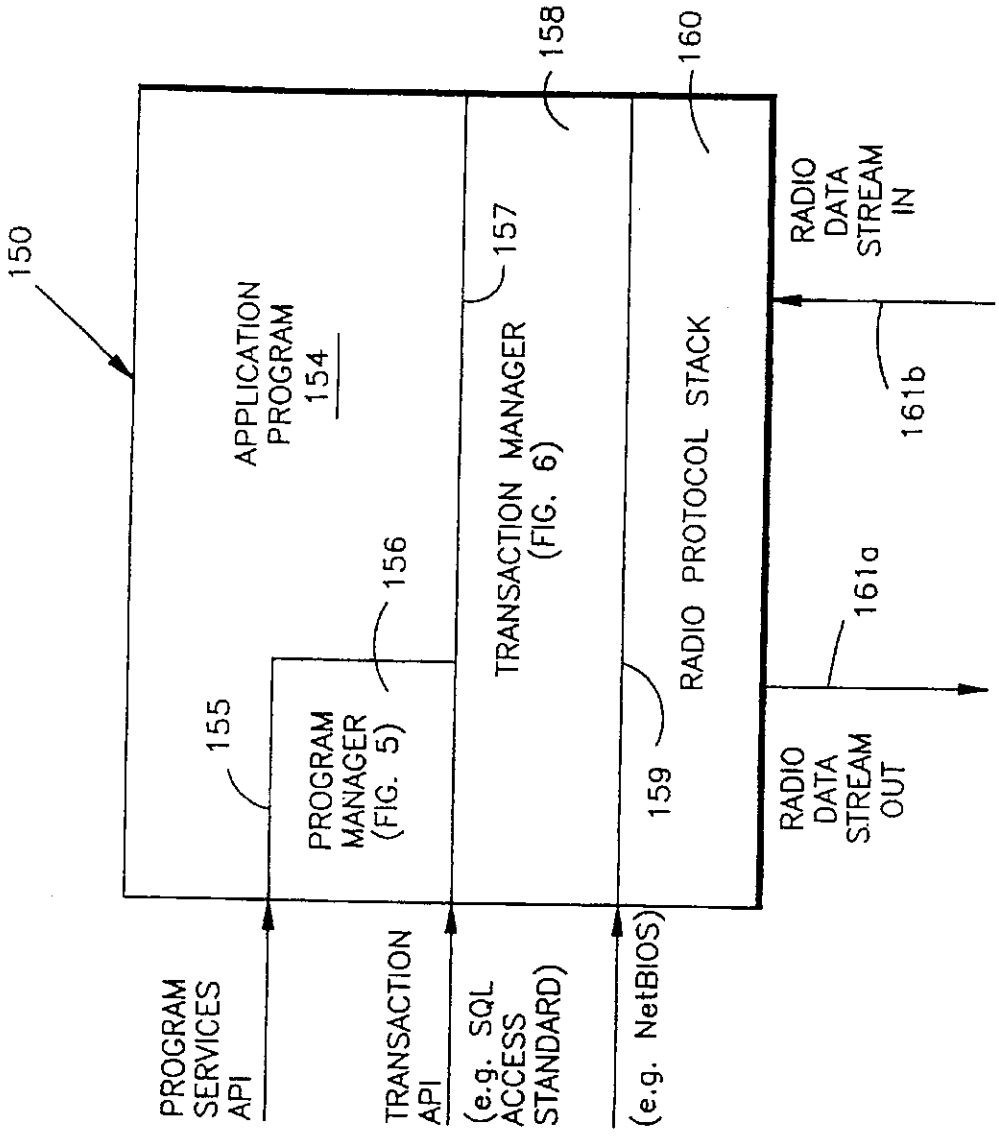

150
APPLICATION PROGRAM 154
155
PROGRAM MANAGER (FIG. 5)
156
TRANSACTION MANAGER (FIG. 6)
157
158
159
RADIO PROTOCOL STACK
160
RADIO DATA STREAM IN
161b
161a
RADIO DATA STREAM OUT
PROGRAM SERVICES API
TRANSACTION API
(e.g. SQL ACCESS STANDARD)
(e.g. NetBIOS)

FIG. 4

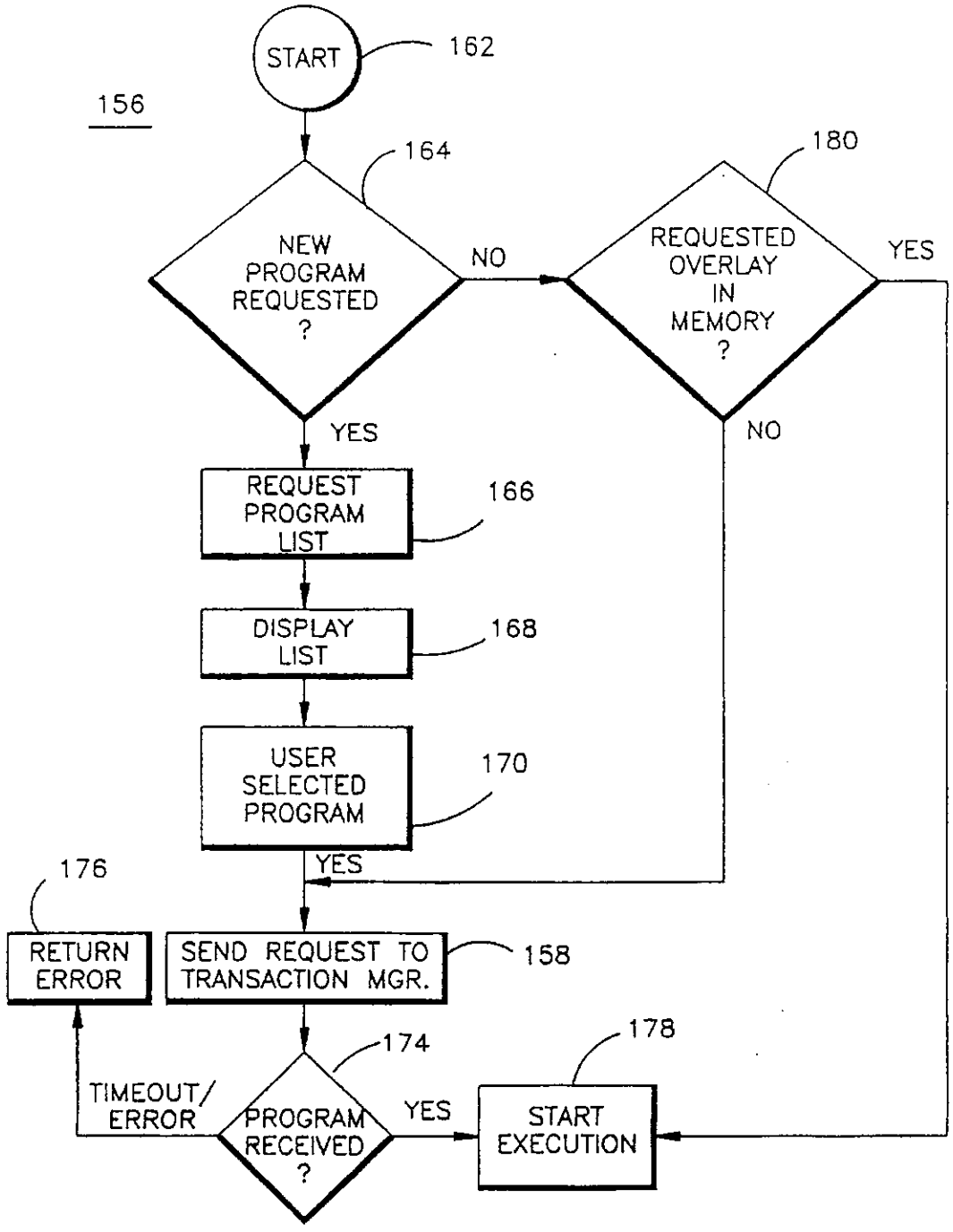

START
162
156
164
NEW PROGRAM REQUESTED ?
NO
180
REQUESTED OVERLAY IN MEMORY ?
YES
YES
NO
REQUEST PROGRAM LIST
166
DISPLAY LIST
168
USER SELECTED PROGRAM
170
YES
176
RETURN ERROR
SEND REQUEST TO TRANSACTION MGR.
158
174
178
TIMEOUT/ ERROR
PROGRAM RECEIVED ?
YES
START EXECUTION

FIG. 5

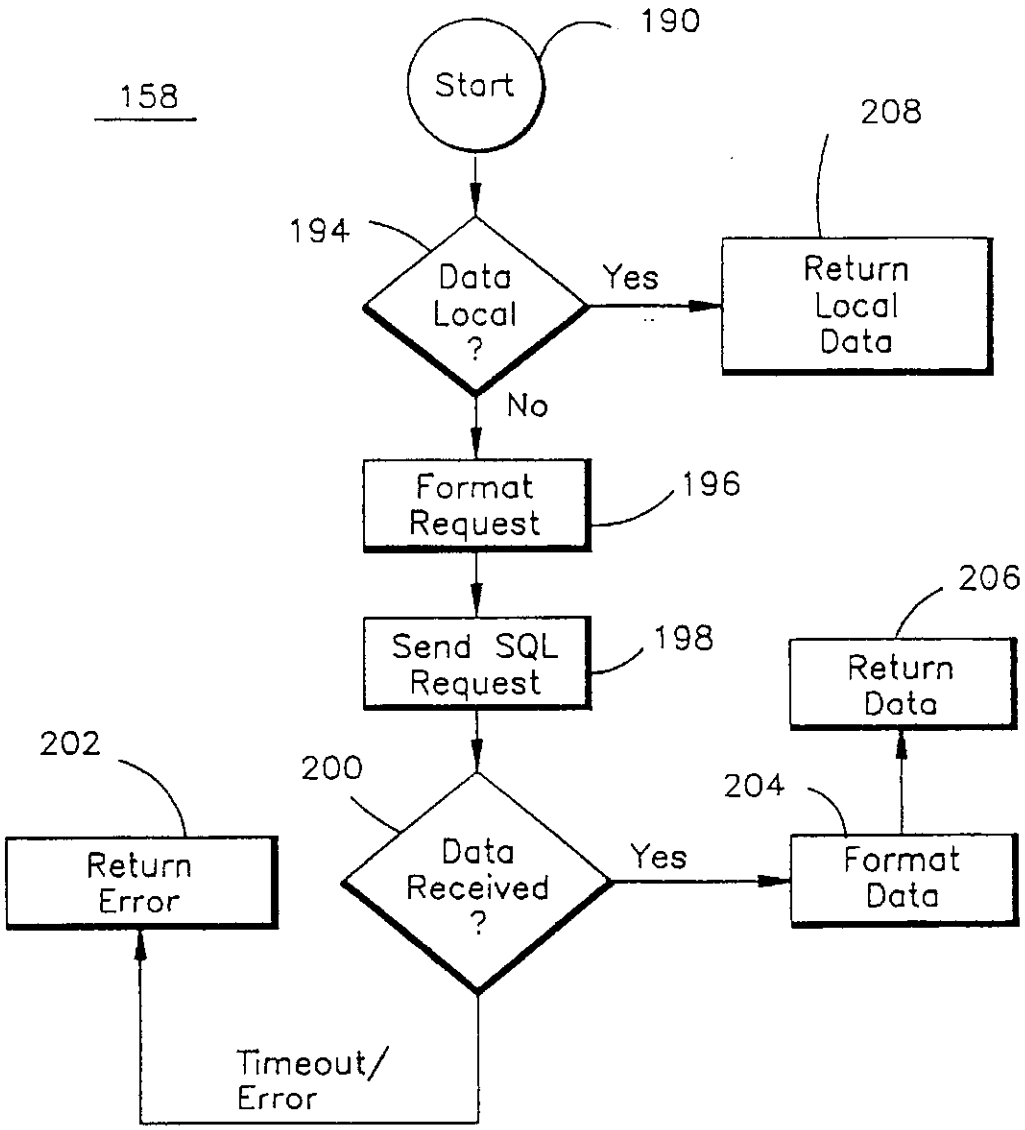

158
Start
190
208
194
Data Local ?
Yes
Return Local Data
No
Format Request
196
206
Send SQL Request
198
Return Data
202
200
204
Return Error
Data Received ?
Yes
Format Data
Timeout/ Error

FIG. 6

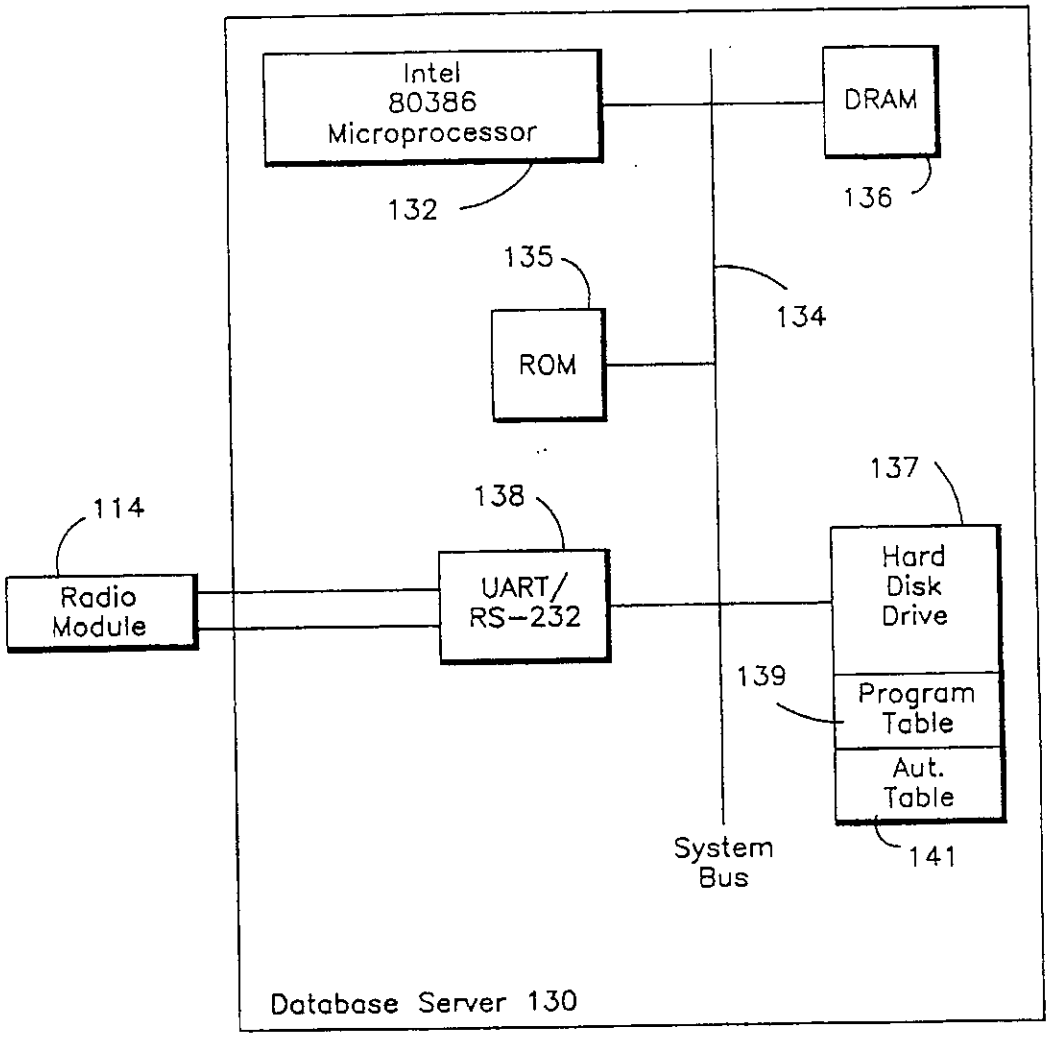

Intel
80386
Microprocessor
132
DRAM
136
135
ROM
134
137
114
138
Radio
Module
UART/
RS-232
Hard
Disk
Drive
139
Program
Table
Aut.
Table
141
System
Bus
Database Server 130

FIG. 7

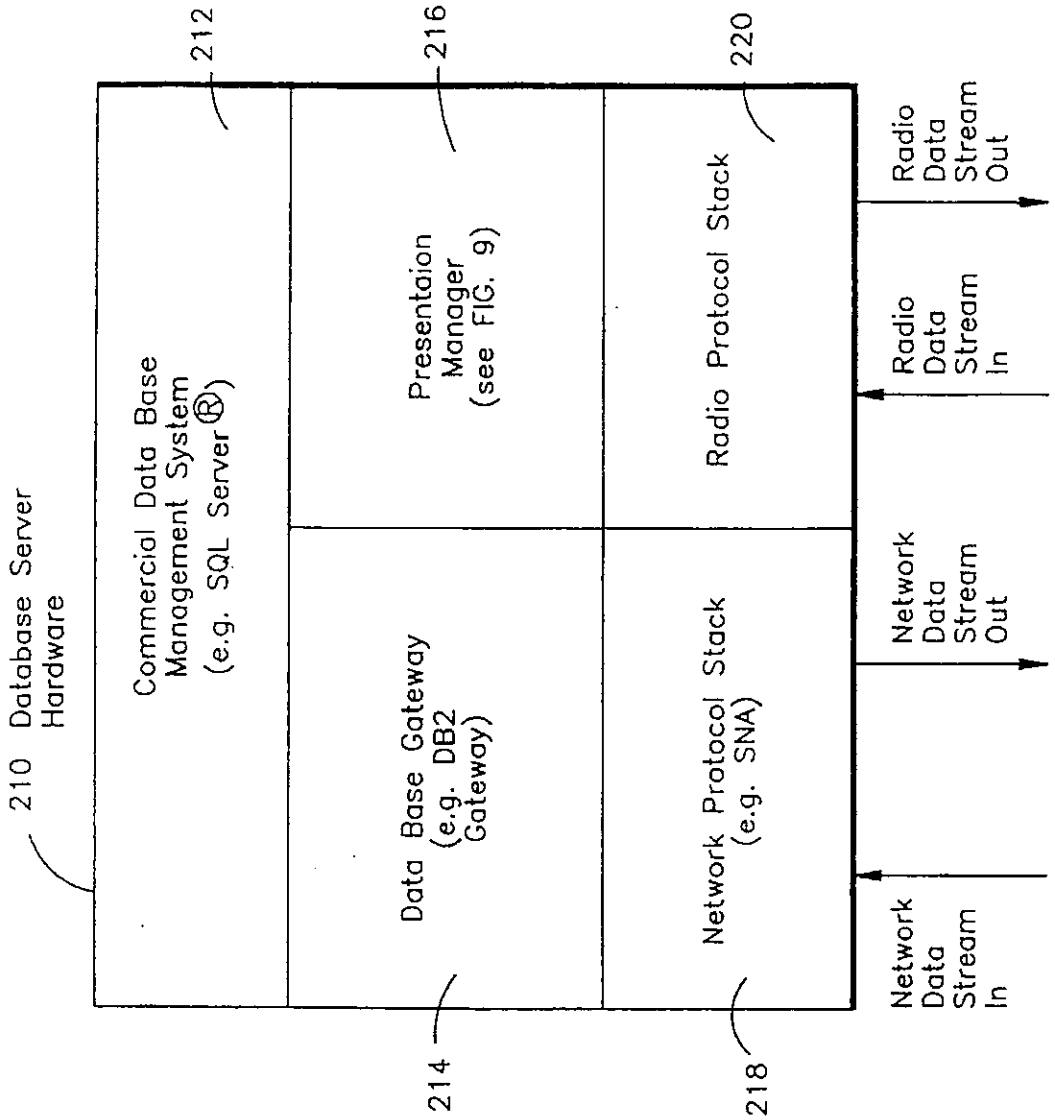

210 Database Server Hardware
Commercial Data Base Management System (e.g. SQL Server®)
212
Presentaion Manager (see FIG. 9)
216
Data Base Gateway (e.g. DB2 Gateway)
214
Radio Protocol Stack
220
Network Protocol Stack (e.g. SNA)
218
Radio Data Stream Out
Radio Data Stream In
Network Data Stream Out
Network Data Stream In

FIG. 8

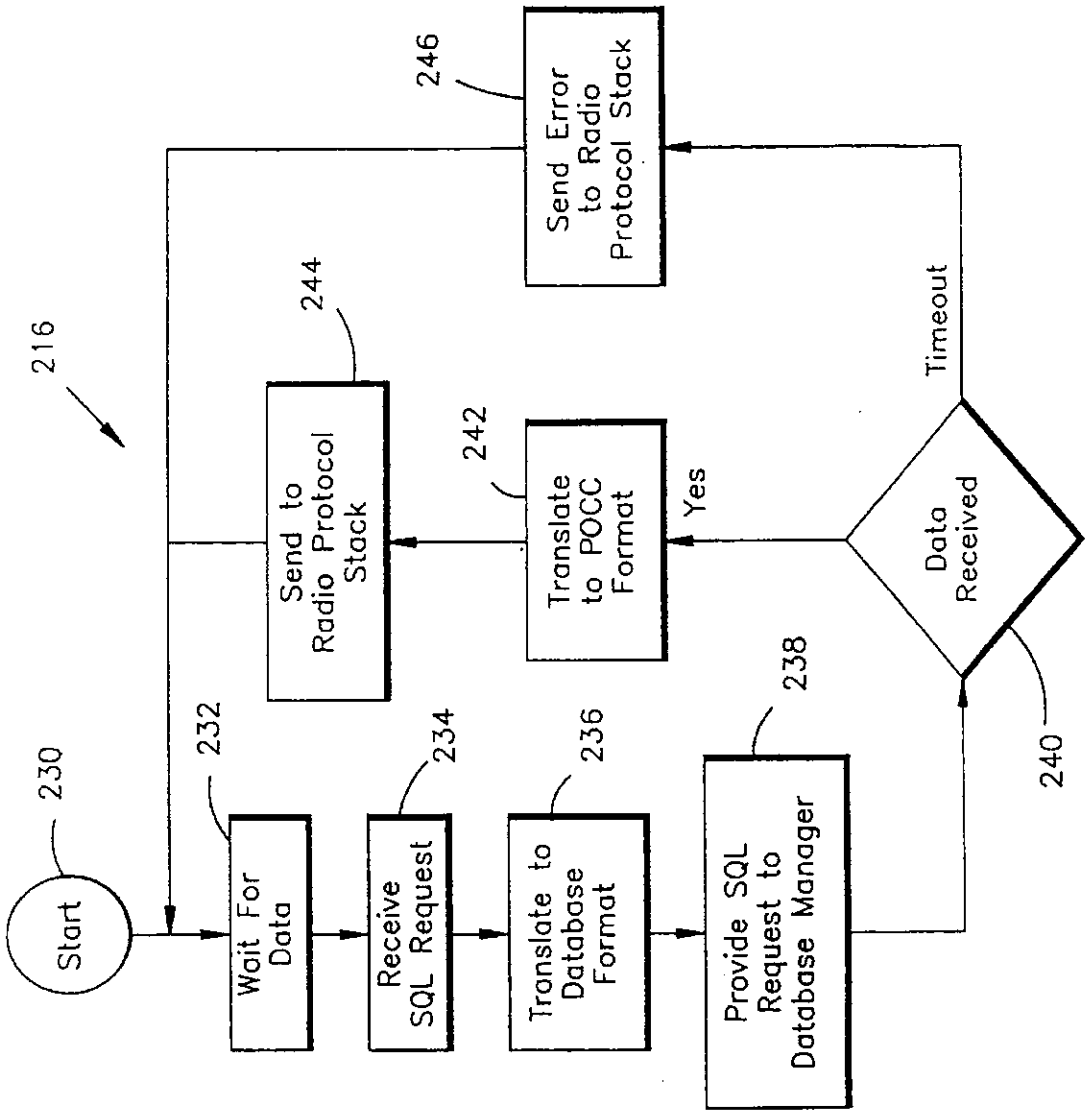

216
230
Start
232
Wait For Data
234
Receive SQL Request
236
Translate to Database Format
238
Provide SQL Request to Database Manager
240
Data Received
Timeout
Yes
242
Translate to POCC Format
244
Send to Radio Protocol Stack
246
Send Error to Radio Protocol Stack

FIG. 9

VERSATILE RF DATA CAPTURE SYSTEM

CROSS-REFERENCE

The present application is a continuation of U.S. application Ser. No. 08/267,758 (Attorney Docket No. DN37613A), filed Jul. 5, 1994, by Michael D. Morris et al., (now U.S. Pat. No. 5,568,645) which is a continuation of U.S. application Ser. No. 07/748,150 (Attorney Docket No. DN37613), filed Aug. 21, 1991, now U.S. Pat. No. 5,349,678.

AUTHORIZATION PURSUANT TO 37 CFR 1.71 (d) AND (e)

A portion of the disclosure of this patent document contains material which is subject to copyright protection. The copyright owner has no objection to the facsimile reproduction by anyone of the patent document or the patent disclosure, as it appears in the Patent and Trademark Office patent file or records, but otherwise reserves all copyright rights whatsoever.

REFERENCE TO RELATED, CO-PENDING PATENT APPLICATIONS

The following, co-pending applications are all assigned to assignee of this invention and are incorporated herein by reference:

1. U.S. Ser. No. 700704 (Express Mail Label No.: FB 537 394 682US), entitled "SYSTEM FOR COUPLING A MULTIPLICITY OF RF DATA COLLECTION TERMINALS WITH HOST COMPUTER MEANS" filed on May 14, 1991 in the names of Gollnick et al. (Attorney Docket No. DN37834X) now abandoned in favor of U.S. Ser. No. 07/857,603, filed Mar. 30, 1992 (Attorney Docket No. DN36834XA), now abandoned in favor of U.S. Ser. No. 07/947,102 filed Sep. 14, 1992 (Attorney Docket No. DN37834XXB); and
2. U.S. Ser. No. 660618 (Express Mail mailing Label No.: FB 537 394 671US), entitled "SYSTEM FOR PROCESSING COMMUNICATIONS WITH MULTIPLE PORTABLE RF DATA COLLECTION TERMINALS", filed Feb. 25, 1991 in the name of P. Miller (Attorney Docket No. 37734) now abandoned in favor of U.S. Ser. No. 07/830,561, filed Jan. 30, 1992 (Attorney Docket No. DN37734A.

BACKGROUND OF THE INVENTION

The present invention relates to a data capture system **10** illustrated in FIG. **1** for entering data at a plurality of remote locations using means such as a plurality of portable data collection terminals **12***a, b–n*. The data capture system **10** is applicable to receive and collect a wide variety of data and has found particular application in warehouses or retail store where a data capture system **10** would be used to keep an up-to-date record of the products to be marketed. Typically, the system **10** would be capable of updating on a real time basis the inventory count of products, and to use stock locator data to identify where each product of the remaining inventory is stored, when a product is moved from one place to another, and which employee has current charge of that product. In addition, when a product is sold, the price and sales person who sold the product are recorded.

Such data may be inputted into a terminal **12** by means of its keyboard **13**. For example, a terminal user could count the number of one type of product and enter that number via the terminal's keyboard **13**. Alternatively, data could be

entered to the terminal **10** via a CCD bar code scanner **22**, which is electrically coupled by a cable **20** to its terminal **12**. In an illustrative embodiment of this invention, the scanner as illustratively identified in FIG. **1** by the numeral **22***a* and its terminal **12***a* could take the form of that modular scanner/terminal described in PCT international application W090/16033 published Dec. 27, 1990. Differing types of scanners **22***b* and **22***n* could also be used witl the terminals **12** and may illustratively take the form of those scanners described in U.S. Pat. Nos. 4,970,379 of Danstrom, 4,882,476 of White, 4,894,523 of Chadima, 4,877,949 of Danielson et al., 5,019,669 of Adams et al. and 4,924,462 of Sojka; International Application No. PCT/US90/03282 of Koenck et al.; and European Patent Publication No. 0, 353, 759 of Mahany et al.

The data capture system **10** utilizes illustratively RF transmission to bilaterally transmit data between each of the plurality of terminals **12***a, b–n* and a base radio transceiver **14**. By way of example, the base radio transceiver may illustratively take the form of that model RB3000 base radio transceiver manufactured by Norand Corporation, Cedar Rapids of Iowa. In turn, the base radio transceiver **14** is connected via a communications multiplexer **16***a* or a communications controller **16***b* to a host computer **18**. Illustratively, the multiplexer **16***a* could take the form of that model RM3200 as manufactured by Norand Corporation and the controller **16***b* could take the form of that controller identified as model RC2250 of Norand Corporation. The host computer **18** may illustratively be an International Business Machines Corporation of AT class or higher. As illustrated in FIG. **1**, the host computer **18** includes a keyboard **28**, a display **24** and a system unit **26**.

Each of the portable data collection terminals **12***a, b–n* includes a transceiver (not shown in FIG. **1**) for transmitting RF messages to and from the base radio transceiver **14**. A transmitted message comprises an initialization sequence, an address indicative of the particular terminal **12***a, b*-or *n* from or to which the message is directed, a message identifier and system information, the message data and/or control commands, error control, and an end of message indication. U.S. Pat. Nos. 4,910,794; 4,924,462; and 4,940,974, each assigned to the assignee of this invention and incorporated herein by reference, provide further information on RF data collection terminals and systems.

In a RF data capture system similar to that shown in FIG. **1** known as the RT1200 system of Norand Corporation, controlled RF transmission between a plurality of terminals and a radio base is established using a communications multiplexer similar to that of the multiplexer **16***a* shown in FIG. **1** to provide access to a particular one of the terminals **12***a, b–n*. The RT1200 system utilizes time division multiplexing on a single frequency channel. The RT1200 communications protocol is based on a sequential polling method that transmits a query addressed to each portable terminal in succession, and allows a specified amount of time for the addressed terminal to respond when the addressed terminal has a data message ready for transmission. U.S. Pat. No. 4,940,974 describes an improved, adaptive data communications system wherein the base radio transceiver **14** transmits a multi-terminal polling signal to each of its terminals **12***a, b–n*. That multi-terminal polling signal defines a series of successive response time slots in which the terminals **12** may randomly select to respond. A terminal **12** having a message to be transmitted to the host computer **18** via the base radio transceiver **14** transmits a brief response burst in the selected time slot giving its own unique identification address. After receiving the responses

from the ready terminals **12**, the base radio transceiver **14** polls each of the responding terminals **12**, ignoring those terminals without messages to be transmitted. This system is adaptive in that the number of time slots may be changed depending upon the number of active terminals ready to transmit data messages.

The present invention is particularly related to adapting such data capture system **10** as shown in FIG. **1** to employ distributed processing concepts. Each of the portable data collection terminals **12** has a computer processing capability in the illustrative form of a microprocessor, whereby the entire system's processing capability may be distributed between the host computer **18** and the portable terminals **12**. The system **10** is structured in accordance with a client/server architecture whereby the host computer **18** acts as a server to each of the plurality of client terminals **12**, whereby programs may be dynamically loaded across that RF (or any serial) data link established between the host computer **18** and its terminals **12**.

The use of distributed processing is enhanced by relational database technology and the use of Structured Query Language (SQL) developed by the International Business Machines Company to provide access to relational databases. The use of relational database technology depends on organizing data in tables (or relations); each row of the table represents a record and each column represents an attribute. Various operations may be performed on these relations and, since the mathematics of these operations is very well understood, the results are predictable. An example of these operations is the "join", where two or more relations may be put together based on some common attribute. The advantage of this organization is that data may be easily retrieved in a form not envisioned by the designers; that is, ad hoc retrievals are quite easy to perform.

A further concept of distributed processing is to partition the system so that data is available to all network users but the data physically resides where it is most likely to be processed. This provides universal access without incurring severe communication overhead penalties. In the context of the data capture system **10** illustrated in FIG. **1**, data is made available to each of the terminals **12** and to the host computer **18** by the use of the RF transmission between each of terminals **12** and the base radio transceiver **14**. However, employing the concept of distributed processing would direct that more data and application programs be stored within each of the terminals **12**, where such data is used or such programs executed. As a result, overhead penalties, primarily in terms of delays as would occur by the transmission of data between the terminals **12** and its host computer **18** are avoided.

In a client/server model, the server provides a general function to several client processes. Some of the more useful implementations of this concept are distributed databases, remote procedure calls and networked pipes. The distributed databases currently rely on some form of communication through Structured Query Language (SQL). These databases are comprised of front-end applications and a database server. The application interacts with the user. When database access is required, the application sends an SQL request to the database server which services the request across a network. This allows most of the processing to be done locally, but provides for a central data store that may be shared by many distributed users.

The remote procedure call concept allows systems to become specialized servers so that many applications may use their specialized hardware. To access these remote services, the application program makes a procedure call that is like any procedure call to the program's code. The difference is that the call results in a request to a remote system to provide the computation designated by the call.

The concept of pipes relates to supplying the output of one process to the input of another process. If the two processes are on different computers then this becomes a method of distributed processing. A variant of this method is the named pipe which allows select output to be input to another process over a named connection. This is the primary method of distributed interprocess communications with an OS/2 LAN Manager.

The efficient transmission of data to a remote terminal of a system is key to distributed processing. IBMl's solution is their Distributed Data Management (DDM) protocols. These are a set of published IBM protocols that describe how to access files and databases on a remote system. IBM alsodeveloped a System Application Architecture (SAA) with common programming interfaces for program access to remote data on IBM SAA compliant systems. The importance of these protocols (which use LU 6.2 protocols for inter-system communication) is that a remote system such as a PC may access IBM host databases and files without having to program the host computer.

Remote data access in the non-IBM world is also becoming standard. The Network File System (NFS™) protocols (developed by Sun Microsystems but placed in the public domain) may be used to access or create files on any system running an NFS server. Novell Corporation is also providing similar services to a wide range of systems with its portable Netware™.

In current data capture systems employing a plurality of remote terminals **12**, the application program is run in the centrally disposed host computer **18** for real time control of the remote terminals **12**. Placing control in the host computer **18** increases significantly the hardware and software complexity forcing the host computer **18** to run multiple processes. Such application programs residing in the host computer **18** are complicated by the need to assure the concurrent control over shared data. Further, the host computer **18** must be fast enough to service all remote terminals **12** in real time. In such current data capture systems, the host computer **18** must normally validate data entry by the user and must respond to all user input, thus requiring significant amounts of data to be sent back and forth over an RF link between each of the terminals **10** and its host computer **18** as well as increasing the number of data transition session between the host computer **18** and its terminals **12**.

The present invention is related to the use of distributed processing concepts in a RF data capture system **10** as generally shown in FIG. **1** and in particular to improve the efficiency of such overall systems by improving the speed and efficiency of data transmission over the RF link between each of the terminals **12***a, b–n* and the base radio transceiver **14**.

SUMMARY OF THE INVENTION

It is therefore an object of this invention to decrease the response time required for a portable data collection terminal to respond to its user.

It is a further object of this invention to minimize the data transmitted typically by RF transmission between each of a plurality of terminals and its centrally disposed host computer.

It is a still further object of this invention to eliminate programming the host computer for real time control of its plurality of data collection terminals.

It is another object of this invention to provide an environment for the ready development of application programs for each of a plurality of data collection terminals.

It is a still further object of this invention to provide a new and improved scheme of distributive processing between a central or host computer and a plurality of remote terminals.

It still a further object of this invention to provide a new and improved battery operated terminal for se in a data capture system comprised of a plurality of such terminals, wherein the drain imposed by large memory and frequent use of radio modules is minimized.

In accordance with these and other objects of the invention, a data capture system comprises a plurality of client data collection terminals, and a server station. Each terminal includes a mechanism for collecting data, a dynamic addressable memory and a first controller operating on data formatted in a first style. The server station comprises a mass memory, which is larger than the dynamic addressable memory of a terminal for storing data to be used by the data collection terminals, an addresser responsive to a memory altering request for addressing the mass memory and a second controller operating on data formatted in a second style different from said first style. The data stored in the dynamic addressable memory is formatted in the second style. A communication system interconnects the server station and each of the plurality of client data collection terminals. The first controller of each client data collection terminal is responsive to a need for further data to generate a memory altering request and for actuating the communication system to transmit the generated request to the server station. The request is generated to identify its terminal and the particular needed data. The second controller of the server station is responsive to the transmitted request to address and retrieve the needed data from the mass memory before acting the communication system to transmit the needed data back to the requesting terminal as identified by the request.

In a further aspect of this invention, each of the plurality application programs is partitioned into a root module and at least one overlay module. The first controller of each terminal includes a processor for executing a selected application of the plurality and is responsive to the execution of an application program to generate the memory altering request and for actuating the communication system to transmit the generated request to the server station. The request identifies its terminal and the particular overlay module needed to continue the execution of its application program. The second controller of the server station is responsive to transmitted request for addressing and retrieving from its mass memory the particular overlay module, before actuating the communication system to transmit the particular overlay module back to the requesting terminal.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is diagrammatic illustration of an existing prior art data capture system which may be upgraded to incorporate features of the present invention;

FIG. 2 is diagrammatic illustration of a data capture system configured in a client/server architecture to effect distributed processing in accordance with the teachings of this invention;

FIG. 3 is a functional block diagram illustrating the architecture of a portable data collection terminal as shown in FIG. 2;

FIG. 4 is diagram of the application program architecture as stored within the ROM of the portable data collection terminal shown in FIG. 3;

FIG. 5 is a flow diagram of the Program Manager program shown in the architecture diagram of FIG. 4;

FIG. 6 is a flow diagram of the Transaction Manager program shown in the architecture diagram of FIG. 4;

FIG. 7 is a functional block diagram of the database server shown in FIG. 2;

FIG. 8 is a diagrammatic showing of the architecture of the database server memory; and

FIG. 9 is a flow diagram of the Presentation Manager program shown in the architecture diagram of FIG. 8.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings and, in particular to FIG. 2, there is shown a data capture system **110** in accordance with the teachings of this invention, where elements similar to those of FIG.1 are identified by like numerals but in the **100**'s series. The data capture system **110** includes a plurality of portable data collection terminals **112***a, b–n*, which in an illustrative embodiment of this invention may take the form of that terminal RT1000 as manufactured by Norand Corporation. Each terminal **112** includes, as shown in FIG.3, a radio module **152** which is capable of receiving and transmitting RF signals to a base radio transceiver **114**, which may illustratively take the form of that model RB3000 base radio transceiver as manufactured by Norand Corporion. The RB3000 base radio transceiver **114** is capable of operating at multiple baud rates as described in U.S. Pat. No. 4,910,794. In turn, the received signals are transmitted to a database server **130**, which in response to the received signals applies signals to the base radio transceiver **114** to be transmitted to a selected one of the plurality of the terminals **112**. Each message transmitted between one of the terminals **112** and the transceiver **114** includes an identification number or ID indicating the originating terminal **112** or its user. In turn, the database server **130** is coupled to a host computer **118**. In an illustrative embodiment of this invention, the host computer **118** may take the form of an IBM 3090 main frame with a DB2 database engine. As will be explained in detail below, each terminal **112** is programmed to compose an SQL request that will cause the database server **130** to return an application program, a memory overlay or application specific data to the requesting terminal **112**. The host computer **118** may also access the database server **130** by generating and transmitting SQL request messages thereto.

The host computer **118** has a database, which is accessible through the database server **130** to respond to the SQL request from one of the terminals **112**, supplying to the requesting terminal **112** a computer program, memory overlays or application specific data. The host computer **118** may illustratively take the form of an IBM 3090 main frame with a DB2 database engine and would have a memory of a capacity many orders greater than that of the terminals **112**. Much of the data Ed software to be used by* terminals **112** need not be stored with in the terminal's memory, but rather may reside in the database of the server **130** or in the memory of the host computer **118**. Thus, when that data and/or program stored in the database server **130** is needed, the needing terminal **112** formulates its SQL request message, transmits that message via the base radio transceiver **14** to be processed by the database server **130**, which accesses its database (or the memory of the host computer **118**) and retransmits the requested data or programs back to the requesting terminal **112**. At least two tables are defined as shown in FIG. 7 in a memory of the database server **130**

including a first program table **139** and a second authorization table **141**. The program table **139** keeps track of all of the programs, the overlays and the locations where they are stored in the database of the server **130**. The programs are typically stored as a "bulk" or "binary" data type. The program table requires at a minimum the following fields or attributes:

attribute	type	description
program name	char	Name of the program
overlay	char	root or other named overlay
date	char or date	Date program was created (revision control)
program	varbinary or varchar	The actual program or overlay
size	integer	The size of the binary to be loaded

As will be explained later with respect to FIG. **7**, the first, program table **139** and the second, authorization table **141** may be established within a hard disk drive **137** of the database server **130**. The SQL request includes an attribute to identify whether a new program or an overlay is to be accessed and sent by the requesting terminal **112**, and the address or name of the first, program table **139**. The SQL request does not need to have the address of the requested program or overlay, but accesses the program table **139**, which provides an address within the hard disk drive **137** in accordance with the attribute. As will be explained, the database server **130** in response to the SQL request accesses a particular program or overlay and transmits it back to the requesting terminal **112**. The second authorization table **141** identifies the relationship between a particular user and each of the programs which that user is authorized to access. For example, each user has an ID and the authorization table **141** would list the program names which may be accessed by that particular user ID. Similarly, the SQL includes the ID and an address for the authorization table **141**. Thus, the SQL request accesses the authorization table **141** to see if the requesting terminal **112** or its user as identified by the ID is permitted to use a particular program or overlay. If there is a match between the ID and one of the listed programs stored in the authorization table **141**, then as will be explained, the database server **130** will access that program or overlay and transmit it back to the requesting terminal **112**. On the other hand, if the ID is not found within the authorization table **141**, the requested program or overlay to not transmitted back to the requesting terminal **112**.

FIG.3 shows an illustrative embodiment of the hardware architecture of the elements of the portable data collection terminals **112**. Each terminal **112** includes a data bus **142** for interconnecting the elements of the terminal **112**, which may include a ROM **144** for the bootstrap loader, a flash ROM **150** for storing system and application programs, a static RAM (SRAM) **146** for storing data, programs and dynamically loadable program overlays, a microprocessor **140** which may take the form of that processor made by NEC as a model V25, the radio module **152**, a serial communication interface (UART) **148** for the radio module **152**, a bar coding scanning interface **149**, a manual input system such as a keyboard **113** and a display **115**. The serial communication interface **148** permit messages to be transmitted and received via the radio module **152**. The keyboard **113** and the bar code scanning interface **149** permit data entry respectively by the terminal user and a CCD bar code scanner similar to those identified in FIG. 1 by the numeral **22**. As is well known in the art, a scanner **22** would be moved across coded data to provide data descriptive of the item to which the bar code was attached, typically including a description of the item, its price and/or other inventory data.

Appreciating that each terminal **112** is battery operated, a plurality of memories **144, 146** and **150** are provided therein to store various types and sizes of data and programs dependent upon their use and to the end, that battery drain be minimized. The ROM **144** stores the operating system and basic input/output system (BIOS) for the microprocessor **140**. The SRAM **146** stores the dynamically loadable program overlays and data. The flash ROM **150** stores the system operating program and the application programs to be executed by the microprocessor **140**, typically carrying out the various inventory functions for which a terminal **112** may be programmed. A portion of the SRAM **146** is partitioned into tables for application specific data, i.e., data to be used by the stored application programs. It is a significant aspect of this invention, that not all of the application programs or application specific data which may be used by a terminal **112**, should be stored in the SRAM **146**, but rather that significant portions of the application programs and specific data may be stored in the database server **130** (or even in the host computer **118**) to be accessed when needed by a particular terminal **112**.

The archectiture of the software stored in the flash ROM **150** is shown in FIG. **4**. The flash ROM **150** stores a plurality of application programs **154**, e.g., inventory tracking, a program manager program **156** explained below with respect to FIG. **5** for transmitting the SQL request to the database server **130** to obtain an overlay module or a new program, a transaction manager **158** as explained below in detail with respect to FIG. **6** for opening a new session to receive or to transmit streams of data thereto, and a radio protocol stack **160** for effecting the RF transmission of a data stream out **161***a* to the database server **130** and for receiving an RF transmission via a data stream input **151***b* from the database server **130**. An application interface **155** is established between the application programs **154** and the program manager **156**, whereby any of the application programs can request the services of the program manager **156**, which may be illustratively thought of as a collection of sub-routine calls for new overlay modules or a new program as will be explained below with respect to FIG. **5**. Further, the application programs **154** have a transaction application programming interface (API) **157** with the transaction manager **158** as will be explained below with respect to FIG. **6**. The transaction API **157** permits an application to transmit a SQL request to the database server **130**. In turn, the transaction manager **158** has an interface **159** as exemplified by a NetBIOS with the radio protocol stack **160**, which effects by RF transmission the sending and receiving of data to and from the database server **130**. As indicated by the archectiture of the data stored within the flash ROM **150** shown in FIG. **4**, the radio protocol stack **160** is transparent with respect to an application program, i.e., the application program need not be programmed to effect radio transmission but only to place a call to transmit or to receive data. Either the program manager **156** or the transaction manager **158** carries out that step without any special program of the application programs **154**.

The database server **130**, as shown generally in FIG.2, may illustratively take the form of an IBM PS/2 model **80** computer running IBM's OS/2 Extended Edition operating system. Generally, the database server **130** responds to a SQL request transmitted by a radio module **152** of a data collection terminal **112** (see FIG. **3**), or from the host computer **118**. The response of the database server **130** to the SQL request is determined by the semantics of that SQL

request, which is formatted in the ANSI standard SQL. The database server **130** need not store state information about each of the terminals **112***a, b–n*. Data relating to a particular or specific terminal **112** is assigned to its own memory table, which may be illustratively formed at its unique address within a DRAM **136** of the database server **130** as shown in FIG. **7**. That table for terminal specific data may be used at a buffer, where the addressed location within the DRAM **136** acts as a buffer memory to be addressed by a SQL request and in response thereto, to transmit the data stored in that buffer to the requesting terminal **112**. Alternatively, the terminal specific data could be stored in the hard disk drive **137** of the database server **130** and could be accessed by assigning an identifier attribute for that data to each terminal **112**, whereby the appropriate relation in the hard disk drive **137** of the database server **130** could be defined. As will be explained, each SQL request identifies a new program, an overlay or application specific data which is required by the requesting terminal **112**; the database server **130** responds to that request and transmits in turn the requested program, memory overlay or application specific data to the particular requesting terminal **112**.

FIG. **7** shows the hardware architecture of the database server **130**, including a data bus **134** for connecting the various elements thereof, a microprocessor **132** illustrative taking the form of that processor manufactured by Intel under its model No. 80386, a ROM **135** for the computer powerup program, the diagnostic programs and the BIOS program, the dynamic RAM (DRAM) **136** serving as a memory for a database server program, server data, and a "cache" memory for the database, and a mass storage in the illustrative form of the hard disk drive **137** for storing all of the partitioned application programs and application specific data to be called by the plurality of terminals **112***a, b–n*. The database server **130** may provide gateway functions to other databases, e.g., DB2. In an operational sense, a gateway function permits access to a remote database by passing and/or reformatting the request. In other words, the SQL request could be translated into a format that would correspond and be recognized by that format of the remote database.

Referring now to FIG. **3**, the SRAM **146** of a portable data collection terminal **112** is significantly smaller than the disk drive **137** of a database server **130** and may have a capacity insufficient to store all of an application program and data to be executed by its microprocessor **140**. Distributed processing is accomplished in the context of this data capture system **110** employing a plurality of terminals **112** and a database server **130**, by partitioning each application program into a plurality of parts or second information portions or modules. The first program part is known as a root module and will be loaded first when a request for a new program is issued by the microprocessor **140** at power up or entered by a user through the terminal's key board **113**. There will be at least one and typically many further parts or second information portion known as memory overlays or overlay modules. The root module and the overlay modules will be given unique identifiers so that they may be loaded when requested. When the microprocessor **140** is executing the last instruction of a root module or an overlay module, then it is necessary to request and retrieve the next overlay module to permit the application program to continue to be executed without interruption. As will be explained below, this data capture system **110** is capable of formatting a SQL request for that original program or root module and for the subsequent overlay modules. In the simplest embodiment of this invention, the programmer builds into the application program a request to the program manager program **156** (see FIG. **4**) to request and load an overlay module and jump to it. In a more sophisticated version, a program in the development environment determines the external function calls in program and substitutes a call to the program manager program **156**. The development in partitioning of an application program is accomplished on the database server **130** using a data collection terminal emulator system that emulates the keyboard **113**, the display **115** and other possible peripherals of the terminal **112**. The only programming to be done specific to the database server **130** is to create the database tables and load them with any application specific data.

The software architecture of the DRAM **136** is further described in FIG. **8**, as being partitioned to store a commercial database management system **212** such as the SQL Server (Microsoft), a database gateway **214**, e.g., a DB2 Gateway by IBM, a presentation manager **216** to be more fully disclosed in the flow diagram of FIG. **9**, a network protocol stack **218**, and a radio protocol stack **220**.

The program manager program **156** generally shown in the software architecture diagram of FIG. **4** is more fully shown in the flow diagram of FIG. **5**. Basically, the program manager program **156** is disposed in the next lower layer below an application program, e.g., an inventory program, and responds to its request for either a new program or a memory overlay, to configure and transmit an SQL request to the database server **130**. Upon receipt of the requested program or memory overlay, the program manager program **156** stores it in SRAM **146** before initiating its execution by the microprocessor **140**. A start **162** is initiated in a number of ways by the associated application program. At power up when typically there is no application being executed, the operating system program, which is stored in the ROM **144**, places a call to the program manager **156**. Alternatively, a new application program may be called by the operator by actuating a selected key(s) of the keyboard **113**. Appreciating that all of a particular application program need not be stored in the SRAM **146**, overlay modules of the application program presently being executed may be stored in the database of the server **130** and may be called by the program manager program **156**. The application program continues to be executed until it recognizes that the next step is not available, at which time it places a call through the start step **162** for the next section or overlay module of the application program to be retrieved and placed in the SRAM **146** of the requesting terminal **112**.

After a start has been provided in any of these ways, step **164** determines whether a new program or memory overlay is being requested. If a new program is requested, step **166** accesses the database in the server **130** for the requested program. In particular, step **166** initiates the radio protocol stack program **160**, whereby the radio module **152** (see FIG. **3**) is activated to transmit the SQL request to the database server **130** via the transceiver **114** (see FIG. **2**). The SQL request initiated by step **166** seeks as will be described below a list of programs which are stored in the database server **130** and is available to this originating terminal **112**. Initially, step **166** calls the radio protocol stack program **160** (see FIG. **2**), whereby access is made through the UART **148** (see FIG. **3**) to the module **152**, turning module **152** "on" to transmit the SQL request to the transceiver **114**. In addition to actuating the radio module **152**, the radio protocol stack **160** provides the protocols and media access to allow the SQL request to be sent via the transceiver **114** to the database server **130**. Illustratively, the radio protocol stack **160** would include the RTC system as described in U.S. Pat. No.

4,940,974. When the radio protocol stack **160** is called to initiate transmission, a session is said to be held between the requesting terminal **112** and the database server **130**. For example, when a SQL request is generated by the transaction manager **158** (see FIG. **4**, a session is opened. Each session enjoys a logical relationship between the requesting terminal **112** and the database, e.g., the hard disk drive **137**, within the database server **130**. Each session includes one or more data packets, the data packet being the maximum byte size of the data stream appearing on the output **161***a* that may be transmitted by the radio module **152**. The radio protocol stack **160** functions to segregate a data stream out **161***a* to be transmitted to the database server **130**, into a number of data packets and, in similar fashion, to reassemble the data packets of an incoming data stream appearing at the input **161***b* into a continuous data stream. Each SQL request includes an address or ID of its originating terminal **112**. As will be explained later, the database server **130** uses a presentation manager program **216** to store the relationship (mapping) between the terminal ID and the operating system session identificer, which is stored in a known location within the DRAM **136** of the database server **130**. In this way, the database server **130** remembers to which of the plurality of terminals **112***a, b–n* that the requested data or memory overlay, should be transmitted.

The database server **130** operating as will be explained, will respond to the SQL request for a program overlay by accessing a list of programs authorized for the particular requesting terminal **112** or user and transmitting that list back via the transceiver **114** to the requesting terminal **112**. Illustratively, step **166** may format an SQL request in the following manner:

```
select distinct program_name from
authorization where user_id = "morrismd"
```

Here the SQL request is seeking a list of distinct programs, not duplicates, which have been authorized for transmission to a particular user, i.e., a particular terminal **112**. In the illustrative request, the user ID is "morrismd"; in other words, all program names having an ID attribute "morrismd" are distributed to the requesting terminal **112**. Next, step **168** displays the received list of authorized programs on the terminal's display **115**.

In step **170** of FIG. **5**, the terminal user selects from that list of available programs as displayed in step **168** and enters via the terminal keyboard **113** the selected program to be requested from the database of the server **130**. When a program is selected from the menu displayed upon the display **115** (see FIG. **2**) by user actuation of the keyboard **113**, the transaction manager **158** (see FIG. **6**) is called to format the SQL request to retrieve from the remote database the particular program selected in step **170**. An illustratively example of such a SQL request may take the form of:

```
select program from program_table where
program_name = "inventory.exe" and overlay =
"root"
```

Illustratively, the SQL request accesses the first, program table **139** (see FIG. **7**) to obtain the address in the hard disk drive **137** of the requested program, e.g. the "inventory.exe" program, which is an original program or it's root overlay.

After transmission of the SQL request for a new program, step **174** waits for a returned message to the terminal **112** and will time out after a set period, e.g., 30 seconds. If no response is received by the requesting terminal **112** within this period, step **176** generates a return error message and returns it to the calling application program. On the other hand if the requested original program is received within the period, step **178** updates a mapping memory or table, which may be illustratively included within the SRAM **146** see FIG. **3** of the terminal **112**. A record of the application program or module thereof presently being executed by the microprocesor **140** is recorded in the mapping memory in terms of its starting address and length. When a new program is received and loaded into SRAM **146**, step **178** records its starting address and length in the mapping memory, before loading the root module of the new program into a designated location of the SRAM **146** and, thereafter, initiates execution of the received and loaded program instead of returning control to the application program. The SRAM **146** is used as a "cache" memory to receive the **140** programs and memory overlays to be executed by the microprocessor **140**. Thus, the SRAM **146** provides a local memory from which the application program may be executed, whereas the remaining sections or memory overlays of the application program and other original programs may be stored distantly in the database of the server **130**.

It is appreciated that application programs are sometimes larger than it's sections or memory overlays. Therefore to efficiently use the local memory, e.g., the SRAM **146** , new programs are illustratively stored in the database of the server **130**, whereas program overlays may be stored in both the database of the server **130** and in the local memory, i.e. the SRAM **146**. Therefore, if step **164** determines that the application is not requesting a new program, but rather an overlay module, step **180** examines the SRAM **146** and if the requested overlay module is in SRAM **146**, the program moves to step **178** to initiate execution of the overlay module and control is passed to the overlay module. However, if the requested overlay module is not in the SRAM **146**, step **180** moves control moves to the transaction manager **158**, which formulates and transmits a SQL request via the transceiver **114** to retrieve the needed overlay module from the database of the server **130**. The requested memory overlay is transmitted back via the transceiver **114** and is loaded into SRAM **146** and, thereafter, the local mapping memory in SRAM **146** is updated in terms of its starting address and length. After step **174** determines that the requested program has been timely received as explained above, step **178** initiates execution of the overlay module before returning control to the application program.

Referring now to FIG. **6**, there is shown the transaction manager program **158** which responds to a call from the application program **154** (see FIG. **4**) for data to be processed thereby and provides an application programming interface (API) **157** to the application program which allows it to access the database in the server **130**. The transaction manager program **158** also supports the program manager program **156** to access programs stored in the database of the server **130**. Thus, it is seen that the program manager program **156** of FIG. **5** accesses second information portions such as remote programs and overlay modules whereas the transaction manager **158** of FIG. **6** accesses any kind of data. Initially, step **194** determines whether the requested data is in the local memory, i.e., SRAM **146**, and, if so stored, step **208** returns the local data to be processed by the application program. If not, step **196** formats an SQL request for the requested data and step **198** calls the radio protocol stack program **160** (see FIG. **4**) thus actuating the radio module **152** and transmitting the SQL request via the transceiver **114** to access the requested data in the database in the of the

server **130**. Step **200** waits while the server **130** accesses the requested data and transmits it via the transceiver **114** to the requesting terminal **112**. Step **200** times a response period, e.g., 1 minute, and if that period is exceeded indicating an error condition, step **202** returns an error message to the calling application program. If the data is received within the response period, step **204** formats the requested data in a form usable by the calling application program, before step **206** returns that data to the application program. Step **206** returns the data to the SRAM **146**, whereby control is passed to the application program which uses the returned data.

The presentation manager program **216**, shown in FIG. **9**, processes the SQL request transmitted from one of the terminals **112** (see FIG. **2**) via the transceiver **114** and a standard interface, e.g. Unix sockets or IBM NetBIOS, to the database manager program **212** (see FIG. **8**). The database manager program **212** interprets the SQL request and accesses the hard disk drive **137** accordingly (see FIG. **7**). This allows an application program being executed by the microprocessor **140** (see FIG. **3**) to establish sessions with any SQL accessible database as maybe formed within the hard disk drive **137** of the database server **130**. The principle function of the presentation manager program **216** is to translate between that format used by the transaction manager program **158** of a terminal **112** and the SQL format of the database of the hard disk drive **137**, if these formats are different. The SQL request to be applied to the database management program **212** is semantically configured in accordance with the function to be achieved. The SQL request may direct that data be inserted in the disk drive **137**, that data be accessed and retrieved, that a new program or overlay module be retrieved from the disk drive **137**, that data be added to one or more fields in a set of records stored in the disk drive **137** or that data be deleted from one or more records of the disk drive **137**. Updating involves the transmitting of new variable values from the originating terminal **112**.

Referring now to the flow diagram of FIG. **9**, the presentation manager program **216** enters through start step **230** to step **232**, which waits for a SQL request to be forwarded from the radio protocol stack **220** (see FIG. **8**). As will be described below, the SQL request is directed toward the database manager program **212**. Step **234** receives the SQL request as a sequence of bytes. Step **236** comes into play only if some reformulation of the SQL request is necessary. In a first instance, if the database manager program **212** was not adapted to support the ANSI standard SQL format or if the SQL request was compressed, then step **236** would be necessary to decompress the data or to translate the format of the SQL request into that of the particular database manager program **212** employed in the system. Next, step **236** provides the data to the database manager program **212** through an interface in the illustrative form of the IBM NetBIOS interface. The translation step **236** is identical to the formatting request **196** of the transaction manager program **158** of FIG. **6** and, ordinarily, it would be only necessary to perform the formatting or translation step once upon a particular SQL request, preferably in the presentation manager program **216**. Step **240** waits for the database manager program **212** to access the disk drive **137** for a predetermined time period. If the requested material, i.e., a second information portion such as the application specific data, root overlay or memory overlay, is received within the time period, it is translated in step **242** to the format of the requesting terminal **112**, before calling the radio protocol stack program **220** to transmit the accessed material back to the requesting terminal **112**. On the other hand, if the SQL request is one to add or delete data from the hard disk drive **137**, step **240** generates a status message indicating that the change of the hard disk drive **137** has been completed, before step **242** translates that status message into the terminal format and the radio protocol stack **220** is called in step **244** to send that message back to the requesting terminal **112**. If the time period set in step **240** times out, without receiving the requested material, step **246** transmits an error pachet to the radio protocol stack program **220**, whereby an error message is returned to the requesting terminal **112**.

Thus, there has been described a data capture system **110** that distributes the application program between the memory of a terminal **112** and a database server **130** serving a plurality of such terminals **112**. In this fashion, the complexity of the program to be executed upon a terminal **112** is minimized by permitting the data base server **130** and its hard disk **137** to store a large variety of application programs to be served to its client terminals **112**. The above data capture system **110** permits dynamic loading of the original programs or root modules and subsequent memory overlays from the hard disk **137**, whereby the size of the SRAM **146** of a terminal **112** and the power required by a terminal **112** is minimized. Further, the amount of data transmitted via the RF link between each of the plurality of terminals **112** and the database server **130** is minimized. Further, the database server **130** provides a "user friendly" environment for the development of application programs for the terminals **112**. In particular, the database server **130** is capable of readily developing both the client and server portions of the application programs to be executed by the terminal's microprocessor **140**.

It will be apparent that many modifications and variations may be effected without departing from the scope of the teachings and concepts of the present disclosure.

We claim:

1. A data collecting system for collecting data from at least one remote site and transmitting the collected data to a main information center, and having information distributed throughout said data collecting system, the information being partitioned into a first information portion and a second information portion, said data collection system comprising:

at least one terminal for collecting data at the remote site, said terminal comprising a data collection mechanism, a first memory for storing the first information portion, a first controller responsive to the need for information by said terminal to generate an information call identifying the needed information, said first controller further responsive to the information call by searching said first memory for the presence or absence of that needed information, said first controller responsive to the presence of that needed information by accessing said first memory and supplying that accessed, needed information for use by said terminal;

a server for said terminal;

a communication system communicatively interconnecting said terminal and said server, said first controller responsive to the absence of that needed information within said first memory by transmitting the information call via said communication system from said terminal to said server; and

said server disposed at the main information center and comprising a second memory for storing the second information portion, and a second controller responsive to the information call transmitted via said communications system from said terminal by accessing the requested information from said second controller and

transmitting the accessed information via said communication system from said server to said terminal.

2. The data collecting system as claimed in claim 1, wherein the information comprises a plurality of application programs, the first information portion comprises a root module and the second information portion comprises at least one overlay module, said terminal comprising a processor for executing a selected one application program, and said first controller responsive during the executing of the root module by said processor to generate the information call requesting a particular overlay module.

3. The data collecting system as claimed in claim 2, wherein the second information portion also comprises application specific data and a request encoded within each of said application programs for the corresponding application specific data, said first controller responsive during the execution of one of said pluralities of the application programs by said processor to generate the information call for the corresponding application specific data.

4. The data collecting system as claimed 2, wherein said terminal comprises a keyboard for user entry of a request for a root module for a new application program of said plurality thereof, said first controller responsive to the root module request by generating in turn the information call thereof.

5. The data collecting system as claimed in claim 1, wherein said communication system is wireless.

6. The data collecting system as claimed in claim 5, wherein said terminal comprises a first radio and said server comprises a second radio, said communication system comprising said first and second radios.

7. The data collecting system as claimed in claim 6, wherein said first controller is responsive to the absence of the requested information within said first memory by actuating said first radio.

8. The data collecting system as claimed in claim 6, wherein said second controller is responsive to the receipt of the information call to actuate said second radio.

9. A data collection system comprising:

a portable terminal having processing circuit and a memory that both selectively stores at least portions of a plurality of application programs, and stores a listing of the plurality of application programs;

a computer network comprising a first computing device and a second computing device, each computing device stores at least portions of the plurality of application programs;

the portable terminal displays the listing of application programs for selection;

the portable terminal attempts to locate each portion of a selected one of the plurality of application programs as needed from the memory, but, if the portable terminal fails to locate the at least portions of the plurality of application programs in the memory, the portable terminal generates information calls and communicates the information calls to the first computing device; and

the first computing device attempts to service the information calls, but, if the attempt fails, the first computing device forwards the information calls to the second computing device for servicing.

10. The data collection system of claim 9 wherein the computer network is located at a remote location from the portable terminal.

11. The data collection system of claim 9 wherein the first and the second computing devices comprise server devices.

12. The data collection system of claim 11 wherein the information calls comprise SQL statements.

13. The data collection system of claim 10 wherein the first and the second computing devices comprise server devices.

14. The data collection system of claim 13 wherein the information calls comprise SQL statements.

15. A data collection system comprising:

a main information center with a plurality of servers, each server storing a plurality of application programs and associated application-specific data;

a plurality of remote data collection centers, each data collection center comprising one or more terminals;

each of the one or more terminal selectively requests the application programs from the main information center; and

the main information center delivers requested ones of the application programs in executable portions.

16. The data collection system of claim 15 wherein the terminal establishes a communication link with the main information center to deliver the requests, and the requests are selectively forwarded to at least one of the plurality of servers for servicing.

17. The data collection system of claim 16 wherein the requests comprise SQL statements.

* * * * *

EXHIBIT D

US005468947A

United States Patent [19]

Danielson et al.

[11] Patent Number: 5,468,947

[45] Date of Patent: Nov. 21, 1995

[54] **POCKET SIZE DATA CAPTURE UNIT WITH PROCESSOR AND SHELL MODULES**

[75] Inventors: **Arvin D. Danielson**, Solon; **Dennis A. Durbin**, Cedar Rapids, both of Iowa

[73] Assignee: **Norand Corporation**, Cedar Rapids, Iowa

[21] Appl. No.: **40,313**

[22] Filed: **Mar. 29, 1993**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 451,322, Dec. 15, 1989, Pat. No. 5,227,614, and a continuation-in-part of Ser. No. 947,036, Sep. 16, 1992, Pat. No. 5,308,966, which is a continuation of Ser. No. 875,791, Apr. 27, 1992, abandoned, which is a continuation-in-part of Ser. No. 422,052, Oct. 16, 1989, abandoned, which is a division of Ser. No. 894,689, Aug. 8, 1986, Pat. No. 4,877,949, said Ser. No. 451,322is a continuation-in-part of Ser. No. 143,921, Jan. 14, 1988, abandoned, which is a continuation-in-part of Ser. No. 897,547, Aug. 15, 1986, abandoned.

[51] **Int. Cl.**[6] **G06K 7/10**

[52] **U.S. Cl.** **235/472**; 235/462

[58] **Field of Search** 235/375, 379, 235/380, 382, 383, 381, 487, 492; 902/20–26; 364/700, 704, 705.01, 705.03, 705.06, 706, 708.1, 709.01, 709.09, 709.1, 709.11

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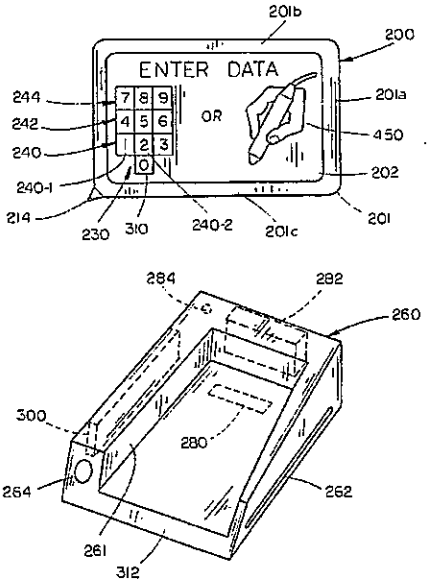
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Primary Examiner—Donald Hajec
Assistant Examiner—Mark S. Tremblay
Attorney, Agent, or Firm—Suiter & Associates

[57] **ABSTRACT**

A hand-held processing system wherein a peripheral module may receive therein a computer processor basic module of standardized construction, with a user-immune real-time multi-tasking operating system. Advantageously the peripheral module or computer processor module may include a touch screen or other highly versatile and compact data input/output device adaptable to graphical and/or other input/output modes suitable for different applications, languages and the like.

22 Claims, 16 Drawing Sheets



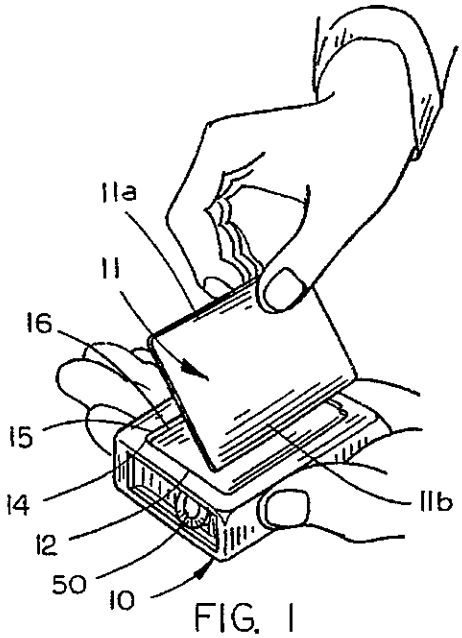


FIG. 1

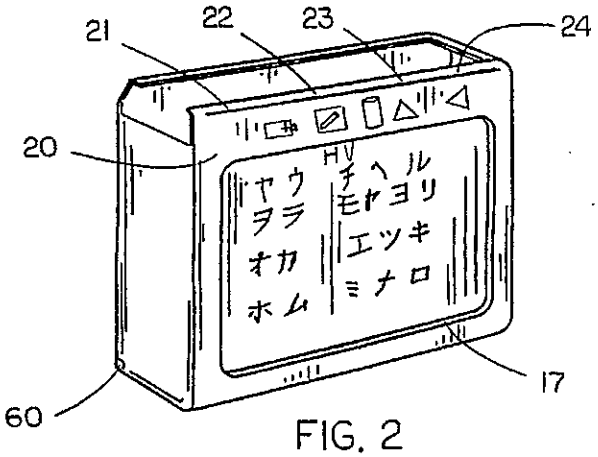


FIG. 2

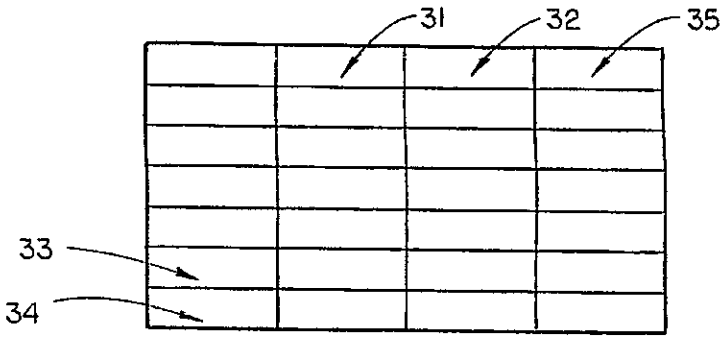


FIG. 3

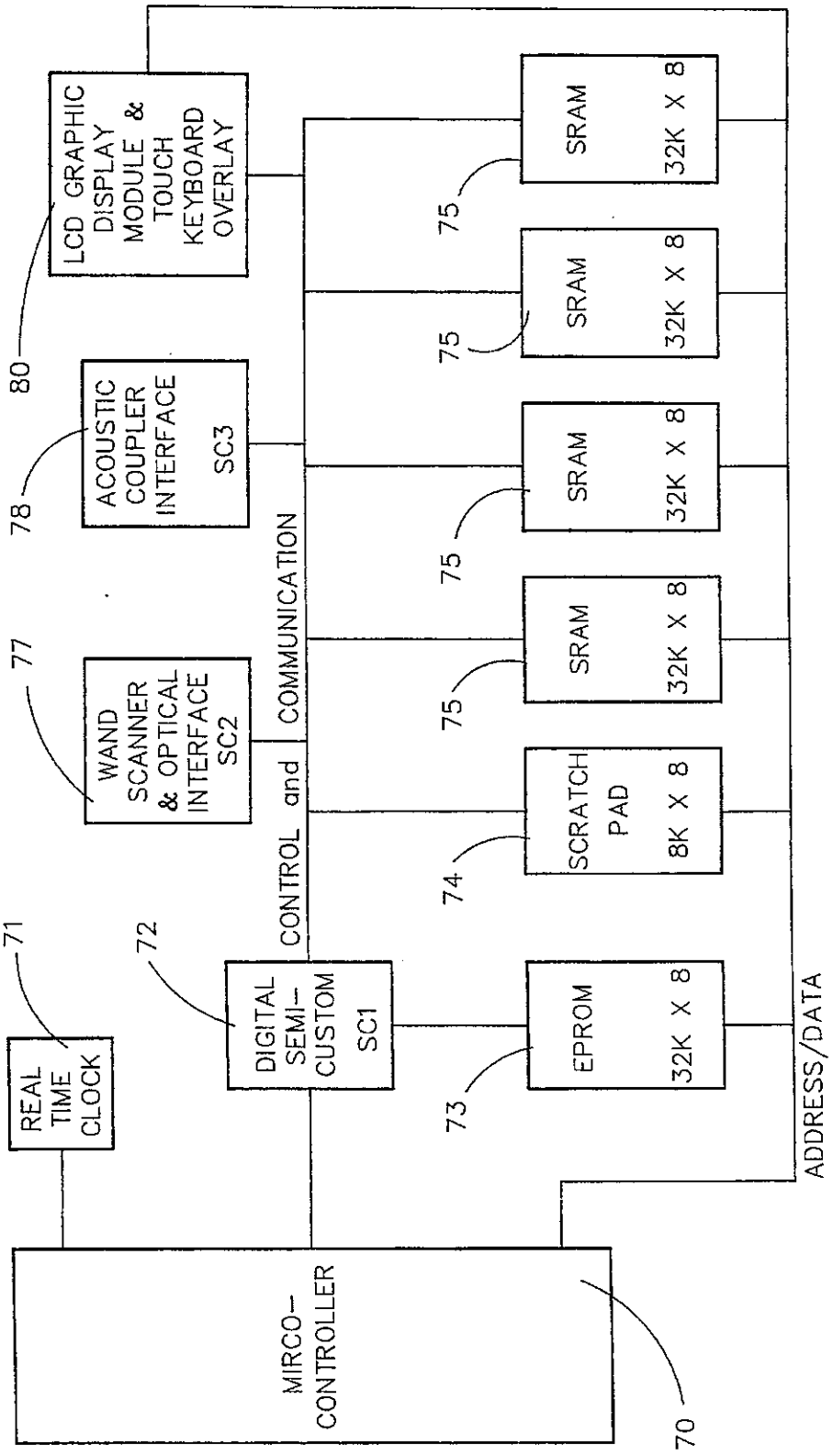

LCD GRAPHIC DISPLAY MODULE & TOUCH KEYBOARD OVERLAY
80
ACOUSTIC COUPLER INTERFACE SC3
78
WAND SCANNER & OPTICAL INTERFACE SC2
77
REAL TIME CLOCK
71
DIGITAL SEMI-CUSTOM SC1
72
MIRCO-CONTROLLER
70
CONTROL and COMMUNICATION
SRAM 32K X 8
75
SRAM 32K X 8
75
SRAM 32K X 8
75
SRAM 32K X 8
75
SCRATCH PAD 8K X 8
74
EPROM 32K X 8
73
ADDRESS/DATA

FIG. 4

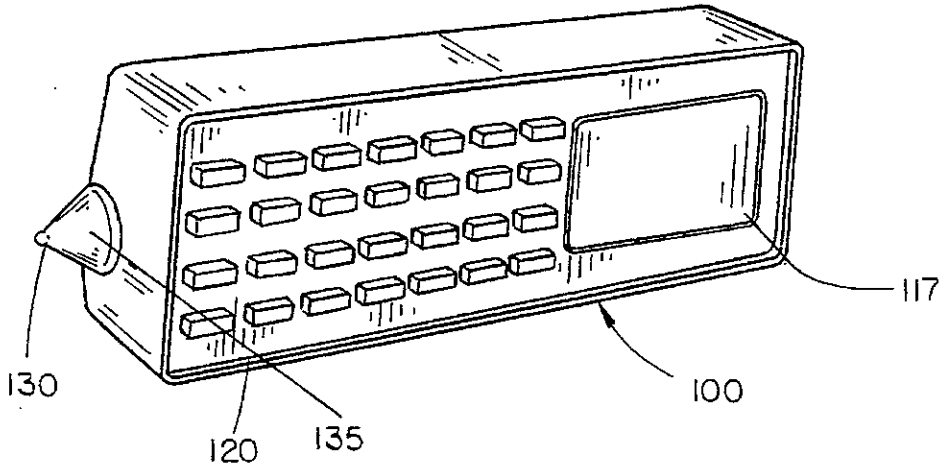


FIG. 5A

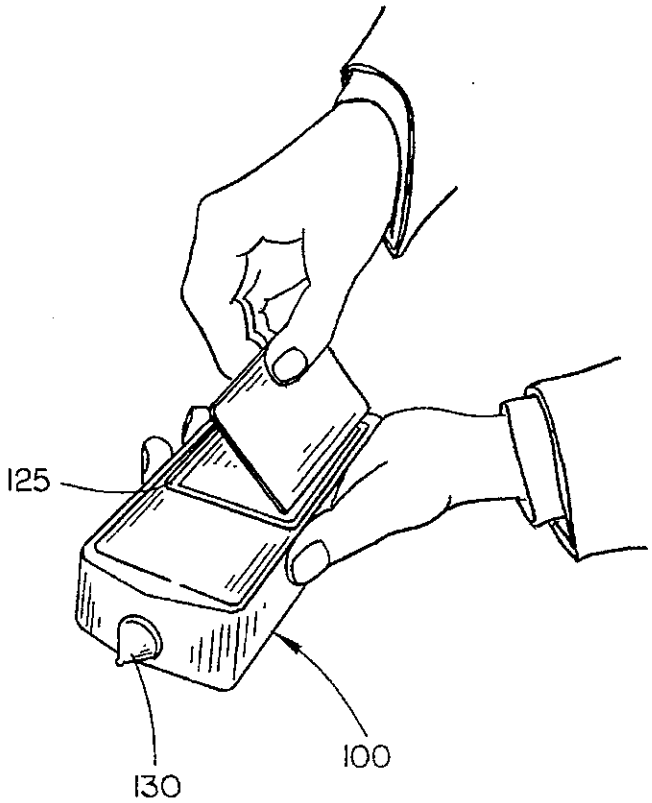


FIG. 5B

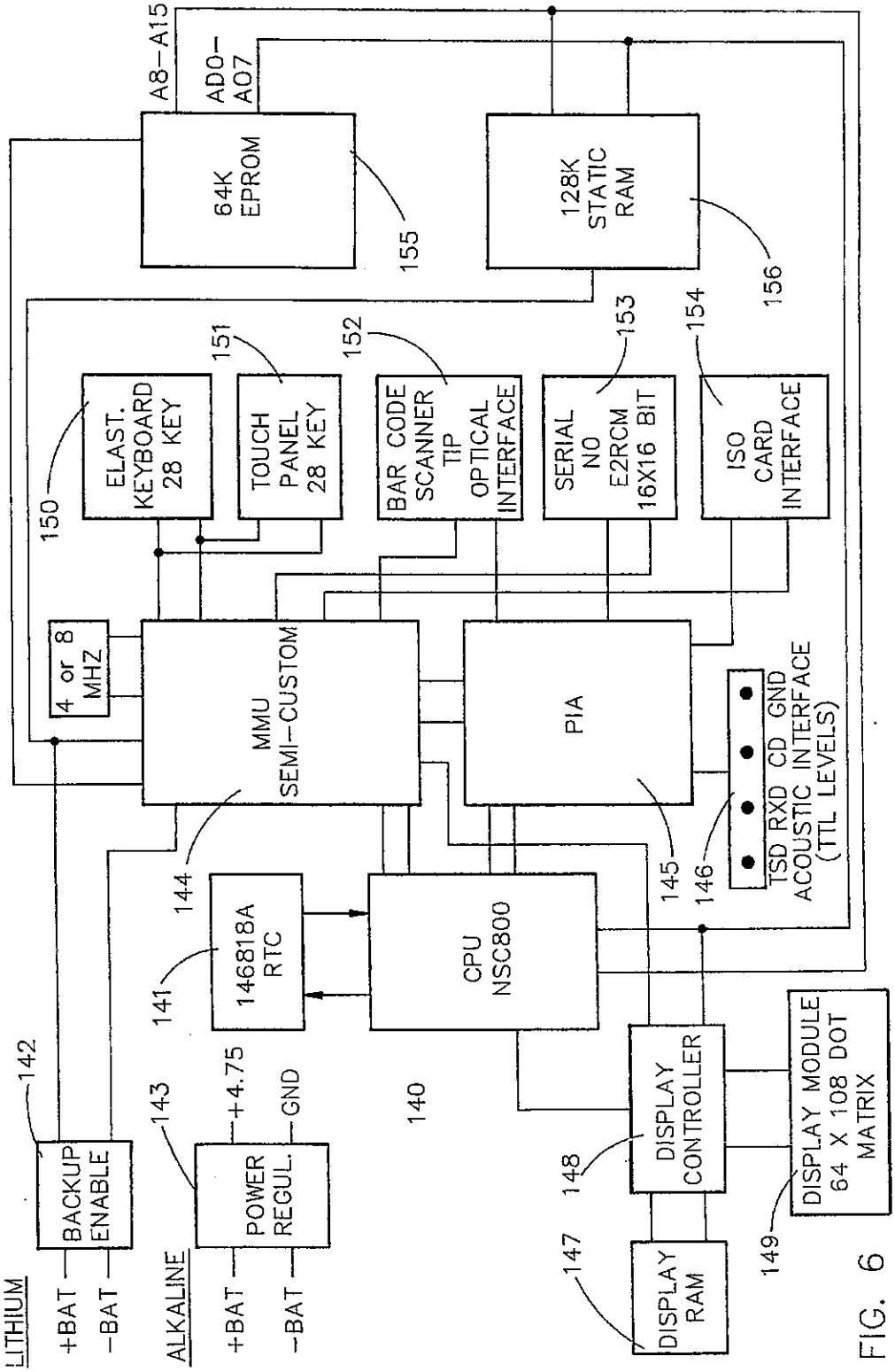

A8–A15
AD0–AD7
64K EPROM
155
128K STATIC RAM
156
150
ELAST. KEYBOARD 28 KEY
151
TOUCH PANEL 28 KEY
152
BAR CODE SCANNER TIP OPTICAL INTERFACE
153
SERIAL NO E2RCM 16X16 BIT
154
ISO CARD INTERFACE
4 or 8 MHZ
MMU SEMI–CUSTOM
PIA
TSD RXD CD GND ACOUSTIC INTERFACE (TTL LEVELS)
144
145
146
146818A RTC
141
CPU NSC800
140
142
143
+4.75
GND
DISPLAY CONTROLLER
148
DISPLAY MODULE 64 X 108 DOT MATRIX
149
147
DISPLAY RAM
BACKUP ENABLE
POWER REGUL.
LITHIUM
+BAT
–BAT
ALKALINE
+BAT
–BAT

FIG. 6

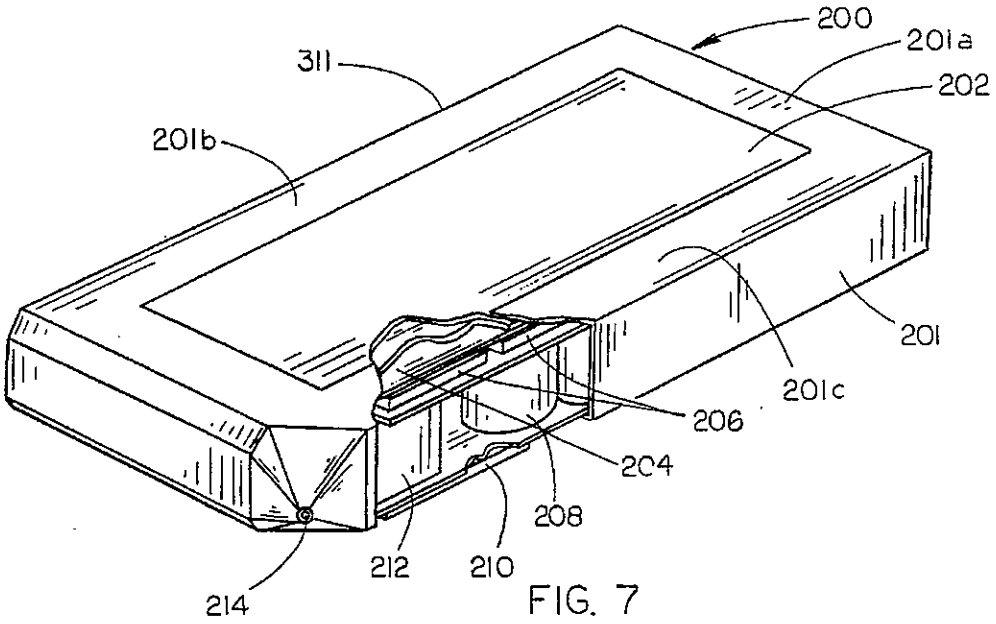


FIG. 7

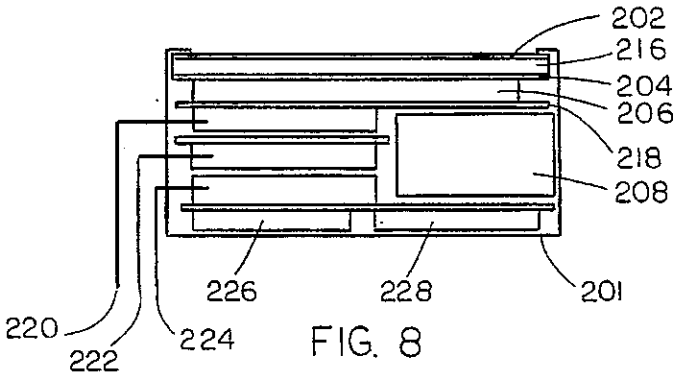


FIG. 8

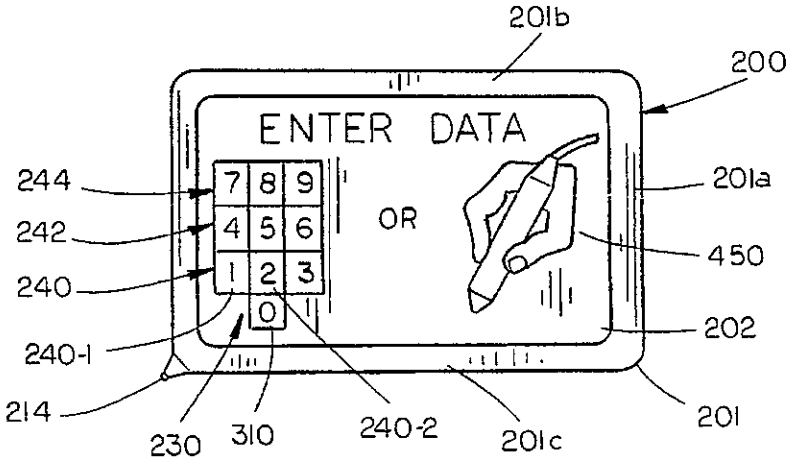


FIG. 9

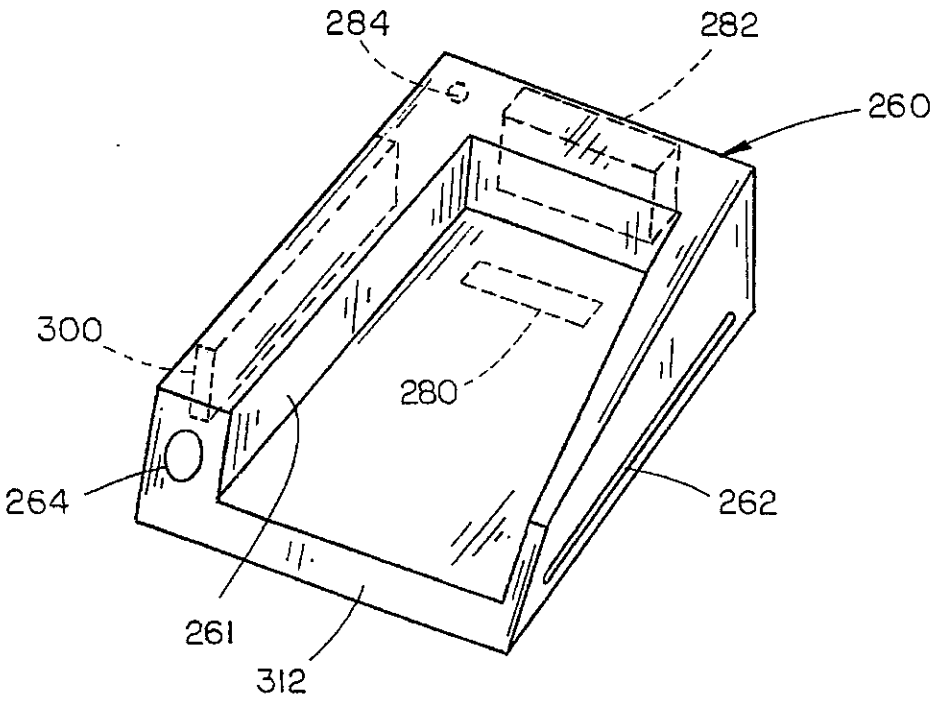


FIG. 10

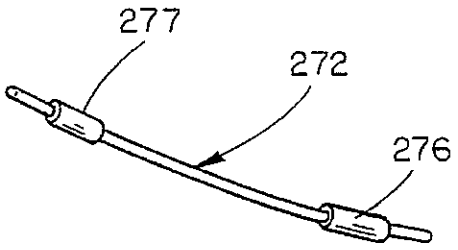


FIG. 12

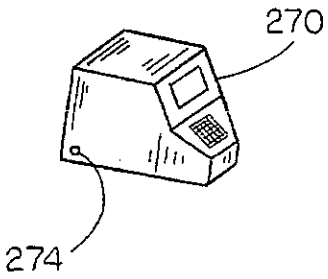


FIG. 11

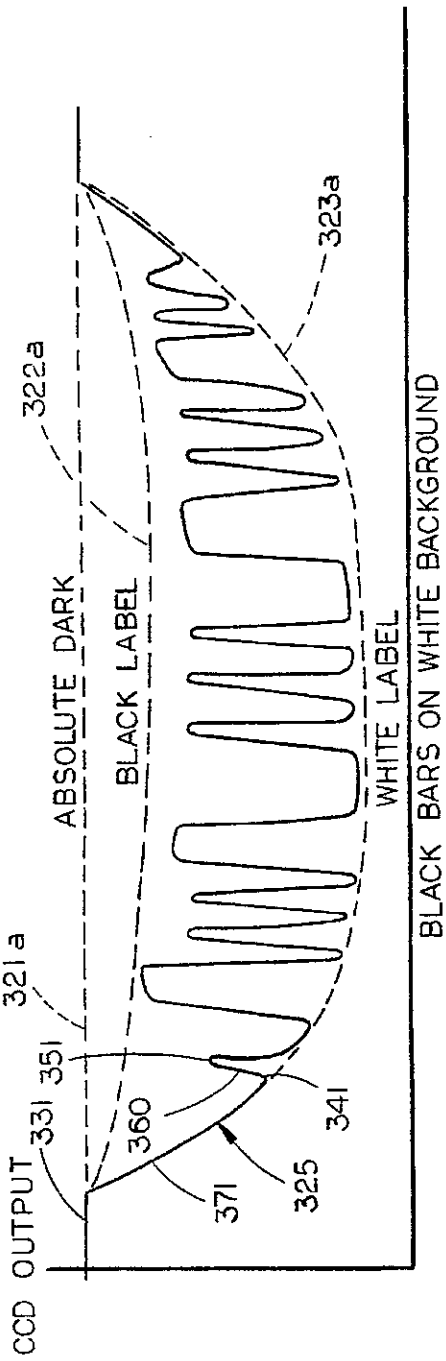


FIG. 13A

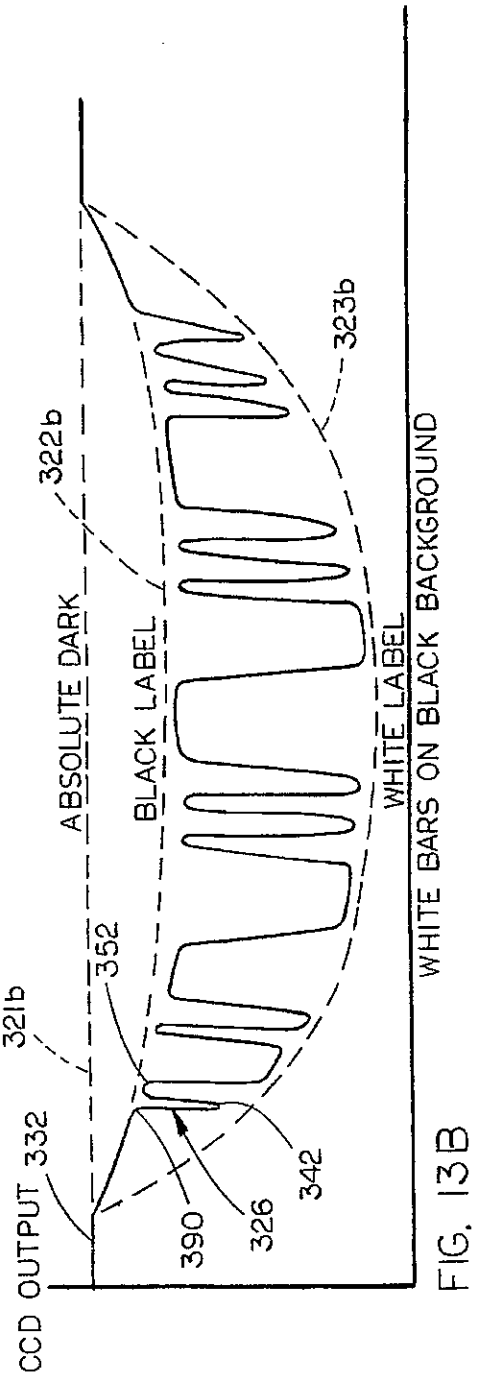


FIG. 13B

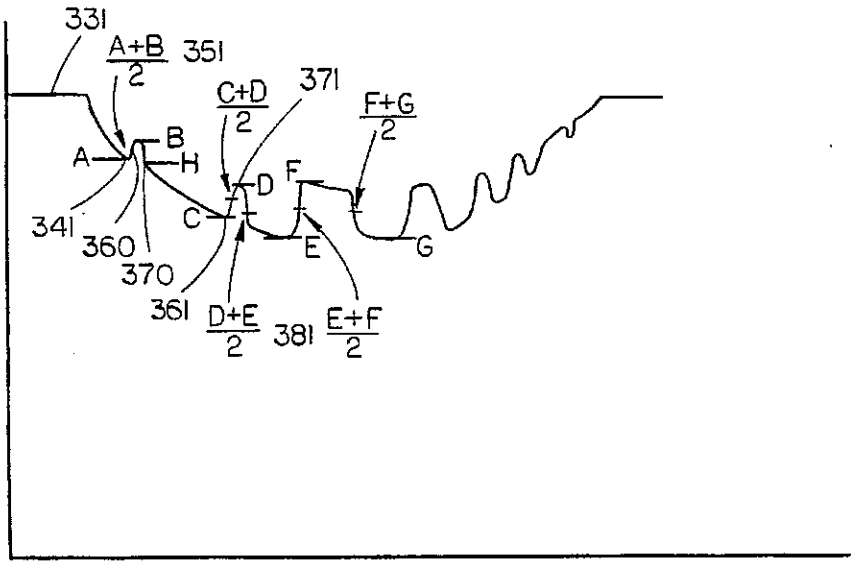


FIG. 14

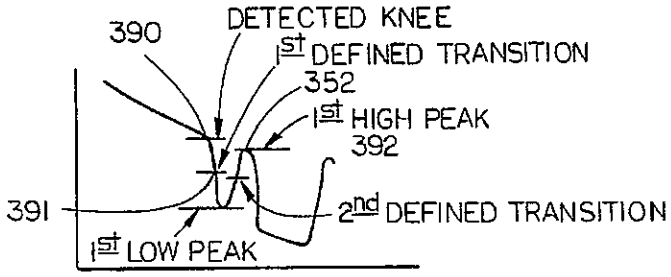


FIG. 15

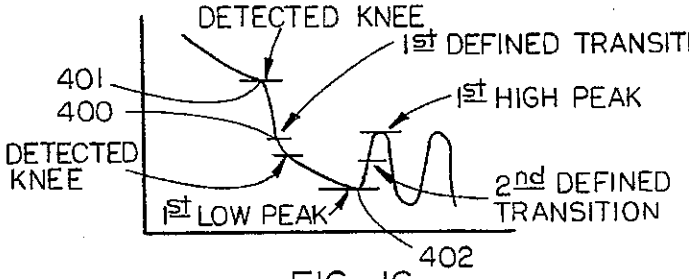


FIG. 16

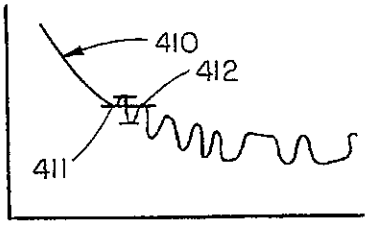


FIG. 17

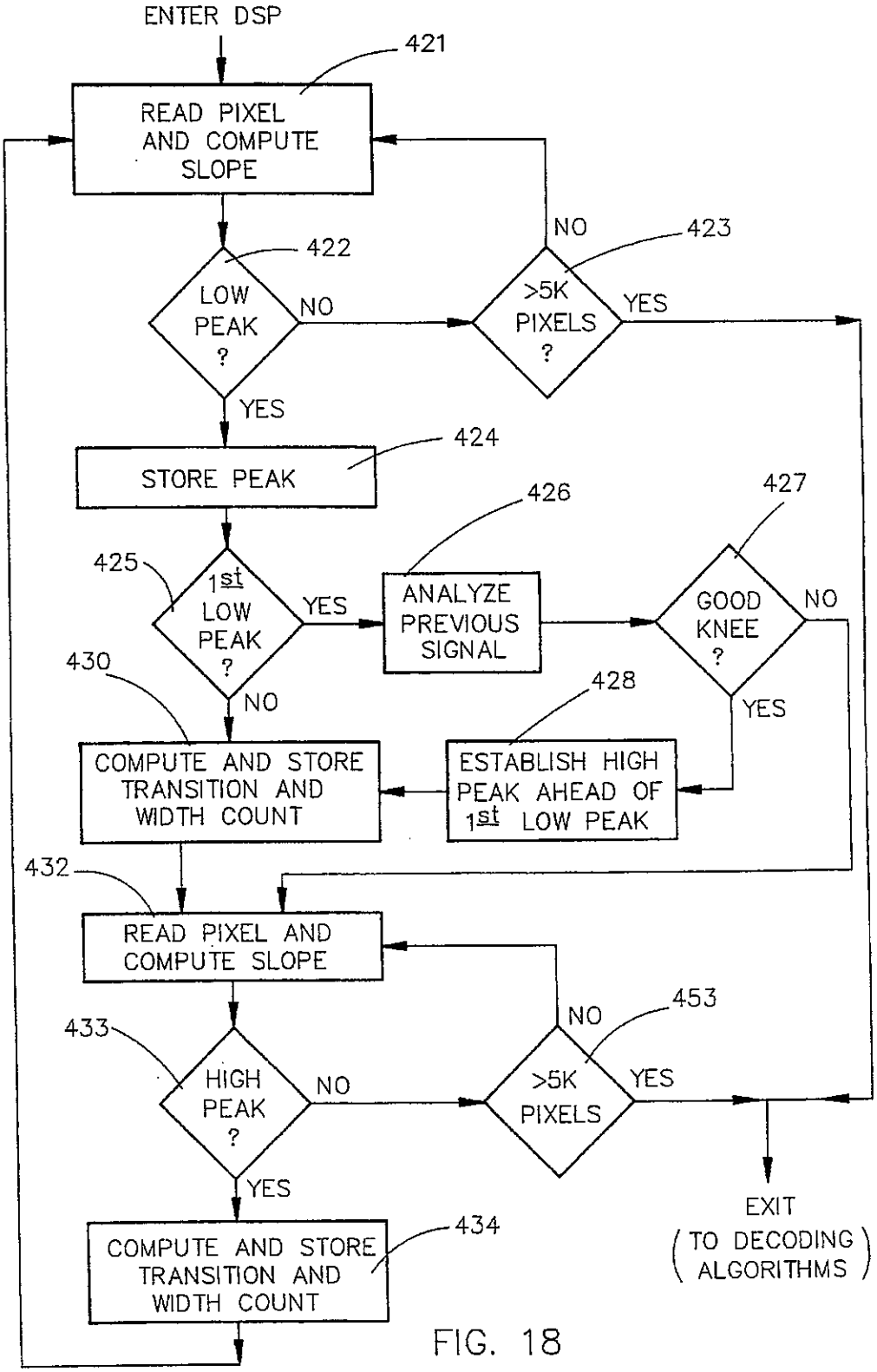

ENTER DSP
421
READ PIXEL AND COMPUTE SLOPE
422
LOW PEAK ?
NO
YES
423
>5K PIXELS ?
NO
YES
424
STORE PEAK
425
1st LOW PEAK ?
YES
NO
426
ANALYZE PREVIOUS SIGNAL
427
GOOD KNEE ?
NO
YES
428
ESTABLISH HIGH PEAK AHEAD OF 1st LOW PEAK
430
COMPUTE AND STORE TRANSITION AND WIDTH COUNT
432
READ PIXEL AND COMPUTE SLOPE
433
HIGH PEAK ?
NO
YES
453
>5K PIXELS
NO
YES
434
COMPUTE AND STORE TRANSITION AND WIDTH COUNT
EXIT (TO DECODING ALGORITHMS)

FIG. 18

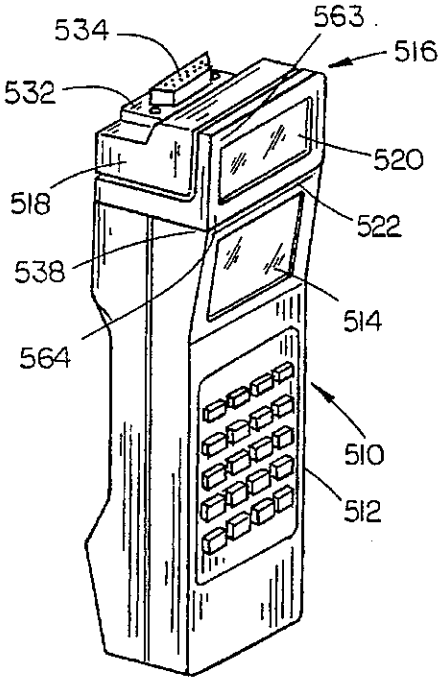


FIG. 19

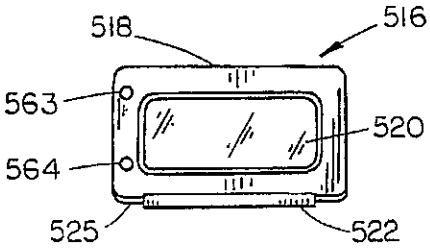


FIG. 20

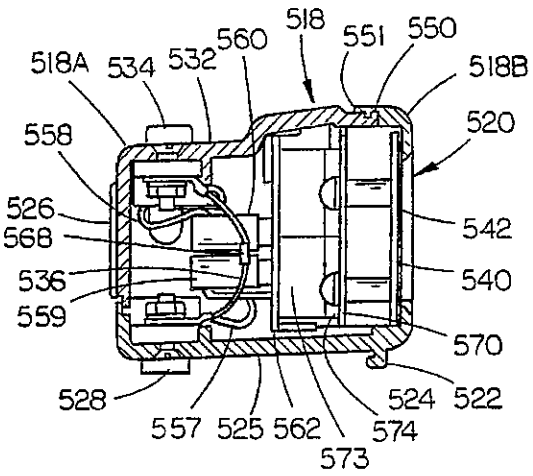


FIG. 21

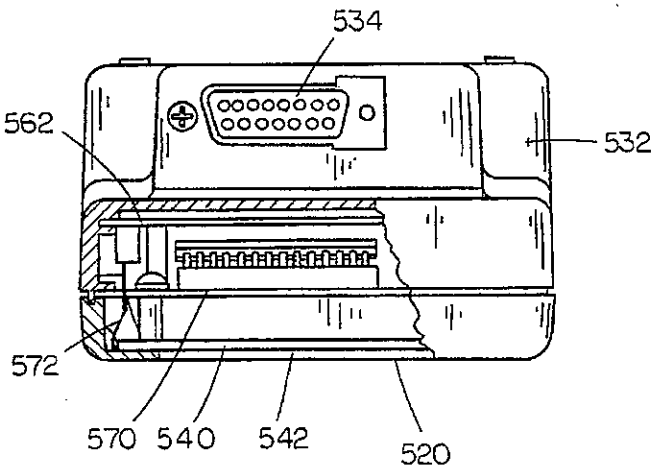


FIG. 22

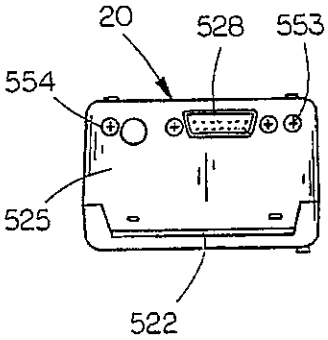


FIG. 23

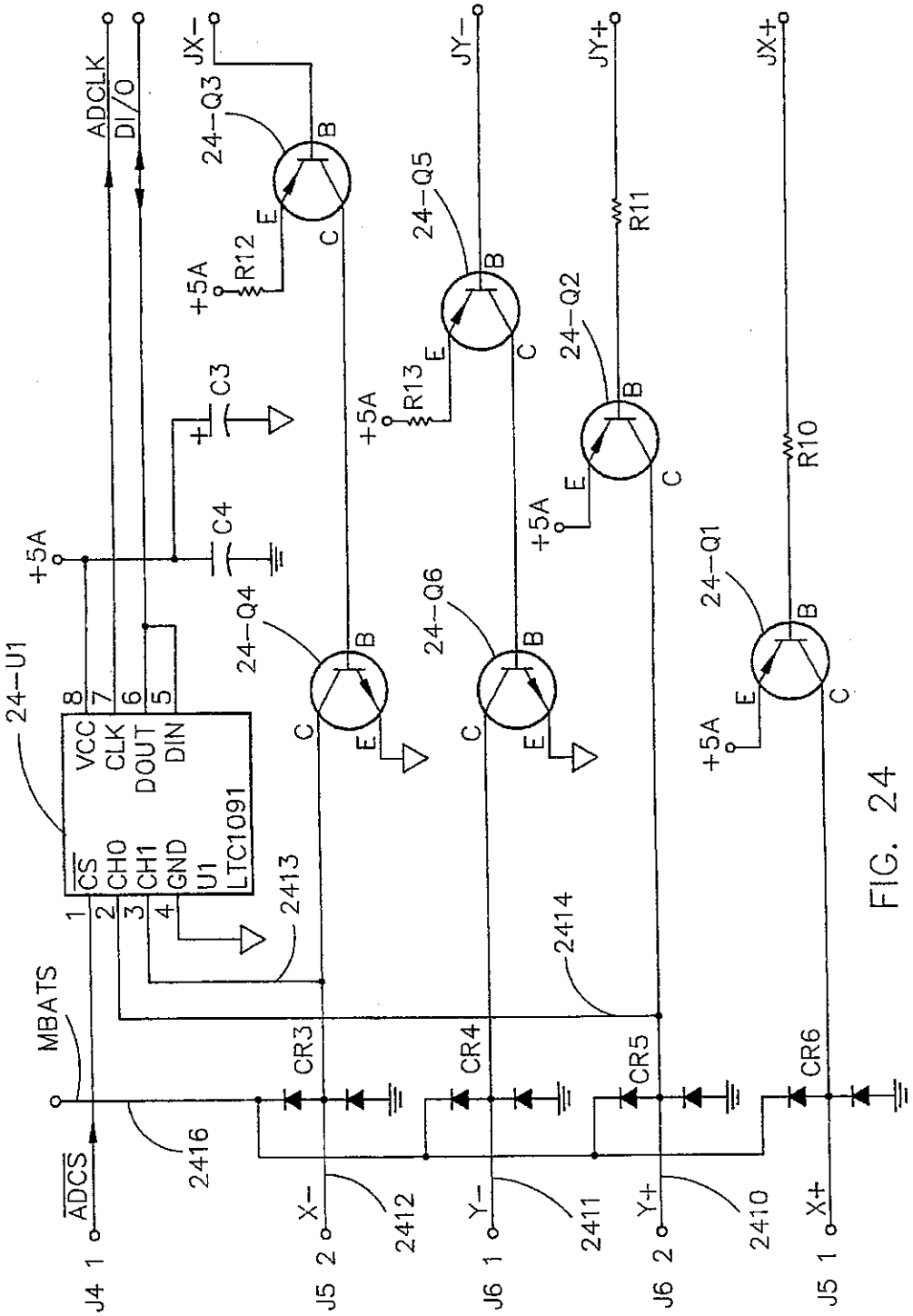

ADCLK
DI/O
JX−
JY−
JY+
JX+
24−Q3
24−Q5
24−Q2
24−Q1
24−Q4
24−Q6
R12
R13
R11
R10
C3
C4
+5A
24−U1
VCC
CLK
DOUT
DIN
CS
CH0
CH1
GND
U1
LTC1091
2413
2414
MBATS
CR3
CR4
CR5
CR6
2416
ADCS
X−
Y−
Y+
X+
2412
2411
2410
J4 1
J5 2
J6 1
J6 2
J5 1

FIG. 24

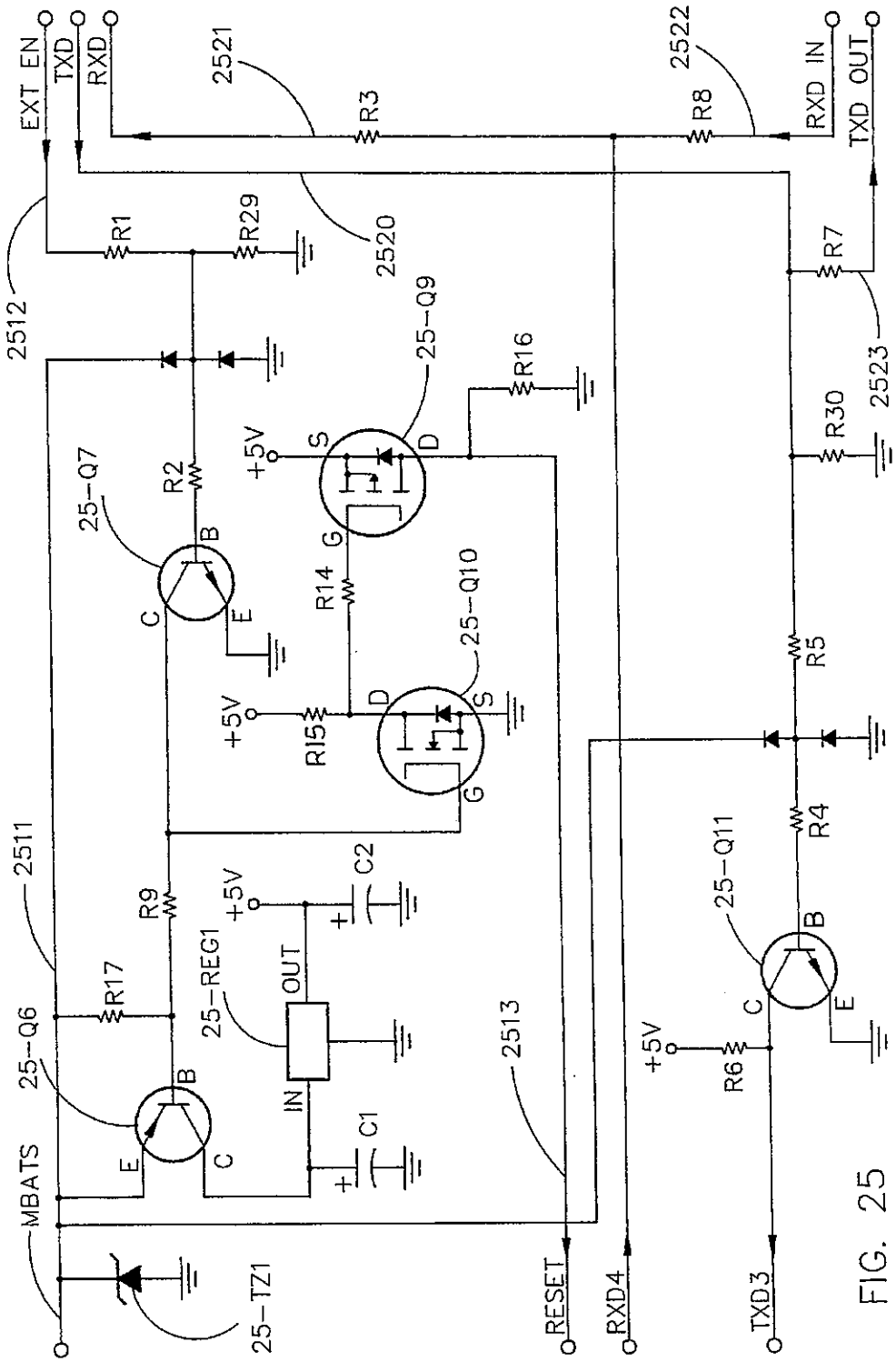

EXT EN
TXD
RXD
2521
R3
2522
R8
RXD IN
TXD OUT
2520
R1
R29
R7
2512
2523
25-Q9
R16
R30
+5V
S
D
25-Q7
R2
B
G
R14
25-Q10
C
E
R5
+5V
D
S
R15
G
2511
R4
C2
R9
+5V
25-Q11
R17
25-REG1
OUT
B
25-Q6
2513
C
E
+5V
R6
IN
C1
B
E
C
MBATS
25-TZ1
RESET
RXD4
TXD3

FIG. 25

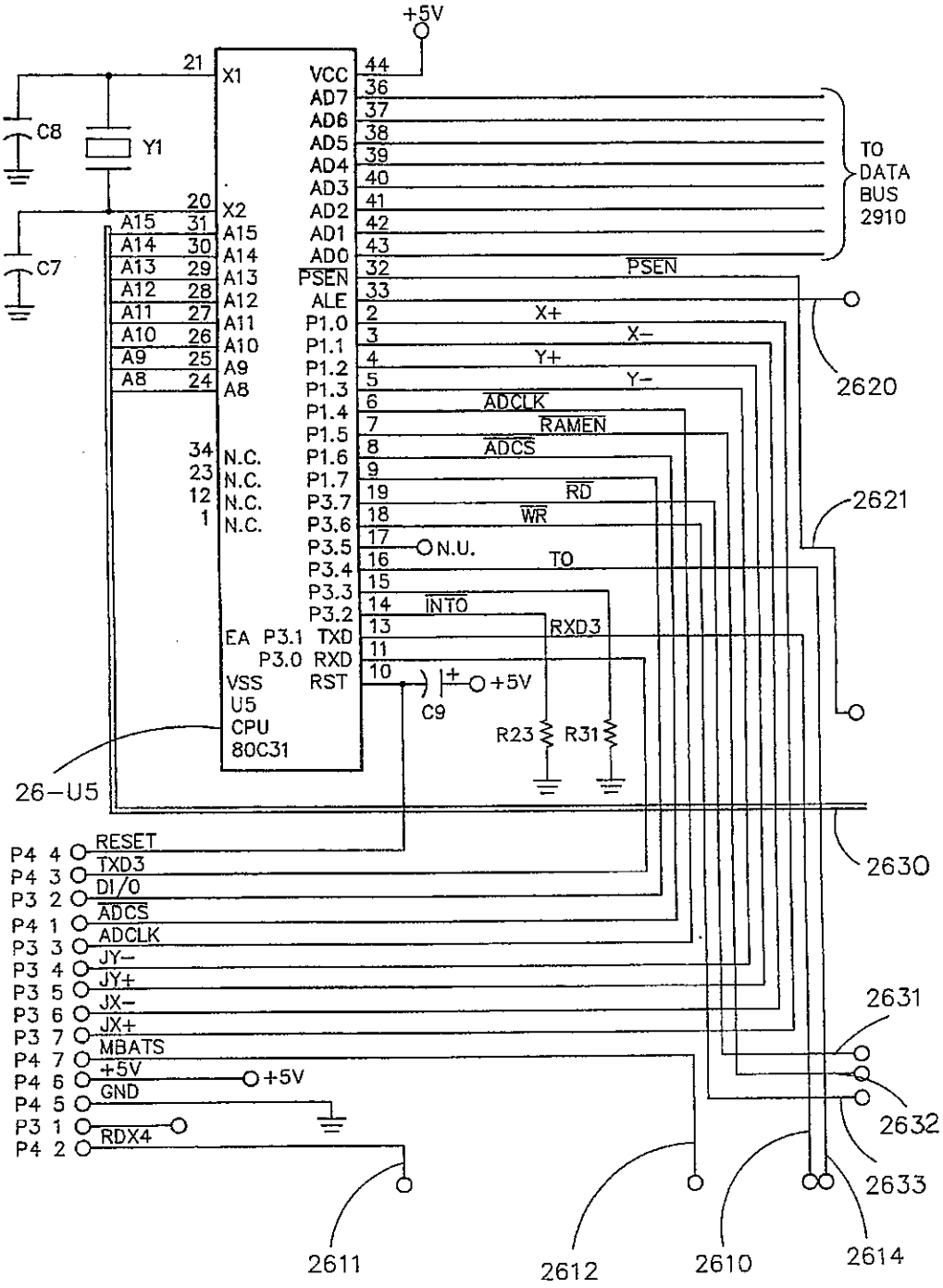

+5V
21
X1
VCC 44
AD7 36
AD6 37
AD5 38
AD4 39
AD3 40
AD2 41
AD1 42
AD0 43
C8
Y1
20
X2
C7
A15 31
A14 30
A13 29
A12 28
A11 27
A10 26
A9 25
A8 24
A15
A14
A13
A12
A11
A10
A9
A8
PSEN 32
ALE 33
P1.0 2
P1.1 3
P1.2 4
P1.3 5
P1.4 6
P1.5 7
P1.6 8
P1.7 9
P3.7 19
P3.6 18
P3.5 17
P3.4 16
P3.3 15
P3.2 14
EA P3.1 TXD 11
P3.0 RXD
VSS RST 10
34 N.C.
23 N.C.
12 N.C.
1 N.C.
U5
CPU
80C31
TO DATA BUS 2910
PSEN
X+
X−
Y+
Y−
ADCLK
RAMEN
ADCS
RD
WR
N.U.
TO
INTO
RXD3
+5V
C9
R23
R31
2620
2621
26−U5
2630
P4 4 RESET
P4 3 TXD3
P3 2 DI/O
P4 1 ADCS
P3 3 ADCLK
P3 4 JY−
P3 5 JY+
P3 6 JX−
P3 7 JX+
P4 7 MBATS
P4 6 +5V
P4 5 GND
P3 1 RDX4
P4 2
2631
2632
2633
2611
2612
2610
2614

FIG. 26

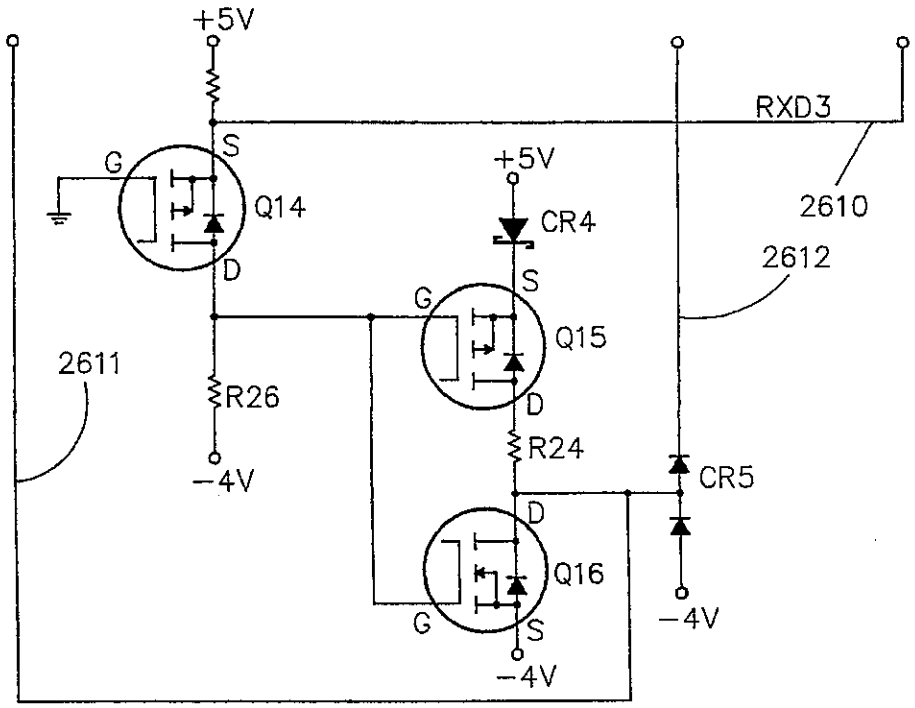

+5V
RXD3
G
S
Q14
D
+5V
CR4
2610
2612
S
G
Q15
D
2611
R26
R24
CR5
−4V
D
Q16
G
S
−4V
−4V

FIG. 27

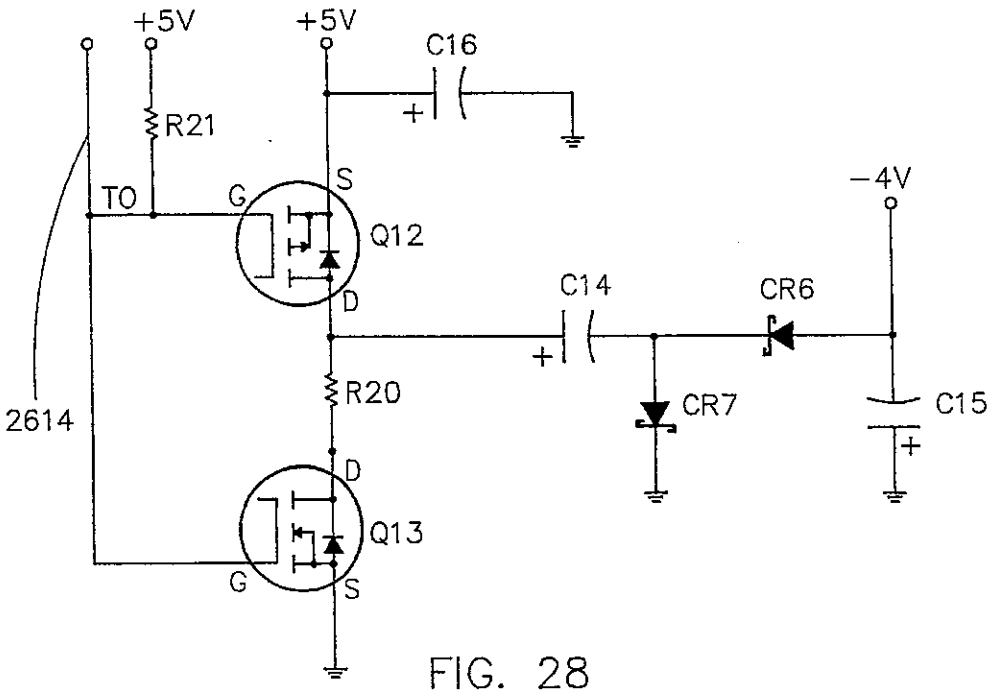

+5V
+5V
C16
+
R21
TO
G
S
Q12
D
−4V
C14
CR6
+
R20
CR7
C15
+
2614
D
Q13
G
S

FIG. 28

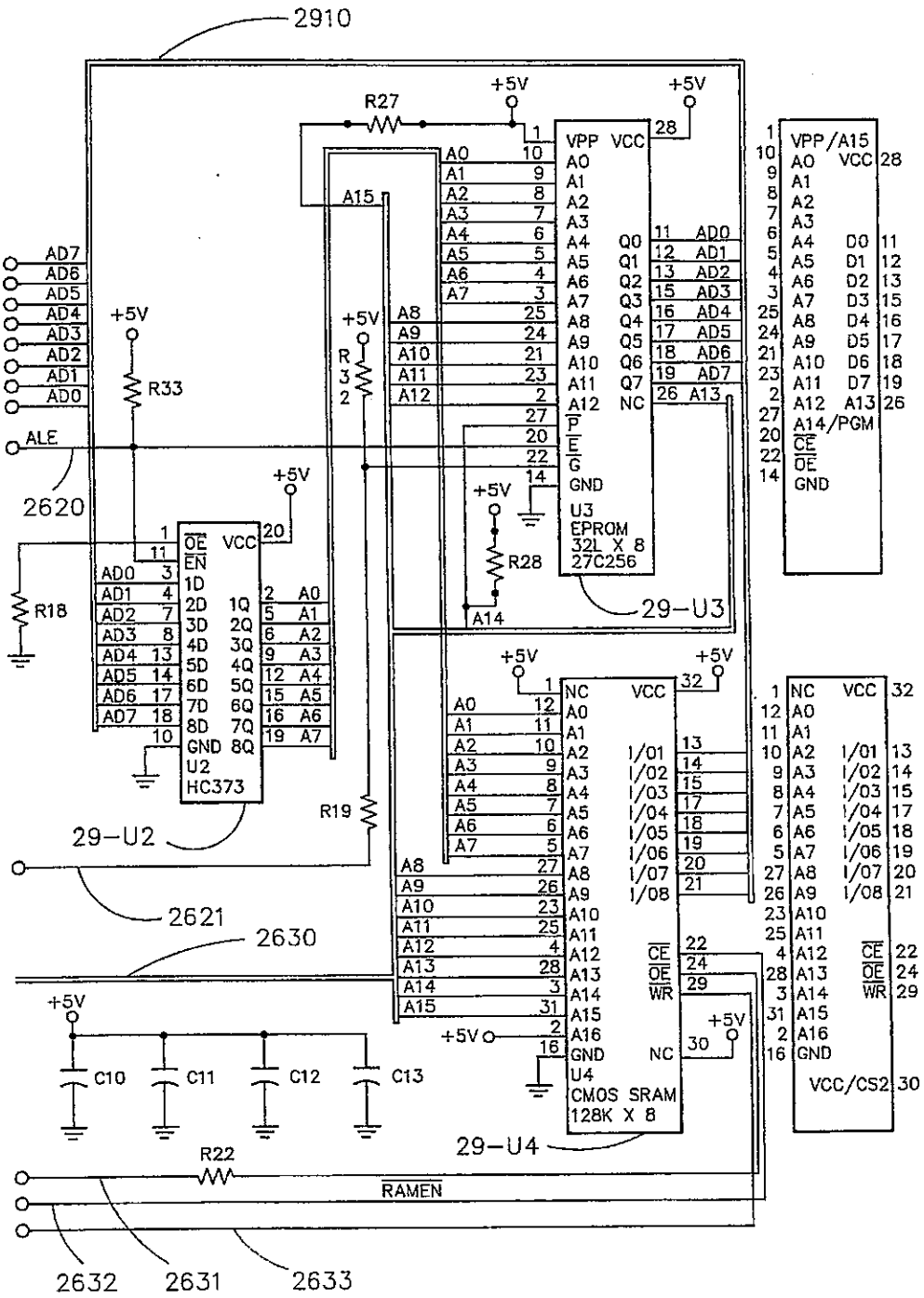

2910
R27
+5V
VPP VCC
A0
A1
A2
A3
A4
A5
A6
A7
A8
A9
A10
A11
A12
NC
Q0
Q1
Q2
Q3
Q4
Q5
Q6
Q7
P
E
G
GND
U3
EPROM
32L X 8
27C256
29-U3
A15
AD7
AD6
AD5
AD4
AD3
AD2
AD1
AD0
R33
ALE
2620
R18
R28
A14
OE
EN
1D
2D
3D
4D
5D
6D
7D
8D
GND
U2
HC373
1Q
2Q
3Q
4Q
5Q
6Q
7Q
8Q
29-U2
R19
2621
2630
R3
2
C10
C11
C12
C13
NC
I/01
I/02
I/03
I/04
I/05
I/06
I/07
I/08
CE
OE
WR
U4
CMOS SRAM
128K X 8
29-U4
R22
RAMEN
2632
2631
2633
VPP/A15
A14/PGM
D0
D1
D2
D3
D4
D5
D6
D7
VCC/CS2

FIG. 29

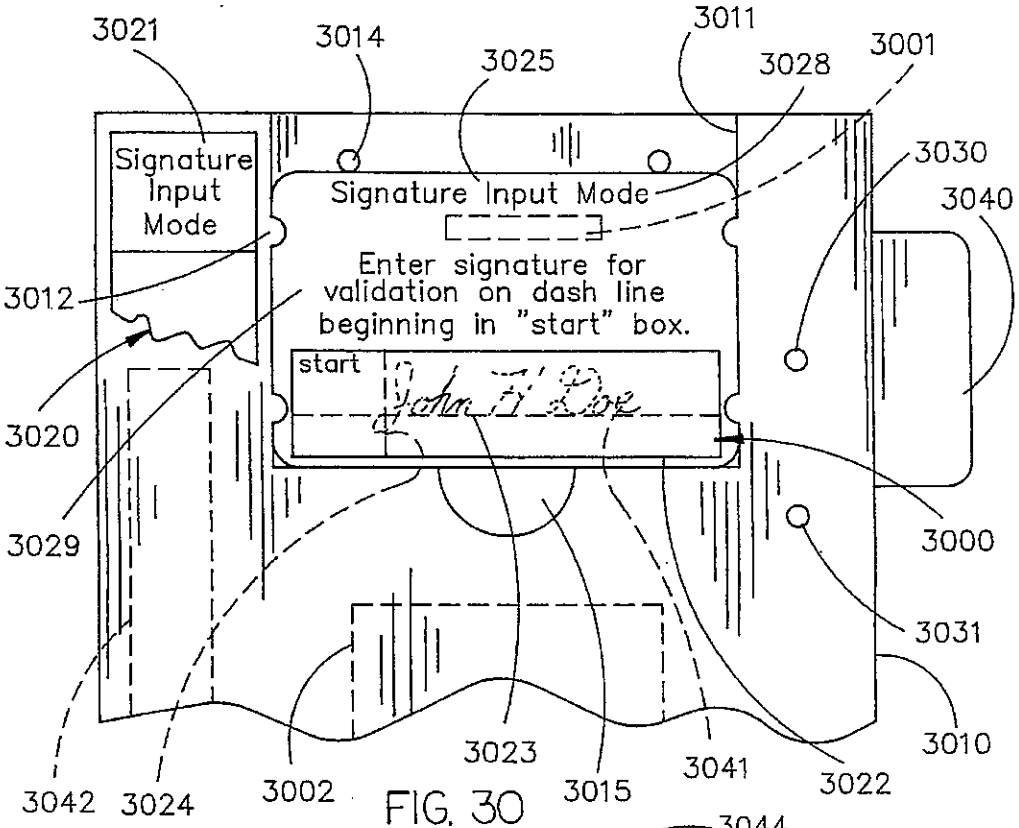

3021
3014
3025
3011
3028
3001
3030
3040
Signature Input Mode
Signature Input Mode
Enter signature for validation on dash line beginning in "start" box.
start
John H. Doe
3012
3020
3029
3000
3031
3010
3042
3024
3002
3023
3015
3041
3022

FIG. 30

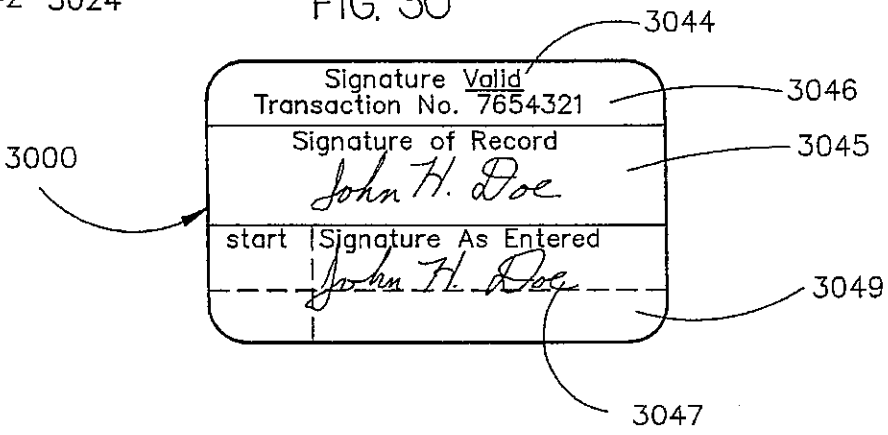

3044
Signature Valid
Transaction No. 7654321
3046
Signature of Record
3045
John H. Doe
start
Signature As Entered
John H. Doe
3049
3000
3047

FIG. 31

POCKET SIZE DATA CAPTURE UNIT WITH PROCESSOR AND SHELL MODULES

CROSS-REFERENCE TO RELATED APPLICATIONS

The present application is a continuation-in-part of application Ser. No. 07/451,322 (attorney docket number 5769Y), filed Dec. 15, 1989, now U.S. Pat. No. 5,227,614, issued Jul. 13, 1993, which is a continuation-in-part of application Ser. No. 143,921 (attorney docket number 5769X), filed Jan. 14, 1988, now abandoned, which is a continuation-in-part of application Ser. No. 06/897,547 (attorney docket number 5769) filed Aug. 15, 1986, now abandoned.

The present application is also a continuation-in-part of application Ser. No. 947,036 (attorney docket number 35740XYA), filed Sept. 16, 1992, now U.S. Pat. No. 5,308,966, issued May 3, 1994, which is a continuation of application Ser. No. 875,791 (attorney docket number 35740XY), filed Apr. 27, 1992, now abandoned, which is a continuation-in-part of application Ser. No. 07/422,052 (attorney docket number 35740X), filed Oct. 16, 1989, now abandoned, which is a division of application Ser. No. 06/894,689 (attorney docket number 5740), filed Aug. 8, 1986, now U.S. Pat. No. 4,877,949, issued Oct. 31, 1989.

Each of U.S. Pat. No. 5,227,614 (attorney docket number 5769Y) issued Jul. 13, 1993, U.S. Pat. No. 4,877,949 (attorney docket number 5740) issued Oct. 31, 1989, and U.S. Pat. No. 5,019,699 (attorney docket number 6240) issued May 28, 1991, is hereby incorporated herein by reference in its entirety including drawings and appendices.

BACKGROUND OF THE INVENTION

This invention relates to shirt pocket size computer processor system means, and particularly to a plural module computer processor system capable of incorporating various data entry peripheral devices and of coupling with various data storage and data transmission devices while yet being suitable to be carried on the person of an individual user throughout a working day.

A long-standing problem in the hand-held computer field has been to provide a compact and efficient system for data capture while yet achieving low production cost. It is conceived that a breakthrough can be realized by an optimum plural module system configuration.

In another aspect, the invention relates to novel terminal means for association with information cards and is particularly concerned with such terminal means for use by an individual user in communication with another computer system. There are many circumstances for example where an individual may desire to carry out transactions with a central computer processing station. In one example, a racing establishment such as a horse racing organization may desire to enable individual members having accounts with the organization to place bets from various locations such as home or office. In such a circumstance, it would be highly advantageous if the individual could communicate directly with a central computer system placing with the system all the information concerning a bet, and receive from the computer system essentially instantaneous information as to whether such a bet has been accepted. Another example relates to food service functions where orders may be transmitted to a central order processing center, and where credit or debit card purchases may be approved and/or related data stored at the central processor. Still another example is in the field of direct store delivery of merchandise. A pocket size terminal may contain the necessary information concerning the items being delivered and may be coupled with the store computer system to effect a paperless delivery transaction.

SUMMARY OF THE INVENTION

Accordingly, it is an object of the present invention to provide a plural module system configuration that is adaptable to a wide range of data capture applications while retaining shirt pocket size and utilizing a core computer processor module of standard size and characteristics so as to achieve the economy of large scale production.

In a preferred embodiment, the standardized computer processor module is provided with a multi-tasking operating system such that battery monitoring software and diagnostic routines will run at a fixed priority level at all times while a wide range of applications software can be run concurrently without jeopardizing the reliability of the system under extended portable operating conditions.

Preferably, the standardized computer processor module is selectively associated with peripheral device shell configurations for adapting the system to specific applications. For example, a shell configuration may include a scanner module for reading bar codes and a manual data entry and display means specifically tailored to a particular job such as package tracking, inventory, direct store delivery accounting, or the like. As a specific embodiment, the peripheral device shell may comprise a digitizer input tablet and display means which can receive handwritten input data and provide a desired confirming display. A conversational mode may provide for multiple interpretive displays of successively lesser probability in response to an input character for a word which is ambiguous with function key selection of the correct interpretation, or the like. A voice input and/or voice synthesizer shell module is another exemplary embodiment. Again in a conversational mode, the module may repeat input words in synthesized speech and/or provide a visual display thereof whereupon actuation of a function button or the like may instruct the module to present a second most probable selection from its vocabulary.

The handwritten or voice input modules may include a learning program for progressively improving recognition of the individual user's characteristic handwritten or voice input. Physical objects related to a given user application may be assigned respective code words e.g. of eight bits length; thus in the case of a food service function, in a food selection mode, the writing of the letter "P" with a stylus on an input tablet or the spoken word "potato chip" may be stored as the ASCII code for the character P in a special food selection storage. A nonvolatile storage section would enable the translation of the "P" code in food selection mode into the string of characters "potato chips" on the display and/or produce the synthesized speech output "potato chips". In a conversational mode, if there were two or more P items, the shell module could in response to a "P" input, present on the display a listing of the P selections, e.g., as P1, P2, P3, etc., whereupon the user could enter with a stylus or the like, the correct numeral "1", "2", "3", etc.

According to an exemplary embodiment, a peripheral device shell may provide a transparent tablet serving as data input and as a display window. A sonic wave digitizer arrangement for example may sense stylus (or finger) position on the tablet. The display may include a graphics liquid crystal display (LCD) behind the transparent tablet for

defining a keyboard in a touch data entry mode, and for display of data supplied by touch entry, or by other means such as handwritten input, speech input, optical scanner input, and so on. Keyboard touch selection positions can be labeled by means of icons (pictorial images) where this is most effective. The shirt pocket size unit may be of sealed construction so as to be ideal for meter reading, timber inventory, or any environmentally demanding application.

The computer processor module may be employed with peripheral devices such as printers, laser bar code readers, RF modules, smart card interface modules, disk systems, full travel keyboards, high resolution displays, local area network (LAN) interface modules, etc., and various such devices may be combined in a single self-contained battery powered hand-held unit.

It is also an object of the present invention to provide a terminal means which can be utilized by an individual at various locations for direct communication with another computer system for the purpose of carrying out desired individual transactions.

It is another object of the present invention to provide such a terminal which can be conveniently carried on the person of an individual, for example, in a shirt pocket.

A further object of the invention is to produce a terminal unit which is adapted to incorporate a means for reliably identifying an individual who uses the terminal and wherein the terminal facilitates each step in carrying out the desired transaction.

A feature of the invention resides in the provision of a terminal capable of removably receiving an information card with extensive memory capability and which, together with the terminal, can be held in one hand during entry of information concerning a transaction.

In accordance with a further feature, such a hand-held terminal system may incorporate means for two-way communication with a central computer system, e.g., via telephone lines or a radio frequency link.

In accordance with another feature, such a hand-held terminal system may be provided with a scanner for optically scanning visual information such as bar codes.

In accordance with another feature of the invention, such a hand-held terminal system may have dimensions of width and length comparable to a standard intelligent information card and of thickness to fit in the pocket, such as a shirt pocket.

In accordance with still another feature of the invention, such a terminal configuration is designed so as to be adaptable to a wide variety of applications without change in its basic housing configuration.

The foregoing objects will be more fully understood by reference to the following detailed description, and other and further objects, features and advantages will also become apparent from the present disclosure as a whole and from the individual features and relationships of the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a somewhat diagrammatic perspective view illustrating the insertion of an intelligent information card into a receptacle of a terminal means in accordance with the present invention while the terminal means is held by one hand;

FIG. **2** is a perspective view showing a terminal means in accordance with the present invention and showing an exemplary display including four single lines of characters and at the bottom Chinese characters occupying the height of two character lines of the display;

FIG. **3** illustrates a matrix of touch regions for a touch screen such as indicated in FIG. **2**;

FIG. **4** is a schematic block diagram for illustrating an exemplary processing means occupying the interior of the terminal of FIGS. **1** and **2**;

FIG. **5A** is a somewhat diagrammatic perspective view showing a terminal which may be utilized particularly for selecting desired functions in a particular application of the terminal of FIGS. **1–4**;

FIG. **5B** shows the insertion of an intelligent information card into a receptacle of the terminal of FIG. **5A**, while the terminal is held by one hand;

FIG. **6** is a somewhat schematic block diagram for illustrating the electronic processing components which may be utilized with the embodiment of FIGS. **5A** and **5B**;

FIG. **7** is a diagrammatic perspective view of a shirt pocket size terminal means in accordance with the present invention, including a scanner tip, and having portions broken away to show internal components;

FIG. **8** is a diagrammatic cross sectional view for indicating internal components of the terminal means of FIG. **7**;

FIG. **9** is a diagrammatic view of a core processor module with touch screen type display and having length and width comparable to a standard credit or debit card and thickness to fit in a shirt pocket;

FIG. **10** is a diagrammatic perspective view showing an exemplary shell configuration for readily receiving the core processor module of FIG. **9**, to form a plural module terminal system, e.g., adapted for direct store delivery accounting;

FIG. **11** shows a store terminal device for coupling with the system of FIGS. **9** and **10**;

FIG. **12** shows an exemplary coupling means for coupling the system of FIGS. **9** and **10** with the store terminal of FIG. **11**;

FIGS. **13A** and **13B** are plots showing the variation of a bar code signal over the length of the bar code as generated for example when the illumination geometry is non-uniform, FIG. **13A** being the case of black bars on a white background and FIG. **13B** showing the signal variation for white bars on a black background;

FIGS. **14**, **15**, **16** and **17** are plots of bar code signal variation in the vicinity of a first bar, FIG. **14** showing a plot for a narrow first black bar on a white background, FIG. **15** showing the case of a narrow first white bar on a black background, FIG. **16** showing the variation for a wide first white bar, and FIG. **17** showing the case of black bars on a low contrast highly reflective white background;

FIG. **18** is a flow diagram useful for explaining the processing of bar code signals such as shown in FIGS. **13A**, **13B**, and **14**, **15**, **16** and **17**;

FIG. **19** is a perspective view of a hand-held data terminal with a signature pad module in place;

FIG. **20** is a front elevational view of the module;

FIG. **21** is a sectional view of the module;

FIG. **22** is a top view of the module, partly in section;

FIG. **23** is a bottom view of the module;

FIGS. **24** and **25** show exemplary circuitry for the input/output printed circuit board of the embodiment of FIGS. **19–23**;

FIGS. **26–29** show exemplary circuitry for the CPU

printed circuit board of the embodiment of FIGS. 19–23;

FIG. 30 is a partial plan view showing a computerized processor module assembled in a receiving module and operating in signature input mode; and

FIG. 31 shows the computerized processor module displaying the results of a signature verification operation for the case where the processor module functions as a separate self-contained unit using its own battery power.

DETAILED DESCRIPTION

FIG. 1 is a perspective view illustrating a preferred terminal configuration 10 of a size to be held in the hand of the user. FIG. 1 illustrates the placing of an information card 11 into a receptacle 12 of the terminal. The card 11 may be a standard intelligent information card conforming with international standards such as the present ISO standard. Such a card may have the same length and width and thickness as a standard credit card now in use. By way of example, such a card may have an array of eight contact terminals at one side thereof providing for interface with other devices. Such a card may have an electrically erasable programmable read only memory of a sufficient capacity to record an individual's account number, personal identification number and other information which may be desired for reliably identifying the individual. Further, such a memory may have a capacity for receiving extensive additional information such as might be required in effecting betting on a number of horse races.

By way of example, receptacle 12 may be provided with nub means 14 which is configured to cause the card 11 to flex at its edge 11 a as it is pivoted into receptacle 12. Thus the nub means 14 may be spaced above the floor of the receptacle 12 by a distance slightly greater than the thickness of the card. An opposite side edge 11*b* of card 11 may be inserted under similar nub means at the opposite side of receptacle 12 and the card 11 then pivoted downwardly until edge 11*a* of the card is snapped under nub means 14. The nub means at opposite sides of receptacle 12 which cooperate with card edges 11*a* and 11*b* hold the card 11 in receptacle 12, and spring urged contacts in the floor of receptacle 12 make pressure engagement with the array of eight contacts on the underside of the card, once the card has been inserted.

Any suitable means may be employed to facilitate removal of a card from the receptacle 12. For example, a wall 15 of terminal 10 may be provided with a notch 16 enabling insertion of a fingernail or stylus under edge 11*a* of the card for prying the card upwardly and out of the recess. The standard card 11 is sufficiently flexible so that this is readily accomplished.

In the embodiment of FIG. 1, a touch screen 17 occupies the side of the terminal opposite receptacle 12 and has an area generally comparable to the area of the standard card. By way of example, the touch screen may utilize LCD (liquid crystal display) technology and may be capable of displaying a number of lines of characters, for example four lines relating to four bets and additional lines which may, for example, provide an integrated graphic display (e.g., a single line of Chinese characters).

By way of example, associated with the touch screen at a surface 20 may be suitable indicia such as 21–24 for explaining the format of the display. In the specific illustration of FIG. 2, the characters "HV" may represent the initial letters of the name of a race track (e.g., Happy Valley), the next series of characters representing the data (e.g., year, month and day of month). Further characters on the display may relate to the day of the week, the type of bet or the like.

In the example of a transaction involving betting on a horse race, an exemplary keyboard display for touch screen 17 is indicated in FIG. 3. In an example, where several race tracks may be involved, the identities of respective race tracks may be displayed at locations such as 31 and 32 in FIG. 3. Each location may display indicia indicating the programmed significance of the location. Simply by way of example, a prompt message at lines 33 and 34 might instruct the user to select the race track where the race to be the subject of a wager is to take place. At the same time, indicia representing the two race tracks would appear at 31 and 32. The user would then press location 31 or 32 with his finger to indicate the identity of the race track. A similar procedure could be followed for identifying the day of the race, the number of the particular horse on which the bet is being placed, the amount of the wager, and so on.

In the preferred embodiment of FIGS. 1 and 2, the terminal 10 is provided with an acoustic coupling means 50 which may serve to couple the terminal with telephone lines, for example. Thus in the case of betting transactions, once the user of the terminal has entered desired bets, for example on a number of horse races, the user may couple the terminal, e.g. via an acoustic coupler, with a handset of a conventional telephone, for establishing two-way telephone communication with a central computer system equipped to deal with the particular type of transaction and to authorize the individual participant. The touch screen 17 may display suitable prompt messages in establishing the telephone link with the central computer, or the processor of the terminal 10 may itself be programmed to establish the telephone link automatically, for example in response to actuation of a "SEND" location 35 of FIG. 3. Once communication is established, the processor of terminal 10 is able to transmit the data stored on the information card 11 via the telephone link to the central computer system so that the central computer system can verify that the individual is authorized to carry out the relevant transactions. In the case of horse race betting, the information on the particular race and particular horses involved and the other details of the bet would be transmitted to the central computer system for verification and for evaluation of the total amount being bet, for example in relation to the individual's established account balance.

Also in the preferred embodiment as shown in FIG. 2, the housing is provided at a corner thereof with an optical scanner module 60 which may be utilized as a hand-held bar code scanner, and which also can serve for receiving optical communication via a suitable receiving device. In the case where the terminal utilizes rechargeable batteries, a receiving boot could automatically couple with a charging circuit for the battery means and this boot could also be provided with a host computer or suitable communication to a host computer system such that data from the intelligent card 11 and from the memory of the terminal itself could be communicated with the host system via an optical link including the scanner module 60, if desired.

Also as a preferred implementation, FIG. 4 illustrates a suitable processing system for the housing 10, including a micro-controller 70, a real-time clock 71, control and communication circuits 72, EPROM 73, random access components 71 and 75, a wand scanner and optical interface component 77, an acoustical coupler interface 78 and a module 80 for controlling character and or graphic display of the touch keyboard screen for a particular desired application.

By way of example intelligent information card **1** may be approximately 3⅜ inches by 2⅛ inches (about 9.5 centimeters by 5.4 centimeters). The dimensions of displays **17** and **117** are thus approximately comparable to the length and width of the card. (The card thickness is standard and about 1/32 inch). In FIGS. **1–4**, the overall dimensions of the terminal **10** are not substantially greater than the corresponding card dimensions; the thickness is such that terminal **10** fits in an ordinary shirt pocket. By way of example the terminal may have a thickness of less than one inch i.e. less than 2.5 centimeters.

In the development of a preferred pocket-size terminal such as indicated in FIGS. **1** and **2**, it is sometimes convenient to utilize a larger development terminal such as indicated at **100** in FIGS. **5A** and **5B**, which may utilize the same size of touch screen **117** (i.e. two inches by three inches) but may further utilize a highly versatile keyboard **120** and a much larger memory capacity so that many different features can be tried out for a particular application. At the rear of the touch screen **117** there may be a receptacle **125**, FIG. **5B**, for an intelligent information card exactly corresponding to receptacle **11** of FIG. **1**. The terminal **100** is shown as being provided with an optical scanner module **130**, which may function in the same manner as the module **60** of the preferred embodiment of FIGS. **1** and **2**. In the example of FIGS. **5A** and **5B**, rechargeable batteries may be utilized and a boot receiving the housing of terminal **100** may have provision for optical coupling with the computer system of the housing via an optical output means **135**. Optical communication from a host computer system may be via the optical scanner module **130** as in the embodiment of FIGS. **1–4**. The housing of terminal **100** is provided with an acoustical coupling means for telephonic communication corresponding to the acoustical coupling means **50** of FIG. **1**. An exemplary embodiment according to FIGS. **5A** and **5B** may utilize internal components as indicated in FIG. **6**.

In the specific embodiment of FIG. **5**, components **140–156** may have the functions and parameters as indicated by labels for the respective components in FIG. **6**.

DESCRIPTION OF FIGS. 7 THROUGH 12

FIGS. **7**, **8** and **9** show a shirt pocket size terminal configuration **200** generally corresponding to that of FIGS. **1–4**, but omitting the card receptacle **12**, terminal **200** includes the following components:

201—casing
202—membrane keyboard
204—liquid crystal display
206—display drivers
208—batteries
210—real time clock
212—scanner module
214—scanner tip
216—plastic support for membrane keyboard **202** (FIG. **8**)
218—printed circuit board
220—display keyboard controller
222—RAM
224—microprocessor
226—ROM-A/D
228—real time clock, decode circuits

Referring to the graphics display of FIG. **9**, data input into unit **200** may be by means of a touch screen display as indicated at region **230**, or by means of a digitizer system for sensing the position of a manually held stylus.

Exemplary characteristics for such a unit are summarized as follows:

V25 CMOS MICROPROCESSOR 8 MHZ
- 16 bit arithmetic logic unit
  8086 software compatible
- 16K byte mask ROM
  retains VRTX operating system
  diagnostic/power control routines
  sophisticated loader

1 MEGABYTE ADDRESS RANGE
- 2 UARTS—
  Full Duplex
  Internal Baud Rate Generators

RAM CMOS STATIC
- 1 Megabyte—Less 16K ROM and 512 Internal RAM and SFR
- Holds Application Programs
- Also is Data Storage
- Battery Back-Up (Non-Volatile)

REAL TIME CLOCK/CALENDAR
- Provides Date/Time Information
- Back-Up

PLASTIC LCD DISPLAY
- 64×128 Pixel Graphics Dot Matrix
- Built-In ASCII Character Generator
- Programmable Character Capability
- Limited Animation Capability

TRANSPARENT KEYPAD
- 50 Keys in 5×10 Matrix
- Defined by Display For Location, Size, & Legend

BUILT-IN WAND TYPE SCANNER
- User Input Capability In Addition To Keypad

RECHARGEABLE BATTERIES
- Nicad or Lithium
- Complete Control/Monitor Via Software
- Offers Highly Reliable Remaining Battery Operating Time
- Gauge
- Provides power to RAM+RTC Under All Conditions

I/O CONNECTOR
- 8 Pin
- Programmable
- Only Ground and Charge Pins Dedicated
- 5 Volt Interface
- Never Powers Peripherals

ENVIRONMENTALLY SEALED
- Plastic Case is Glued or Sonic Welded
- Repair Procedure Is To Cut Case Away and Replace
- Can Be Submerged

DISCUSSION OF FIGS. 7, 8 AND 9

The main attractions of a V25 micro-controller for the system of FIGS. **7**, **8** and **9** are that it is CMOS, very high speed, and sixteen bits internal, with a nice collection of built-in peripherals. The fact it is 8086 software compatible means that VRTX (versatile real-time operating system) can easily be ported to the V25, with the addition of new I/O drivers. VRTX is a multi-tasking operating system, so the battery control circuitry software will run at a fixed priority level at all times as will diagnostic routines. Applications will be moved in and out as necessary.

The one megabyte of CMOS static RAM and the RTC are

always supplied power. When battery voltage drops below a selected value, e.g., 4.5 volts, (the fuel gauge will read zero at this point) the unit shuts down and cannot be worked unless proper power is supplied to it on its charge pin. The unit will appear to shut down when not actively doing anything; however, touching the keypad will bring it to use. (Also I/O activity wake it.)

The plastic LCD display is light in weight and relatively immune to mechanical injury. The graphics capability is advantageous so that the display can define the keypad, key location, size, and legend. It will display icons and provide vertical and horizontal movement. The display controller can work from a page larger than can be displayed and move around in the page without rewriting the display memory. The ability to load in custom character sets lets the unit perform I/O suitable to the country in which it is used (just by downloading new software).

The I/O may be strictly serial in operation; however, besides the two UARTS of the V25 there will be an 8530 SCC (serial communication chip) which will provide two more serial channels. This enables protocols to be run synchronously as well as asynchronously. The 8530 will provide bit, byte, and A-Sync communication at a high data rate—up to 1.5 megabytes per second.

Pursuant to an early concept of peripheral shells, the unit can stand alone in a package tracking, meter reading, tree counting or warehouse/store inventory environment, but possesses a great amount of power and with more peripherals could well become the next generation of low and mid-range terminals. A shell would be used to envelope the unit and house the external peripherals and additional power source they would require. A hand-held computer unit could be composed of a keyboard and a fifteen pin I/O interface with the whole under keyboard area filled with alkaline batteries to power the peripherals and the V25 core unit.

Similarly, a larger display, a printer, a permissive modem, an RF link module and other peripherals could be shelled around the core unit of FIGS. **7**, **8** and **9**.

By way of example, the terminal unit of FIGS. **7**, **8**, and **9** may have a width of the order of two inches (e.g. 2⅛ inches), a length of the order of three inches (e.g. 3⅜ inches) and a thickness of the order of one inch (e.g. ¾ inch).

In a digitizing input mode of operation of the unit of FIGS. **7**, **8** and **9**, successive character entry fields may be defined in a line across a screen area such as indicated at **240**. For example, the rectangle **240-1** (presently containing the numeral "1") could receive a first character, e.g. manually entered as a series of strokes by means of a stylus. The unit could produce a graphical display in the form of lines corresponding to the paths of the successive strokes, e.g. at the line 242 above line 240. The program could analyze the input on the basis of the sequence in which the strokes were entered, rates of stylus movement, and so on, so as to interpret the intended character with substantial accuracy. The unit may display its interpretation of a manual character entry by displaying the corresponding stored character from its repertory at a line 244, e.g., as soon as there is a pause of selected (programmable) duration. If then the user begins drawing a new character, e.g., in a second field **240-2**, the program will assume that its interpretation is correct and will automatically store it. If a given field is skipped, a space may be correspondingly automatically stored. The size of each character field and other parameters (such as pause duration) can be selected to have values convenient to the individual user, during a mode, with suitable prompts from the display. The processor, during manual character entry, can be set to a learning mode where it seeks to adapt as accurately as possible to the writing style of a given user. Such learning mode can be switched off whenever desired, as a further user set up mode parameter. A similar procedure could be followed for processor learning in the case of a speech input module.

FIG. **10** illustrates a shell module **260** having a receptacle **261** for receiving a processor core module such as **200**, FIGS. **7**, **8** and **9**. Module **260** may cooperate with module **200** to provide a direct store delivery terminal. The terminal may have a card slot **262** for receiving a conventional smart card containing the information related to a delivery transaction, and may have an input/output coupler such as a one-fourth inch phone jack **264** for coupling with a store device **270**, FIG. **11**, via a connecting link such as **272**, FIG. **12**. Phone jack **264**, FIG. **10**, and phone jack **274**, FIG. **11**, may be one-fourth inch three conductor phone jacks for receiving cooperating phone plugs **276**, **277** of link **272**.

The coupling between a smart card and a receiving terminal (such as **260**, FIG. **10**) is illustrated in the third figure at page 45 of an article entitled, "Smart Credit Cards: The Answer to Cashless-Shopping" in *IEEE Spectrum*, February 1984 (pages 43–49) and this article is incorporated herein by reference by way of background. A similar coupling arrangement is preferred between modules **200** and **260**.

By way of example, the core module **200** may have an array of eight I/O contacts similar to those of the smart card of the third figure at page 15 of the *IEEE Spectrum* article just referred to. These contacts would mate with cooperating contacts at a contact region such as indicated at **280** of module **260**. Charge and ground contacts of module **200** could be of fixed function, while the other contacts could be programmable as channels, clocked data, analog inputs or outputs, or event inputs and outputs.

Module **260** may have a battery compartment **282** for receiving alkaline batteries for energizing suitable interface circuitry such as represented in the above-referenced third figure. A telephone jack may be located at **284** for coupling with the modem of the referenced third figure. Module **200** may couple with the interface circuitry of module **250** via contact region **280** in the same way as represented in the referenced third figure for the case of "Peripherals" and/or as represented for the case of a "Display", and "Keyboard", for example. A customer keypad may be coupled with module **260** in the same way as represented in the referenced third figure.

Typical shells for forming hand-held terminals with module **200** could be printers, laser bar code readers, RF modules; smart card interfaces (as at **262**, FIG. **10**), disk systems, full travel keyboards, larger displays, local area network interfaces, etc. A hand-held printer device which could serve as a shell for the processor module **600** is available from NORAND Corporation, Cedar Rapids, Iowa and is referred to as a 40-column hand-held printer for use in product distribution systems, and is described in a brochure designated "960-182-0485" of Norand Data Systems.

DISCUSSION APPLICABLE TO ALL EMBODIMENTS

The concept of a plural module hand-held data processing system enables the use of a single computing engine to drive an entire product line. The basic or core module may comprise a self-contained limited input/output device with extreme reliability and flexibility. While the core module can

serve many markets directly, many more can be met by using peripheral device shell modules which may integrate the core module into its confines. An internal fixed operating system protects the critical core module functions while allowing user applications to execute in a multi-tasking real time environment.

Of prime importance are the two requirements and tremendous capability. The lowest possible cost is achieved by use of technology yielding low manufacturing costs at high volumes. High volumes are achieved when a single product is flexible enough to perform well in multiple markets.

Of particular interest are flexible shirt pocket size plural module configurations which enable data input independently of a conventional keyboard. For example, a digitizer tablet input such as described with reference to FIGS. **7–12** is also applicable to the embodiments of FIGS. **1–6**. Various optical type scanners are also of substantial utility for quick, easy and highly accurate input of existing printed data, e.g., bar codes, text, and graphical information. Instant type optical readers which may be integrated into a hand-held shell module according to the present invention are disclosed in a pending application of the present inventors U.S. Ser. No. 894,689 filed Aug. 8, 1986, (now U.S. Pat. No. 4,877,949 issued Oct. 31, 1989), and the disclosure including the drawings of this pending application are incorporated herein by reference in their entirety as illustrating arrangements which may be embodied in a peripheral shell such as indicated at **250** in FIG. **10**. For the embodiments of the co-pending application, the optical output means may be at opposite ends of battery compartment **282**, while the reflected light optics and processing components may occupy the region below compartment **282** and a region replacing card slot **262**, FIG. **10**. The control and processing means of said co-pending application could be embodied in the basic core module such as represented at **200**, or the display and manual data input means could be provided by a separate module in receptacle **261**, while a basic processing module occupied a greatly reduced space such as represented at **300**, FIG. **10**, the processing module being inserted into a receiving well via a removable cover as is commonly the case with battery compartments such as **282**. Such a cover could incorporate resilient means so that when the cover was latched, a core processing module at location **300** would have its eight metal contacts pressed against cooperating contacts of the receiving shell module such as **260**. Referring to the article "Smart Cards" by Robert McIvor in Scientific American, November, 1985, at page 153, an eight contact terminal is shown in association with a single chip microprocessor system, from which it will be apparent that the width of the smart card could be reduced from fifty-four millimeters to twenty millimeters and fit edgewise into the region **300** (vertically as viewed in FIG. **10**). For such a strip type core module, the thickness could be substantially greater than the standard card thickness of 0.75 millimeters, for example ten millimeters.

The core module may incorporate the components of FIG. **1** or FIG. **6**, or components such as **77**, **78** and **80**, FIG. **4**, may be incorporated into a peripheral device module, for example one fitting into receptacle **261** of shell module **260**, the core module incorporating the remaining components. Similarly as to FIG. **5**, components such as **147**, **148**, **149**, **150** and **151** can be incorporated into a module fitting into receptacle **251**, while component such as **152** and **154** may be incorporated into the shell module **260**, and **261** the remaining components incorporated into the strip core module fitting into region **300**.

Preferred features of an exemplary core module such as might fit into receptacle **12**, FIG. **1**, receptacle **125**, FIG. **5B**, or region **300**, FIG. **10**, are as follows:

(1) User immune real-time multi-tasking operating system. The multi-tasking ability allows system programs of the core module to run in the background and never lose control. This ensures proper operation of the user's application(s) and system status availability.

A program known as VRTX (Versatile Real-Time Executive) and IOX (Input/Output Executive), available commercially, together with input/output drivers, monitors and control programs preferably compose the operating system stored in the core module (for example in read only memory ROM).

(2) A microcomputer compatible with personal computer architecture, e.g., an NEC V25 microcomputer with 8086 type architecture, supports the implementation of the operating system in that VRTX and IOX are 8086 oriented. A high integration CMOS construction directly supports the lower power standby and shut down features which are desired for the core module versatile interface adapter (VIA) software control. A one megabyte addressing range would be considered a minimum for hand-held units, along with a sixteen bit internal arithmetic logic unit.

(3) With a one megabyte memory, for example, read only memory necessary to contain the operating system would require about eighty kilobytes. All the rest of memory in the addressing range may be CMOS static random access memory used for applications.

(4) The core module preferably provides clock and calendar functions, and a hardware real time clock chip is compatible with very low power requirements.

(5) Battery operation is presently a key hardware aspect of a core module, and this is the main reason VRTX should provide immunity from the user. In order to offer unparalleled reliability in the field, the power control system should never be tampered with except under operating system control. The core module may use nickel cadmium rechargeable batteries. Such a core module preferably implements the intelligent battery system such as disclosed in U.S. Pat. Nos. 4,455,523; 4,553,081, and in a pending application of Steven E. Koenck, et al., U.S. Ser. No. 876,194, filed Jun. 19, 1986, now U.S. Pat. No. 4,709,202. The intelligent battery system allows a very accurate "fuel gauge" for advising the user of remaining battery capacity. Fast charge capability offsets the lower capacity batteries which are preferably used in the core module. All of the RAM, the RTC and internal registers, e.g., of the V25 are battery backed up, even with the unit shut down.

Battery monitoring will also indicate possible problems before they become serious and, combined with other system monitoring, will provide unprecedented forewarning of possible impending failure. All devices will ultimately fail, but it is extremely advantageous if a unit can be removed from service before a hard failure occurs.

(6) The core module should be able to communicate with a host and with peripheral devices, for downloading of the application programs into the core module and for communicating with all types of input/output devices such as those referred to herein. Extensive flexibility in the communication protocol is provided for example by using two high speed serial channels capable of being programmed as asynchronous, byte synchronous or bit synchronous. Eight input/output contacts provide electrical connection to the outside. The charge and ground contacts may be fixed while the other contacts may be programmable as serial channels, clocked data channels, analog inputs or outputs, or event

inputs and outputs. The concept of using peripheral shell modules for selective coupling with the core module offers complete expansion capability with minimal development time to enter new markets. Typical shell modules could comprise graphics LCD display means providing a touch keyboard, digitizer tablet means, printers, laser bar code readers, RF modules, smart card interfaces, disk systems, full travel keyboards, larger displays, local area network interfaces, et cetera. Optionally, as illustrated in FIGS. **7**, **8** and **9**, for example, the core module may have a built-in minimal input/output capability such as may be achieved by using a graphics LCD display on one face of the core module for output and a touch responsive keyboard directly behind and defined by the display. The display, for example, may comprise 64×128 pixels, or eight lines by twenty-one characters, and may support any character set that can be defined. This is ideal for foreign applications. Since the keyboard is defined by the display, it will naturally be in the same language. The display (and keyboard) may be back lighted by a built-in electro-luminescent panel. Many stand-alone applications for such a core module would require bar code scanning and thus a built-in scanner is illustrated at **212**, **214**, FIG. **7**. Such a display would have the ability to use icons (pictorial images) as labels for keyboard locations, and to change them as the application requires.

A core module such as shown in FIGS. **7** and **8** could have a housing comprised of two die cast magnesium shells, glued together. Preferably there are no holes through the housing, so that the unit is submergible. It is ideal for meter reading, package tracking, timber inventory, or environmentally demanding application. Internal construction is preferably of one continuous flexible printed circuit board. This eliminates connectors, weight, and sources of failure. Preferably even the batteries are soldered in. The core module may withstand being dropped to a concrete surface from seven feet without functional damage. A minimum number of integrated circuits will reduce the cost and increase the reliability of the core module.

Where the graphics type keyboard displays icons representing physical objects, it will be apparent that such physical objects may be represented by a single code word such as utilized to represent any other keyboard entry. Such code may be translated into a corresponding graphical icon type display by means of a suitable read only memory or the like. A similar situation can prevail for example where shorthand characters are input to respective receiving regions such as indicated at **240-1** and **240-2** in FIG. **9**. Spoken words related to a given application may likewise be represented by single code words in random access memory, and translated via read only memory or the like into corresponding strings of characters for display, or for synthesized speech output. As previously mentioned, if the letter P is related to a number of objects for a given user application, the user may input the letter "P" at a region such as **240-1** or **240-2**, FIG. **9**, whereupon the input strokes may be repeated at a corresponding location in row 242, and possible interpretations, either graphically, or as character strings, may be sequentially presented, e.g. at row 244. When the correct interpretation is displayed, the user may touch a suitable region of the display such as indicated at **310** to indicate approval of the current displayed interpretation.

In preferred hardware for implementing the illustrated embodiments, all memory and input/output accesses are allowed when the system is in the supervisor or system mode. On the other hand, any access by an application program to any area outside of its work and program areas (as assigned by the system) must immediately return control to the operating system for proper action. A microcomputer such as the V25 is advantageous because of its non-multiplexed bus, and built-in software controlled power down. It would also be advantageous to have a built in hardware boundary checking of applications being run (as in the 80286). A digital semi-custom chip can accommodate this function externally.

A V25 internal timer may be used as the VRTX tick. Entrance to VRTX is through the NMI input of the V25. This is the only input (besides reset) that not only can wake the chip up if its in a sleep mode, but also cannot be shut off by an application (thus disabling VRTX). Many sources may logically OR into NMI. The real-time clock, serial channels, charge indicator, and keyboard are some of these. Most of these should be programmable as to whether they can activate NMI.

The random access memory can be built as a separate module. For example eight 128 kilobyte chips and decoding may be in the module. A module select line should also be included since the module is expected to be useful in other product lines in multiple configurations. Standby currents of fifteen microamperes at two volts are being presently considered.

As real-time clock, an Intersil 7170 may be used since it is guaranteed to operate at two volts, the same as for RAM. The RTC and RAM are all battery backed up once low battery condition is entered.

For a shell module containing a display, a plastic LCD dot matrix display from Polaroid Corporation may be used. A display size of 64×128 pixels with eighteen mil pitch gives eight lines of twenty-one characters each (5×7 font). The controller may be the Epson E-1330. This is a graphics controller that can support three separate planes or pages for the screen and can combine them in many different ways. The planes can be graphic or characters. The characters can come from the internal ROM or RAM loaded by the application. A graphics plane could create boxes and a character plane could put legends in them. The E-1330 uses S-MOS 1180 and 1190 drivers to run the columns and rows (respectively) of the display. They apply a ten to fifteen volt bias on the display. This may be obtained from a plus five volt supply in the core module in combination with a variable minus twelve volt supply in the shell module and providing two to three milliamperes for the display. This supply is controlled by the E-1330 as for on-off but the V25 will be responsible for controlling the actually used voltage based on the temperature of the core module and user input information. A fast recovery crystal is preferred to minimize the time delay upon release of pressure (e.g. by the manual entry stylus or finger). Using a fast recovery plastic LCD display enables the user to press through the display and activate a keyboard behind it. The display is used to define the keyboard or provide the "overlay". This gives the advantage of not only being able to continually change the keyboard as the application requires, but if the display is programmed in a foreign language such as Ethiopian, the keyboard is in the same language. Putting the keyboard behind the display allows for an opaque design of low contact resistance. The keyboard may be a 5×10 matrix (fifty keys) software configurable to be combined for any shape or icon style key defined by the display.

A soft (but tough) electro-luminescent panel is preferred for back lighting, the keyboard being activated by pressing through the display and the electro-luminescent panel. A tremendous advantage here is that not only is the display operable at night, but so is the keyboard (which is further programmable).

A built-in wand scanner such as indicated in FIG. **7**

preferably has a sapphire lens in a stainless steel or other hard metallic housing. Testing has shown that sapphire tipped wands will chip concrete before they break. It is preferable to make the chip very rugged rather than to make it easily replaceable. The wand housing is preferably clamped (and glued) right into a casing such as **201**. The light source may be a near infrared visible LED to be able to read non-carbon inks and let the user know it is on, yet take advantage of the infrared capacity to read through many stains and smudges. Preferably the scanner is capable of reading in direct sunlight, and in this connection reference may be made to an application of Eric J. Danstrom, U.S. Ser. No. 044,820 filed Apr. 30, 1987 (abandoned in favor of U.S. Ser. No. 07/257,106, now U.S. Pat. No. 4,970,379 issued Nov. 13, 1990), the disclosure including the drawings of which being incorporated herein by reference in its entirety.

An initial approach of a four N-cell nickel cadmium battery pack with each cell treated individually is now less preferred than a one cell "battery pack". The one cell pack requires a converter to boost the voltage. The single cell has many more advantages. No cell matching is required. No conditioning cycles are required, and it is not necessary to be concerned about cell voltage depression. A single converter to step up the voltage for a shell display module would be suitable, with a single switching regulator (current mode) to charge the cell from a much wider input range (e.g. from four to twenty volts). Fast charging on the order of 1C (or perhaps 2C) can be achieved since continuous monitoring of cell voltage and temperature curves (with respect to previous cell conditions will allow proper charging with no risk of overcharge, This same monitoring applied to discharge as well, provides a very accurate "fuel gauge". Rechargeable lithium batteries may be considered, but the general recommended operating requirements do not match the preferred embodiment as described herein as well as nickel cadmium batteries. The charging line will have a diode blocking reverse current flow and inserted prior to the input/output terminal (for protection). This same single battery pack may also serve as the backup battery. The operating system may operate to equate ten percent or twenty percent of remaining capacity in the battery pack to "zero" on the "fuel gauge" being displayed to the user.

In a preferred embodiment a surface type connector as used in smart cards has advantages in that it takes up very little space and cannot clog with dirt (can be wiped clean, e.g., during interconnecting of respective modules). Further, a surface type connector avoids the use of a cable. To maintain input/output protection and immunity from the environment, each core module may have all of its programmable input/output terminals disabled. The charge pin of a core module may be used to determine the presence of a peripheral shell. Each peripheral may have its own power supply and may or may not provide charge to the core. A peripheral module must at least provide a logic ONE (greater than one volt) to the charge pin in order to signal its presence. If such a logic ONE is present, the core module will determine if the peripheral module can charge it by enabling the charge regulator on the charge pin. If the level pulls low, it will indicate that the peripheral module is meant to only communicate with the core module but not charge it.

Preferably immediately inside of the case of a module will be an electrostatic discharge (ESI)) resistor/diode clamp protection scheme. From there the I/O lines may go to a cross-point type multi-plexing circuit. Since in a preferred embodiment any of the six remaining pins can be inputs or outputs and connect to A/D channels in the module, voltage measurements could be made in a peripheral, e.g., by the core module and appropriate messages displayed to the user as to peripheral readiness and power levels.

The eight contacts of each module could be gold plated or the like such that they would be very conductive and yet tough. The contacts may be molded in a plastic insert that is glued into a hole at a location such as indicated at **280**, FIG. **10**, for example.

A case such as indicated at **201** in FIG. **7** can be in two pieces a front half and a back half, and the back half may have one rectangular flanged hole in which to glue the oppositely flanged I/O contact plate. The back half may be glued with conductive epoxy glue to the top case half. The top case half may have a large rectangular opening in which the display/electro-luminescent panel/keyboard assembly fits. There may be a shelf behind this assembly for support with a glued-in bezel to seal the display and other components into the depression.

In an embodiment such as FIG. **7**, preferably the mating corner portions of both halves may be specially molded to clamp around the scanner housing. When finally glued together, the resulting casing **201** may be completely sealed. It may be water and gas tight, but preferably not hermetically sealed where the display plastic is permeable. Purging the casing such as **201** with dry nitrogen at the time of assembly and sealing may increase reliability. Operation may be from somewhat below sea level (e.g. actually under water) up to 10,000 feet. The case such as **201** may have a size a little over three inches long by a little over two inches deep by about three-fourths inch thick, for example.

A module such as indicated in FIGS. **7**, **8** and **9**, would be suitable by itself for fields such as package tracking, price checking, inventory control, meter reading, consumer comparative shopping, et cetera. Various countries may require individually designed modules to couple with the module or module assembly of FIGS. **7**, **8** and **9**, in order to meet national requirements and the like, e.g, with respect to such peripheral devices as modems, power supplies and so on.

The core module previously referred to as being insertable into a space such as **300**, FIG. **10**, may also be insertable into a similar space in the module of FIGS. **7**, **8** and **9**, and may represent a standardized basic processing module having the real-time multi-tasking operating system and other characteristics previously described herein.

It will be apparent that many modifications and variations may be effected without departing from the scope of the teachings of the present disclosure. For example, scanner tips such as indicated at **60**, FIG. **2**, or at **214**, FIG. **7**, may be adapted to left-handed users, by inverting the contents of the display. Thus if tip **214**, FIG. **9**, would be at the lower left with an upright display as shown in FIG. **9** for right-handed manual data entry, the module **200** might be turned by a left-handed user so that the tip **211** was at the upper right, and the contents of the display inverted.

DIGITAL SIGNAL PROCESSING (FIGS. 13A, 13B and 14–18)

Reference is made pursuant to 35 U.S.C. Section 120 to Arvin D. Danielson and Dennis A. Durbin co-pending application for patent U.S. Ser. No. 894,689 filed Aug. 8, 1986 (now U.S. Pat. No. 4,877,949 issued Oct. 31, 1989), Attorney's Docket No. 5740, and the disclosure of the specification including the claims, and of the drawings of said co-pending application is hereby incorporated herein by reference.

A module such as shown in FIGS. **7**, **8** and **9** may have a non-contact essentially instantaneous bar code scanner, e.g., at a long edge such as **311**. Flash illumination where needed for the instantaneous bar code reader could be provided by a receiving shell such as shown in FIG. **10**. The shell could contain the battery power for the flash illumination means in the shell and also for any LED marker light sources associated with the photodiode array of the processor module. A series of light emitting diodes could be used for each of the flash illumination sources of the second and third figures of the incorporated patent application Ser. No. 894,689 (now U.S. Pat. No. 4,877,949), and such LEDs could all be energized with simultaneous electric pulses, or the pulses could be supplied in quick succession to essentially simulate an instantaneous flash. Where the long edge **311**, FIG. 7, contains the scanner window for receiving a reflected bar code image, the receptacle **261** could be shaped so that edge **311** would face frontally, and a frontal face such as **312**, FIG. **10**, but of a greater dimension would contain the flashable light source means, for example. The processor module and shell when assembled would be hand held in operation, and could be of overall size to fit in a shirt pocket.

The present invention is particularly concerned with improvements in instant bar code readers of the type shown in U.S. Pat. Nos. 4,282,425 and 4,570,057. The disclosures of these U.S. patents are incorporated herein by reference by way of background.

The instantaneous type of bar code reader with flashable illuminator means has proved to be extremely desirable for portable applications because of its unique simplicity and compact design. A significant goal of the present invention is to retain the major advantages of the present commercial instant bar code readers with flashable illuminator means while enhancing the capacity for reading bar codes of substantially greater length. An important related aspect of the invention is to enable the reading of such large labels by illuminating the same with an instantaneous flash of light while the labels are at a greater distance from the frontal end of the reader. A further development goal is to more effectively adapt the reading operation both to close up bar code labels of high reflectivity and to labels at greater distances and of curved configuration. It is also conceived that a major improvement is possible in the processing of bar code signals however generated.

In FIGS. **13**A and **13**B, the output level indicated at **321***a*, **321***b* may represent the output from the image sensor in the absence of light, while reference lines **322***a*, **322***b* and **323***a*, **323***b*, may represent the output level from the image sensor for the case of a black label of a specific uniform reflectivity and of a white label of a specific uniform reflectivity. The non-uniformity of the signal level over the length of a bar code is a result of the non-uniformity of the illumination of the bar code, and/or of the curvature of the bar code. The characteristics shown in FIGS. **13**A and **13**B apply generally to bar code reader systems where illumination is non-uniform or where the label is curved, and are not limited to flash illumination systems.

In accordance with the present embodiment, it is conceived that digital signal processing of a bar code signal before the normal decoding algorithms are applied can greatly increase the read rate and general readability demonstrated by a scanner. By way of example, the output waveforms **325** and **326** of FIGS. **13**A and **13**B may represent the image sensor output of instant bar code readers such as shown in U.S. Pat. Nos. 4,282,425 and 4,570,057. As shown, the sensor output is smaller at both ends of a label than in the center. The main reason for this is the fall off of illumination at the ends according to the function $1/r^2$ where r is the radius from the effective point source at an end of the bar code. At the central portion of the bar code label, the corresponding function is $1/r$ due to an effective line source of illumination of the bar code at the center. This effect is multiplied when reading labels curved around cans and bottles where the label towards its ends is progressively farther away from the reader.

An image sensor has the advantage that it establishes an absolute dark signal as indicated at **331**, FIG. **13**A, and at **332**, FIG. **13**B, at the beginning of each reading operation. This allows the reader electronics the ability to always properly set up for detecting all bars and spaces of a label. A commercial instant bar code reader of the type shown in U.S. Pat. Nos. 4,282,425 and 4,570,057 uses this feature but incorporates a peak detector hardware circuit that digitizes the analog CCD output based on detecting peaks and comparing them with a fixed hysteresis to determine where a bar or space transition is located. This allows what is called first bar stretch if the hysteresis is too small and missed bars or spaces if the hysteresis is too large. The varying intensity pattern of the CCD output as illustrated in FIGS. **13**A and **13**B, when a single hysteresis value is used, contributes to radiometric errors in the width counts of bars and spaces and makes it more difficult for the decoding algorithms to function in an optimum manner. The algorithms are designed to overcome only a fixed amount of variation. Most readers set up to detect a first black bar on white background as in FIG. **13**A, will miss the first bar for the case of a white bar on a black background as represented for example in FIG. **13**B, while those set up to detect the first white bar for the case of FIG. **13**B will tend to insert a bar when reading a label such as represented in FIG. **13**A. Digital signal processing according to the present embodiment will result in proper detection of a first black bar on a white background as illustrated in FIG. **13**A and will not insert bars or spaces in the case of either FIG. **13**A or FIG. **13**B.

By storing each sample in digital form until no longer needed, the successive pixels of the stored signal can be examined so as to greatly enhance the sensitivity and accuracy of the bar code reading process. In a preferred embodiment, the first pixels supplied by the CCD shift registers give absolute dark values such as indicated at **331** and **332**. The corresponding stored pixel values provide a valid reference level from which to examine pixels of the bar code signal as digitally stored. As illustrated in FIGS. **13**A and **13**B, all bar codes will produce a negatively sloped signal in the vicinity of the first bar.

In one example of a signal processing procedure for processing the bar code signals resulting from scanning black bars on a white background and white bars on a black background, each signal is examined first to locate a slope reversal such as indicated at **341**, FIG. **13**A, or **342**, FIG. **13**B.

In a preferred embodiment, the criteria for a slope reversal is not only a change from negative slope to positive slope (or vice versa) but also a requirement that the changed slope extend for a specified amplitude range. This requirement is described as a need to meet a minimum "hysteresis level" once slope has changed (using a concept derived from the "hysteresis" effect where the output is made dependent on the direction of the input current traverse in certain electrical devices, e.g., in comparator type switching circuits where it is desired to avoid repeated cycling due to noise pulses). For example, in a preferred embodiment, a change from negative slope to positive slope in an initial part of a bar code, following a reference level such as indicated at **331**, FIG.

13A, or 332, FIG. 13B, would require a signal amplitude increase as measured directly at the output A/D3 or A/D4 of the CCD array of sixty millivolts. Thus, if the amplitude increase from 341 to 351 in FIG. 13A is sixty millivolts or more, a first slope transition would be recognized at 341 for the purpose of further processing steps herein. Similarly, in FIG. 13B, the transition from 342 to 352 would need to have an amplitude of at least sixty millivolts to have transition point 342 recognized as the first slope transition for purposes of the further processing steps. In examining the bar code signals for further slope transitions, as the signal increases in magnitude as the center of a bar code is approached, the required amplitude change or hysteresis value can be adjusted to correspondingly larger magnitudes to reduce the risk of error due to signal noise or label aberrations. The various hysteresis values can be software selected, and thus readily modified to adapt the processing to special labels or situations.

Once a first slope reversal is found as at 341, FIGS. 13A, or at 342, FIGS. 13B, the processor means may be programmed to examine succeeding pixels of the stored signal to locate a slope transition of opposite type, e.g., as indicated at 351, FIGS. 13A, or at 13B.

As previously explained, a slope transition is accepted for processing purposes if the signal level beyond the possible slope transition changes by a selectable value. Where the peaks 351 and 352 meet this criterion, the signal between peaks 341 and 351, and between peaks 342 and 352 is examined to establish a suitable reference point for measuring bar width.

For the case of dark bars on a light label, the problem is better understood by reference to FIG. 14. If a first valid slope transition has a signal level A and a second valid slope transition has a signal level B, the measurement of the width of the first dark bar should be taken from a transition point 360, FIG. 14, which is midway between the signal levels A and B, i.e., at (A+B)/2. On the other hand for a following stored signal pattern between valid slope reversals at signal levels of B and C, a midpoint between levels B and C would not properly represent the point for measurement of the width of the first dark bar. The correct transition point is actually at a signal level of H. Thus, in order to identify the proper transition points for measurement of bar width, according to the procedure of the present invention, the maximum slope of the bar code signal between valid slope transitions is also taken into account.

In a preferred embodiment, a transition for purposes of measurement of bar width is taken as the maximum slope section of the signal closest to the midpoint between the signal levels of two successive valid slope reversals of opposite type. Utilizing this preferred criterion, the transitions in FIG. 14 for bar width measurement are (A+B)/2, H, (C+D)/2, (D+E)/2, (E+F)/2 and (F+G)/2.

Thus, in analyzing a stored signal pattern as represented in FIG. 14, the processor would proceed from the reference absolute dark level 331, and locate the slope transition from negative slope to positive slope at 341. The processor would then analyze the signal levels beyond point 341 to determine if the transition at 341 was to be regarded as a valid transition. For example, if the differential between levels A and B corresponded to sixty millivolts of signal amplitude as measured directly from the output of the CCD array, the peak at 341 would be treated as a valid slope reversal for purposes of locating the measurement point 360.

In preparing signal data for processing, a filtering algorithm may be applied such that the stored and filtered data to be analyzed would plot as shown in FIGS. 13A, 13B and 14 without high frequency superimposed noise disturbances. In this case, the processor can simply identify peaks such as 341, 351 and 361 by their respective slope transitions and obtain the difference between levels B and C to determine if slope transitions 341 and 351 are to be considered valid. If the level B minus level A value does not meet the initial hysteresis criterion, then slope reversals 341 and 351 would be ignored, and slope transition 361 would be analyzed based on the required initial hysteresis value between levels C and D.

If the slope transition at 351 was such that the differential between levels C and B did not meet the hysteresis criterion, then slope transitions 351 and 361 would be ignored, and a further positive slope to negative slope transition, e.g., at 371 would be examined with respect to the required hysteresis criterion.

Once the first two bar width measurement points such as 360 and 370, FIG. 14, have been determined, the pixel count value between these measurement points is computed as a measure of the width of a first dark bar. Such processing steps can proceed as background while further portions of the bar code signal are being read and converted to digital form.

When the predetermined number of pixels available from the photosensor 11, e.g., 5000 pixels, has been read into the processor, the read in process is complete, and processor 10 completes the bar code evaluation as promptly as possible.

Where a single processor program is to handle the analysis of both black bars on a white background and white bars on a black background, the program must analyze the signal region prior to the first valid negative to positive slope transition or first low peak for a knee such as indicated at 390, FIG. 13B. As indicated in FIG. 15, the width of the first white bar is then to be measured between points such as 391 and 392, FIG. 15. In other words, while the transition as at 360, FIG. 14, from a white space to a first black bar occurs after the first negative slope to positive slope transition, for the case of the transition from a black space to a first white bar, the transition occurs as shown at 391, FIG. 15, prior to the first negative slope to positive slope transition.

FIG. 16 is similar to FIG. 15 but illustrates the situation where the first white bar is much wider, and the black background to white bar transition occurs at a point such as indicated at 400 between a knee 401 and negative slope to positive slope transition at 402.

In order to examine the portion of a bar code signal prior to a first slope transition for a knee such as indicated at 390, FIGS. 13B and 15, or as indicated at 401, FIG. 16, the program analyzes the slope of the bar code signal at the beginning and working toward the first slope reversal.

First an initial slope is established based on the first few pixel measurements beyond the absolute dark reference portion (such as 331, FIG. 13A, or 332, FIG. 13B). Then the processor looks for an abrupt slope change in the negative direction relative to such initial slope of at least two to one. For example, if the initial slope was minus forty millivolts per pixel, then an abrupt change to at least minus eighty millivolts per pixel would be required to qualify as a valid knee prior to the first negative to positive slope transition. The slope value for comparison purposes is adjusted from the initial value after each determination of a gradual slope change so that gradual slope changes over a number of pixels will not cause a false indication of a knee transition. If no sufficiently abrupt transition in negative slope is found, it may be assumed that the first space to bar transition is

located after the first negative slope to positive slope transition (as in FIG. 13A).

If a sufficiently abrupt change in negative slope is found, the program may treat such knee-like transition as a first slope transition, and then proceed the same as for the case of FIGS. 13A and 14.

By way of example, if the processor is to establish a list of valid slope transitions and has entered the pixel address of slope transition 342, FIG. 13B, as a first negative to positive slope transition, the processor may shift such pixel address to a location for a second slope transition, and enter the pixel address of transition 390, FIG. 13B, as the first slope transition. Having then established two valid slope transitions, the processor can subtract the respective signal level values from each other and divide by two to identify the level midpoint. If the processor has previously established a list of slope values for pixel addresses between points 390 and 342, the processor can examine the list to identify the maximum slope value. If several slope values close to the maximum slope are present, the processor selects the one closest to the level midpoint. For example, slope values within ten percent of the greatest slope value within an interval under consideration may all be considered as maxima for the purpose of selecting the maximum slope closest to the level midpoint, especially where individual pixel readings are subject to errors of this magnitude.

FIG. 17 illustrates the signal variation 410 for the case of black bars on a white background where the label is of low contrast and highly reflective. As indicated, a first low peak 411 may actually have a magnitude equal or greater than the second high peak 412, thus emphasizing the importance of controlling the processor to adaptively examine successive portions of the bar code signal as taught in reference to FIGS. 13A, 13B, 15 and 16. By controlling the processor to examine each transition with respect to its own peaks and slopes, it is possible to validly decode a bar code signal which could not be otherwise analyzed.

As with all signals, there is noise to be accounted for, and the processor is controlled to maintain a minimum hysteresis for all values and to average multiple pixels for determining slopes. The number of pixels to be averaged and the minimum hysteresis to be used in the control of the processor can be software selected, and thus can be modified to adapt the processing to special labels or situations.

FIG. 18 illustrates an exemplary control program for the processing means 10 of FIG. 1 in implementing the analysis of bar code signals such as represented in FIGS. 13A and 13B which have been stored pixel by pixel in digital form. In digital signal processing mode, the processing means is controlled to read successive pixels so as to compute a slope value for a given pixel based on suitable average values. For the successive slope values as computed in step 421, the slopes are compared to identify a transition from a negative slope to positive slope as a "low peak". If such a transition is not found in step 422, decision step 423 is executed normally with a return to processing step 421 and the reading of a further pixel value and the computation of an associated average slope value. When a low peak such as 341, FIG. 14A, 342, FIG. 14B, or 402, FIG. 16, is located, the signal value associated with this low peak is stored as indicated by processing step 424. As represented by decision step 425, if this is the first low peak, then processing as indicated by step 426 takes place to examine the stored pixels in the region between the absolute dark signal portion 331, FIG. 13A, or 332, FIG. 13B, and such first low peak. If a valid detected knee is found such as indicated at 390, FIGS. 13B and 15, or at 401, FIG. 16, then according to step 427, such valid detected knee is established as a first high peak value for the purpose of further processing as shown by step 428. Processing then proceeds according to step 430 with a computation of the first defined transition point such as indicated at 360, FIG. 13A, 391, FIG. 15, or 400, FIG. 16.

If decision step 427 failed to locate a "detected knee" before the first low peak, then the example of FIG. 13A would apply and processing would proceed directly to step 432. According to step 430, the pixel number associated with the transition 391 or 400 could be stored in a memory associated with processing means 10.

For the case of FIG. 13A, a high peak such as 351 would be identified by processing step 433 and the associated transition 360 would be determined by step 434, the processor storing the pixel number associated with the transition 360 in memory, and then proceeding to examine the stored signal according to processing step 421. A similar processing at steps 433 and 434 would detect the first high peak 352 and second defined transition 392, FIG. 15, and the first high peak 450 and second defined transition 451 for the case of FIG. 15. With the computation of the second transition in step 434, the processor would compute the bar code width as the difference between the pixel number of the second defined transition 392 or 451 and the first defined transition 391 or 400, and store such difference as the width count for the first white bar.

In either event, processing would terminate as represented by decision block 423 or 453 after all of the pixels of the bar code signal had been examined.

It would be feasible to utilize the early decoding of initial bars of a bar code signal in order to speed up auto discrimination, e.g., the automatic decision by the processor as to whether a bar code is being read from a white or black background.

It will be apparent that many further modifications and variations may be effected without departing from the teachings and concepts of the present disclosure.

SUPPLEMENTARY DISCUSSION RE FIGS. 7 THROUGH 12

The following gives examples pursuant to FIGS. 7 through 12 where the assembled plural module device has overall size so as to readily be carried in a shirt pocket when not in use.

EXAMPLE I

In this Example I, the computerized processing module 200 of FIGS. 7, 8 and 9 has a width of 2⅛ inches, a length of 3⅜ inches and a maximum thickness of ¾ inch. The scanner tip 214 may lie essentially within the foregoing dimensions as in FIG. 7.

The receptacle 261 of the peripheral shell module 260, FIG. 10, may have a uniform width so as to snugly receive the width dimension of the processing module 200 and a length dimension such that the module 200 is substantially contained within the receptacle 261 while the portion with scanner tip 214 projects a sufficient distance beyond edge 312 for convenient scanning of bar codes while it is assembled with the shell module 260. A ledge (not shown) may extend about the margin of the recess 261 so as to overlie a top margin of the casing 201 at regions such as 201*a*, 201*b* and 201*c*, FIG. 7, while leaving the region of membrane 202, FIG. 7, accessible to the user and leaving the

display region of display **204** visible through the membrane **202** as in FIG. **9**.

With such an arrangement the assembled parts **260** and **200** may have an overall length of five inches or less, and a uniform overall cross sectional perimeter of less than eight inches.

In this Example I, a smart card would be inserted lengthwise into a slot such as **262** which slot would have a width of about 2⅛ inches, but such slot would be at the opposite side of the assembly from scanner tip **214** since the smart card would project a substantial distance from the assembly even when fully inserted into the slot, e.g. to a depth of two inches.

Example I may include all of the electrical and mechanical auxiliary means referred to herein with respect to FIGS. **7** through **12**, and may include a smart card interface for reading and modifying transaction data stored on a smart card, and for effecting display of stored data from the smart card on the display of processor module **200**, and for modifying data stored on the smart card according to data and instructions entered via the input/output means of processing module **200**.

EXAMPLE II

In this Example II, the computerized processing module **200** may have the same length and width dimensions as described for Example I, but may be inserted into recess **261** of the peripheral shell module **260** in a width-wise manner, the sides of recess **261** being separated by a uniform distance of about 3⅜ inches, and such sides having longitudinal dimensions of less than 2⅛ inches so that the long edge **311**, FIG. **7**, of the processing module **200** would be at the rear of recess **261** adjacent battery compartment **282**, and the scanner tip **214** would project beyond frontal face **312**, FIG. **10**, for convenient contact with bar codes to be scanned.

In Example II, the smart card slot **262** would again accommodate a smart card width of about 2⅛ inches, but the depth could be such as to receive the entire length of the smart card (if a suitable card ejection mechanism were provided).

With such an arrangement of parts and with such a modified peripheral shell configuration, location **300**, FIG. **10**, might be at the bottom of a shirt pocket and slot **262** at the top of the shirt pocket, with the overall length less than five inches. With the overall dimension of the assembled modules between scanner tip **214** and the external wall of battery compartment **282** being about 3½ inches, the overall thickness could be about ½ inch, so that processing module **200** would be substantially thinner than ¾ inch, for the case of a cross sectional perimeter of about eight inches (shirt pocket size). By way of example, a thin processing module **200** could receive its display and digitizer operating power from the shell module batteries at **282**, FIG. **10**.

Example II may include all of the electrical and mechanical auxiliary means referred to herein with respect to FIGS. **7** through **12**, and may include a smart card interface as described for Example I as an auxiliary means of the processor module means for executing an auxiliary function, e.g., reading/writing with respect to a smart card in slot **262**, FIG. **10**.

EXAMPLE III

For a configuration according to Example I or Example II, the display of FIG. **9** would still be visible with parts **200** and **260** assembled.

With the particular screen of FIG. **9** being displayed, touching any part of region **230** could place the system in touch screen data entry mode with a desired touch type keyboard or graphics display occupying the entire length of the display area over multiple lines, for example. Touching any part of the symbol **450**, FIG. **9**, on the other hand could place the entire display area in digitizer mode, e.g. using a digitizer stylus of suitable construction. For the digitizer example previously given with respect to FIG. **9**, outlines of entry fields such as **240-1** and **240-2** of suitable size could extend across the entire display region; and lines of characters such as generated at 240, 242 and 244 would correspondingly be able to extend across the entire display area in digitizer data entry mode.

EXAMPLE IV

The computerized processing module such as **200**, FIGS. **7**, **8** and **9**, and such as **300**, FIG. **10**, for any of Examples I, II, or III may be of standardized construction, even where the shell module means have different configurations as in Examples I and II.

As previously described in detail, the computerized processing module **200** may be self-contained and may have a display screen occupying substantially an entire broad side of the unit, as is shown in FIG. **9**. Input information, e.g. applied to a touch input region **230**, FIG. **9**, may be displayed over the surface of the display screen e.g. in five or more lines to the right of region **230**. In the stylus input mode as depicted by the graphical symbol **450**, FIG. **9**, the unit registers the path of movement of the manually held stylus e.g. at successive fields such as **240-1**, **240-2**, FIG. **9**, along one or more lines e.g. as at 240, FIG. **9**, extending substantially completely across the screen and of length comparable to the maximum length of the unit.

EXAMPLES I THROUGH IV

The computerized processing module **200** in each example provides highly versatile and compact input/output means adaptable to graphical display of any desired patterns, facilitating utilization of the standardized module for different applications, and on the basis of the languages or graphical symbols required for marketing of the unit in any desired locality worldwide.

The term "pocket size" as used herein refers to a device with overall dimensions so as to be carried in a shirt pocket. A shirt pocket is here taken as having a size of about four inches wide by five inches high; thus a device of overall size to readily fit in a shirt pocket would have a maximum cross sectional perimeter of about two shirt pocket widths (2×4 inches) or about eight inches. A device with maximum height of about five inches would fit inside a shirt pocket while a height of about seven inches might be carried safely in a shirt pocket.

EXAMPLE V

As Example V, any of the embodiments of the foregoing Examples may utilize a digitizer screen, e.g., operating on a sonic principle with a sound transmitter located in the stylus and two receivers located some distance apart along each screen axis such that the differences in the x and y coordinates can be calculated. To digitize successive points, the stylus can be activated automatically to transmit sound pulses at time intervals such that the set of position readings for each point is readily segregated and processed, and desired resolution is obtained.

The digitizer screen may be part of a peripheral shell such as **260**, FIG. **10**, e.g., fitting in a receiving recess **261** and retained by any suitable means, or the digitizer screen may be provided by membrane **202** itself, FIGS. **7**, **8** and **9**, and thus be part of a standardized computerized processing module.

In each case, the digitizer screen preferably occupies substantially the entire area of a broad side of the shell module such as **260** or of the standard processor module such as **200**. The digitizer screen preferably has a size such as two inches by three inches when part of a processor module, but may have a size of e.g. approaching four inches by six inches for the case of a shirt pocket size shell module with a standardized processor module such as indicated at **300**, FIG. **10**.

EXAMPLE VI

This example may correspond with Example V but the digitizer may operate on an optical principle such as described in U.S. Pat. No. 3,764,813 wherein a passive stylus may be utilized.

Again, the digitizer screen may be part of a peripheral shell device such as **260**, FIG. **10**, or may be formed by membrane **202**, FIG. **7**, **8** and **9** of a standardized computerized processing module. The dimensions of the digitizer screen may be as in Example V.

DESCRIPTION OF FIGS. 19 TO 23

FIGS. **19** to **23** show a signature pad module with dimensions of 2.870 inches (length), 1.5000 inches (width) and 2.27 inches (height). Accordingly such a module may be adapted to fit in a pocket size shell configuration such as shown in FIG. **10**, to form a self contained portable battery operated system. The following description is considered relevant in explaining further the significance of the graphical input capability of the pocket size systems of FIGS. **7** through **10**, and particularly those of Examples III, IV, V and VI.

While hand-held data terminals have greatly increased the accuracy and efficiency of product distribution, there are situations where it is desirable to allow the capture and recording of handwritten data rather than data that is entered by keystrokes. One such use would be to provide for the recording of signatures and for verification of the signatures recorded. In some applications, digitized pads are available to permit the entry of handwritten data, usually in situations where the data is entered by marking a predetermined location on a form that overlies the pad. However, to date there does not appear to be available any means for combining a handwritten data entry module with a portable data terminal in such a way that the handwritten data can be directly entered or read and entered by a scanner.

In an illustrated embodiment, the module contains a digitized pad which can capture and enter the handwritten data immediately as it is entered on the pad. The illustrated module is easily and quickly attached to a hand-held computer terminal by a hook-hinge arrangement, using the existing connector on the computer terminal and a connector on the module. In the embodiment of the module using a digitized pad, the module and hand-held terminal provide an integrated system while allowing normal hand-held portable operation with the module in place.

Referring first to FIG. **19** of the drawings, there is illustrated a hand-held data terminal or computer terminal **510** of a type suitable for use with the signature pad module. A computer terminal such as the Model NT141GL hand-held computer terminal of Norand Corporation, Cedar Rapids, Iowa, has the necessary power and flexibility for this application. The computer terminal **510** has a keyboard **512** and a display **514**. In addition to keyboard entry, data can be downloaded to the computer terminal **510** from a host computer or entered from a peripheral device such as a scanner.

The module providing for the entry of handwritten data is indicated generally by the reference numeral **516** and is shown in more detail in FIGS. **20** through **23**. The module **516** comprises a suitable case **518** that houses a pad **520** for recording data in the manner described hereinafter. The case **518** has formed along the lower edge near the front a depending hinge **522** having a lug **524** extending along its entire length. Also, along the bottom surface **525** of the module **516** near the rear wall **526** is a cable plug **528** that will engage a standard receptacle (not shown) the top surface of the hand-held computer terminal **510**. Plug **528** and the receptacle provide a standard 15-pin connection between these components. Near the top surface **532** of module **516** there is provided a suitable 15-pin receptacle **534** that provides for connection of other external devices. The receptacle **534** and plug **528** are suitably interconnected by means including ground cable **536** inside of the case **518**.

The hinge **522** with its locking lug **524** provides for easy, quick and removable connection of the module **516** to the computer terminal **510**. By engaging the locking lug **524** under a corresponding shoulder at **538** in the top surface of computer terminal **510** and rotating the module **516** rearwardly until the plug **528** on the module **516** engages the receptacle on the computer terminal **510**, the module **516** is quickly and solidly affixed to the computer terminal **510** and all necessary connections made between plug **528** and its mating receptacle. The force applied by a user to the module **516** in entering handwritten data on the pad **520** will bias the module further into a locked position on the computer terminal **510**. In order to remove the module **516** from the computer terminal **510**, the module **516** is grasped and rotated forwardly in the direction opposite to the force that is applied during use. Thus, connection between the module **516** and computer terminal **510** is a solid, positive connection that is quickly and easily made.

The pad **520** can be of any suitable type for recording handwritten data. If a suitable optical scanner (not shown) is to be used as a part of the system, the pad **520** can very simply be any suitable means in which handwritten data can be visibly recorded so that it can be scanned and entered into the system by the scanner. Suitable optical scanners are available for reading handwritten data of all types and processing the information read digitally and entering the digitized data into the computer terminal **510**. A suitable optical scanner for this purpose is described in the U.S. patent application Ser. No. 07/238,701, filed Aug. 31, 1988, by Steven E. Koenck, (Attorney Docket No. 6240), which application has been assigned to Norand Corporation, the same assignee of this application.

The pad **520** also may be a digitizer pad of a any suitable type containing resistive sheets forming a digitizer means **540** (FIG. **22**) responsive to operating pressures in a suitable range normally applied by a user using a ballpoint pen. The digitized pad **520** using resistive sheets at **540** preferably has sufficiently high resolution to provide an accurate representation of handwritten data including signatures. The resistive sheets at **540** are preferably covered with an abrasion resistant cover **542** of a suitable polyester material. When the user enters data onto pad **520** by supplying sufficient

pressure with a writing instrument to activate the resistive sheets at **540**, the information is digitized, compressed and stored and/or transmitted to the computer terminal **510**. For example, if the module **516** is being used for signature verification, a signature written on pad **520** can be immediately verified or stored for future verification.

From the foregoing description, it is evident that the data capture module provides the capability of capturing and recording handwritten data of all types, which data can be entered either directly using a digitizing pad on the module, or the handwritten data can be entered into the data terminal by a suitable optical scanner for further processing. All types of handwritten data, including both text and graphics, can be captured using the module in connection with a portable hand-held data terminal. One example that has been described is the verification of signatures, but any handwritten data can be entered directly or scanned into the terminal, the amount of data being limited by the available memory. The module thus provides a vehicle for significant data entry means not presently available with hand-held type computer terminals.

The actual volume occupied by the signature pad **520** and the printed circuit boards **562** and **570** is about 1¾ inch (wide) by 3¼ inch (long) by about 13/8 inch (deep). This is consistent with use with a pocket size receiving module such as shown in FIG. **10**.

The pad active area may be 2.375 inches by 0.875 inch by 0.055 inch. The covering **542** may be 0.007 inch polyester. The pad may utilize a silicone elastomer pad sensor, and may provide a pad resolution of 175 points per inch giving a resolution of 415 points across and at least 150 points in height.

Generally the signature pad may comprise upper and lower resistive sheets of silicone elastomer which have resistive ink applied to the confronting faces so as to present uniform resistivity over the surfaces. Application of point pressure to the cover sheet **542** causes the resistive layers to contact at a corresponding point.

For tractor fed forms, alignment pegs **563**, **564** on the bezel part **518B** are used to engage in the form feed holes to hold the form in position during the signature capture process. Should the sensor pad **520** be damaged, the bezel part **518B** including the sensor pad can be replaced without replacing the entire unit. This is accomplished by removing screws **553**, **554** and pivoting parts **518A**, **518B** away from each other. The connector **560** can then be unplugged from the input/output printed circuit board **562**. The ground cable **536** may be separable at **568**.

Printed circuit board **570** may carry components such as a CPU chip (e.g. type 80C31), CMOS static RAM (e.g. 32K×8), and an EPROM component (e.g. type 27C256) as indicated at **571**, FIG. **22**.

The printed circuit boards **562** and **570** are 13/8 inch by 3 inch by less than 1/16 inch and are separated from each other by about one-half inch. Coupling between the digitizer pad **540** and the circuitry of board **562** may be by means of two twin conductor ribbons such as that indicated at **572**, FIG. **22**.

Referring to FIG. **21**, it can be seen that case **518** is formed of a base assembly **518A** and a bezel assembly **518B**. The base assembly includes an outwardly facing hook plate **550** which interlocks with a receiving recess of the bezel assembly. The parts **518A**, **518B** are pivotal at the hook plate-recess into a snug interfitting relationship, with edge **551** fitting into a receiving channel of part **518B**. The parts are then secured together by means of screws **553**,**554**, FIG. **23**. The channel may have a sealing strip seated therein, e.g. a 0.052 inch diameter elastomer 12.5 inches long.

Ribbon connectors **557**, **558** from the 15-pin plug **528** and 15-pin receptacle **534** are provided with internal **16** position receptacles **559**, **560** which connect with headers on the input/output printed circuit board **562**. When the pad is disabled, communications will pass between connectors **528** and **534** unmodified.

By way of an alternate example, the resistive sheets may be of Mylar of five mils (0.005 inch) thickness. In any case, conductive x-axis conductive strips may extend along the long edges of the upper resistive layer, and Y-axis conductive strips may extend along the short edges of the lower resistive layer, the pairs of conductive strips being connected with conductors of respective ribbons such as **572**, FIG. **22**.

Conveniently the outer sheet is somewhat longer in the length and width dimensions so as to overlie a metal frame **573**, FIG. **22**, while the inner sheet is seated in a recess within the confines of the frame **573**. The outer resistive sheet is then fastened at its margins to the frame so that there is normally a clearance air space of approximately ten to thirty mils (one mil equals 0.001 inch) between the two resistive layers. The confronting resistive surfaces may comprise graphite ink resistive surfaces as is well understood in the art.

DESCRIPTION OF FIGS. 24 AND 25

FIGS. **24** and **25** illustrate exemplary circuitry for the input/output printed circuit board **562**. FIG. **24** shows the circuitry connected to the X and Y axis conductive strips of the signature pad **520**. For reading an X-axis dimension from the signature pad, transistors **24-Q2**, **24-Q5** and **24-Q6** are turned on to apply a potential of five volts analog, (+5A), through transistor **24-Q2** to the Y+ conductor **2410** which leads to the Y axis strip at one end of the inner resistive surface. The return path from the other end of the inner resistive strip is via Y-conductor **2411** and transistor **24-Q6**, creating a potential distribution along the long X-axis dimension of the pad. The X-axis potential value at the point contacting the outer resistive sheet is coupled via conductors **2412** and **2413** to the channel one input of analog to digital converter **24-U1** (e.g. type LTC1091).

Similarly, to read out a Y-axis value, transistors **24-Q3**, **24-Q4** and **24-Q1** are turned on, and the Y-axis potential at the contact point is read out via the inner resistive sheet and conductors **2410** and **2414** leading to the channel zero input of the analog to digital converter **24-U1**.

In FIG. **25**, line 2511 receives battery voltage MBATS from the terminal **10**. Line 2511 is coupled with pin **15** of connector **528**, via position 15 of receptacle **559**, FIG. **21**. The I/O printed circuit board **562** connects position 15 of the header receiving receptacle **559** with position 15 of the header for receptacle **560**. Line 2511 connects with line 2416, FIG. **24**, and connects to the CPU printed circuit board **570** via mating interboard connectors such as **573**, **574**, FIG. **3**, a capacitor (not shown, 0.01 microfarad, 50 volts), being connected between MBATS and ground in parallel with **25-TZ1**.

Applying EXT EN to conductor **2512** serves to transmit a reset signal to the processor of board **570** via **25-Q7**, **25-Q10**, **25-Q9** and **2513** (RESET).

The signals associated with the various positions of connectors **528** and **534** are as follows:

	Connector 528			Connector 534	
J1	1	TXD	J2	1	TXD Out
J1	2	DTR	J2	2	DTR
J1	3	RTS	J2	3	RTS
J1	4	RCT	J2	4	RCT
J1	5	RXD	J2	5	RXD IN
J1	6	CTS	J2	6	CTS
J1	7	DSR	J2	7	DSR
J1	8	CHG In	J2	8	CHG In
J1	9	GND	J2	9	GND
J1	10	XOVER/TXL	J2	10	XOVER/TXL
J1	11	———PROX/RXC	J2	11	———PROX/RXC
J1	12	SCAN/PWR	J2	12	SCAN/PWR
J1	13	EXT EN	J2	13	N.U.
J1	14	RCR/CD	J2	14	RCR/CD
J1	15	MBATS	J2	15	MBATS
J1	16	N.U.	J2	16	N.U.

The symbols J1 and J2 actually refer to the headers on I/O board **562** receiving connectors **559** and **560**, respectively. Thus position 16 is not used. Position 13 of J1 connects with line 2512, position 1 connects with line 2520 and position 5 connects with line 2521. Line 2522 connects with position 5 of J2, and line 2523 connects with position 1 of J2. The printed circuit board provides direct connections between positions of J1 and J2 designated DTR, RTS, RCT, CTS, DSR, RCR/CD, RCT, CHG IN, XOVER/TXL, and $\overline{\text{PROX}}$/RSC, MBATS and GND.

The transistor **25-Q6** controls supply of power to the pad regulator **25-REG1**.

The interboard connectors on board **562** such as **573**, FIG. **21**, are designated J3 and J4 carry the following signals.

J3	1	N.U.	J4	1	———ADCS
J3	2	DI/O	J4	2	RDX4
J3	3	ADCLK	J4	3	TXD3
J3	4	JY–	J4	4	RESET
J3	5	JY+	J4	5	GND
J3	6	JX–	J4	6	+5V
J3	7	JX+	J4	7	MBATS

DESCRIPTION OF FIGS. 26, 27, 28 AND 29

FIGS. **26–29** show exemplary circuitry for the CPU board **570**. The interboard connectors on board **570** such as connector **574** are designated P3 and P4 and connect with the CPU, **26-U5**, of board **570** as indicated in the following table:

		CPU (Type 80C31)		
			Pin	CPU Pin Designation
P3	1	N.U.		
P3	2	DI/9	9	P 1.7
P3	3	ADCLK	6	P 1.4
P3	4	JY–	5	P 1.3
P3	5	JY+	4	P 1.2
P3	6	JX–	3	P 1.1
P3	7	JX+	2	P 1.0
P4	1	———ADCS	8	P 1.6
P4	3	TXD3	11	RXD
P4	4	RESET	10	RST
P4	5	GND	22, 35	VSS, EA
PR	6	+5V	44	VCC

Pin **13** (TXD) of CPU **26-U5** connects via line 2610 (RXD3) with the circuit of FIG. **27**, which in turn drives line 2611 (RXD4). MBATS line 2612 also connects with FIG. **27**. Line 2614 connects with the circuit of FIG. **28**. Pins of CPU **26-U5** designated AD7-AD0, respectively connect with data bus **2910**, FIG. **29**. The pin of **26-U5** designated ALE connects with latch **29-U2** and EPROM **29-U3** via line 2620. Pin **32** of ($\overline{\text{PSEN}}$) connects via line 2621 with **29-U3**. Address bus **2630** from pins designated **A8-A15** of **26-U5** connects with components **29-U3** and **29-U4** (a CMOS static random access memory, e.g., 128K×8).

Pin $\overline{\text{RD}}$ of CPU **26-U5** connects via line 2631, pin $\overline{\text{RAMEN}}$ connects via line 2632; and pin $\overline{\text{WR}}$ connects via line 2633, with **29-U4**.

Although the invention has been described in connection with certain preferred embodiments thereof, it will be evident to those skilled in the art that various revisions and modifications may be made. Also the illustrated embodiments can be adapted to applications differing from those described by way of example herein without departing from the spirit and scope of the invention. It is our intention that all such revisions and modifications be included within the scope of the present disclosure.

EXAMPLE VII

As an example pursuant to FIG. **10** and FIGS. **19–29**, a signature pad may have the configuration illustrated in FIG. **7** for interfitting in receptacle **261**, FIG. **10**, as described in Example I for module **200**. The printed circuit boards **562** and **570** could be consolidated into a single printed circuit board underlying the signature pad and having comparable dimensions, e.g. about two inches by three inches. The inputs and outputs from the consolidated circuit board could comprise MBATS, GND, EXT EN, and the communication lines for two-way alternate point-to-point communication. These inputs and outputs could couple with module **200** at a region such as **280** using mating surface contacts as previously described with reference to FIG. **10**.

Battery power could be available in the receiving module **260** at **282**, and protocol conversion and other functions of the terminal could be performed by a modular processor at **300**. A touch screen corresponding to **202** could be included at the three margins of the signature pad at the top surfaces of module **260**, FIG. **10**.

By way of example, signatures as digitized by means of the signature pad module could be transferred under the control of the processor module at **300** to a data storage card inserted in slot **262**. Alignment pegs such as **563**, **564**, FIG. **20**, could form part of the signature pad module, such that a touch screen overlying battery compartment **282** would be accessible to activate the signature pad module by transmitting EXT EN to the pad module in response to actuation of a region of the touch screen in signature capture mode.

Such touch screen would then signal when a signature had been properly digitized and stored. The touch screen associated with module **260** can accommodate the entire data capture command set.

EXAMPLE VIII (FIGS. 30 and 31)

In Example VIII, the circuitry of FIGS. **24–29** may be part of a computerized processing module **3000**, FIG. **30**, generally as described with respect to FIGS. **7**, **8** and **9**. A receiving module **3010** (corresponding to module **260** of FIG. **10**) may receive the module **3000** and may have

coupling means such as **280**, FIG. **10**, for engagement with cooperating connection means **3001** of module **3000**.

In this Example VIII, the receiving module **3010** may perform the functions of data entry terminal **510**, FIG. **19**, and in common with FIG. **10**, may provide battery means **3002** (as at **282**, FIG. **10**) capable of providing for battery operation of the circuitry of FIGS. **24–29**. In particular, receiving module **3010** would have coupling means (corresponding to **280**, FIG. **10**) for automatically engaging with the connection means **3001** as module **3000** is inserted into a receptacle **3011** of module **3010**. The coupling means and connection means **3001** could also provide automatically completed signal communication paths such as provided by the terminal connector automatically mating with connector **528**, FIG. **23**, during assembly of parts **510** and **516**, FIG. **19**. The module **3010** may have ledges such as **3012** for overlying the side edges of the module **3000**, and may include segmental spherical detents such as **3014** which are spring urged into receptacle **3011** to retain the module **3000** therein. A notch **3015** may facilitate removal of the complete module **3000** as a unit from the receptacle **3011**.

The module **3010** may have a touch screen **3020** such as described with reference to FIGS. **7**, **8**, **9**. One of the touch switch positions may be "Signature Input Mode" as indicated at **3021**. When this mode is selected by manually depressing region **3021**, a graphic display is produced on module **3000** as indicated in FIG. **30** which facilitates the handwritten entry of a signature e.g. in a space indicated by a box displayed at **3022** with a signature line at **3023**, and a "start" box indicated by a dash line **3024**.

As described with reference to FIGS. **7**, **8** and **9**, module **3000** may include a digitizer input screen **3025** over substantially its entire length and width as viewed in FIG. **30**, and a graphic display e.g. of the dot matrix type may underlie the digitizer screen and have a resolution sufficient to accurately display handwritten data such as signatures and the like, as well as indicia such as **3022**, **3023**, and **3024**. (See the displays at **230** and **450**, FIG. **9** as further examples).

Where the signature is to be entered directly on the digitizer screen **3025**, a wooden stylus is conveniently used. In this event, the display means of module **3000** may display the mode at **3028** and suitable instructions at **3029**.

Where a form with feed holes is to be engaged with pegs **3030**, **3031** on module **3010**, the form may have printed thereon indicia such as **3022**, **3023**, **3024**, "start", and **3029**. In this case, a conventional ball point pen may be used to enter the signature on the form, and to apply a corresponding impression to the digitizer input screen **3025** of FIG. **30**.

By way of example, the computerized processing module **3000**, or a data storage card such as indicated at **3040** (inserted into a slot such as **262**, FIG. **10**) may store the authorized signatures of persons empowered to approve a given transaction. Thus, a person delivering goods to various establishments may download authorized signatures for a given delivery into the module **3000** just prior to making the delivery, or may select a respective data storage card **3040** from a file thereof.

After the signature impression such as **3041** has been entered in space **3022** of the digitizer input screen, the processor of module **3000** or a processor **3042** of module **3010** (e.g. as at **300**, FIG. **10**) may carry out a comparison of the signature impression **3041** with the stored authorized signatures. If there is a sufficient match with an authorized signature the graphical display may indicate that the signature was a valid authorized signature as at **3044**, FIG. **31**. The matching authorized signature of record may be displayed in space **3045**, FIG. **31**, or the name represented by the signature may be simply printed in space **3045**. A transaction number may be assigned as indicated at **3046**. Further, the signature **3047** corresponding to impression **3041**, as stored by module **3000**, module **3010** or storage card **3040** may be displayed at a region **3049** adjacent region **3045** so that the operator can confirm the matching condition, or actually make the decision as to whether the signature is to be accepted. Of course, the signature as entered may be stored in fully digitized form or in a suitably compacted form in module **3000**, module **3010** or storage card **3040**.

DESCRIPTION OF EXAMPLE IX

Example VIII could be applied to the embodiment of FIGS. **19–29** as a further example, in which case the resistive type digitizer screen **520** could be used for the direct entry of a signature e.g. using a passive wooden stylus, and display **514** could provide a resultant display such as indicated in FIG. **31**, and could display indicia such as **3028** and **3029**, prior to entry of the signature impression **3041**. The signature comparison program, and the set of authorized signatures could then be downloaded into the data terminal **510**, e.g. via connectors **534** and **528** from a data storage system within a delivery vehicle or the like. Reference may be made to U.S. Pat. No. 4,798,919 which teaches using the sensing of pressure applied across the signature as a further parameter for use in signature verification.

SUMMARY RE EXAMPLES VIII AND IX

In examples VIII and IX, computerized processing module **3000** provides for the computerized processing and storage of data as described in detail in reference to FIGS. **19–29**. The stored data e.g. complete digitized information concerning a signature impression **304 1** may be transmitted from random access storage such as indicated at **29-U4** via connection means **3001** to an external receiving module such as **3010** or **510**, FIG. **19**. The computerized processing module **3000** could be of size to fit in a shirt pocket as with module **516**, FIG. **19**, e.g. a cross sectional perimeter of not more than about eight inches and a length dimension of not more than about five inches.

The connection means **3001** of module **3000** automatically engages with the coupling means in receptacle **3011** (analogous to coupling means **280**, FIG. **10**), as the module **3000** is inserted over detents **3014** and under ledges **3012** to assemble the module **3000** with the receiving module **3010**. Correspondingly, the connection means **3001** is automatically disengaged from the coupling means as the module **3000** is removed as a unit from receptacle **3011** (e.g. with the use of one finger inserted into notch **3015**).

The digitizer input screen **3025** is transparent so that the matrix type display there beneath is visible to the user through the digitizer screen. Any of the digitizer technologies currently available such as those referred to herein may be utilized. Both the digitizer input and the graphical display of module **3000** have a resolution to accurately record and display handwritten characters such as represented by signatures **3041**, **3045** and **3047**. The data such as signatures stored in module **3000** in complete digitized form or in compacted form may be transmitted to the coupling means of receiving module **3010** for utilization externally of module **3000**. For example, receiving module **3010** may have a

programmed processor at **3042** for comparing a signature impression data relating to a signature impression **3041** with a set of authorized signatures stored on a data storage card **3040**.

The display of module **3000** may display indicia such as **3022**, **3023**, and **3024** for facilitating input of a signature impression such as **3041** directly on the digitizer input screen **3025**, or a form may be located e.g. by pegs **3030**, **3031** and itself have indicia printed thereon. In Example IX, a conventional display screen at **514**, FIG. **19**, of a receiving module **510**, may display instructions adjacent a digitizer screen at **520**, and may provide a display such as indicated in FIG. **31**, once a signature impression at **520** has been compared with a set of authorized signatures stored by the receiving module **510**, FIG. **19**.

It will be apparent that many further modifications and variations may be effected without departing from the teachings and concepts of the present disclosure.

We claim as our invention:

1. A hand-held data processing system, comprising:

a self-contained computerized processing module for computerized processing of data;

said processing module having a graphical display with a display screen occupying substantially an entire broad side of the processing module;

means for displaying information over substantially the entire surface of the display screen;

said self-contained computerized processing module having a size so as to be readily contained in a shirt pocket; and

said processing module further including optical reader means for effecting the input of optical information.

2. The hand-held data processing system according to claim **1**, wherein said graphical display means is operably coupled with said optical reader means, whereby information read by said optical reader means is displayed.

3. The hand-held data processing system according to claim **1**, further including means for registering the path of movement of a stylus over the surface of the display screen to receive a manually generated path information.

4. The hand-held data capture system, comprising:

multipurpose computerized processing module means for computerized processing of data;

shell module means having auxiliary means for executing an auxiliary function, having battery means supplying power thereto, and having a receptacle for receiving said computerized processing module means so that the computerized processing module means is substantially contained within said shell module means during hand-held operation;

coupling means for providing communication between said shell module means and a computerized processing module means in said receptacle;

said shell module means with said computerized processing module means assembled in its receptacle having an overall size so as to be readily contained in a shirt pocket;

said computerized processing module means includes battery means for supplying power thereto and said computerized processing module fitting into the receptacle together with said battery means for removal as a unit therewith;

said coupling means providing a quick-connect, quick-disconnect coupling readily accommodating bodily removal of the computerized processing module means and the battery means as a unit from the receptacle of the shell module means; and

said shell module means including means accommodating insertion of a smart card therein for coupling with the computerized processing module means.

5. The hand-held data capture system according to claim **4**, wherein said computerized processing module means includes means operable for carrying out an optical reading function while entirely separate from said shell module means, and also for carrying out an optical reading function while substantially contained within said shell module means.

6. The hand-held data capture system according to claim **4**, wherein said computerized processing module means includes touch screen display means operable for presenting a graphical display and for receiving and storing manual input data while entirely separate from said shell module means.

7. The hand-held data capture system according to claim **4**, wherein said computerized processing module means includes input screen means for registering the path of movement of a stylus thereon so as to receive manually entered path information while entirely separate from said shell module means.

8. The hand-held data capture system according to claim **4**, wherein said computerized processing module means together with said peripheral shell module means selectively provides a touch screen display and a stylus path responsive digitizing input at a common display region.

9. The hand-held data capture system according to claim **4**, further including automatic reading data capture means for the automatic reading of data into the system.

10. The hand-held data capture system according to claim **9** wherein said automatic reading data capture means comprise an automatic optical reader including a light source means for illuminating a complete line of data.

11. The hand-held data capture system according to claim **9**, wherein said automatic reading data capture means comprises automatic path input means for automatically registering hand-entered path configurations.

12. The hand-held data capture system according to claim **11**, wherein said automatic path input means comprises digitizing means responsive to stylus generated handwriting configurations.

13. A hand-held data capture system, comprising:

multipurpose computerized processing module means for computerized processing of data;

shell module means having auxiliary means for executing an auxiliary function, having battery means supplying power thereto, and having a receptacle for receiving said computerized processing module means so that the computerized processing module means is substantially contained within said shell module means during hand-held operation;

coupling means for providing communication between said shell module means and a computerized processing module means in said receptacle;

said shell module means with said computerized processing module means assembled in its receptacle having an overall size so as to be readily contained in a shirt pocket;

said computerized processing module means includes battery means for supplying power thereto and said computerized processing module fitting into the receptacle together with said battery means for removal as a unit therewith;

said coupling means providing a quick-connect, quick-disconnect coupling readily accommodating bodily removal of the computerized processing module means and the battery means as a unit from the receptacle of the shell module means;

automatic reading data capture means for the automatic reading of data into the system; and

said computerized processing module means including means operable for carrying out an optical reading function while entirely separate from said shell module means, and also for carrying out an optical reading function while substantially contained within said shell module means.

14. A hand-held data capture system, comprising:

multipurpose computerized processing module means for computerized processing of data;

shell module means having auxiliary means for executing an auxiliary function, having battery means supplying power thereto, and having a receptacle for receiving said computerized processing module means so that the computerized processing module means is substantially contained within said shell module means during hand-held operation;

coupling means for providing communication between said shell module means and a computerized processing module means in said receptacle;

said shell module means with said computerized processing module means assembled in its receptacle having an overall size so as to be readily contained in a shirt pocket;

said computerized processing module means includes battery means for supplying power thereto and said computerized processing module fitting into the receptacle together with said battery means for removal as a unit therewith;

said coupling means providing a quick-connect, quick-disconnect coupling readily accommodating bodily removal of the computerized processing module means and the battery means as a unit from the receptacle of the shell module means;

automatic reading data capture means for the automatic reading of data into the system; and

said computerized processing module means including touch screen display means operable for presenting a graphical display and for receiving and storing manual input data while entirely separate from said shell module means.

15. A hand-held data capture system, comprising:

multipurpose computerized processing module means for computerized processing of data;

shell module means having auxiliary means for executing an auxiliary function, having battery means supplying power thereto, and having a receptacle for receiving said computerized processing module means so that the computerized processing module means is substantially contained within said shell module means during hand-held operation;

coupling means for providing communication between said shell module means and a computerized processing module means in said receptacle;

said shell module means with said computerized processing module means assembled in its receptacle having an overall size so as to be readily contained in a shirt pocket;

said computerized processing module means includes battery means for supplying power thereto and said computerized processing module fitting into the receptacle together with said battery means for removal as a unit therewith;

said coupling means providing a quick-connect, quick-disconnect coupling readily accommodating bodily removal of the computerized processing module means and the battery means as a unit from the receptacle of the shell module means;

automatic reading data capture means for the automatic reading of data into the system; and

said computerized processing module means including input screen means for registering the path of movement of a stylus thereon so as to receive manually entered path information while entirely separate from said shell module means.

16. In a hand-held data capture system,

(a) computerized processing module means for computerized processing of data;

(b) shell module means having auxiliary means for executing an auxiliary function, having battery means supplying power thereto, and having a receptacle for receiving said computerized processing means so that the computerized processing module means is substantially contained within said shell module means during hand-held operation;

(c) coupling means providing communication between said shell module means and a computerized processing module means in said receptacle;

(d) said shell module means with said computerized processing module means assembled in its receptacle having an overall size so as to be readily contained in a shirt pocket;

(e) said computerized processing module means having battery means supplying power thereto and said computerized processing module means fitting into the receptacle together with said battery means for removal as a unit therewith;

(f) said coupling means providing a quick-connect, quick-disconnect coupling readily accommodating bodily removal of the computerized processing module means and the battery means as a unit from the receptacle of the shell module means;

(g) said system comprising automatic reading data capture means for the automatic reading of data into the system; and

(h) said computerized processing module means having means operable for carrying out an optical reading function while entirely separate from said shell module means, and also for carrying out an optical reading function while substantially contained within said shell module means.

17. The hand-held data capture system according to claim **16** wherein said automatic reading data capture means comprises an automatic optical reader including a light source means for illuminating a complete line of data.

18. In a hand-held data capture system according to claim **16**, said automatic reading data capture means comprising automatic path input means for automatically registering hand-entered path configurations.

19. In a hand-held data capture system according to claim **16**, said automatic path input means comprising digitizing means responsive to stylus generated handwriting configurations.

20. In a hand-held data capture system,

(a) multipurpose computerized processing module means for computerized processing of data;

(b) shell module means having auxiliary means for executing an auxiliary function, having battery means supplying power thereto, and having a receptacle for receiving said computerized processing means so that the computerized processing module means is substantially contained within said shell module means during hand-held operation;

(c) coupling means providing communication between said shell module means and a computerized processing module means in said receptacle;

(d) said shell module means with said computerized processing module means assembled in its receptacle having an overall size so as to be readily contained in a shirt pocket;

(e) said computerized processing module means having battery means supplying power thereto and said computerized processing module means fitting into the receptacle together with said battery means for removal as a unit therewith;

(f) said coupling means providing a quick-connect, quick-disconnect coupling readily accommodating bodily removal of the computerized processing module means and the battery means as a unit from the receptacle of the shell module means;

(g) said system comprising automatic reading data capture means for the automatic reading of data into the system; and

(h) said computerized processing module means having touch screen display means operable for presenting a graphical display and for receiving and storing manual input data while entirely separate from said shell module means.

21. In a hand-held data capture system,

(a) computerized processing module means for computerized processing of data;

(b) shell module means having auxiliary means for executing an auxiliary function, having battery means supplying power thereto, and having a receptacle for receiving said computerized processing means so that the computerized processing module means is substantially contained within said shell module means during hand-held operation;

(c) coupling means providing communication between said shell module means and a computerized processing module means in said receptacle;

(d) said shell module means with said computerized processing module means assembled in its receptacle having an overall size so as to be readily contained in a shirt pocket;

(e) said computerized processing module means having battery means supplying power thereto and said computerized processing module means fitting into the receptacle together with said battery means for removal as a unit therewith;

(f) said coupling means providing a quick-connect, quick-disconnect coupling readily accommodating bodily removal of the computerized processing module means and the battery means as a unit from the receptacle of the shell module means;

(g) said system comprising automatic reading data capture means for the automatic reading of data into the system; and

(h) said computerized processing module means having input screen means for registering the path of movement of a stylus thereon so as to receiving manually entered path information while entirely separate from said shell module means.

22. In a hand-held data capture system,

(a) computerized processing module means for computerized processing of data,

(b) shell module means having auxiliary means for executing an auxiliary function, having battery means supplying power thereto, and having a receptacle for receiving said computerized processing means so that the computerized processing module means is substantially contained within said shell module means during hand-held operation, and

(c) coupling means providing communication between said shell module means and a computerized processing module means in said receptacle,

(d) said shell module means with said computerized processing module means assembled in its receptacle having an overall size so as to be readily contained in a shirt pocket,

(e) said computerized processing module means having input screen means for registering the path of movement of a stylus thereon so as to receiving manually entered path information while entirely separate from said shell module means.

* * * * *

EXHIBIT E

US005892971A

United States Patent [19]

Danielson et al.

[11] **Patent Number: 5,892,971**

[45] **Date of Patent: Apr. 6, 1999**

[54] **PORTABLE DATA PROCESSING DEVICE HAVING AN INDICIA READER AND A MULTI-TASKING OPERATING SYSTEM CAPABLE OF EXECUTING BATTERY MONITORING INSTRUCTIONS WHILE CONCURRENTLY EXECUTING APPLICATION PROGRAMS**

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[73] Assignee: **Norand Corporation**, Cedar Rapids, Iowa

[21] Appl. No.: **448,169**

[22] Filed: **May 23, 1995**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 40,313, Mar. 29, 1993, Pat. No. 5,468,947, which is a continuation-in-part of Ser. No. 451,322, Dec. 15, 1989, Pat. No. 5,227,614, which is a continuation-in-part of Ser. No. 143,921, Jan. 14, 1988, abandoned, which is a continuation-in-part of Ser. No. 897,547, Aug. 15, 1986, abandoned, said Ser. No. 40,313, is a continuation-in-part of Ser. No. 947,036, Sep. 16, 1992, Pat. No. 5,308,966, which is a continuation of Ser. No. 875,791, Apr. 27, 1992, abandoned, which is a continuation-in-part of Ser. No. 422,052, Oct. 16, 1989, abandoned, which is a division of Ser. No. 894,689, Aug. 8, 1986, Pat. No. 4,877,949.

[51] **Int. Cl.**^{6} **G06F 9/38**

[52] **U.S. Cl.** **395/827**; 395/840

[58] **Field of Search** 235/462; 364/708.1; 375/202; 395/673, 893, 827, 840

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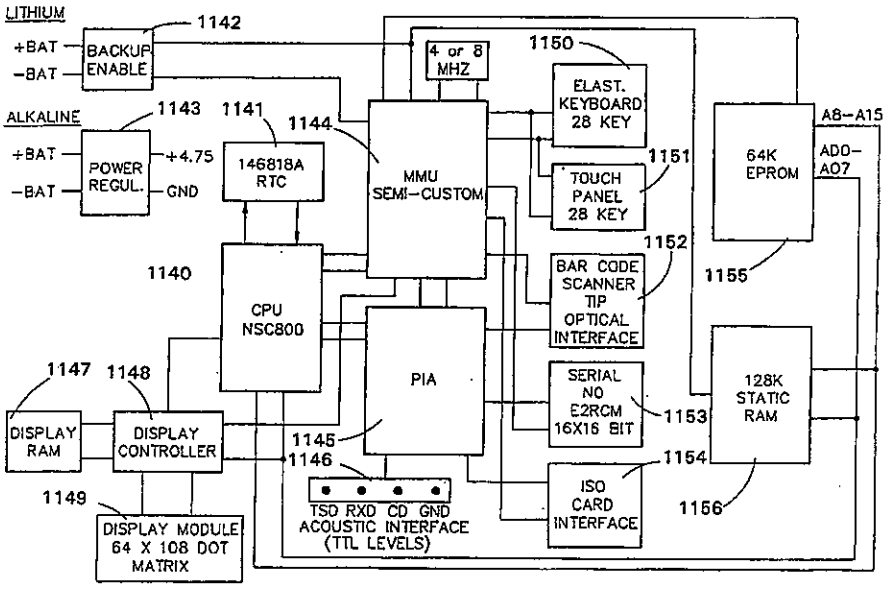
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Primary Examiner—Thomas C. Lee
Assistant Examiner—David Ton
Attorney, Agent, or Firm—Simmons, Perrine, Albright & Ellwood

[57] **ABSTRACT**

A portable, hand-held data processing assembly of modular structure includes a base unit with a keyboard and a display screen. An indicia reader module is housed in a housing shell which is attachable to the base unit. The indicia reader module can contain a reflected light indicia reader for non-contact essentially instantaneous reading of bar codes of the like disposed in a spaced, non-contacting relationship to the assembly. The indicia reader module can also include a processor. Additionally, the base unit can include a battery for powering the hand-held data processing assembly. A data collection and communications module can include a stacked arrangement of a communications interface main circuit board, a radio and a laser scanner assembly which are housed in a housing shell attachable to the base unit. A support frame and a plurality of ground planes in the sandwiched main circuit board and a routing circuit board form an RF cage for shielding RF interference which may be generated by the radio. Also disclosed is a method for reducing the operational power consumption requirements of laser bar code scanners by analyzing reflected laser light in order to determine the presence of optically readable information sets. In any described embodiment, the hand-held data processing assembly can include a multitasking operating system. The multitasking operating system can execute battery monitoring instructions and diagnostic routines while concurrently executing application programs.

19 Claims, 24 Drawing Sheets



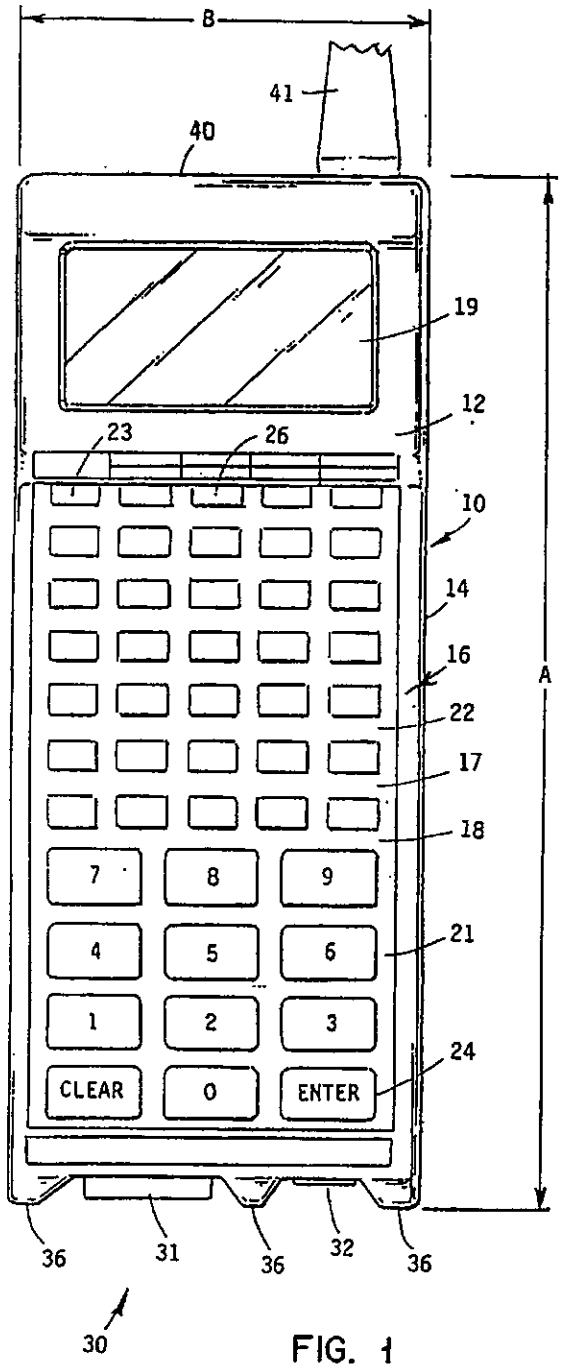

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12
23
26
10
14
16
22
17
18
7
8
9
4
5
6
21
1
2
3
24
CLEAR
0
ENTER
A
36
31
36
32
36
30

FIG. 1

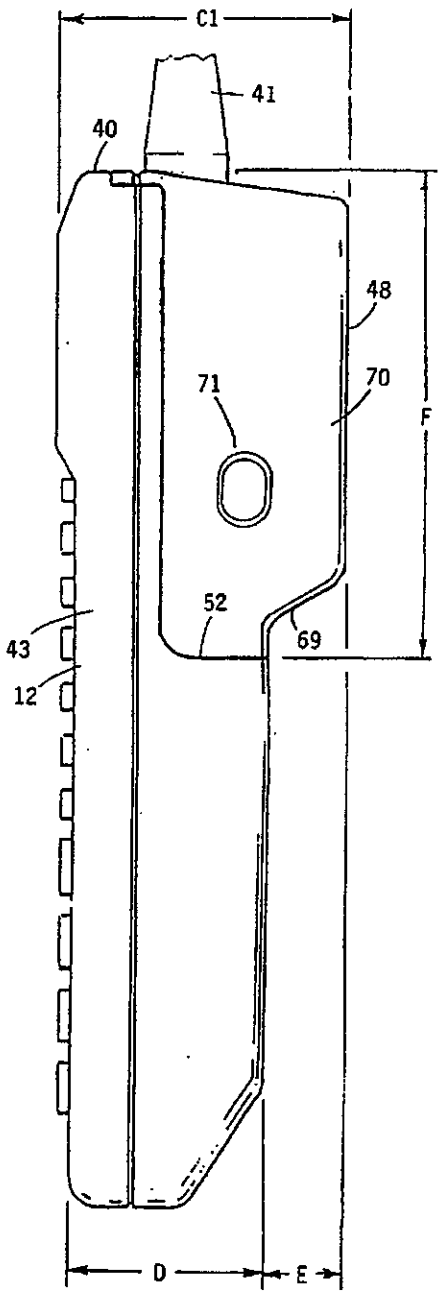

C1
41
40
48
71
70
F
52
43
69
12
D
E

FIG. 2

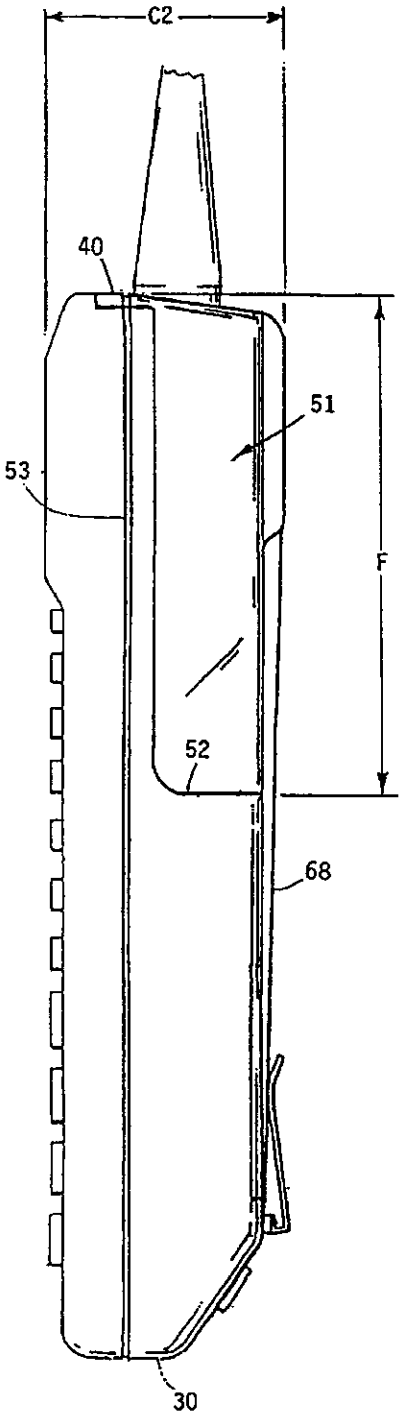


FIG. 3

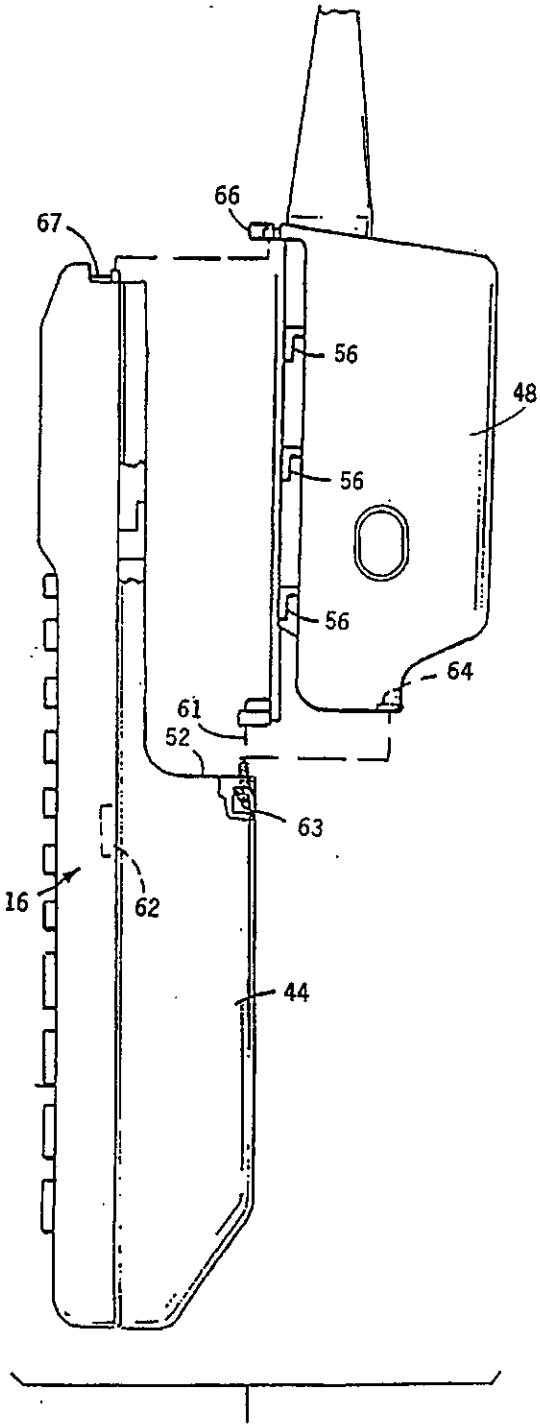


FIG. 4

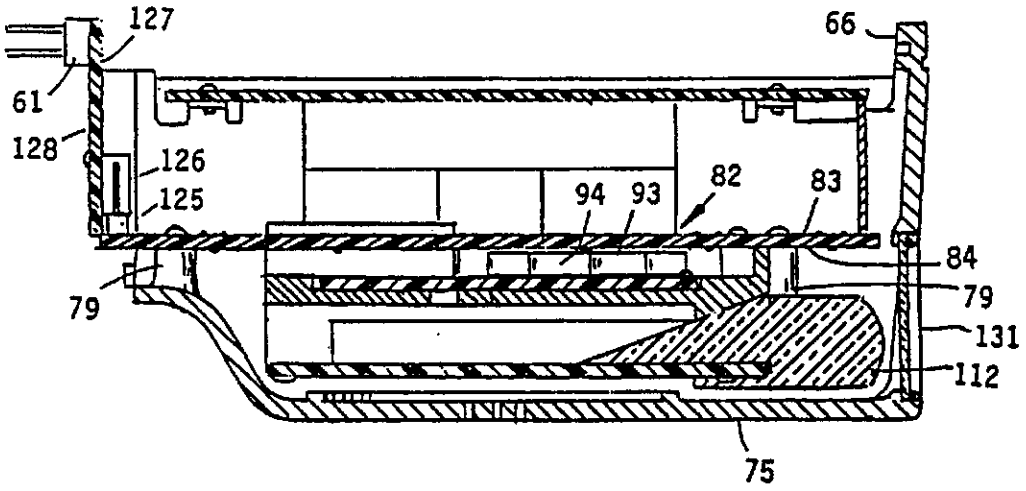

127
66
61
128
126
125
94
93
82
83
84
79
79
131
112
75

FIG. 5

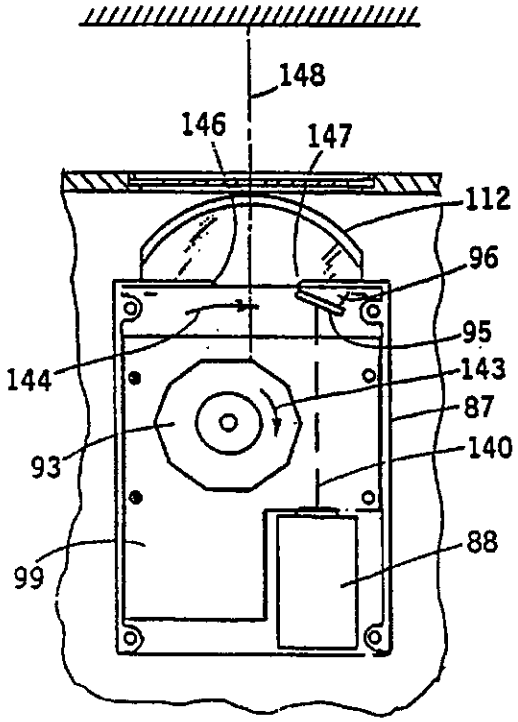
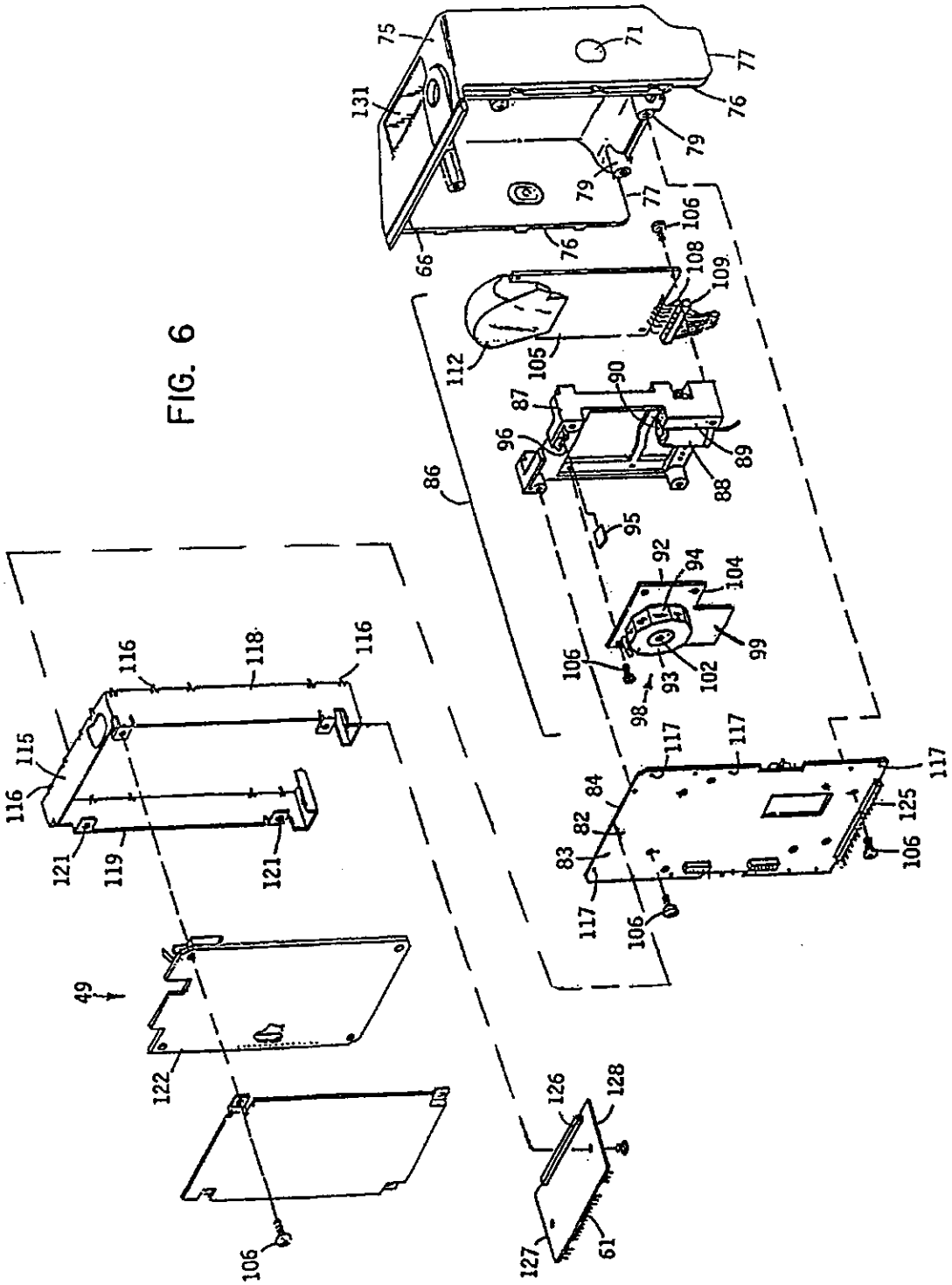

148
146
147
112
96
95
144
143
87
93
140
88
99

FIG. 7

FIG. 6


75
71
77
131
76
79
66
106
108
109
112
105
90
87
96
89
88
86
95
92
94
104
99
102
93
98
116
118
115
121
119
49
122
126
128
127
61
117
84
82
83
125

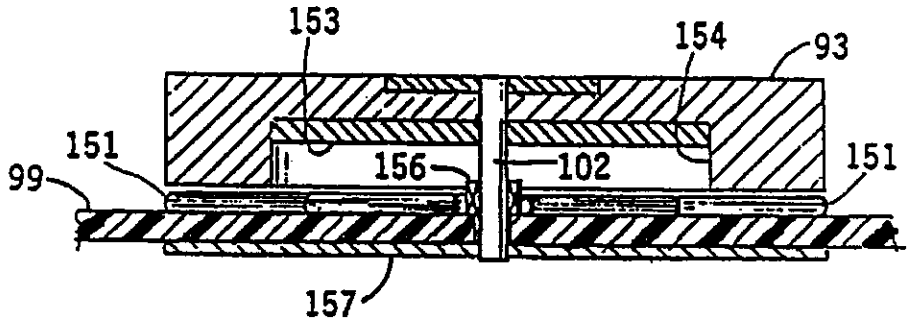

153
154
93
151
99
156
102
151
157

FIG. 8

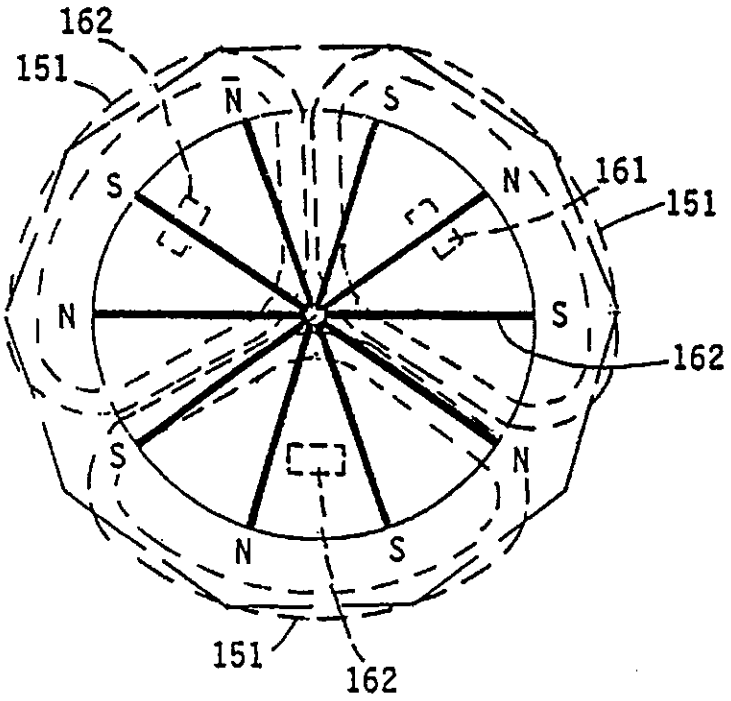

162
151
N
S
S
N
161
151
N
S
162
S
N
N
S
151
162

FIG. 9

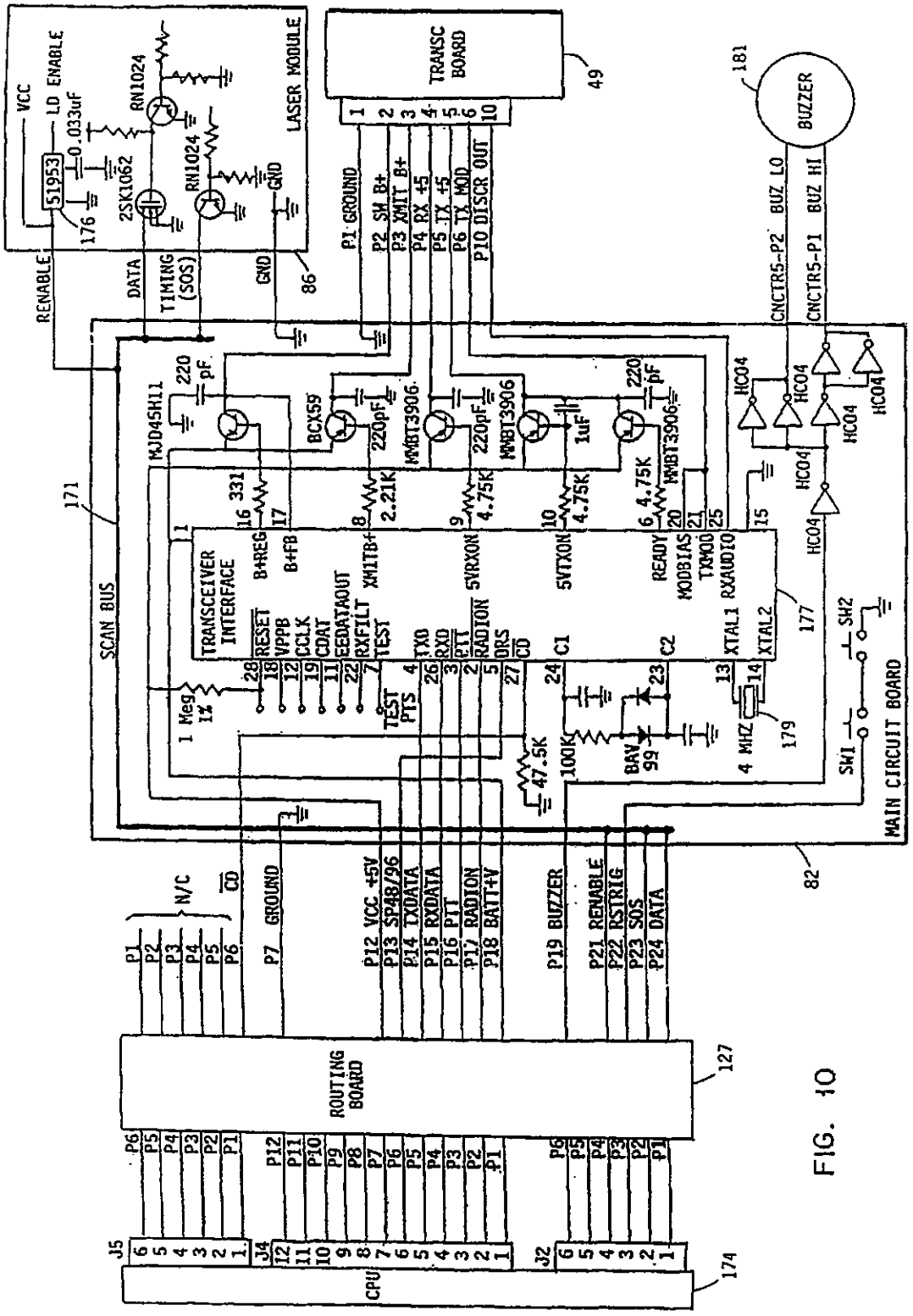

LASER MODULE
VCC
LD ENABLE
0.033uF
RN1024
RN1024
51953
2SK1062
176
GND
RENABLE
DATA
TIMING (SOS)
GND
86
TRANSC BOARD
49
P1 GROUND
P2 SW B+
P3 XMIT B+
P4 RX +5
P5 TX +5
P6 TX MOD
P10 DISCR OUT
BUZZER
181
CNCTR5-P2 BUZ LO
CNCTR5-P1 BUZ HI
MJD45H11
220 pF
BCX59
220pF
MMBT3906
220pF
MMBT3906
1uF
220 pF
MMBT3906
HC04
HC04
HC04
HC04
HC04
331
2.21K
4.75K
4.75K
4.75K
171
SCAN BUS
TRANSCEIVER INTERFACE
B+REG
B+FB
XMITB+
5VRXON
5VTXON
READY
MODBIAS
TXMOD
RXAUDIO
RESET
VPPB
CCLK
CDAT
EEDATAOUT
RXFILT
TEST
TXD
RXD
PTT
RADION
DRS
CD
C1
C2
XTAL1
XTAL2
177
1 Meg 1%
TEST PTS
47.5K
100K
BAV 99
4 MHZ
179
SW1
SW2
MAIN CIRCUIT BOARD
82
N/C
CD
P1
P2
P3
P4
P5
P6
P7 GROUND
P12 VCC +5V
P13 SP48/96
P14 TXDATA
P15 RXDATA
P16 PTT
P17 RADION
P18 BATT+V
P19 BUZZER
P21 RENABLE
P22 RSTRIG
P23 SOS
P24 DATA
ROUTING BOARD
127
J5
J4
J2
CPU
174

FIG. 10

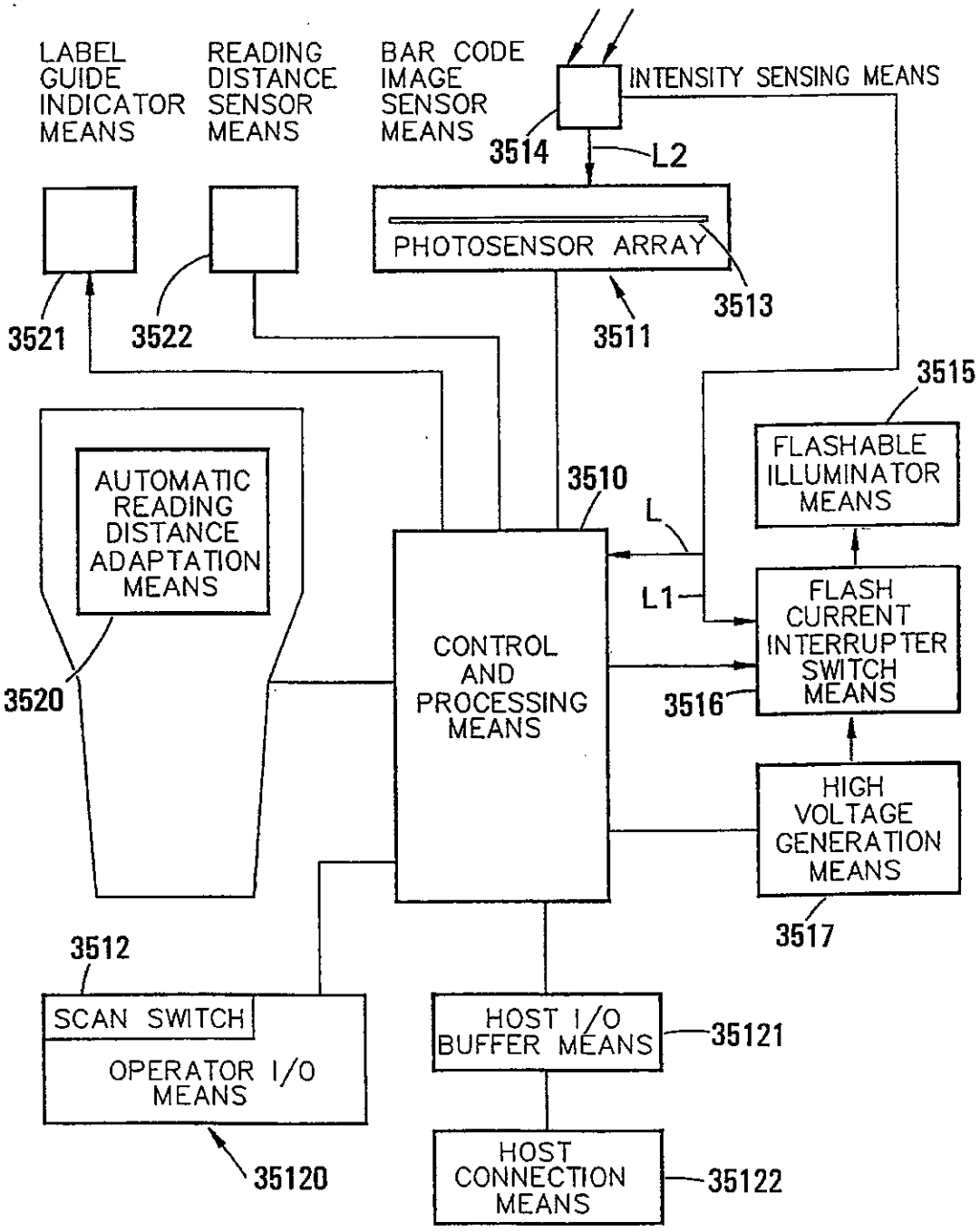

LABEL GUIDE INDICATOR MEANS
READING DISTANCE SENSOR MEANS
BAR CODE IMAGE SENSOR MEANS
INTENSITY SENSING MEANS
3514
L2
PHOTOSENSOR ARRAY
3513
3521
3522
3511
3515
FLASHABLE ILLUMINATOR MEANS
AUTOMATIC READING DISTANCE ADAPTATION MEANS
3510
L
L1
FLASH CURRENT INTERRUPTER SWITCH MEANS
3520
CONTROL AND PROCESSING MEANS
3516
HIGH VOLTAGE GENERATION MEANS
3517
3512
SCAN SWITCH
OPERATOR I/O MEANS
HOST I/O BUFFER MEANS
35121
HOST CONNECTION MEANS
35122
35120

FIG. 11

FIG. 12

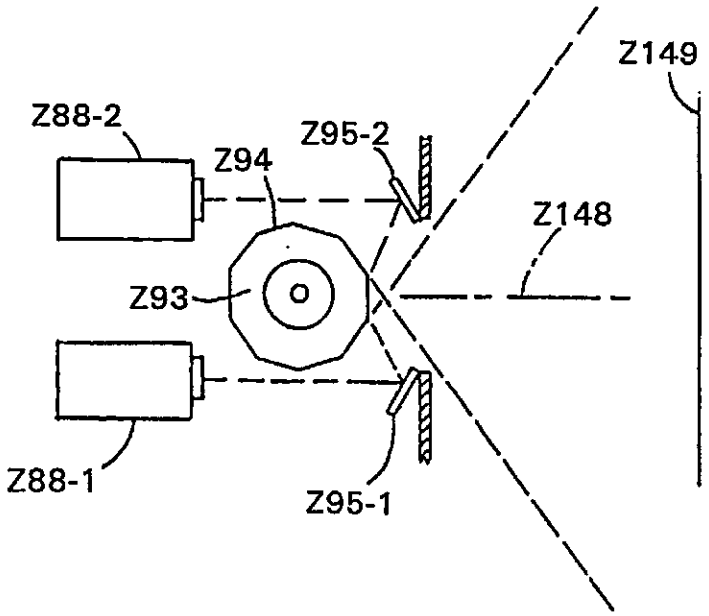
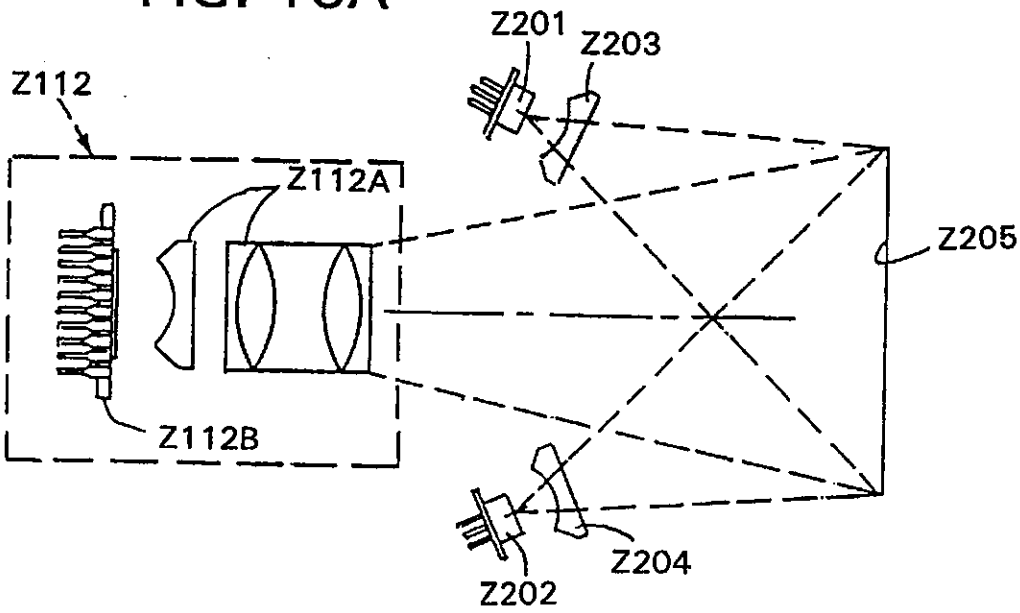


FIG. 13A



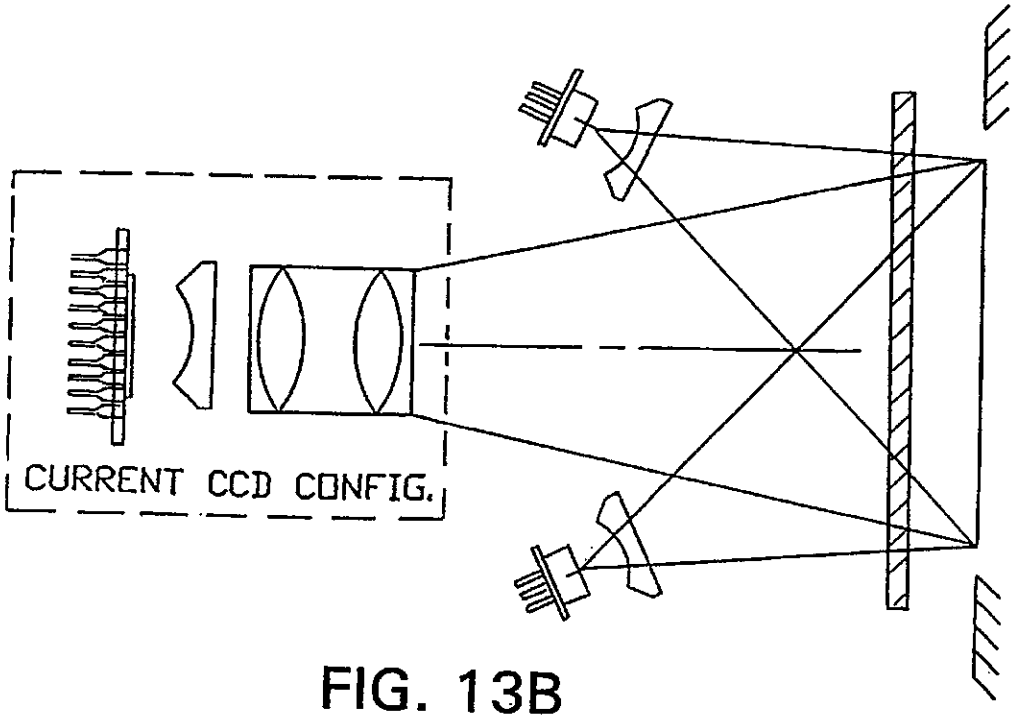


FIG. 13B

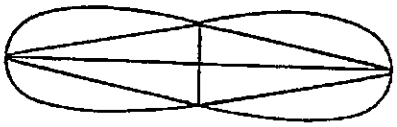


FIG. 13C

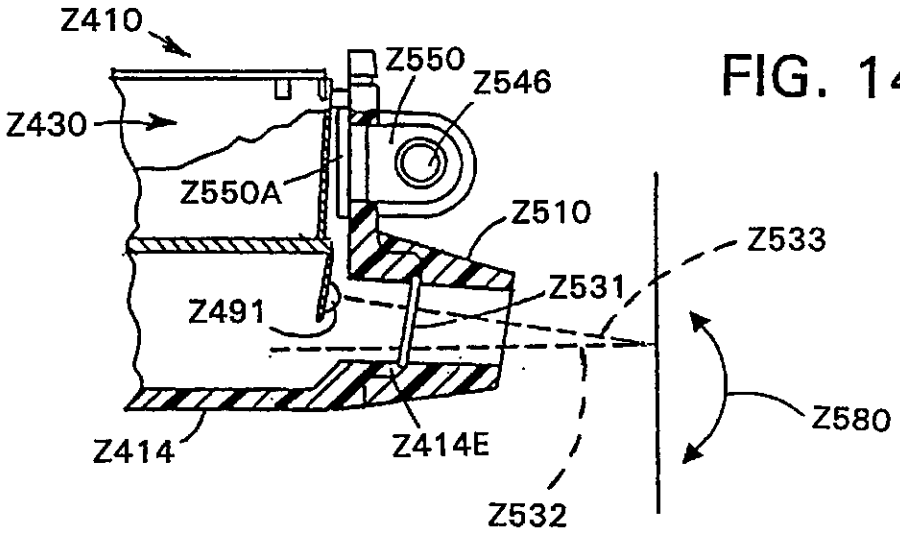

Z410
Z550
Z546
Z430
Z550A
Z510
Z533
Z531
Z491
Z580
Z414
Z414E
Z532

FIG. 14

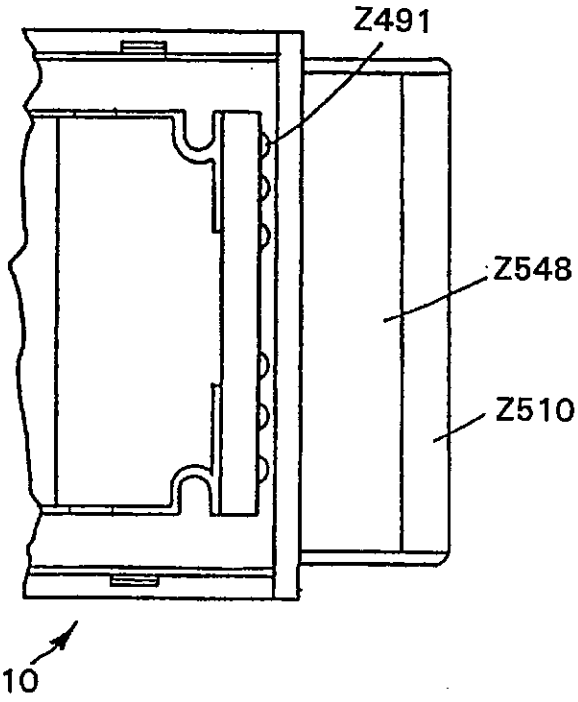

Z491
Z548
Z510
Z410

FIG. 15

FIG. 16

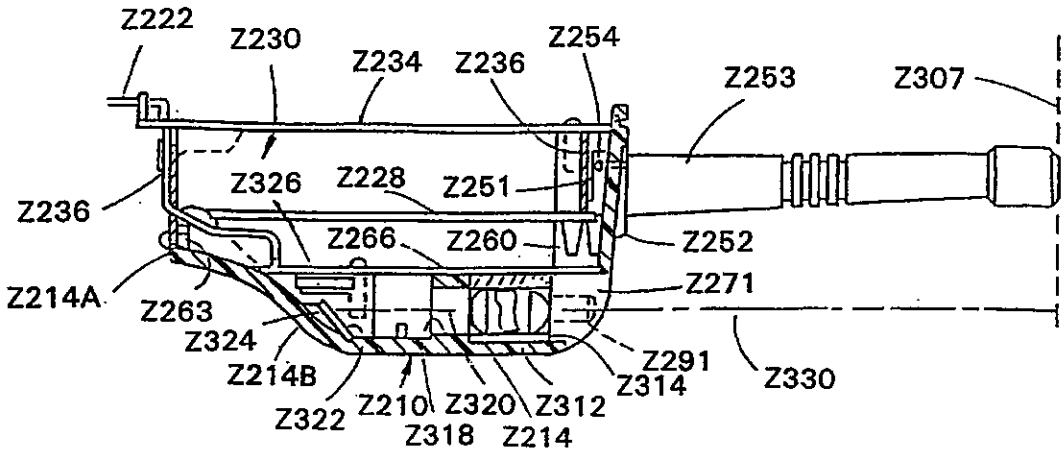
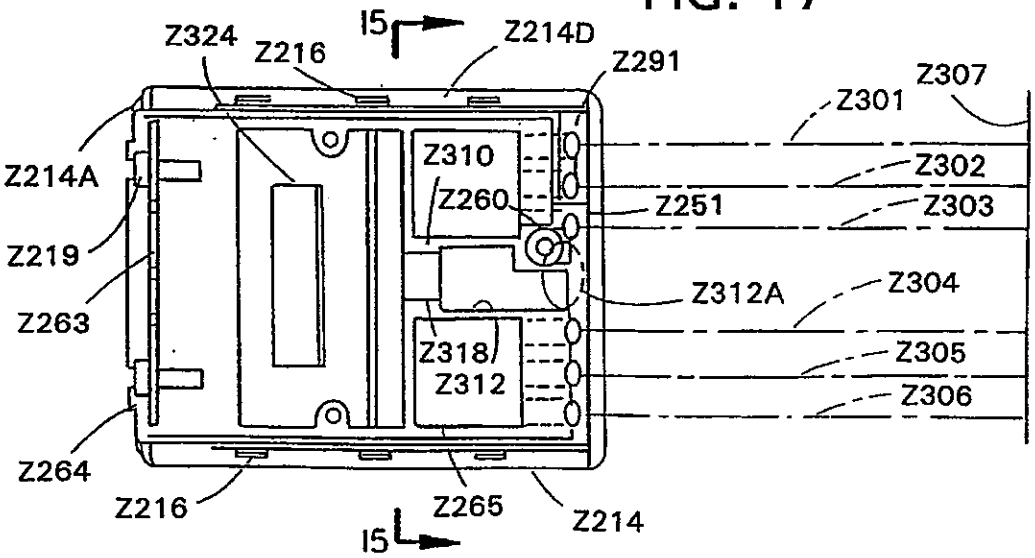

Z222
Z230
Z234
Z236
Z254
Z253
Z307
Z326
Z228
Z251
Z236
Z266
Z260
Z252
Z271
Z214A
Z263
Z324
Z214B
Z291
Z314
Z330
Z322
Z210
Z320
Z312
Z318
Z214

FIG. 17


15
Z324
Z216
Z214D
Z291
Z307
Z301
Z214A
Z310
Z302
Z260
Z251
Z303
Z219
Z312A
Z304
Z263
Z318
Z312
Z305
Z306
Z264
Z216
Z265
Z214
15

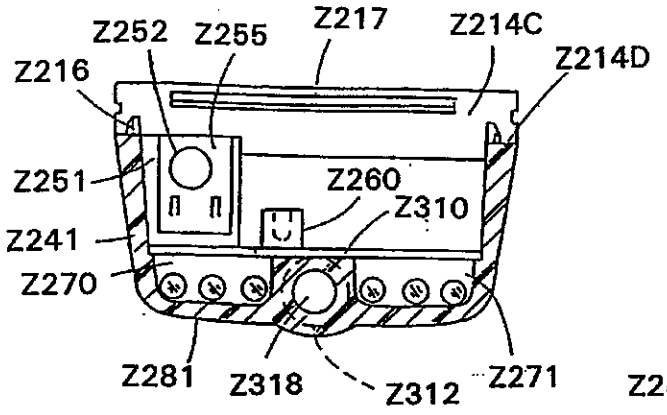


FIG. 18A

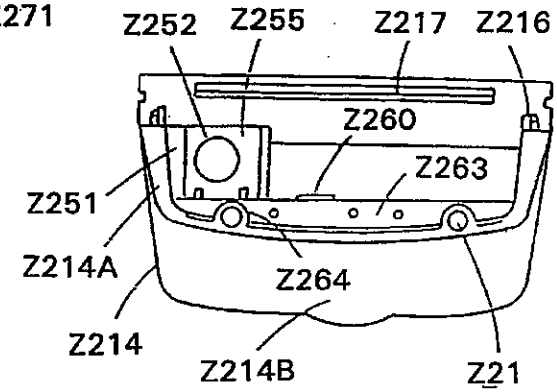


FIG. 18B

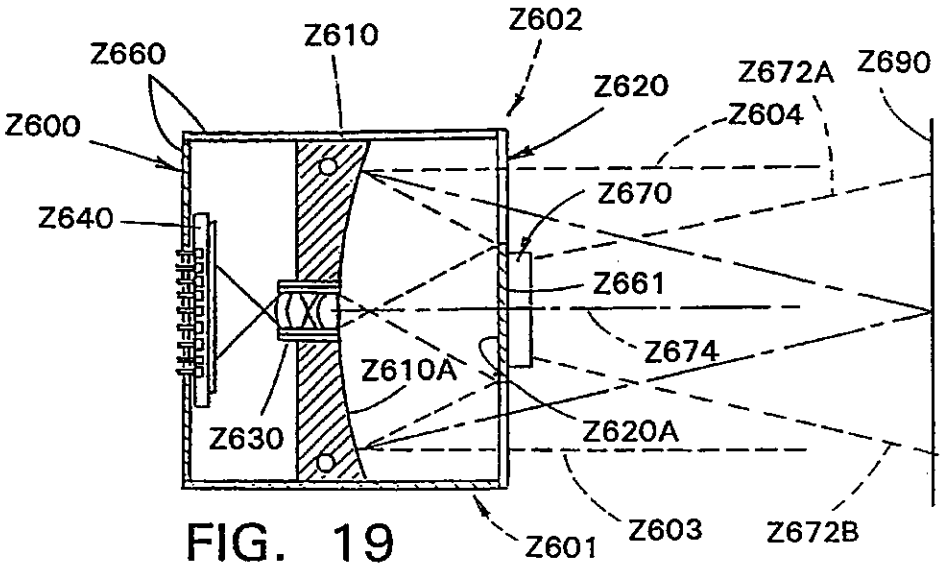


FIG. 19

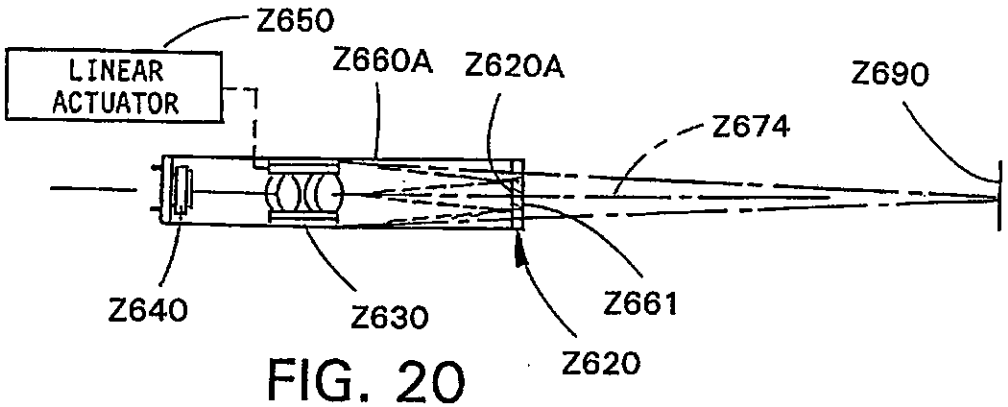


FIG. 20

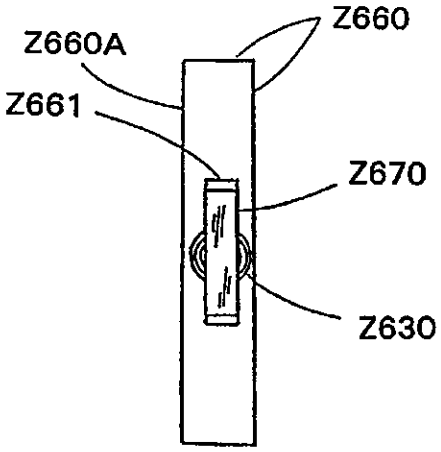


FIG. 21

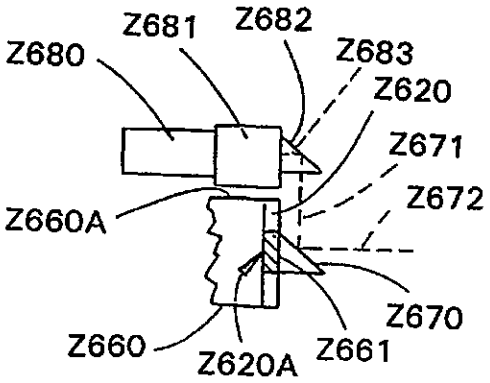


FIG. 22

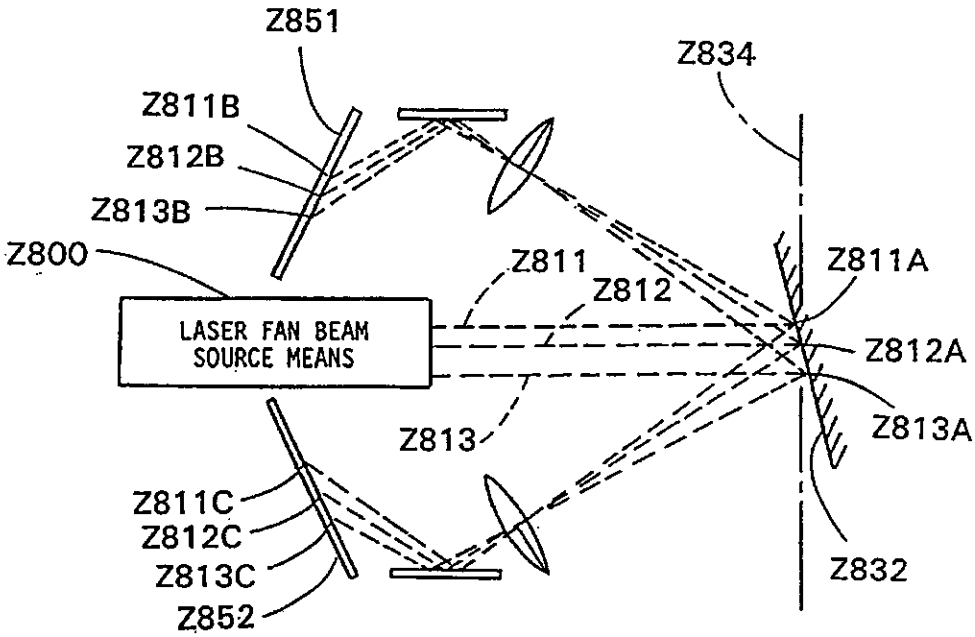

Z851
Z834
Z811B
Z812B
Z813B
Z800
Z811
Z812
Z811A
LASER FAN BEAM SOURCE MEANS
Z812A
Z813A
Z813
Z811C
Z812C
Z813C
Z852
Z832

FIG. 23

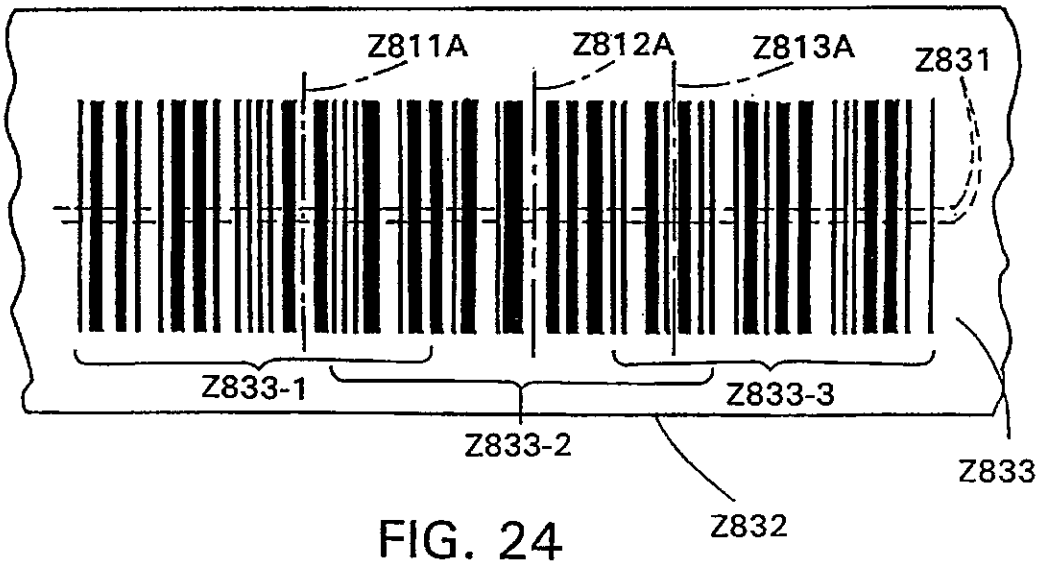

Z811A
Z812A
Z813A
Z831
Z833-1
Z833-3
Z833-2
Z833
Z832

FIG. 24

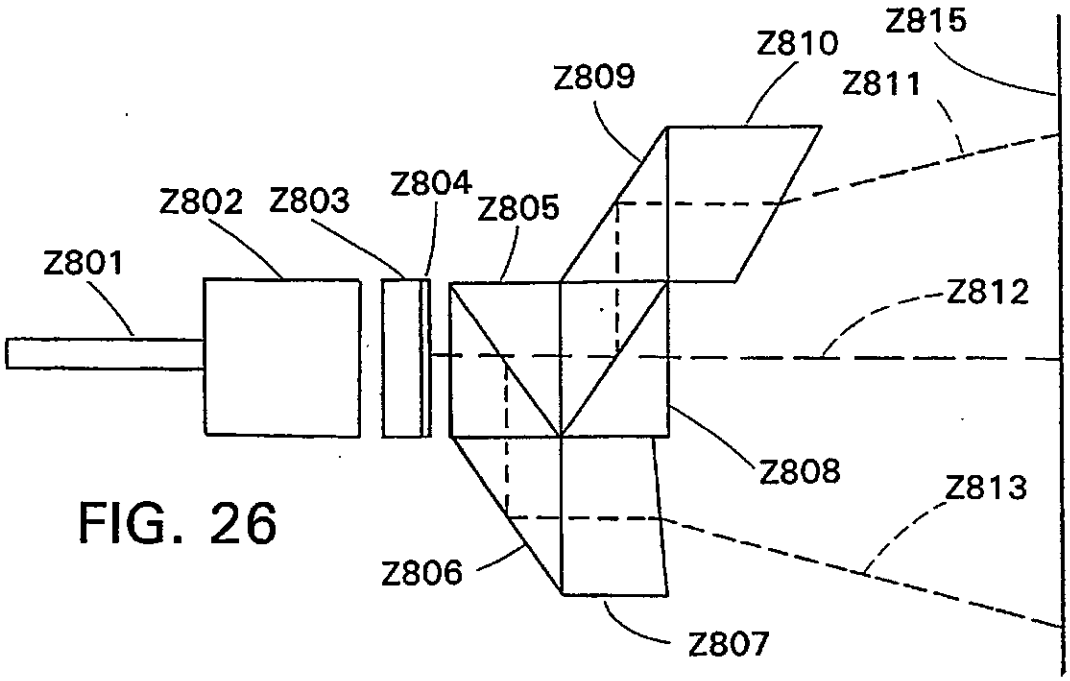

Z815
Z810
Z809
Z811
Z802
Z803
Z804
Z805
Z801
Z812
Z808
Z813
Z806
Z807

FIG. 26

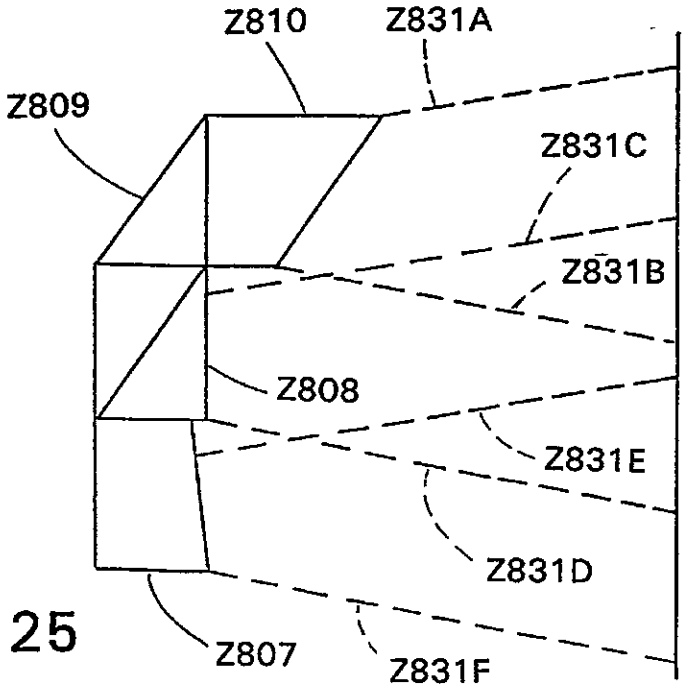

Z810
Z831A
Z809
Z831C
Z831B
Z808
Z831E
Z831D
Z807
Z831F

FIG. 25

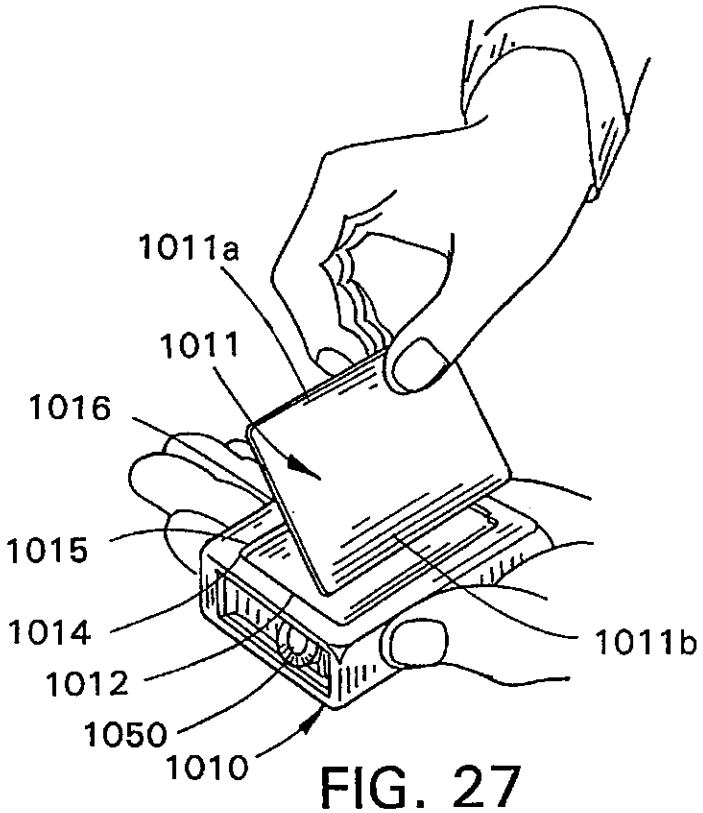

1011a
1011
1016
1015
1014
1012
1050
1010
1011b

FIG. 27

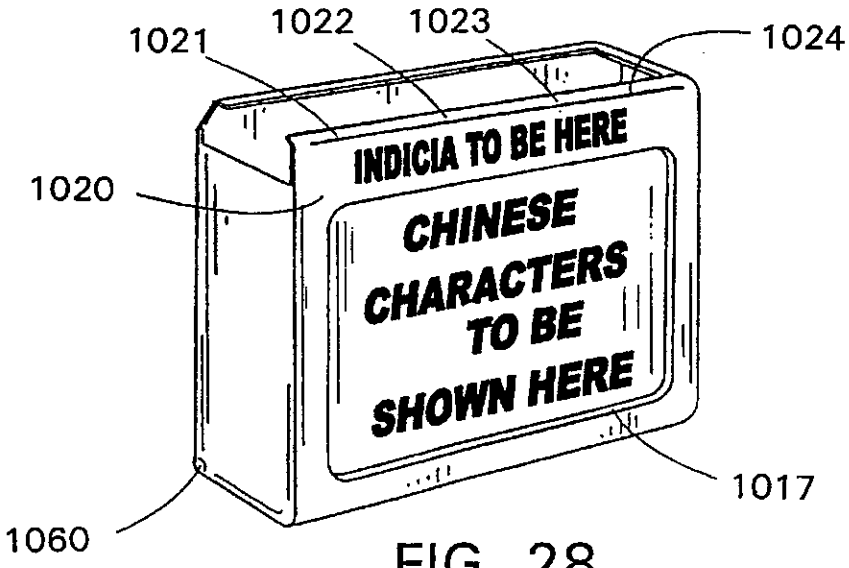

1021
1022
1023
1024
1020
INDICIA TO BE HERE
CHINESE CHARACTERS TO BE SHOWN HERE
1017
1060

FIG. 28

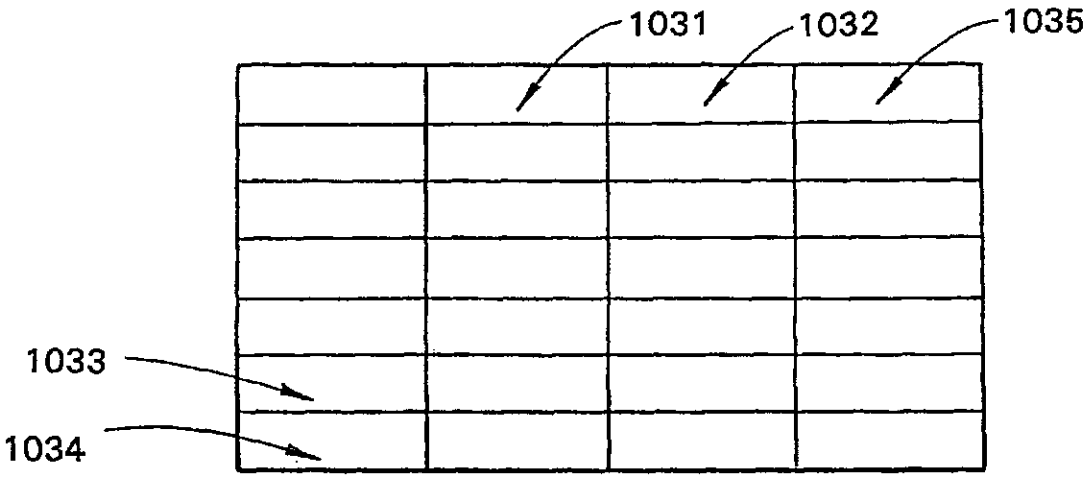


FIG. 29

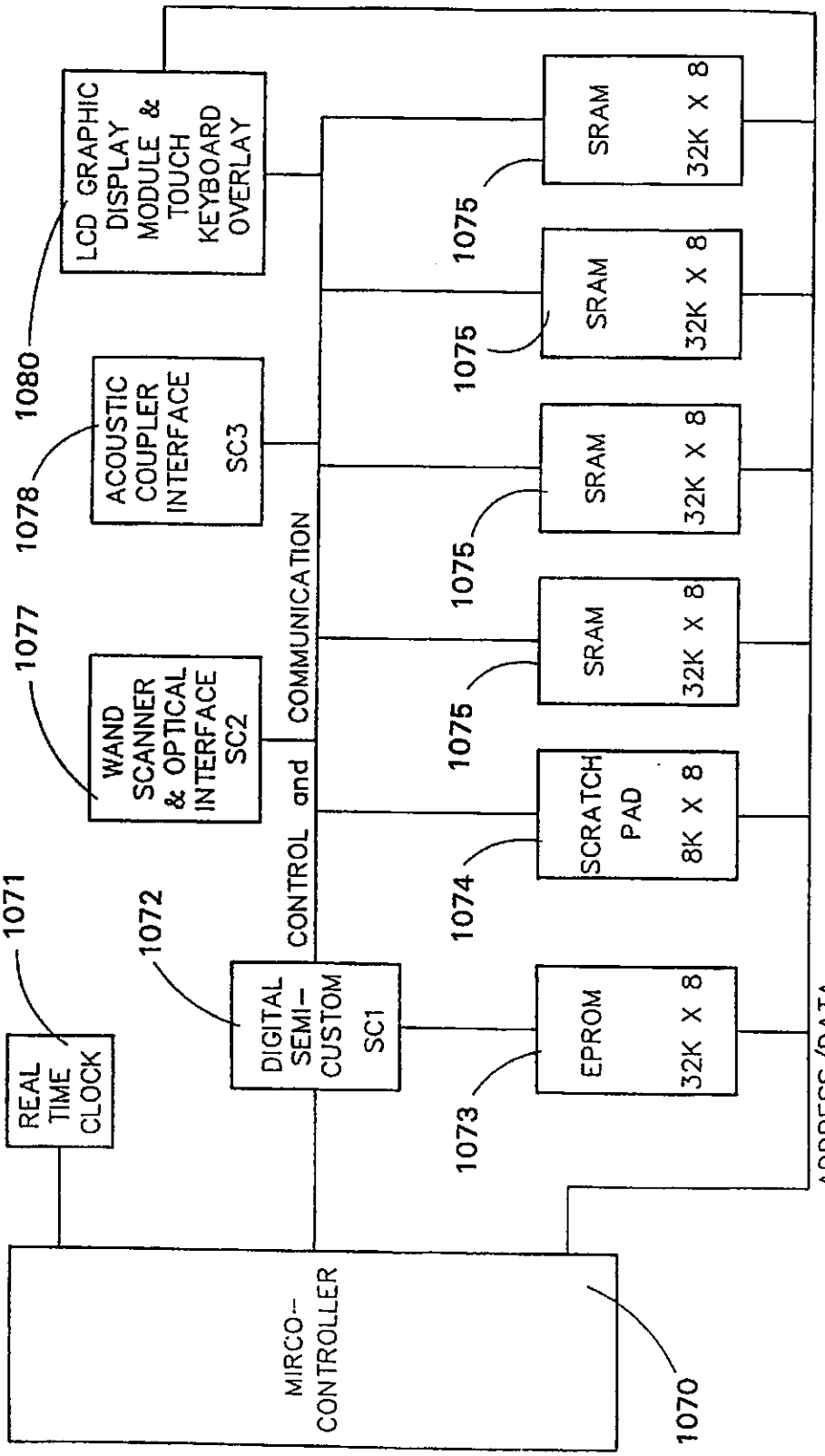

LCD GRAPHIC DISPLAY MODULE & TOUCH KEYBOARD OVERLAY
1080
ACOUSTIC COUPLER INTERFACE SC3
1078
WAND SCANNER & OPTICAL INTERFACE SC2
1077
COMMUNICATION and CONTROL
REAL TIME CLOCK
1071
DIGITAL SEMI-CUSTOM SC1
1072
MIRCO-CONTROLLER
1070
SRAM 32K X 8
1075
SRAM 32K X 8
1075
SRAM 32K X 8
1075
SRAM 32K X 8
1075
SCRATCH PAD 8K X 8
1074
EPROM 32K X 8
1073
ADDRESS/DATA

FIG. 30

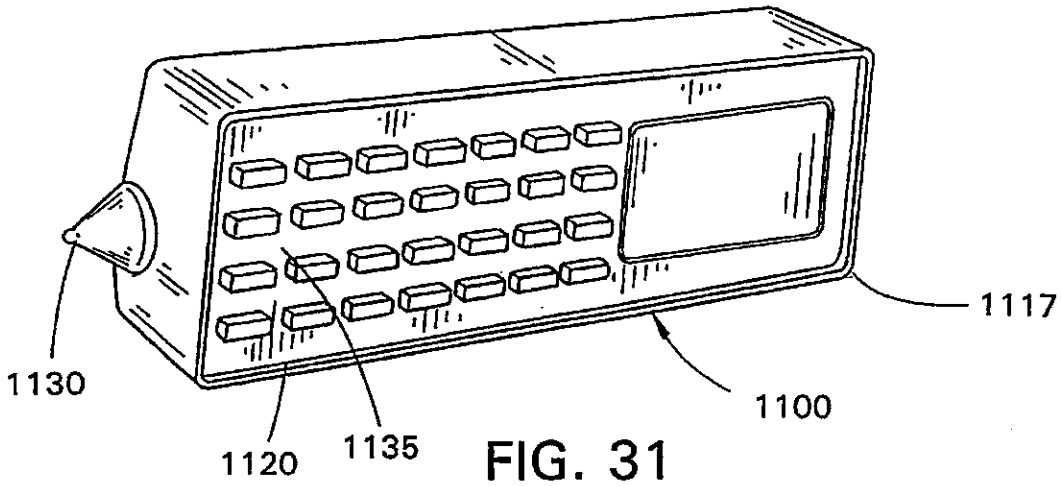


FIG. 31

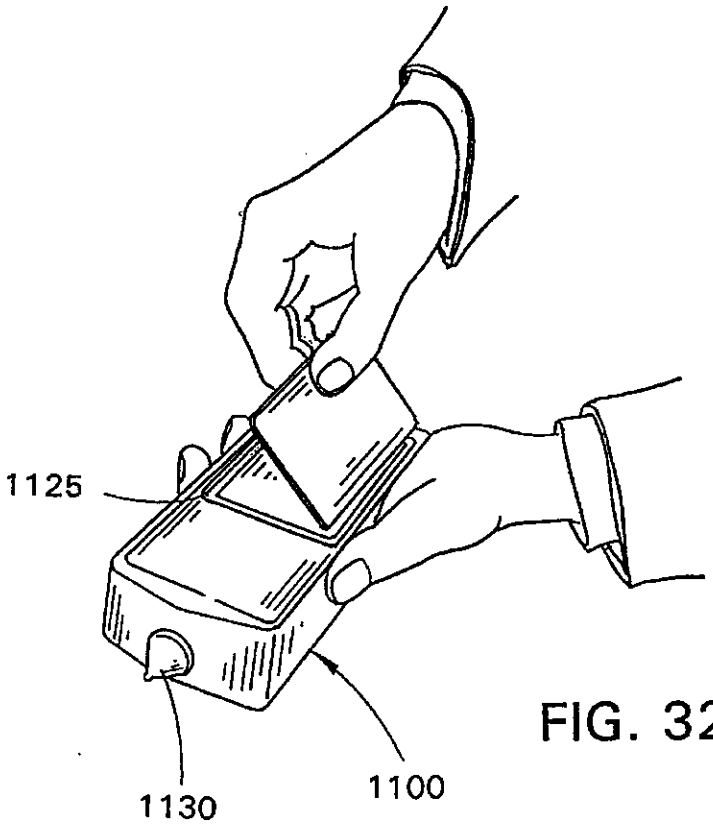


FIG. 32

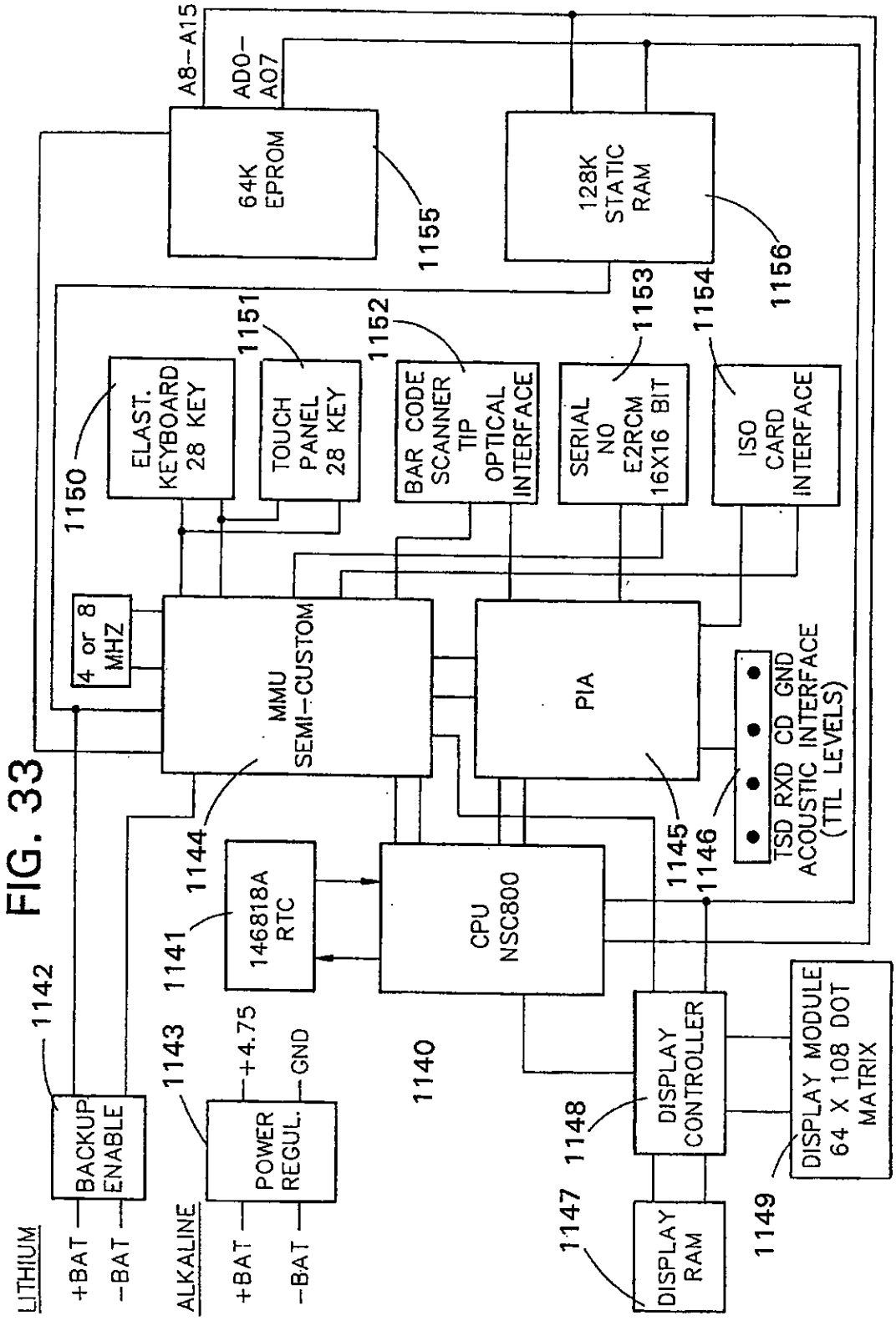

A8–A15
AD0–A07
64K EPROM
1155
128K STATIC RAM
1156
1151
1152
1153
1154
1150
ELAST. KEYBOARD 28 KEY
TOUCH PANEL 28 KEY
BAR CODE SCANNER TIP OPTICAL INTERFACE
SERIAL NO E2RCM 16X16 BIT
ISO CARD INTERFACE
4 or 8 MHZ
MMU SEMI–CUSTOM
PIA
TSD RXD CD GND
ACOUSTIC INTERFACE (TTL LEVELS)
1144
1145
1146
1141
146818A RTC
CPU NSC800
1142
1143
+4.75
GND
1140
BACKUP ENABLE
POWER REGUL.
DISPLAY CONTROLLER
DISPLAY MODULE 64 X 108 DOT MATRIX
1148
1147
1149
DISPLAY RAM
LITHIUM
+BAT
–BAT
ALKALINE
+BAT
–BAT

FIG. 33

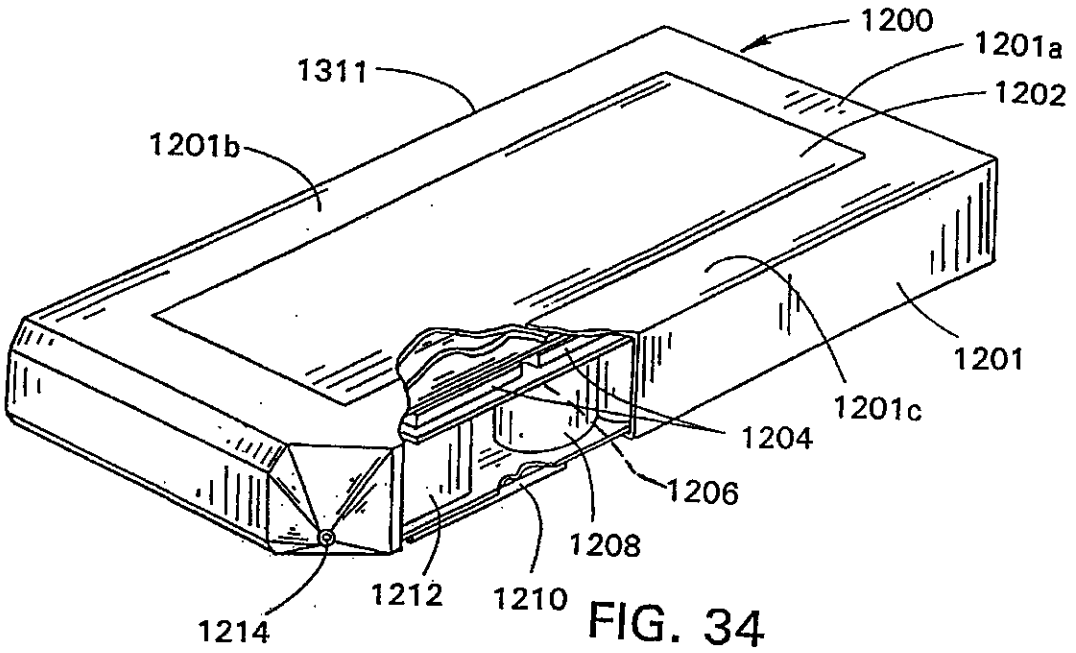

1200
1201a
1202
1311
1201b
1201
1201c
1204
1206
1208
1212
1210
1214

FIG. 34

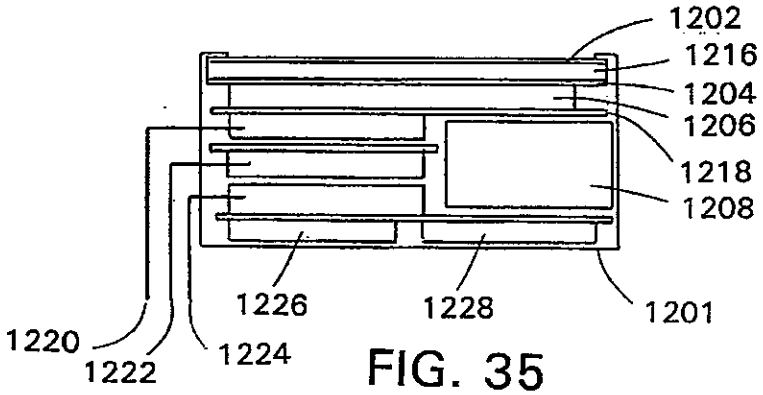

1202
1216
1204
1206
1218
1208
1226
1228
1201
1220
1222
1224

FIG. 35

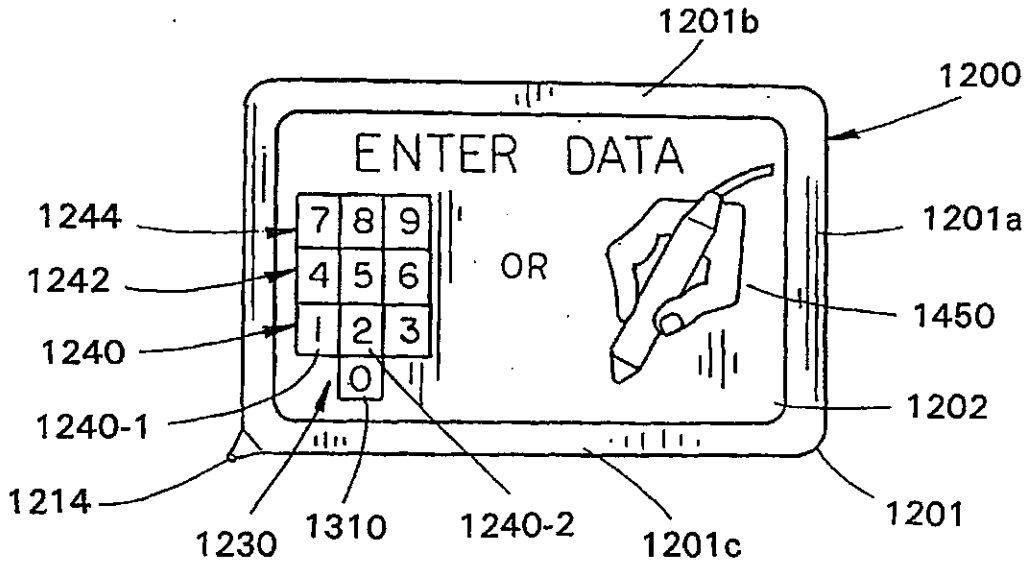

1201b
1200
ENTER DATA
1244
1242
1240
1240-1
1214
7 8 9
4 5 6
1 2 3
0
OR
1201a
1450
1202
1201
1230
1310
1240-2
1201c

FIG. 36

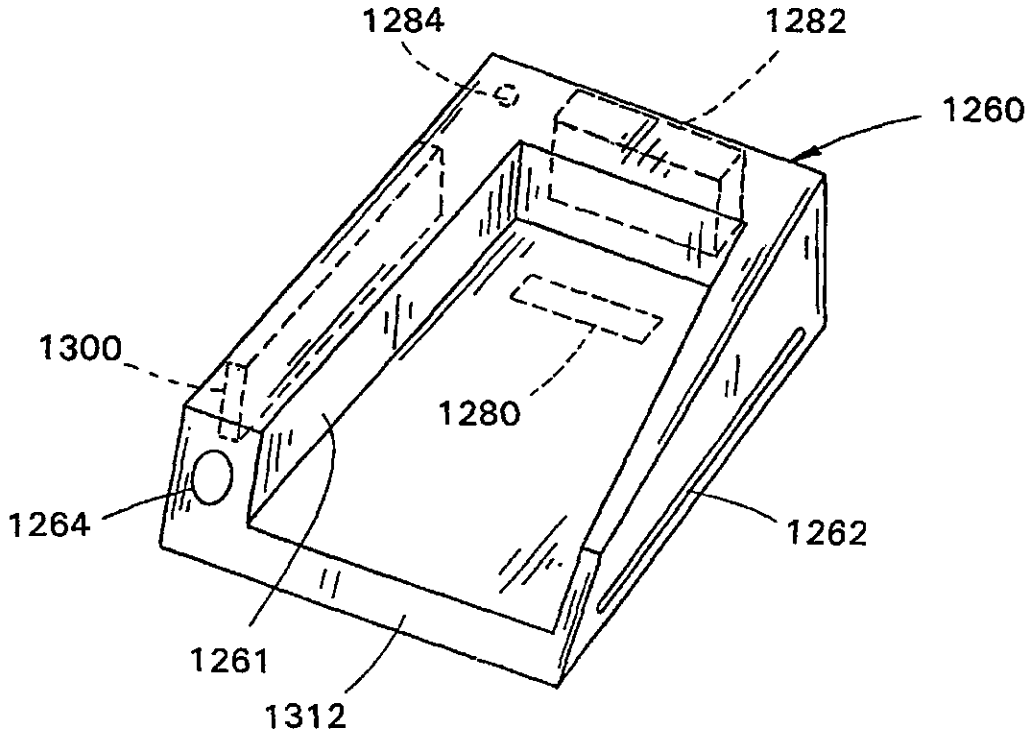

1284
1282
1260
1300
1280
1264
1262
1261
1312

FIG. 37

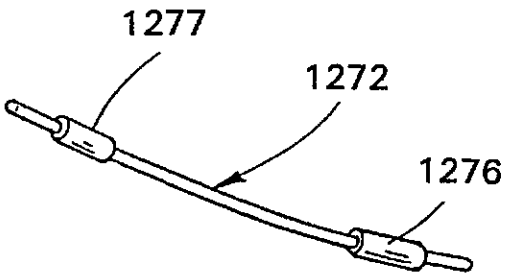


FIG. 39

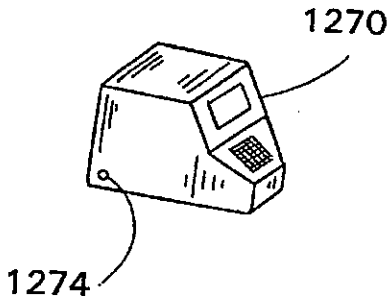


FIG. 38

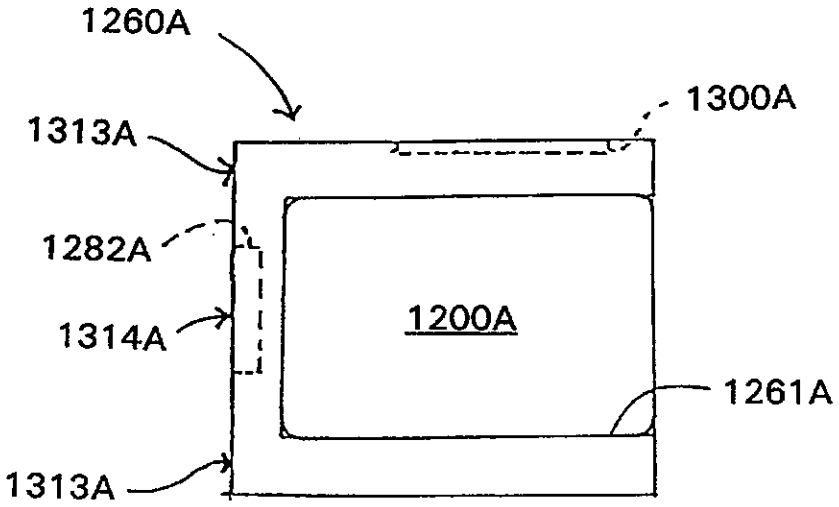


FIG. 40

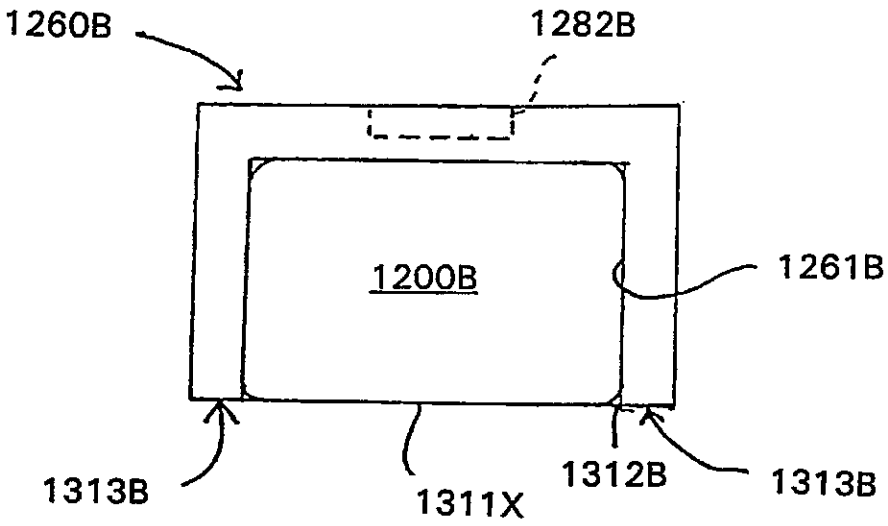


FIG. 41

PORTABLE DATA PROCESSING DEVICE HAVING AN INDICIA READER AND A MULTI-TASKING OPERATING SYSTEM CAPABLE OF EXECUTING BATTERY MONITORING INSTRUCTIONS WHILE CONCURRENTLY EXECUTING APPLICATION PROGRAMS

CROSS REFERENCES TO RELATED APPLICATIONS

a. Claiming Benefit Under 35 U.S.C. 120

The present application is a continuation-in-part of application Ser. No. 08/040,313, filed Mar. 29, 1993, now U.S. Pat. No. 5,468,947, issued Nov. 21, 1995, which is a continuation-in-part of application Ser. No. 07/451,322, filed Dec. 15, 1989, now U.S. Pat. No. 5,227,614, issued Jul. 13, 1993, which is a continuation-in-part of application Ser. No. 07/143,921, filed Jan. 14, 1988, now abandoned, which is a continuation-in-part of application Ser. No. 06/897,547, filed Aug. 15, 1986, now abandoned, and said application Ser. No. 08/040,313 is further a continuation-in-part of application Ser. No. 07/947,036, filed Sep. 16, 1992, now U.S. Pat. No. 5,308,966, issued May 3, 1994, which is a continuation of application Ser. No. 07/875,791, filed Apr. 27, 1992, now abandoned, which is a continuation-in-part of application Ser. No. 07/422,052, filed Oct. 16, 1989, now abandoned, which is a division of application Ser. No. 06/894,689, filed Aug. 8, 1986, now U.S. Pat. No. 4,877,949, issued Oct. 31, 1989.

b. Incorporation by Reference

The following related commonly owned patent applications are incorporated herein by reference in their entirety, including appendices and drawings:

Inventor(s)	Ser. No.	Filing Date	U.S. Pat. No.	Issue Date
Miller, et al.	07/136,097	12/21/87		
Danielson, et al.	07/143,921	01/14/88		
Koenck	07/238,701	08/31/88	5,019,699	05/28/91
Main, et al	07/321,932	03/09/89		
(for published version of 07/321,932, see continuation disclosure, identified by:				
Main, et al.	07/966,907	10/26/92	5,216,233	06/01/93)
Hanson, et al.	07/346,771	05/02/89		
Hanson, et al.	07/347,298	05/02/89		
Danielson, et al.	07/364,902	06/08/89		
(for application including the 07/364,902 disclosure, see:				
Danielson, et al.	07/777,393	01/07/92	issue fee paid)	
Chadima, et al.	07/339,953	04/18/89	4,894,523	01/16/90
Miller, et al.	07/347,602	05/03/89		
(for published version of 07/347,602, see continuation disclosure, identified by:				
Miller, et al.	08/046,048	04/12/93	5,331,580	07/19/94)
Danielson, et al.	07/422,052	10/16/89		
Koenck, et al.	07/467,096	01/18/90	5,052,020	09/24/91
Danielson, et al.	07/626,711	12/12/90		
Koenck, et al.	07/660,615	02/25/91	5,218,187	06/08/93
Koenck, et al.	07/987,574	12/08/92	5,313,053	05/17/94
Koenck, et al.	08/215,115	03/17/94		

Further, the following related commonly owned international patent applications are incorporated herein by reference in their entirety:

Inventor(s)	International Application Number	International Filing Date	International Publication Number	International Publication Date
Koenck, et al.	US90/03282	06/07/90	WO90/16033	12/27/90
Koenck, et al.	US91/00435	01/18/91	WO91/11065	07/25/91

The entire disclosures of the foregoing publications are incorporated herein by reference.

BACKGROUND OF THE INVENTION

This invention relates to pocket size computer processor system means, and particularly to a plural module computer processor system capable of incorporating various data entry peripheral devices and of coupling with various data storage and data transmission devices while yet being suitable to be carried on the person of an individual user throughout a working day.

A long-standing problem in the hand-held computer field has been to provide a compact and efficient system for data capture while yet achieving low production cost. It is conceived that a breakthrough can be realized by an optimum plural module system configuration.

In another aspect, the invention relates to novel terminal means for association with information cards and is particularly concerned with such terminal means for use by an individual user in communication with another computer system. There are many circumstances for example where an individual may desire to carry out transactions with a central computer processing station. In one example, a racing establishment such as a horse racing organization may desire to enable individual members having accounts with the organization to place bets from various locations such as home or office. In such a circumstance, it would be highly advantageous if the individual could communicate directly with a central computer system placing with the system all the information concerning a bet, and receive from the computer system essentially instantaneous information as to whether such a bet has been accepted. Another example relates to food service functions where orders may be transmitted to a central order processing center, and where credit or debit card purchases may be approved and/or related data stored at the central processor. Still another example is in the field of direct store delivery of merchandise. A pocket size terminal may contain the necessary information concerning the items being delivered and may be coupled with the store computer system to effect a paperless delivery transaction. (Pocket size may here be taken as a terminal with a base perimeter of not more than twelve inches so as to fit in a typical side pocket of a jacket or the like having a depth of e.g. eight inches.)

This invention also relates generally to data collection and processing systems using portable, hand-held data terminals for collecting data, and for selectively processing and communicating collected data to other system elements. More particularly, the invention relates to collection apparatus of such hand-held data terminals. Typical collection processes may include reading data and manually keying in such read data. The present invention relates particularly to apparatus for reading data into the terminal. Known automated reading processes are executed by apparatus which includes scanning readers, for example.

In efforts to adapt data collection terminals to a wider scope of uses, terminals with increased ruggedness over

state of the art terminals are bringing advances to the art. However, the usefulness of the data collection terminals may also be increased by further reducing the weight and size of the data collection terminals to sizes and weights below the present lower limits of state of the art terminals. Typically a reduction in size might result in the elimination of at least some desirable features. The use of modular data collection terminals would support the reduction in non-essential features to achieve certain reduction in size and weight.

In the data capture field, there are many applications where hand-held data terminals should be of rugged construction so as to survive rough handling. Many operators are not inclined toward painstaking or precise manipulations. An example is in the use of RF data capture terminals on forklift trucks in factories and warehouses where items to be transported are identified by bar codes. Other examples are found in the fields of route delivery and direct store delivery where many items are handled and the terminal means automates the accounting function. Even in applications where bar code data is transmitted on-line to a central station, it may be desirable for hand-held terminals to be inserted into docking apparatus for the interchange of data signals e.g. the loading of scheduling information or the like into the terminal at the beginning of a working shift. Further where terminal means has memory capacity for accumulating data during a delivery operation or the like, it may be desirable for such data to be transferred to a printer so that a hard copy may be produced. In cases where rechargeable batteries are used, the docking apparatus may provide for the recharging of such batteries at the same time as data communication is taking place.

It is conceived that it would be highly advantageous to provide a data capture system with docking apparatus adaptable to a wide range of terminal means, and which furthermore could be quickly and simply loaded in a relatively foolproof manner, and without requiring attention and care from operators engaged in physically demanding and arduous work routines. A docking apparatus would be desirable that completely avoids the use of mating pin and socket type electrical connections, and that does not rely on a specialized configuration of the terminal, e.g. the provision of an optical scanner tip which may be used for data communication. However, pin and socket type connectors may be utilized.

In connection with the use of portable data systems it is conceived that it would be highly advantageous to be able to readily upgrade a basic hand-held terminal to incorporate bar code scan type readers and various image readers as they are progressively improved and developed. A particular goal would be the implementation of the auxiliary image reader function in a rugged configuration free of moving parts. However, in the case of autofocus readers, the current state of the art may require dynamic components for the sake of optimum compactness and economy.

SUMMARY OF THE INVENTION

Accordingly it is an object of the present invention to provide a plural module system configuration that is adaptable to a wide range of data capture applications while retaining pocket size and utilizing a core computer processor module of standard size and characteristics so as to achieve the economy of large scale production.

In a preferred embodiment the standardized computer processor module is provided with a multi-tasking operating system such that battery monitoring software and diagnostic routines will run at a fixed priority level at all times while a wide range of applications software can be run concurrently without jeopardizing the reliability of the system under extended portable operating conditions.

Preferably the standardized computer processor module is selectively associated with peripheral device shell configurations for adapting the system to specific applications. For example a shell configuration may include a scanner module for reading bar codes and a manual data entry and display means specifically tailored to a particular job such as package tracking, inventory, direct store delivery accounting, or the like. As a specific embodiment, the peripheral device shell may comprise a digitizer input tablet and display means which can receive handwritten input data and provide a desired confirming display. A conversational mode may provide for multiple interpretive displays of successively lesser probability in response to an input character or word which is ambiguous with function key selection of the correct interpretation, or the like. A voice input and/or voice synthesizer shell module is another exemplary embodiment. Again in a conversational mode, the module may repeat input words in synthesized speech and/or provide a visual display thereof whereupon actuation of a function button or the like may instruct the module to present a second most probable selection from its vocabulary.

The handwritten or voice input modules may include a learning program for progressively improving recognition of the individual user's characteristic handwritten or voice input. Physical objects related to a given user application may be assigned respective code words e.g. of eight bits length; thus in the case of a food service function, in a food selection mode, the writing of the letter "P" with a stylus on an input tablet or the spoken word "potato chip" may be stored as the ASCII code for the character P in a special food selection storage. A nonvolatile storage section would enable the translation of the "P" code in food selection mode into the string of characters "potato chips" on the display and/or produce the synthesized speech output "potato chips". In a conversational mode, if there were two or more P items, the shell module could in response to a "P" input, present on the display a listing of the P selections, e.g., as P1, P2, P3, etc., whereupon the user could enter with a stylus or the like the correct numeral "1", "2", "3", etc.

According to an exemplary embodiment, a peripheral device shell may provide a transparent tablet serving as data input and as a display window. A sonic wave digitizer arrangement for example may sense stylus (or finger) position on the tablet. The display may include a graphics liquid crystal display (LCD) behind the transparent tablet for defining a keyboard in a touch data entry mode, and for display of data supplied by touch entry, or by other means such as handwritten input, speech input, optical scanner input, and so on. Keyboard touch selection positions can be labeled by means of icons (pictorial images) where this is most effective. The pocket size unit may be of sealed construction so as to be ideal for meter reading, timber inventory, or any environmentally demanding application.

The computer processor module may be employed with peripheral devices such as printers, laser bar code readers, RF modules, smart card interface modules, disk systems, full travel keyboards, high resolution displays, local area network (LAN) interface modules, etc., and various such devices may be combined in a single self-contained battery powered hand-held unit.

It is also an object of the present invention to provide a terminal means which can be utilized by an individual at various locations for direct communication with another computer system for the purpose of carrying out desired individual transactions.

It is another object of the present invention to provide such a terminal which can be conveniently carried on the person of an individual, for example, in a shirt pocket.

A further object of the invention is to provide a terminal unit which is adapted to incorporate a means for reliably identifying an individual who uses the terminal and wherein the terminal facilitates each step in carrying out the desired transaction.

A feature of the invention resides in the provision of a terminal capable of removably receiving an information card with extensive memory capability and which, together with the terminal, can be held in one hand during entry of information concerning a transaction.

In accordance with a further feature, such a hand-held terminal system may incorporate means for two-way communication with a central computer system, e.g., via telephone lines or a radio frequency link.

In accordance with another feature, such a hand-held terminal system may be provided with a scanner for optically scanning visual information such as bar codes.

In accordance with another feature of the invention, such a hand-held terminal system may have dimensions of width and length comparable to a standard intelligent information card and of thickness to fit in the pocket, such as a shirt pocket.

In accordance with still another feature of the invention, such a terminal configuration is designed so as to be adaptable to a wide variety of applications without change in its basic housing configuration.

The PCT application Serial No. 90/0382, filed Jun. 7, 1990, assigned to and owned by the assignee of the present application, the descriptive matter of which is incorporated herein by reference in its entirety, refers to such a modular hand-held unit and discloses a manner of attaching one functional module to another. The use of functional modules increases the scope of use of the basic data collection terminals by allowing the substitution of a most desirable feature in a particular application for another feature which may have become redundant. The eliminated feature may be least likely to be used in conjunction with the newly added feature. Without increase in size and weight of one type data collection terminal over another, respective functions may be adapted to specific situations. In certain applications, however, selected modules desirably include added features. The addition of such features in accordance with the invention is advantageously accomplished with a minimal size and weight change.

Hence, as contemplated, a laser scanner is added to a data collection terminal unit which typically features a radio frequency transceiver module. In accordance with particular features of the invention, a radio transceiver and a laser scanner are integrated into a single module with only a minimal increase in volume over the volume of a radio transceiver module without the laser scanner unit.

According to another aspect of the invention, rotatively mounted scanning mirrors of a laser scanner are formed about magnetic poles of an armature of a motor for rotating the mirrors.

In accordance with another feature of the invention, electronic elements and physical elements for implementing functions of a laser scanner of the hand-held data collection terminal and electronic coupling circuits for interconnecting the laser scanner with the data collection terminal are disposed in interleaved relationship with electronic components for processing communications between a transceiver and the laser scanner.

Accordingly, it is an important object of the present invention to provide a portable data system wherein technologically advanced image reader devices can be readily accommodated.

In a presently preferred configuration particularly suited for forklift truck applications and the like, a portable data terminal with a rugged surface contact configuration accommodates supply of power by the vehicle when the terminal is placed in a vehicle mount; further, the terminal batteries may receive charge while the terminal is operating from the vehicle power so that full battery capacity is available when portable operation is required. However, other contact means might also be utilized.

In accordance with a further development of the invention, portable terminals, for example, may be quickly removed from the charging system by grasping of the terminal itself followed by a simple lifting extraction.

In accordance with an important aspect of the present invention, a docking apparatus removably receives portable data terminal and code reader means for purposes of data communication, e.g., with a host computer and/or for the recharging of rechargeable batteries. In one potential embodiment the terminal and reader means may have electrical contact pad means generally flush on their exterior. In such an embodiment, an abutting type engagement between the contact pad means and cooperating electrical contact means of the docking apparatus may be used for transmitting charging current such that the typical pin and socket type docking connections are entirely avoided.

In accordance with another aspect of the invention the same basic docking structure may be provided with greater or lesser numbers of contact positions. For example, one type of hand-held terminal intended for on-line RF communication with a host computer may have six contact pads for coupling with a local area network, and may have a nine position electrical connector for compatibility with an earlier type of interface system requiring interfitting of pin and socket connectors; another type of hand-held terminal designed for route accounting applications may have, e.g., twelve external contact pads and be intended for interfacing only with systems having provision for open abutment type interconnection.

The terminal and/or reader receptacle means is preferably arranged so that with the terminal or reader secured therein, each line of the display remains visually observable in a convenient orientation relative to a driver of a vehicle. Also all of the key positions of the keyboard are manually accessible, the legends on the keyboard having an orientation so as to be conveniently readable, e.g. by the driver of the vehicle. In particular the axis of each line of the display and of each row of key positions should be generally horizontal (rather than vertical) and the alphanumeric characters of the display and keyboard legends should be upright (rather than inverted) as viewed by the operator.

Also most preferably the terminal or reader can be inserted into the receptacle with one hand and is securely retained. Ideally the terminal or reader is automatically secured with a snap type action which is perceptible, e.g., audibly and tactually to the operator.

In some instances a resilient bias may serve to firmly position the terminal or reader for steady reliable electrical contact at each abutting type contact position in spite of vehicle jarring and vibration or the like. For enhanced security of retention with the docking apparatus, e.g. in mobile applications, the terminal or reader may be automatically affirmatively retained in its receptacle e.g. by means of a detent type action.

One exemplary embodiment of data capture terminal unit is provided with a plurality of electrically conductive pads generally coplanar with the external surface of the housing. Such electrically conductive pads may be interconnected by internal circuitry to the connector elements of a D-style connector mounted upon the housing end cap such that recharge power and data communication pathways may be made through either or both of the connector means. The electrically conductive pads are positioned such that they may be engaged with mating elements having sufficient resilience to maintain stable electrical contact therebetween while the terminal is in a docking receptacle or the like.

According to another aspect of the invention, a laser light source may provide simultaneous illumination of a complete image line or a complete image column, or a substantial linear segment thereof, facilitating the achievement of a rugged image reader unit preferably without moving parts in the illumination system. In a further development a long range CCD image reader having autofocus capabilities may be utilized with a fan beam for simultaneously illuminating a complete image line over a substantial range of distances.

Various other features and advantages of the data terminal in accordance with the invention will become apparent from the following detailed description, which may be best understood when read with reference to the appended drawings.

INCORPORATION BY REFERENCE

The descriptive matter of the above-referred to PCT International application PCT/US90/03282, filed Jun. 7, 1990, as published under International Publication No. WO 90/16033 on Dec. 27, 1990, which entered the U.S. national stage as Ser. No. 07/777,393 with a filing date of Dec. 6, 1991 and an effective date of Jan. 7, 1992, (now U.S. Pat. No. 5,410,141, issued Apr. 25, 1995), including forty-six pages of specification and nineteen sheets of drawings including FIGS. 1 through 37 is hereby incorporated by reference.

FEATURES OF THE INCORPORATED PUBLISHED APPLICATION

The PCT International Publication No. WO 90/16033, which is incorporated herein by reference in its entirety, refers to a modular hand-held data collection unit and discloses a manner of attaching one functional module to another. The use of functional modules increases the scope of use of the basic data collection terminals by allowing the substitution of a most desirable feature in a particular application for another feature which may have become redundant. The eliminated feature may be least likely to be used in conjunction with the newly added feature. Without increase in size and weight of one type data collection terminal over another, respective functions may be adapted to specific situations. In certain applications, however, selected modules desirably include added features. The addition of such features in accordance with the invention is advantageously accomplished with a minimal size and weight change.

Hence, as contemplated, an image scanner utilizing an image sensor array may be incorporated in a module for a data collection terminal unit which may also include a radio frequency transceiver. In accordance with particular features of the invention, a radio transceiver and an automatic bar code reader with image sensor array and are integrated into a single module.

Various other features and advantages of the data terminal in accordance with the invention will become apparent from the following detailed description, which may be best understood when read with reference to the appended drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** shows a frontal view of a modular data terminal;

FIG. **2** is a side view of the data terminal shown in FIG. **1**;

FIG. **3** is a side view of a related data collection terminal having a communications module without a laser scanner;

FIG. **4** is a side view of the data terminal shown in FIG. **1**, showing somewhat schematically a data collection and communications module;

FIG. **5** is a sectional view, showing somewhat simplified a stacked arrangement of a radio, a communications interface main circuit board and a laser scanner assembly;

FIG. **6** is an exploded view of the data collection and communications module:

FIG. **7** is a partial plan view of the laser scanner assembly of FIG. **5**;

FIG. **8** is a somewhat simplified sectional view of a motor assembly of the laser scanner assembly shown in FIG. **7**;

FIG. **9** is a schematic plan view diagram of the motor assembly shown in section in FIG. **8**;

FIG. **10** is a functional schematic diagram showing the manner in which the various elements of the data collection and communications module interact with each other;

FIG. **11** corresponds with the first figure of incorporated U.S. Pat. No. 4,877,949;

FIG. **12** is a partial plan view of a laser scanner;

FIG. **13A** shows an image sensor system utilizing a laser line type beam generator and an image focusing and sensing system for reading a reflected bar code image;

FIG. **13B** shows a non-scanning laser illuminated bar code scanner for reading a reflected bar code image;

FIG. **13C** shows the cross sectional shape of the beams produced by the laser sources of FIG. **13B**;

FIG. **14** is a partial longitudinal sectional view of an image reader module similar to that of FIG. **16**, but incorporating a transversely disposed antenna and a different optical port construction;

FIG. **15** is a partial plan view of the module of FIG. **14**;

FIG. **16** shows an image reader module which may optionally use the image sensor system of FIG. **13A**;

FIG. **17** is a plan view of the module case of the embodiment of FIG. **16**, and illustrates an LED illumination system;

FIG. **18A** is a cross sectional view of the module case taken generally along the line **15**—**15** of FIG. **17**;

FIG. **18B** is an end elevational view of the module case of FIG. **17**;

FIG. **19** is a somewhat diagrammatic horizontal sectional view showing a different image reader system for incorporation in the reader modules herein disclosed;

FIG. **20** is a diagrammatic longitudinal sectional view of the system of FIG. **19**;

FIG. **21** is a front view of the system of FIG. **19**;

FIG. **22** is a diagrammatic illustration of the manner of applying a fan type laser line generator to the system of FIGS. **19**, **20** and **21**;

FIG. **23** is a diagrammatic illustration of a range and angle measurement system;

FIG. **24** is front elevational view of a conventional horizontally disposed bar code illustrating the impingement of a fan beam illuminating a bar code;

FIG. **25** is a diagrammatic illustration of a vertically and horizontally adjustable fan beam selector;

FIG. **26** is a diagrammatic illustration of the vertically and horizontally adjustable fan beam selector of FIG. **25** providing a fan beam output;

FIG. **27** is a somewhat diagrammatic perspective view illustrating the insertion of an intelligent information card into a receptacle of a terminal means in accordance with the present invention while the terminal means is held by one hand;

FIG. **28** is a perspective view showing a terminal means in accordance with the present invention and showing an exemplary display including four single lines of characters and at the bottom Chinese characters occupying the height of two character lines of the display;

FIG. **29** illustrates a matrix of touch regions for a touch screen such as indicated in FIG. **28**;

FIG. **30** is a schematic block diagram for illustrating an exemplary processing means occupying the interior of the terminal of FIGS. **27** and **28**;

FIG. **31** is a somewhat diagrammatic perspective view showing a terminal which may be utilized particularly for selecting desired functions in a particular application of the terminal of FIGS. **27–30**;

FIG. **32** shows the insertion of an intelligent information card into a receptacle of the terminal of FIG. **31** while the terminal is held by one hand;

FIG. **33** is a somewhat schematic block diagram for illustrating the electronic processing components which may be utilized with the embodiment of FIGS. **31** and **32**;

FIG. **34** is a diagrammatic perspective view of a shirt pocket size terminal means in accordance with the present invention, including a scanner tip, and having portions broken away to show internal components;

FIG. **35** is a diagrammatic cross sectional view for indicating internal components of the terminal means of FIG. **34**;

FIG. **36** is a diagrammatic view of a core processor module with touch screen type display and having length and width comparable to a standard credit or debit card and thickness to fit in a shirt pocket;

FIG. **37** is a diagrammatic perspective view showing an exemplary shell configuration for readily receiving the core processor module of FIG. **34**, **35** and **36**, to form a plural module terminal system, e.g., adapted for direct store delivery accounting;

FIG. **38** shows a store terminal device for coupling with the system of FIGS. **36** and **37**;

FIG. **39** shows an exemplary coupling means for coupling the system of FIGS. **36** and **37** with the store terminal of FIG. **38**;

FIG. **40** shows an exemplary plural module terminal system comprised of a shell portion having a processor and battery and also having optical indicia reader components and light output components, and shown with a display and manual data input module assembled in the shell receptacle; and

FIG. **41** shows another exemplary plural module terminal system comprising a shell portion having battery and light output components and a module assembled therewith containing optical indicia reader components.

DETAILED DESCRIPTION OF THE INVENTION

1. Description of FIGS. 1–10

Referring now to FIGS. **1** and **2**, a data collection terminal unit, also referred to herein as data terminal, is designated generally by the numeral **10**. As shown in FIG. **1**, a frontal face **12** of an elongate housing **14** of a base module **16** of the data terminal **10** typical faces upward and is accessible to the user of the data terminal. The upward facing portion of the module **16** houses a keyboard module **17**, including an alphanumerical keyboard **18** and a display screen **19**. The display screen **19** is in a preferred embodiment described herein a 4-line by 16-character Reflective Super Twist Liquid Crystal Display (LCD). Of course, other display means may be used in its stead. The keyboard **18** included a lower, standard numerical keyboard section **21**, above which is disposed an alphabetical keyboard arrangement **22**. An On-Off power key **23** is preferably placed in a leftmost position of an uppermost row on an uppermost row of five keys. The outermost keys **24** in a bottom row are configured as "CLEAR" and "ENTER", while the remaining four keys in the uppermost row are preferably configured as a set of four user-defined function keys **26**.

At a bottom end **30** of the housing **14**, there are located two connector plugs **31** and **32**. The connectors **31** and **32** are protected by adjacent end and interleaved protrusions **36** of the housing **14**, which protrusions extend somewhat past the connectors. A preferred embodiment of the data terminal **10** is intended to withstand without damage a drop of about 1.2 meters to a solid surface, such as concrete. The preferred connector **31** is an input-output port, as may be used for such data collection as bar code reading, for example. In such instance, the connector **31** is preferred to be a 9-pin D-subminiature connector with pins interfacing to typical 5 volt scanning peripherals. The connector **32** may be used for accessing external power sources or provide of combined power and data communication. A circular miniature DIN-type connector **32** may be used in the preferred embodiment. A top end **40** of the preferred embodiment of the base module **16** typically may not include connectors. An antenna **41** shown to extend above the top end **40** is further described in reference to FIG. **2**. The described frontal, substantially rectangular configuration of the data collection terminal **10** has a length of substantially seven inches (Dimension A=7 inches) and a width of approximately two and three quarter inches (Dimension B=2¾"). The size is convenient to hold the terminal in one's hand, and as seen from FIG. **2**, the thickness or depth of the data terminal **10** permits the terminal **10** to be carried about in a potential user's pocket.

FIG. **2** shows depth or thickness features of the data terminal **10**. The base module **16** of the data terminal **10** with the described frontal face **12** includes an elongate upper housing portion **43** which defines the longitudinal and lateral extent of the data terminal **10**. Attached to the upper housing portion **43** and disposed adjacent the bottom end **30** is a lower battery compartment **44**. In the preferred embodiment, the battery compartment **44** is assembled as a lower housing portion to the upper housing portion **43**. Adjacent the top end **40** of the data terminal **10** a data collection and communications module **48** is attached to the lower edge of the upper housing portion **43**. The antenna **41** as is typical for external antennas extends upward from the data collection and communications module **48** above the top end **40** of the data terminal **10**.

One of the features of hand-held data terminals related to this invention and as disclosed in the PCT application PCT/US90/03282 incorporated herein by reference relates

to the exchangeability of modules of different shape and varied function. It is of course desirable to have the various modules, though of different shape, substantially of the same size, such that the feel and handling of the family of data terminals **10** remain substantially identical regardless by what features a particular module may be distinguished over another data terminal **10**. The data collection and communications module **48** in FIG. **2**. includes a radio **49** and laser scanning apparatus **50**, the relative positions of which are best referred to in FIG. **5**. Externally the presence of the radio module **49** is of course indicated by the presence of the antenna **41** in FIG. **2**. The radio module may be a commercially available pretuned 1-watt (UHF) frequency modulated (FM) radio transceiver module, or any similar radio module, such as a Motorola P10tm radio model, for example.

In accordance herewith it is contemplated to provide the data collection and communications module **48** as a module which is capable of readily replacing another module, such as a radio communications module **51** which is shown in FIG. **3**, for example, and which does not include a combined radio and laser scanning function. Each of these interchangeable modules feature a quick exchange mounting mechanism, such as is more clearly illustrated with respect to FIG. **4**. As shown in FIG. **4**, the data collection and communications module **48** is matched in a contour continuation along a juncture line **52** to the housing **14** adjacent edge of the battery compartment **44** and along a longitudinal parting line **53** of the base module **16**. The juncture line **52** defines a cavity within the base module **16** within which modules as the module **48** may be received. The module **48** features a plurality of laterally disposed latching hooks or latch hooks **56** which become engaged by respective latching seats or latch seats **57** disposed along the adjacent edge of the base module **16** when the module **48** is removed toward and into engagement with the adjacent edge and then toward the battery compartment **44**, as shown by the arrow. Electrical communication is established via a power and communications connector **61** the pins of which engage a mating connector socket **62** within the base module **16**. A set of screws **63** may be tightened through the battery compartment **44** into a set of threaded seats **64** disposed in the adjacent wall of the module **48** to securely retain the attached module as an integrated part of the data terminal **10**. At the top end of the data terminal **10**, a lip or extending stop edge **66** of the module **55** engages a complementarily shaped seat **67** to securely interlock the data collection and communications module **48** with the base module **16**.

FIGS. **2** and **3** depict a comparison of relative depths or thicknesses between the data collection and communications module **48** and the radio communications module **51**. The radio communications module **51** is also shown equipped with a preferred hand strap **68** attached longitudinally to the rear of the data terminal **10**. Though not presently contemplated for use on the data terminal **10** featuring the data collection and communications module **48**, it is clearly possible to use the hand strap **68** on the data terminal **10** having the module **48**. As seen in FIG. **3**, the radio communications module **51** fits generally with its thickness into the contour of the housing of the data terminal **10**. The additional laser scanning apparatus **50** does require an increased thickness or depth in the general contour of the housing **14**. However, in accordance herewith, an increase in the thickness of the housing **14** has been minimized, as will become apparent from the further description of the improved arrangement of the laser scanning apparatus **50**, but a necessary increase in the depth has been employed to increase the ease of manually holding the data terminal **10** during use. Either of the modules **48** to **51**, when seated against the rear of the housing **14**, blends with the contour of the housing along the line **52**. FIG. **2** shows a thickness of the data terminal **10** at its bottom end of only about 1½ inches (Dimension D), while the thickness at the top end **40** of the data terminal with the data collection and communications module **48** amounts to two inches (Dimension C1=2"). In FIG. **3**, both top and bottom ends **40** and **30** of the data terminal **10** with the radio module **51** measure substantially the same depth or thickness of about 1½ inches (Dimension C2=1½"). The increase in the thickness of the module **48** over that of the module **51** (Dimension E=½") is formed in a transition **69** which has been found to advantageously provide a resting ledge for the index finger of a user of the data terminal **10**, providing added stability during use of the data terminal **10**. With the index finger of the user resting against the transition or ledge **69**, the thumb of the user is conveniently located along a lateral surface **70** of the module **48**. A pushbutton **71** is disposed in the general area of the lateral surface **70** to be readily accessible for activation by the user's thumb. The pushbutton **71** is hence used to activate a laser scanning operation of the laser scanning apparatus **50**. The pushbutton **71** may be duplicated in an identical location on the opposite lateral wall of the module **48**. In this manner both left-handed and right-handed users of the data terminal **10** would be able to use the laser operation trigger pushbutton **71**. The location of the pushbutton **71** in FIG. **2** denotes both oppositely facing pushbutton locations on the opposite side walls of the module **48**. The overall lengths of the modules **48** and **51** are substantially identical (Dimension F=3¼") because of overall longitudinal restraints.

FIGS. **5** and **6** best illustrate the physical interrelationship between various elements of the radio **49** and the laser scanning apparatus **50** which results in the described minimal increase of the overall thickness of the data collection and communications module **48** over the radio module **51**. The module **48** is contained within a molded protective shell **75** of a high impact plastic material, preferably identical to the material employed for the housing **14**. The outer contour of the shell **75** also blends into that of the housing **14**, such that when edges **76** and **77** and the stop edge **66** are placed and locked against the respectively matching juncture lines **52** and the seat **67**, the protective shell forms part of the housing **14**. The edges **76** include the latch hooks **56** which lock the shell **75** to the housing **14**. An apertured boss, such as indicated at **78** provides a mounting seat for the antenna **41**. Interiorly of the shell **75** a plurality of spaced, internally threaded bosses **79** are disposed in a plane to support the mounting of a main circuit board **82**, which is also referred to as an analog board **82**.

The analog board **82** is a multi-use element, in that it is first of all a circuit board. The circuit board **82** is in particular a four-layer circuit board, having conductive patterns disposed on both major outer surfaces **83** and **84**, the conductive patterns including designate sites form mounting electronic components to both sides of the circuit board. Two inner conductive planes provide ground and interconnection planes for the components on the respective outer surfaces of the circuit board **82**. The ground plane within the circuit board **82** substantially isolates electrical radio noise from interfering with the laser scanning components and to minimize such radio noise from being emitted from the shell **75**.

To the surface **84** of the main circuit board **82** there is mounted a laser scanner submodule **86**. The laser scanner submodule **86** includes a mounting frame **87**, preferably a molded structure of a high impact plastic. A laser diode **88**

is mounted to a support seat **89** of the mounting frame **87**. The laser diode is of cylindrical shape, approximately ½ of an inch in diameter and about ¾ of an inch long. The laser diode **88** is a known commercially available element, such as under the designation TOLD 9211 from Toshiba Electric, for example. The laser diode is provided as a fully assembled unit including collimating optics having a lens window **90** through which a collimated laser beam is emitted. The preferred laser diode **88** is of "InGaAlP" material, a known laser material which emits light in the humanly perceivable wavelength range of 670 nanometers. The emitted light is perceived as ruby red, giving the operator of the laser scanner an indication of the operability of the laser and permitting the laser light to be visually "aimed" against indicia such as a bar code to be read. A scanning mirror assembly **92** is placed adjacent the path of the emitted laser beam, such that in a plan view a regular polygon **93** of highly polished mirrors **94** is disposed in the plane of the laser beam emitted from the window **90**. The mirrors **94** form a cylinder having a sectional shape of a regular polygon. In the preferred embodiment a total of ten mirrors **94** are evenly spaced about the periphery of the right cylinder. The laser beam impinges on a primary reflector mirror **95** which is typically held in a seat **96** of the frame **87**. The scanning mirror assembly **92** is a circuit board mounted assembly of stepping motor assembly **98**. The right cylinder appearing in plan view as a regular polygon **93** of the mirrors **94** constitutes an armature of the motor assembly **98**. The mirrors **94** are formed in the peripheral wall of the armature of the motor assembly **98**. A motor circuit board **99** supports a spindle **102** of the armature **93**. The motor circuit board **99** also supports electronic driver components of the motor assembly **98**. The scanning mirror assembly **92** is mounted to the frame **87**. A cut-out **104** in the circuit board **99** provides clearance between the board **99** and the laser diode **88**, such that the mirrors **94** are disposed in the emission plane of the laser diode **88**.

An optical analog circuit board **105** is mounted against the frame **87** across from the main circuit board **82** and fastened with typical mounting screws **106** to the frame **87**. A typical circuit board connector pin arrangement, such as is shown at **108** may be connected to a typical flat cable **109** to electrically couple the analog circuit board **105** to the main circuit board **82** and to the scanning mirror assembly **92**. The circuit board **105** includes circuit elements for receiving and amplifying optical signals which represent reflected signals as a result of the outgoing laser beam from the laser diode **88**. The circuit elements include such typical elements as photo diodes which are integrated into receiving optics **112** mounted to the circuit board **105**.

Mounted to the surface **83** of the main surface board **82** is a radio support frame **115**. The radio support frame **115** is a U-shaped frame which is mounted peripherally about the circuit board **82** extending upward from its surface **83**. Formed tongues **116** of the support frame **115** are insertible into apertures **117** of the circuit board **82** to fasten the frame **115** to the circuit board. The frame **115** has a predetermined height between a lower edge **118** and an upper edge **119**. Apertured mounting lugs **121** disposed at the upper edge **119** are adapted to receive the threaded fasteners **106**. The radio **49** is mounted on a circuit board **122**. The circuit board **122** is attached, such as by the fasteners **106**, to the lugs **121** of the support frame **115**, the height of the support frame **115** spacing the main circuit board **82** and the radio circuit board **122** to accommodate the components on both boards. The support frame in conjunction with the ground plane of the circuit board **82** also forms a radio frequency emission cage about the components of the radio circuit board **122**, containing radio frequency (RE) emissions in accordance with regulations. The circuit board **122** may in itself contain RF shielding toward the tip of the formed cage, or separate shielding such as an additional board having a ground plane may be added.

A circuit board connector pin arrangement **125** receives a typical circuit board connector strip **126** of a circuit routing board **127**. The circuit routing board **127** routes power and communicative interconnections between the main circuit board **82** and the base module **16**. A conductive ground plane **128** of the routing board **127** may preferably be coupled to the support frame **115** to complete the RF cage in conjunction with the support frame **115** and the ground plane of the main circuit board **82**.

The assembly of the described elements of the main circuit board **82**, the laser scanner assembly **86** and the radio **49** into the housing shell **75** spaces the elements tightly, placing the plane of the laser beam and the receiving optics **112** of the laser scanner analog circuit board **105** adjacent a scanning window **131** of the shell **75**. The scanning laser beam and its reflection pass through the window in the outgoing and incoming directions, respectively. Spacing the described components at minimum distances adjacent one another as shown in the sectional view of FIG. **5**, for example, is made possible by a cutout **132** in the main circuit board **82** to accommodate an upper portion of the laser diode **88**. It has been found that the cutout **132** in the main circuit board **82** and hence in its ground plane does not adversely affect RF shielding of emissions from the radio **49**. Further in reference to the main circuit board **82** as shown in FIG. **6**, the circuit board **82** includes on opposite edges **136** and **137** electrical actuator switches **138**. The switches **138** are the electrical components which in conjunction with the external element of the pushbutton **71**, typically a molded rubber part, form the pushbutton **71**. The external portion of the pushbutton **71** is disposed in the shell **75** to become aligned with the electrical actuator switches **138** when the main circuit board **82** is assembled into the shell **75** as shown in FIG. **5**, for example.

FIG. **7** is a simplified top view of the laser scanner assembly **86** to show the path of the laser beam emitted from the laser diode **88**, as shown at **140**. The laser beam **140** impinges against the primary reflector mirror **95** and is reflected at **142** against the rotating polygon of preferably ten mirrors **94**. The armature **93** rotates during the scanning process in the direction of arrow **143**, such that the laser beam reflected from the mirrors **94** scans at **144** in a direction from left to right of an operator holding the data terminal **10**. Left and right scanning window edges **146** and **147**, respectively, cut off the laser beam to the far left and right and limit the scanning angle to a reasonable deflection from a centerline of the data terminal **10**. The optimum scanning angle may be altered by relocating the window edges **146** and **147** accordingly. The laser beam, when reflected from an impinged on surface **149** into the receiving optics **112**, would be modulated in accordance to reflection patterns on such reflected surface **149**, such as the dark and light alternating regions of a bar code.

FIG. **8** is a cross sectional view through the stepping motor assembly **98** which is somewhat simplified for the sake of clarity. The motor circuit board **99** supports magnetic field coils **151**, of which there may be three equally spaced coils, as in a preferred example. The coils **151** lie in the plane of the motor circuit board **99** and direct a magnetic field substantially perpendicularly thereto out of the plane of the circuit board **99**. The coils **151** are electrically coupled to

electronic driver elements (not shown) which are preferably also disposed adjacent the coils **151** on the motor circuit board **99**. The main body of the armature **93** is of non-magnetic material, such as aluminum. However, a magnetized permanent magnet element **153** is disposed in a central recess **154** of the armature **93**. The armature **93** is rotatably supported by the spindle or shaft **102** which may be mounted for rotation in a bearing **156** disposed on the surface of the motor circuit board **99**. Alternately, the spindle might be fixedly mounted to extend from the motor circuit board **99**, such that the bearing **156** would reside between the spindle and the armature. A circular plate **157** of a magnetically conductive material is disposed below the circuit board **99** to serve as a magnetic flux shunt and provide a magnetic return path for the magnetic flux lines generated by the coils **151**.

FIG. **9** showing a schematic plan view of the armature **93** and the field coils **151**. The magnet element **153** of the armature **93** has a plurality of alternately oriented peripherally spaced magnetic polepieces **161** which are in a preferred embodiment part of the single ceramic type magnet disc **153**. Within each of the coils **151**, there may be located a hall effect sensor device **162**. The hall effect sensors **162** detect from the magnetic field the current position of the armature or rotor **93** to control the switching of the drive current through the coils **151**. In the stepping motor art there are various known ways of switching coils and of overdriving in accordance with the position of the rotor **93** to achieve a desirable drive pattern of the rotor. In the present embodiment of the invention, a substantially uniform scan rate is of course desirable, though the armature or rotor **93** is driven through the stepping sequence of the motor assembly **98**. It should be understood that the use of hall effect devices to determine the position of the armature **93** is but one known manner for controlling the speed of rotation and the position of the armature. It is also possible to use opto-electronic encoding techniques to achieve substantially similar position recognition and to control the speed of rotation of the armature **93**. It is to be realized that the flattened structure of the motor assembly **98** resulting from the folding back of the mirrors **94** on the armature **93** is of significance in containing the radio **49** and the laser scanner **50** within the shell **75** of the preferred size as described herein.

Reference to the schematic diagram in FIG. **10** shows major functional elements of the described data collection and communications module **49**. The functional representation of the laser scanning assembly **86**, referred to in FIG. **10** as laser module **86** is coupled With four connections to a scan bus **171** on the main circuit board **82**. The electronic circuits in the laser module for driving the stepping motor and for amplifying reflected signals is a commercially available configuration. In the preferred embodiment, the circuits of the laser module **86** have been obtained from Optoelectronics Co. Ltd. in Japan. Connections for communicating signals between the laser module **86** and a microprocessor (CPU) **174** of the base module **16** include RENABLE, DATA, TIMING (SOS), and ground (GND). RENABLE activates the laser module **86** upon one of the pushbuttons **71** being closed, as represented by SW1 and SW2 on the main circuit board **82**. Closing of either of the pushbuttons **71** is recognized by the CPU **174** of the base module **16**. The CPU switches the RENABLE connection to a high, which powers up the laser scanner assembly **86**. VCC is a typical power input, while the laser diode is driven through a DC to DC converter "51953", identified by numeral **176**. When the motor **98** has come to speed the laser diode is turned on, and the laser module d**86** sends a signal via TIMING (SOS) to the CPU **174**. The TIMING signal frames the data and alerts the CPU that data are forthcoming. Data are transmitted to the CPU via the DATA line and the scan bus **171**. It should be noted that the scan bus **171** is coupled via the routing board **127** to the CPU **174** of the base module **15**, and all other signal and power lines are simply routed through the routing board **127** between the main circuit board **82** and the base module **16**. There is no further manipulation of data or signals between the CPU and the laser module **86** on the main circuit board. On the other hand, the main circuit board **82** performs various functions relating to the control of radio communication between the CPU **174** and the radio or transceiver board **49**. It should be noted that not all possible control leads to the radio **49** are connected to the CPU **174** or to the main circuit board **82**, though it is conceivable that additional functions may be implemented and connected in variations of the preferred embodiment with respect to which the invention is described. Functions relating in particular to the control of the radio **49** and particularly to the frequency control in digital data transmission are discussed in related U.S. application Ser. No. 07/467,096, filed Jan. 18, 1990, by S. E. Koenck and R. L. Mahany, assigned to the assignee of the present application, now U.S. Pat. No. 5,052,020, the disclosure of which in its entirety is incorporated herein by reference. Thus, as is apparent from FIG. **10**, the TRANSCEIVER INTERFACE function represented by a circuit element **177** is a communications interface for between the radio **49** and the CPU **174**. The circuit element **177** activates power to the radio **49** and controls transmission and reception signals, such as indicated by TX MOD and DISCR OUT. The circuit element **177** is driven by an on board clock timed by a 4 MHZ crystal **179**. A buzzer circuit **181** is amplified using on-board power of the main circuit board **82**. It should be realized that not all connections from any commercially available radio **49** and the main circuit board may be used. Various types of radios are known, of which certain radios may function on more than one frequency or a radio type referred to as spread spectrum radio may require various controls. It is contemplated that such radios referred to as spread spectrum radios may be used in conjunction with and as part of the invention described herein. The descriptive matter of U.S. patent application Ser. No. 07/660,615, filed Feb. 15, 1991, by S. E. Koenck et al., the application being assigned to the assignee of the present application, now U.S. Pat. No. 5,218,187, is being incorporated herein by reference. Such patent application refers to advantages of adapting modules to function with different radios. It appears from the above disclosure herein that the present invention may be adapted to function with a number of such different types of radios.

Various other changes and modifications in the structure of the described embodiment are possible without departing from the spirit and scope of the invention as set forth in the claims.

2. Description of FIG. **11**

FIG. **11** illustrates a preferred instant bar code reader system for extending the versatility of a commercial bar code reader such as shown in U.S. Pat No. 4,570,057. Component **3510**, FIG. **11**, may represent a control and processing means for the system and may include a central processing unit, memory units and analog to digital conversion channels.

The central processing unit and associated memory form the main control portion of the system. The other functional blocks of FIG. **11** may be inputs or outputs with respect to the central processing unit.

The central processing unit may be a microprocessor that executes the program to control the operation of the reader.

The microprocessor acts as a microcontroller with the capability of sensing and controlling the functional elements of the bar code reader, and decoding the bar code as supplied from a code image sensor means **3511**. Where the reader is coupled on line with a host computer system, (for example by a host connection means in the form of a flexible cable), the decoded bar signal is transmitted to the host under the control of the central processing unit. The microprocessor is capable of static operation with shut-down for power conservation. Wake-up of the processor will occur when an operator actuates a scan switch **3512**.

An electrically erasable read only memory of component **3510** may be utilized to store parameters and special modifiable decoding sequences for the bar code reader operation. Examples of these parameters would be label code, and input/output speed and control format.

Component **3510** may also include a random access memory for data collection, decoding work space and buffer storage of the decoded label data for transmission to a host computer, for example. The random access memory can be internal to the microprocessor chip or reside on a data bus.

The analog/digital channels are for receiving the bar code signals generated by the bar code image sensor mean **3511** and for other purposes as will be hereafter explained.

The image sensor means **3511** may, for example, include a photosensor array indicated diagrammatically at **3513** having a one dimensional linear array of photodiodes for detecting the bar code reflection image. To read labels with bar code lengths of greater than seven inches with high resolution requires that the array have relatively high resolution. By way of example, the array **3513** may comprise five thousand photodiode circuits (5,000 pixels) and provide approximately three photodiode circuits (3 pixels) for each five mils (0.005 inch) of a bar code length. (Each pixel of array **3513** may have a length of about seven microns.) A charge coupled device (CCD) shift register may be arranged to receive bar code signal elements from the respective photodiode circuits after a suitable integration interval. Once the bar code signal elements have been transferred to the shift register, the signal elements are retained independently of further exposure of the photodiodes to reflected light from the bar code.

In the embodiment of FIG. **11**, an intensity sensor **3514** is provided and may comprise a photodiode that will determine the relative amount of light exposure of the photosensor array **3513**. If component **3510** operates at sufficiently high speed, the signal from the intensity sensor **3514** may be supplied exclusively to component **3510** via an analog/digital channel so that the control and processing means can determine the optimum point for transfer of the bar code image signals to the shift register.

In a presently preferred implementation, however, the intensity sensor means **3514** is directly coupled with the hardware control circuits of the flashable illuminator means and of the bar code image sensor means, and this is indicated by dash lines L1 and L2 in FIG. **11**; in this case, line L is used only so that the processor component **3510** is advised that a flash has actually occurred. In a preferred embodiment wherein a flashable illuminator **3515** is driven by capacitor discharge current, a component **3516** may effect interruption of the flow of current from the capacitor based directly on the signal supplied via L1 from intensity sensor **3514**. In this way, energy is conserved, and recharging of the capacitor speeded up. Component **3516** may comprise a flash current interrupter switch means, e.g. a solid state switch which is controlled to interrupt discharge of the capacitor of high voltage generation unit **3517** and thus to terminate the flash of light from the flashable illuminator **3515** when intensity sensor **3514** indicates that adequate reflected light has been received from a bar code.

FIG. **11** also indicates an input/output buffer component **35121** for coupling the control and processing means **3510** with a host processor or the like. A connection means **35122** may directly receive a host processor so that the host processor housing is physically attached with the reader housing. As another example, connection means **35122** may comprise a cable containing six conductors. Preferably, such a cable would be detachable at the reader. In this second example, all needed voltages may be generated in the reader from plus five volts supplied by two of the six conductors (+5 V, GND). The other four signal lines of the cable are preferably independently programmable as inputs or outputs. By way of example, the host processor may be part of a held computer such as shown in U.S. Pat. Nos. 4,455,523 and 4,553,081. The rechargeable batteries of the portable computer may supply all needed power to the reader unit of the present invention. In the second example, a host computer unit can be carried in a belt holster for example during extended use of the reader unit of the present invention.

3. Description of FIGS. **12**, **13A**, **13B**, and **13C**

FIG. **12** is a view similar to FIG. 7 of U.S. application Ser. No. 07/881,096 (filed May 11, 1992, now abandoned), but showing the use of two laser diode sources **Z88-1** and **Z88-2**. FIG. **12** is generated by shifting parts **88**, **93**, and **95** in FIG. **7** of U.S. application Ser. No. 07/881,096 (filed May 11, 1992, now abandoned) to the right so that the center of rotation of rotor **Z93** coincides with axis **Z148** lying centrally of reader window **Z131**. Then parts **Z88-1** and **Z95-1** as so located relative to central axis **Z148**, are replicated to the left of axis **Z148** as parts **Z88-2** and **Z95-2**. The frame **87** (as illustrated in the sixth figure of U.S. application Ser. No. 07/881,096, filed May 11, 1992, now abandoned) is now constructed symmetrically to accommodate the two laser diode sources **Z88-1** and **Z88-2**.

FIG. **13A** shows the use of two line type laser sources **Z201**, **Z203**, and **Z202**, **Z204**, each illuminating a total field of view **Z205** in common, in which case moving parts such as rotor **Z93** are entirely eliminated. The image sensor array and optics system **112** (as illustrated by the fifth figure of U.S. application Ser. No. 07/881,096, filed May 11, 1992, now abandoned) **12**, including optics **112A** and image type photosensor array **112B**, e.g., a CCD image sensor array, is located within the dimension E, (as illustrated by the second figure of U.S. application Ser. No. 07/881,096, filed May 11, 1992, now abandoned), below motor circuit board **99** for the embodiments illustrated by figures one through ten and eleven in U.S. application Ser. No. 07/881,096, filed May 11, 1992, now abandoned.

FIG. **13B** shows certain components of a non-scanning laser illuminated bar code scanner wherein two solid state laser sources **Z1201**, **Z1203** and **Z1202**, **Z1204** are placed off axis from the centerline of the CCD optical path. The sensing device does not require a folded light path. Since mirrors are not required sensitivity is increased up to five percent per optical interface removed. The half power radiation line for the solid state laser sources (**Z1201**, **Z1203** and **Z1202**, **Z1204**), after passing through the dispersive optics (**Z1203**, **Z1204**) normally have an elliptical cross-sectional shape. When the ellipse is altered by non-axisymmetric propagation it is fanned out into a distorted pattern which no longer fully resembles an ellipse (FIG. **13C**). This may be corrected by using two laser sources with outputs which overlap a target bar code. Such a configuration acts to partially compensate for this pattern distortion. Further

compensation may be achieved by utilizing a flash A/D converter and applying conventional digital high pass filtering techniques on the converted data to eliminate the residual effect on uneven illumination. The two laser sources are preferably high powered devices which are pulsed rather than used on a continuous basis. This provides intense illumination for a brief period of time. In such an embodiment the high voltages required by a Xenon flash are not necessary.

For the embodiment of FIGS. **13A** and **13B**, the mounting frame **Z87** and the motor circuit board **Z99** may be omitted, and the image reader circuitry associated with system **Z112** and laser diodes **Z201**, **Z202** may be placed at side **Z84** of the main circuit board **Z82**. The laser sources **Z201** and **Z202** may be accommodated by cutouts such as **132** (as illustrated by the sixth figure of U.S. application Ser. No. 07/881,096, filed May 11, 1992, now abandoned) to minimize any required extra thickness E, (see FIG. 2 of 07/881,096), of the image reader/RF module containing the components **Z112** and **Z201–Z204** of FIGS. **13A** and **13B**.

4. Description of FIGS. **16–18B**

FIGS. **16–18B** illustrate an image reader/RF module for assembly with the base module **16** (as illustrated in FIGS. 1 through 10 of 07/881,096), and which may be readily modified to form the system of FIG. **13A** with no moving parts.

FIGS. **16–18B** show an image reader/RF module **Z210** which is interchangeable with module **48** (of the fourth figure of 07/881,096) and Module **51** (of the third figure of 07/881,096) with respect to base module **16**. A terminal housing including base module housing **14** and module shell **214** has the overall dimensions A, B, D and Cl as given with reference to the first and second figures of 07/881,096 (i.e. A is about seven inches, e.g. 6.875 inches or 17.46 centimeters; B is about two and three-fourths inches, e.g., 2.625 inches or 6.68 centimeters; D is about one and one-half inches, e.g. 1.25 inches 3.18 centimeters; and Cl is about two inches or about five centimeters). The image reader module **Z210** is provided with an edge face **Z214A** (FIG. **18B**), mating with edge faces such as **52** and **53** of the base module **16** in the same way as described for the module **48** of the second figure of 07/881,096. A downwardly protruding wall portion **Z214B** advantageously provides a gripping margin for the index finger of a user of the data terminal providing secure support for the terminal even in the absence of a hand strap such as **68** (as illustrated in the third figure of 07/881,096).

The module **Z210** is shown as being provided with latch hooks **Z216** (FIG. **18A**), for interengaging with respective latch seats **57** (FIG. 4 of 07/881,096), as with modules **48** and **51**. Module **Z210** is also equipped with a stop edge **Z214C**, (FIG. **18A**), with a recess **Z217** for interlocking with a projection **Z218** of the seat **67**, (FIG. 4 of 07/881,096), as the module **Z210** is moved longitudinally into its final position. Threaded seats are indicated at **Z219**, (FIG. **18B**), for receiving screws **63**, (FIG. 4 of 07/881,096), so as to fasten module **Z210** as a fixed part of the data terminal.

During longitudinal movement of module **Z210** into its final assembled position, the pins of connector **Z222** interengage with the receiving connector **62**, (FIG. 4 of 07/881,096). The relative longitudinal positions of latch parts (**216**, **57**) assure that the pins of connector **Z222** are moved upwardly to a position just in front of and aligned with connector **62** before the longitudinal movement can begin. The levels of mating edges (**53**, **214D**) of the base module **16** and of the module **Z210** assure that the pins of connector **Z222** must be at the proper level during longitudinal movement as permitted by the interfitting configurations of latch parts (**Z216**, **57**).

In the implementation of image scan/RF module **Z210** shown in FIG. **16**, a main analog board **Z228** underlies a radio subassembly **Z230** including an RF board **Z234**. The main analog board **Z228** essentially corresponds with main analog board **82**, and the RF board **Z234** is essentially the same as RF board **122** of the previous embodiment. An open rectangular metal shielding frame **Z236** surrounds the RF components. The RF board **Z234** may in itself contain RF shielding toward its upper surface, or separate shielding such as an additional board having a ground plane may be provided immediately above the RF board **Z234** as shown at **123**, (FIG. 6 of 07/881,096).

In an embodiment where the RF transmitter is not active at the same time as the scanner subassembly, no special RF shielding was included with the RF board **Z234**.

In a specific implementation, the shielding frame **Z236** is provided with projecting tabs which are inserted into receiving slots of the analog board **Z228** and soldered in place so as to be directly electrically connected with the inner ground plane of the analog board **Z228** (in the same way as for tongues **116** and apertures **117** of the sixth figure of 07/881,096).

FIG. **18A** shows a cross section of the module shell **Z214** taken along line **15—15** of FIG. **17**. This Figure shows integral rib means **Z251** which also appears in FIGS. **16** and **17**, and which adjoins a through-aperture **Z252** accommodating the threaded end of antenna **Z253**. A thin metal plate **Z254** fits into the space **Z255** and is captured therein and prevented from rotation when the antenna is threadedly engaged therewith.

A boss **Z260**, FIG. **18A**, integral with the shell **214** has a threaded insert for use in securing the RF assembly **Z230** to the shell. A transverse rib **Z263**, (FIG. **18B**), extends near edge face **Z214A** and bosses **Z264** for receiving threaded seats **Z219**.

Referring to FIG. **18A**, the shell **Z214** has thickened end wall portions **Z270** and **Z271** with respective sets of cylindrical bores **Z281** for receiving respective light emitting diode units such as **Z291**, (FIG. **16**), for directing illuminating beams along respective beam axes **Z301–Z306**, (FIG. **17**), toward an image plane **Z307**.

Centrally of the shell frontal wall there is an inwardly extending boss **Z310** having a cylindrical chamber **Z312** which opens through the front wall and accommodates insertion from the exterior of an optics subassembly such as diagrammatically indicated at **Z314**, FIG. **16**. The optics **Z314** collects reflected light from a bar code or the like at the image plane **Z307** via an entrance portion which communicates with optics chamber **Z312** and which is diagrammatically indicated at **Z312A** in FIG. **17**. A reduced diameter aperture **Z318** of boss **Z310** accommodates the passage of the focused reflected image along an axis **Z320**. A reflecting mirror **Z322** secured at a seat **Z324** formed by shell **Z214** redirects the reflected bar code image to an image sensor **Z326** which is mechanically and electrically connected to the image reader board **Z266**.

In the exemplary embodiment, the optics **Z314** focuses a bar code image onto image sensor **Z326** for positions of the bar code along optical axis **Z330**, (FIG. **16**), which are beyond the end of the antenna **Z253**. In this way a simple optical arrangement can be utilized, even an optical arrangement with minimal depth of field of approximately one inch.

In the exemplary embodiment, the lens system **Z314** was from a commercial CCD reader of Norand Corporation which utilized a folded optical path generally as shown in

U.S. Pat. No. 4,894,523 issued Jan. 16, 1990. It was possible to eliminate two reflectory mirrors of the folded optical path by placing the bar code sensing region beyond the antenna.

In the exemplary implementation it was found that a substantially more uniform illumination of a bar code could be obtained at an operating range beyond a three inch antenna by adjusting the axes **Z301–Z306** somewhat in comparison to directions parallel to the optical axis **Z330** as indicated in FIG. **16**, such that the axes **Z301–Z306** of the beams intersect the image plane **Z307** at uniformly spaced points.

5. Description of FIGS. **14** and **15**

FIGS. **14–15** illustrate a further image reader/RF module for assembly with the base module **16** of the first through tenth figures of 07/881,096, and which may be readily incorporate the laser reader system of FIG. **13**A with no moving parts.

FIGS. **14** and **15** show the further image reader/RF module **Z410** which is interchangeable with modules **48**, **51**, and **210**. Elements **Z414**, **Z414A**, **Z414B**, **Z414C**, **Z414D**, **Z416**, **Z417**, **Z422**, **Z428**, **Z430**, **Z434**, **Z436**, and **Z491** of FIGS. **14** and **15** substantially conform with elements **Z214**, **Z214A**, **Z214B**, **Z214C**, **Z214D**, **Z216**, **Z217**, **Z222**, **Z228**, **Z230**, **Z234**, **Z236** and **Z291** of FIGS. **16–18**B, so that the description of these elements will be understood by reference to the description of FIGS. **16–18**B.

As seen in FIG. **14**, housing **Z414** is provided with an outwardly protruding seat; **Z414E** which receives a snap-on cowl piece **Z510** which serves to retain an optical window **Z531** covering an elongated generally rectangular opening at the front housing **Z414**.

As shown in FIGS. **14** and **15**, the module **Z410** has a transverse extending antenna **Z546** housed within a dielectric cover **Z548** completely within the confines of the length of housing Z14 with cowl **Z510**, and within the width dimension of housing **Z14**. The antenna may be a helical wound wire type, and may be carried by a fitting **Z510** having an enlarged base **Z550**A for coupling with the RF circuits **Z430**.

6. Description of FIGS. **19–22**

FIGS. **19–22** show a reflected image reader submodule which may be used in any of the embodiments disclosed in U.S. application Ser. No. 07/881,096 such as those of the first through eleventh and the thirteenth through eighteenth figures of Ser. No. 07/881,096, and the foregoing embodiments taken with FIG. **13**A. Coplanar solid state light sources, including laser diodes **Z210**, **Z202**, and cylindrical lenses **Z203**, **Z204**, similar to those shown in FIG. **13**A may also be included with submodule **Z600**, for example at **Z601**, **Z602** outside the margins **Z603**, **Z604** of the collecting zone for the reflected light image, or the submodule may operate from ambient light, or from light from an auxiliary spot-light like the light source on a vehicle and separate from the hand-held bar code reader of any of FIGS. 1–18 of 07/881,096, equipped with the submodule **600**.

In the submodule **Z600**, the reflected image impinges on a reflecting mirror surface **Z610**A of a segmental spherical aluminum mirror **Z610** whose height corresponds to the height of module **Z600** and may correspond generally with height E, (FIG. 2 of 07/881,096). Mirror **Z610**A reflects the incident image to a surface mirror region **Z620**A of a cover glass **Z620**. The image is again reflected and is then focused by lens assembly **Z630** onto an photodetector image array **Z640**. A linear actuator **Z650**, FIG. **20**, may be coupled with the lens assembly **Z630** and control the axial position thereof for optimum focus of the information image onto array **Z640**, e.g., as in referenced U.S. Pat. No. 4,877,949, issued Oct. 31, 1989.

The aluminum spherical mirror **Z610** may function not only as an optical element, but also as a structural element for supporting the lens assembly **Z630** and autofocus linear actuator **Z650**. The use of large mirror surface **Z610**A as seen in FIG. **19** allows the size of the subsequent optical string to be reduced since the lenses **Z630** (an achromatic doublet has been indicated) are not relied upon as the principal light gathering structure.

A preferred approach to integrating a fan beam generator with the photodetector submodule **Z600** is illustrated in FIG. **22**.

In FIG. **22**, the housing of the module **Z600** is shown with light proof walls **Z660** and with the window **Z620** opaque at **Z661** in front of mirror surface **Z620**A. Then a mirror surface is provided at **Z670** for transmitting a vertically incident fan-shaped laser beam **Z671** into a fan beam plane at **Z672** which is coplanar with the optical axis **Z674**, (FIG. **19**).

FIG. **22** shows a laser diode source **Z680**, spreading optics **Z681** and a right angle prism or mirror surface **Z682** for redirecting a horizontal fan-shaped laser beam at **Z683**, these components **Z680–Z682** being carried at a top wall **Z660**A of submodule **Z600**.

The configuration of the fan beam with central axis **Z672** is indicated by marginal rays **Z672**A and **Z672**B in FIG. **19**, and an exemplary image plane is indicated at **Z690** for a given axial position of optics **Z630**.

7. Discussion of FIGS. **12–18**B

In housing a photosensor image array such as a CCD linear multi-element array for component **112**, (FIG. 5 of 07/881,096), the integration time of the sensor array is synchronized to the scan rate of the laser beam (FIG. 7 of 07/881,096) or laser beams (FIG. **12**) so that each pixel of the array would receive an equal amount of light with the beam scanning a uniformly reflecting surface. In reading a bar code, after one or more complete scans of the bar code by the laser beam, the image data is read out of the array such that each pixel of the array is coupled with the laser beam or beams an equal number of times before read out, i.e., receives an equal number of exposures to reflected light from the laser beam or beams.

The problem of synchronization does not arise when a laser line projector or laser line projectors, as in FIG. **13**A, simultaneously illuminate all elements of the bar code. The illuminated complete bar code is then imaged at all of the elements of the sensor array at the same time, so that the integration time can be selected solely from the standpoint of formation of an optimum output signal from the image array.

In FIG. **13**A, the output from each laser diode has a beam cross section which is of an elongated elliptical configuration. The semi-major axis of the beam cross section is oriented so that as it strikes the respective cylindrical lens **Z203**, **Z204**, the elongated nature of the cross section is enhanced and it spreads out to a length preferably to cover a complete line of a bar code. If some collimation is provided in the plane of the semi-minor axis, then the elliptical cross section becomes an approximation of a line.

It will be understood that the line type solid state laser light sources **Z201**, **Z203**, **Z202**, **Z204** of FIG. **13**A are readily substituted for the LED arrays **291** (FIG. 14 of 07/881,096) or **Z491**, FIGS. **14–15**.

In an embodiment according to FIGS. **16–18**B, the light sources **Z201**, **Z203**; **Z202**, **Z204** would be generally in the horizontal plane of the central reflected light ray **Z330** and at opposite sides of the reflected image receiving aperture **Z312**A, FIG. **17**, to provide a coplanar light source/image receiver arrangement.

In an embodiment according to FIGS. **16–18B** if the solid state light sources **Z201, Z203; Z202, Z204** FIG. **13A** were positioned above the horizontal plane of the central reflected ray **Z532**, and were directed somewhat downwardly as represented by ray **Z533**, FIG. **14**, and if the angle of the sloping plane of rays **Z533** was not adjustable as represented by double headed arrow **Z580**, this non-coplanar arrangement would limit the depth of effective illumination since it is intended that the laser beams have a relatively narrow effective thickness dimension in comparison to that provided by the LED arrays **Z291** and **Z491**. Thus a useful modification of FIGS. **14, 15, 19**, and **20** for increased illumination depth would be to place solid state laser light sources **Z201, Z203; Z202, Z204**, (FIG. **13A**), coplanar with the horizontal plane of central reflected ray **Z532**, (FIG. **14**). This is readily accomplished as can be seen from FIG. **15**.

7. Description of FIGS. **23–26**

FIG. **23** illustrates a range and angle measurement system based on U.S. Pat. No. 4,373,804, the first figure. In the present embodiment, laser light source means **Z800** may comprise laser diode means **Z801**, FIG. **26**, spreading optic means **Z802** and selector means **Z803, Z804** for selectively providing a vertically oriented fan beam or a horizontally oriented fan beam. Further beam divider means **Z805–Z810**, FIG. **26**, of source means **Z800** may serve to generate three vertically oriented fan beams such as indicated at **Z811, Z812, Z813** or a single horizontally disposed fan beam such as indicated at **Z831**, FIG. **24**, at bar code label **Z832**.

Where the three vertically oriented fan beams **Z811, Z812, Z813** are directed toward a horizontally disposed bar code **Z833**, FIG. **24**, they may impinge on the bar code as vertical lines with axes **Z811A, Z812A, Z813A** distributed over a substantial portion of the bar code length so as to adequately sample any skew of the label **Z832** relative to a normal axis **Z834**, FIG. **23**. Range measurements at **Z811A, Z812A, Z813A**, for example, will differ as indicated by the displacements of point **Z811A** and **Z813A** from normal axis **Z834** in FIG. **23**. Where beams **Z811, Z812, Z813** diverge so as to intersect bar code **Z833** at respective generally equal segments, and the range measurements to points **Z811A, Z812A, Z813A**, FIG. **23**, differ substantially, linear actuator **Z650**, FIG. **20**, could be set in succession to the three measured ranges for reading the respective bar code segments **Z833-1, Z833-2**, and **Z833-3**, whereupon these three segments could be combined to obtain a complete bar code reading. Processing procedures for joining partial bar code readings are known in the art.

If it is desired to use crossed fan beams generated by a common laser diode source **Z801**, FIG. **25**, then an analyzer plate **Z804**, FIG. **26**, may be provided for transmitting only a horizontally polarized fan beam **Z831**, but blocking a vertically polarized fan beam. An LCD cell **Z803** when energized may rotate the polarization of the input crossed fan beam such that beam **Z831** is blocked and cross hair type fan beams **Z811, Z812, Z813** are produced.

In this case, LCD cell **Z803** is energized to provide the range and slope measurement mode of FIG. **23**, and thereafter the LCD cell **Z803** is de-energized to permit a bar code reading.

With the LCD cell **803** de-energized, the vertically disposed fan beam is intercepted at **Z804**, and the horizontally disposed fan beam with horizontally polarized light is transmitted by analyzer plate **Z804** to the prism or mirror type beam splitter **Z805–Z810** which spreads an incident fan beam disposed in the horizontal plane of FIG. **24** to cover a bar code such as indicated at **Z833**, FIG. **24**. The constituent beams making up the overall beam **Z831** are indicated by marginal rays **Z831A, Z831B, Z831C, Z831D, Z831E, Z831F** in FIG. **25**.

Two laser diodes at **Z801** with junction planes at right angles can supply the respective fan beams, using spreading optics such as **Z203, Z204** for component **Z802**, FIG. **26**.

The photodetector arrays such as **Z851, Z852**, FIG. **23**, could be of the two dimensional matrix type, for example, so as to both sense the variable positions of the incident cross hair beams at **Z811B, Z812B, Z813B, Z811C, Z812C, Z813C** and to sense the spacial modulation of the reflected light beam **Z831** due to bar code **Z833**. However, a linear CCD would most likely sense the bright spots at the code in most cases.

Description of FIGS. **27–33**

FIG. **27** is a perspective view illustrating a preferred terminal configuration **1010** of a size to be held in the hand of the user. FIG. **27** illustrates the placing of an information card **1011** into a receptacle **1012** of the terminal. The card **1011** may be a standard intelligent information card conforming with international standards such as the present ISO standard. Such a card may have the same length and width and thickness as a standard credit card now in use. By way of example, such a card may have an array of eight contact terminals at one side thereof providing for interface with other devices. Such a card may have an electrically erasable programmable read only memory of a sufficient capacity to record an individual's account number, personal identification number and other information which may be desired for reliably identifying the individual. Further, such a memory may have a capacity for receiving extensive additional information such as might be required in effecting betting on a number of horse races.

By way of example, receptacle **1012** may be provided with nub means **1014** which is configured to cause the card **1011** to flex at its edge **1011*a*** as it is pivoted into receptacle **1012**. Thus the nub means **1014** may be spaced above the floor of the receptacle **1012** by a distance slightly greater than the thickness of the card. An opposite side edge **1011*b*** of card **1011** may be inserted under similar nub means at the opposite side of receptacle **1012** and the card **1011** then pivoted downwardly until edge **1011*a*** of the card is snapped under nub means **1014**. The nub means at opposite sides of receptacle **1012** which cooperate with card edges **1011*a*** and **1011*b*** hold the card **1011** in receptacle **1012**, and spring urged contacts in the floor of receptacle **1012** make pressure engagement with the array of eight contacts on the underside of the card, once the card has been inserted.

Any suitable means may be employed to facilitate removal of a card from the receptacle **1012**. For example, a wall **1015** of terminal **1010** may be provided with a notch **1016** enabling insertion of a fingernail or stylus under edge **1011*a*** of the card for prying the card upwardly and out of the recess. The standard card **1011** is sufficiently flexible so that this is readily accomplished.

In the embodiment of FIG. **27**, a touch screen **1017** occupies the side of the terminal opposite receptacle **1012** and has an area generally comparable to the area of the standard card. By way of example, the touch screen may utilize LCD (liquid crystal display) technology and may be capable of displaying a number of lines of characters, for example four lines relating to four bets and additional lines which may, for example, provide an integrated graphic display (e.g., a single line of Chinese characters).

By way of example, associated with the touch screen at a surface **1020** may be suitable indicia such as **1021–1024** for explaining the format of the display. In the specific illustration of FIG. **28**, the characters "HV" may represent the

initial letters of the name of a race track (e.g., Happy Valley), the next series of characters representing the data (e.g., year, month and day of month). Further characters on the display may relate to the day of the week, the type of bet or the like.

In the example of a transaction involving betting on a horse race, an exemplary keyboard display for touch screen **1017** is indicated in FIG. **29**. In an example where several race tracks may be involved, the identities of respective race tracks may be displayed at locations such as **1031** and **1032** in FIG. **29**. Each location may display indicia indicating the programmed significance of the location. Simply by way of example, a prompt message at lines **1033** and **1034** might instruct the user to select the race track where the race to be the subject of a wager is to take place. At the same time indicia representing the two race tracks would appear at **1031** and **1032**. The user would then press location **1031** or **1032** with his finger to indicate the identity of the race track. A similar procedure could be followed for identifying the day of the race, the number of the particular horse on which the bet is being placed, the amount of the wager, and so on.

In the preferred embodiment of FIGS. **27** and **28**, the terminal **1010** is provided with an acoustic coupling means **1050** which may serve to couple the terminal with telephone lines, for example. Thus in the case of betting transactions, once the user of the terminal has entered desired bets, for example on a number of horse races, the user may couple the terminal, e.g. via an acoustic coupler, with a handset of a conventional telephone, for establishing two-way telephone communication with a central computer system equipped to deal with the particular type of transaction and to authorize the individual participant. The touch screen **1017** may display suitable prompt messages in establishing the telephone link with the central computer, or the processor of the terminal **10** may itself be programmed to establish the telephone link automatically, for example in response to actuation of a "SEND" location **1035** of FIG. **29**. Once communication is established, the processor of terminal **1010** is able to transmit the data stored on the information card **1011** via the telephone link to the central computer system so that the central computer system can verify that the individual is authorized to carry out the relevant transactions. In the case of horse race betting, the information on the particular race and particular horses involved and the other details of the bet would be transmitted to the central computer system for verification and for evaluation of the total amount being bet, for example in relation to the individual's established account balance.

Also in the preferred embodiment as shown in FIG. **28**, the housing is provided at a corner thereof with an optical scanner module **1060** which may be utilized as a hand-held bar code scanner, and which also can serve for receiving optical communication via a suitable receiving device. In the case where the terminal utilizes rechargeable batteries, a receiving boot could automatically couple with a charging circuit for the battery means and this boot could also be provided with a host computer or suitable communication to a host computer system such that data from the intelligent card **1011** and from the memory of the terminal itself could be communicated with the host system via an optical link including the scanner module **1060**, if desired.

Also as a preferred implementation, FIG. **30** illustrates a suitable processing system for the housing **1010**, including a microcontroller **1070**, a real-time clock **1071**, control and communication circuits **1072**, EPROM **1073**, random access memory components **1074** and **1075**, a wand scanner and optical interface component **1077**, an acoustical coupler interface **1078** and a module **1080** for controlling character and/or graphic display of the touch keyboard screen for a particular desired application.

By way of example, intelligent information card **1011** may be approximately 3⅜ inches by 2⅛ inches (about 9.5 centimeters by 5.4 centimeters). The dimensions of displays **1017**, FIG. **28** and **1117**, FIG. **31** are thus approximately comparable to the length and width of the card. (The card thickness is standard and about 1/32 inch). In FIGS. **27–30**, the overall dimensions of the terminal **1010** are not substantially greater than the corresponding card dimensions; the thickness is such that terminal **1010** fits in an ordinary shirt pocket. By way of example, the terminal may have a thickness of less than one inch, i.e. less than 2.5 centimeters.

In the development of a preferred pocket-size terminal such as indicated in FIGS. **27** and **28**, it is sometimes convenient to utilize a larger development terminal such as indicated at **1100** in FIGS. **31** and **32**, which may utilize the same size of touch screen **1117**, (i.e. two inches by three inches), but may further utilize a highly versatile keyboard **1120**, and a much larger memory capacity so that many different features can be tried out for a particular application. At the rear of the touch screen **1117**, there may be a receptacle **1125**, FIG. **32**, for an intelligent information card exactly corresponding to receptacle **1011** of FIG. **27**. The terminal **1100** is shown as being provided with an optical scanner module **1130** which may function in the same manner as the module **1060** of the preferred embodiment of FIGS. **27** and **28**. In the example of FIGS. **31** and **32**, rechargeable batteries may be utilized, and a boot receiving the housing of terminal **1100** may have provision for optical coupling with the computer system of the housing via an optical output means **1135**. Optical communication from a host computer system may be via the optical scanner module **130** as in the embodiment of FIGS. **27–30**. The housing of terminal **1100** is provided with an acoustical coupling means for telephonic communication corresponding to the acoustical coupling means **1050** of FIG. **27**. An exemplary embodiment according to FIGS. **31** and **32** may utilize internal components as indicated in FIG. **33**.

In the specific embodiment of FIG. **33**, components **1140–1156** may have the functions and parameters as indicated by labels for the respective components in FIG. **33**.

Description of FIGS. **34** through **40**

FIGS. **34**, **35** and **36** show a shirt pocket size terminal configuration **1200** generally corresponding to that of FIGS. **27–30**, but omitting the card receptacle **1012**, terminal **1200** includes the following components:

1201—casing
1202—membrane keyboard
1204—liquid crystal display
1206—display drivers
1208—batteries
1210—real time clock
1212—scanner module
1214—scanner tip
1216—plastic support for membrane keyboard **202** (FIG. **8**)
1218—printed circuit board
1220—display/keyboard controller
1222—RAM
1224—microprocessor
1226—ROM-A/D
1228—real time clock, decode circuits

Referring to the graphics display of FIG. **36**, data input into unit **1200** may be by means of a touch screen display as indicated at region **1230**, or by means of a digitizer system for sensing the position of a manually held stylus.

Exemplary characteristics for such a unit are summarized as follows:

V25 CMOS MICROPROCESSOR 8 MHZ
- 16 bit arithmetic logic unit
- 8086 software compatible
- 16K byte mask ROM
- retains VRTX operating system
- diagnostic/power control routines
- sophisticated loader

1 MEGABYTE ADDRESS RANGE
- 2 UARTS—
- Full Duplex
- Internal Baud Rate Generators

RAM CMOS STATIC
- 1 Megabyte—Less 16K ROM and 512 Internal RAM and SFR
- Holds Application Programs
- Also is Data Storage
- Battery Back-Up (Non-Volatile)

REAL TIME CLOCK/CALENDAR
- Provides Date/Time Information
- Back-Up

PLASTIC LCD DISPLAY
- 64×128 Pixel Graphics Dot Matrix
- Built-In ASCII Character Generator
- Programmable Character Capability
- Limited Animation Capability

TRANSPARENT KEYPAD
- 50 Keys in 5×10 Matrix
- Defined By Display For Location, Size, & Legend

BUILT-IN WAND TYPE SCANNER
- User Input Capability In Addition To Keypad

RECHARGEABLE BATTERIES
- Nicad or Lithium
- Complete Control/Monitor Via Software
- Offers Highly Reliable Remaining Battery Operating Time
- Gauge
- Provides power to RAM+RTC Under All Conditions

I/O CONNECTOR
- 8 Pin
- Programmable
- Only Ground and Charge Pins Dedicated
- 5 Volt Interface
- Never Powers Peripherals

ENVIRONMENTALLY SEALED
- Plastic Case is Glued or Sonic Welded
- Repair Procedure Is To Cut Case Away and Replace
- Can Be Submerged

Discussion of FIGS. **34, 35** and **36**

The main attractions of a V25 micro-controller for the system of FIGS. **34, 35** and **36** are that it is CMOS, very high speed, and sixteen bits internal, with a nice collection of built-in peripherals. The fact it is 8086 software compatible means that VRTX (versatile real-time operating system) can easily be ported to the V25, with the addition of new I/O drivers. VRTX is a multi-tasking operating system, so the battery control circuitry software will run at a fixed priority level at all times as will diagnostic routines. Applications will be moved in and out as necessary.

The one megabyte of CMOS static RAM and the RTC are always supplied power. When battery voltage drops below a selected value, e.g., 4.5 volts, (the fuel gauge will read zero at this point) the unit shuts down and cannot be worked unless proper power is supplied to it on its charge pin. The unit will appear to shut down when not actively doing anything; however, touching the keypad will bring it to use. (Also I/O activity will wake it.)

The plastic LCD display is light in weight and relatively immune to mechanical injury. The graphics capability is advantageous so that the display can define the keypad, key location, size, and legend. It will display icons and provide vertical and horizontal movement. The display controller can work from a page larger than can be displayed and move around in the page without rewriting the display memory. The ability to load-in custom character sets lets the unit perform I/O suitable to the country in which it is used (just by downloading new software).

The I/O may be strictly serial in operation; however, besides the two UARTS of the V25 there will be an 8530 SCC (serial communication chip) which will provide two more serial channels. This enables protocols to be run synchronously as well as asynchronously. The 8530 will provide bit, byte, and A-Sync communication at a high data rate—up to 1.5 megabytes per second.

Pursuant to an early concept of peripheral shells, the unit can stand alone in a package tracking, meter reading, tree counting or warehouse/store inventory environment, but possesses a great amount of power and with more peripherals could well become the next generation of low and mid-range terminals. A shell would be used to envelope the unit and house the external peripherals and additional power source they would require. A hand-held computer unit could be composed of a keyboard and a fifteen pin I/O interface with the whole under keyboard area filled with alkaline batteries to power the peripherals and the V25 core unit.

Similarly, a larger display, a printer, a permissive modem, an RF link module and other peripherals could be shelled around the core unit of FIGS. **34, 35** and **36**.

By way of example, the terminal unit of FIGS. **34, 35** and **36** may have a width of the order of two inches (e.g. 2⅛ inches), a length of the order of three inches (e.g. 3⅜ inches) and a thickness of the order of one inch (e.g. ¾ inch).

In a digitizing input mode of operation of the unit of FIGS. **34, 35** and **36**, successive character entry fields may be defined in a line across a screen area such as indicated at **1240**. For example, the rectangle **1240-1** (presently containing the numeral "1") could receive a first character, e.g. manually entered as a series of strokes by means of a stylus. The unit could produce a graphical display in the form of lines corresponding to the paths of the successive strokes, e.g. at the line **1242** above line **1240**. The program could analyze the input on the basis of the sequence in which the strokes were entered, rates of stylus movement, and so on, so as to interpret the intended character with substantial accuracy. The unit may display its interpretation of a manual character entry by displaying the corresponding stored character from its repertory at a line **1244**, e.g., as soon as there is a pause of selected (programmable) duration. If then the user begins drawing a new character, e.g., in a second field **1240-2**, the program will assume that its interpretation is correct and will automatically store it. If a given field is skipped, a space may be correspondingly automatically stored. The size of each character field and other parameters (such as pause duration) can be selected to have values convenient to the individual user, during a user set up mode, with suitable prompts from the display. The processor, during manual character entry, can be set to a learning mode where it seeks to adapt as accurately as possible to the

writing style of a given user. Such learning mode can be switched off whenever desired, as a further user set up mode parameter. A similar procedure could be followed for processor learning in the case of a speech input module.

FIG. **37** illustrates a shell module **1260** having a receptacle **1261** for receiving a processor core module such as **1200**, FIGS. **34, 35** and **36**. Module **1260** may cooperate with module **1200** to provide a direct store delivery terminal. The terminal may have a card slot **1262** for receiving a conventional smart card containing the information related to a delivery transaction, and may have an input/output coupler such as a one-fourth inch phone jack **1264** for coupling with a store device **1270**, FIG. **38**, via a connecting link such as **1272**, FIG. **39**. Phone jack **1264**, FIG. **37**, and phone jack **274**, FIG. **38**, may be one-fourth inch three-conductor phone jacks for receiving cooperating phone plugs **1276, 1277** of link **1272**.

The coupling between a smart card and a receiving terminal (such as **1260**, FIG. **37**) is illustrated in the third figure at page 45 of an article entitled, "Smart Credit Cards: The Answer to Cashless Shopping" in *IEEE Spectrum*, February 1984 (pages 43–49) and this article is incorporated herein by reference by way of background. A similar coupling arrangement is preferred between modules **1200** and **1260**.

By way of example the core module **1200** may have an array of eight I/O contacts similar to those of the smart card of the third figure at page 45 of the *IEEE Spectrum* article just referred to. These contacts would mate with cooperating contacts at a contact region such as indicated at **1280** of module **1260**. Charge and ground contacts of module **1200** could be of fixed function, while the other contacts could be programmable as serial channels, clocked data, analog inputs or outputs, or event inputs and outputs.

Module **1260** may have a battery compartment **1282** for receiving alkaline batteries for energizing suitable interface circuitry such as represented in the above-referenced third figure. A telephone jack may be located at **1284** for coupling with the modem of the referenced third figure. Module **1200** may couple with the interface circuitry of module **1260** via contact region **1280** in the same way as represented in the referenced third figure for the case of "Peripherals" and/or as represented for the case of a "Display", and "Keyboard", for example. A customer keypad may be coupled with module **1260** in the same way as represented in the referenced third figure.

Typical shells for forming hand-held terminals with module **1200** could be printers, laser bar code readers, RF modules, smart card interfaces (as at **1262**, FIG. **37**), disk systems, full travel keyboards, larger displays, local area network interfaces, etc. A hand-held printer device which could serve as a shell for the processor module **1200** is available commercially from Norand Corporation, Cedar Rapids, Iowa, and is referred to as a 40-column hand-held printer for use in product distribution systems, and is described in a brochure designated "960-182-0485" of Norand Data Systems.

DISCUSSION APPLICABLE TO ALL EMBODIMENTS

The concept of a plural module hand-held data processing system enables the use of a single computing engine to drive an entire product line. The basic or core module may comprise a self-contained limited input/output device with extreme reliability and flexibility. While the core module can serve many markets directly, many more can be met by using peripheral device shell modules which may integrate the core module into its confines. An internal fixed operating system protects the critical core module functions while allowing user applications to execute in a multi-tasking real time environment.

Of prime importance are the two requirements of low cost and tremendous capability. The lowest possible cost is achieved by use of technology yielding low manufacturing costs at high volumes. High volumes are achieved when a single product is flexible enough to perform well in multiple markets.

Of particular interest are flexible shirt pocket size plural module configurations which enable data input independently of a conventional keyboard. For example, a digitizer tablet input such as described with reference to FIGS. **34–39** is also applicable to the embodiments of FIGS. **27–33**. Various optical type scanners are also of substantial utility for quick, easy and highly accurate input of existing printed data, e.g., bar codes, text, and graphical information. Instant type optical readers which may be integrated into a hand-held shell module according to the present invention are disclosed in an application of Danielson and Durbin, Ser. No. 07/894,689 filed Aug. 8, 1986, now U.S. Pat. No. 4,877,949, issued Oct. 31, 1989, and the disclosure including the drawings of this incorporated Danielson and Durbin application (07/894,689) are incorporated herein by reference in their entirety as illustrating arrangements which may be embodied in a peripheral shell such as indicated at **1260A** in FIG. **40**, which is analogous to shell **1260** in FIG. **37**. For the embodiments of this incorporated Danielson and Durbin application (07/894,689), the optical output means in FIG. **40** may be at opposite ends of battery compartment **1282A** (corresponding to compartment **1282**, FIG. **37**) at locations such as indicated at **1313A** in FIG. **40**, while the reflected light optics and processing components may occupy the region below compartment **1282A** FIG. **40**, and a region replacing card slot **1262**, FIG. **37**, such location being designated by reference numeral **1314A** in FIG. **40**. The control and processing means of said Danielson and Durbin incorporated application could be embodied in the basic core module such as represented at **1200** in FIG. **34**, or, as represented in FIG. **40**, the display and manual data input means could be provided by a separate module **1200A** in receptacle **1261A** in FIG. **40**, while a basic processing module occupied a greatly reduced space such as represented at **1300A** in FIG. **40**, the processing module being inserted into a receiving well via a removable cover as is commonly the case with battery compartments such as **1282** in FIG. **37**. Such a cover, could incorporate resilient means so that when the cover was latched, a core processing module at location **1300**, FIG. **37** would have its eight metal contacts pressed against cooperating contacts of the receiving shell module such as **1260**. Referring to the article "Smart Cards" by Robert McIvor in *Scientific American*, November, 1985, at page 153, an eight contact terminal is shown in association with a single chip microprocessor system, from which it will be apparent that the width of the smart card could be reduced from fifty-four millimeters to twenty millimeters and fit edgewise into the region **1300** (vertically as viewed in FIG. **37**). For such a strip type core module, the thickness could be substantially greater than the standard card thickness of 0.76 millimeters, for example ten millimeters.

The core module may incorporate the components of FIG. **30** or FIG. **33**, or components such as **1077, 1078** and **1080**, FIG. **30**, may be incorporated into a peripheral device module, for example one fitting into receptacle **1261** of shell module **1260**, the core module incorporating the remaining

components. Similarly as to FIG. **33**, components such as **1147**, **1148**, **1149**, **1150** and **1151** can be incorporated into a module fitting into receptacle **1261**, while component such as **1152** and **1154** may be incorporated into the shell module **1260**, and the remaining components incorporated into the strip core module fitting into region **1300**.

Preferred features of an exemplary core module such as might fit into receptacle **1012**, FIG. **27**, receptacle **1125**, FIG. **32** or region **1300**, FIG. **37**, are as follows:

(1) User immune real-time multi-tasking operating system. The multi-tasking ability allows system programs of the core module to run in the background and never lose control. This ensures proper operation of the user's application(s) and system status availability.

A program known as VRTX (Versatile Real-Time Executive) and IOX (Input/Output Executive), available commercially, together with input/output drivers, monitors and control programs preferably compose the operating system stored in the core module (for example in read only memory ROM).

(2) A microcomputer compatible with personal computer architecture, e.g., an NEC V25 microcomputer with 8086 type architecture, supports the implementation of the operating system in that VRTX and IOX are 8086 oriented. A high integration CMOS construction directly supports the lower power standby and shut down features which are desired for the core module versatile interface adapter (VIA) software control. A one megabyte addressing range would be considered a minimum for hand-held units, along with a sixteen bit internal arithmetic logic unit.

(3) With a one megabyte memory, for example, read only memory necessary to contain the operating system would require about eighty kilobytes. All the rest of memory in the addressing range may be CMOS static random access memory used for applications.

(4) The core module preferably provides clock and calendar functions, and a hardware real time clock chip is compatible with very low power requirements.

(5) Battery operation is presently a key hardware aspect of a core module, and this is the main reason VRTX should provide immunity from the user. In order to offer unparalleled reliability in the field, the power control system should never be tampered with except under operating system control. The core module may use nickel cadmium rechargeable batteries. Such a core module preferably implements the intelligent battery system such as disclosed in U.S. Pat. Nos. 4,455,523, 4,553,081 and in a pending application of Steven E. Koenck, et al., U.S. Ser. No. 876,194, filed Jun. 19, 1986, now U.S. Pat. No. 4,709,202. The intelligent battery system allows a very accurate "fuel gauge" for advising the user of remaining battery capacity. Fast charge capability offsets the lower capacity batteries which are preferably used in the core module. All of the RAM, the RTC and internal registers, e.g., of the V25 are battery backed up, even with the unit shut down.

Battery monitoring will also indicate possible problems before they become serious and, combined with other system monitoring, will provide unprecedented forewarning of possible impending failure. All devices will ultimately fail, but it is extremely advantageous if a unit can be removed from service before a hard failure occurs.

(6) The core module should be able to communicate with a host and with peripheral devices, for downloading of the application programs into the core module and for communicating with all types of input/output devices such as those referred to herein. Extensive flexibility in the communication protocol is provided for example by using two high speed serial channels capable of being programmed as asynchronous, byte synchronous or bit synchronous. Eight input/output contacts provide electrical connection to the outside. The charge and ground contacts may be fixed while the other contacts may be programmable as serial channels, clocked data channels, analog inputs or outputs, or event inputs and outputs. The concept of using peripheral shell modules for selective coupling with the core module offers complete expansion capability with minimal development time to enter new markets. Typical shell modules could comprise graphics LCD display means providing a touch keyboard, digitizer tablet means, printers, laser bar code readers, RF modules, smart card interfaces, disk systems, full travel keyboards, larger displays, local area network interfaces, et cetera. Optionally, as illustrated in FIGS. **34**, **35** and **36**, for example, the core module may have a built-in minimal input/output capability such as may be achieved by using a graphics LCD display on one face of the core module for output and a touch responsive keyboard directly behind and defined by the display. The display, for example, may comprise 64×128 pixels, or eight lines by twenty-one characters, and may support any character set that can be defined. This is ideal for foreign applications. Since the keyboard is defined by the display, it will naturally be in the same language. The display (and keyboard) may be backlighted by a built-in electroluminescent panel. Many standalone applications for such a core module would require bar code scanning and thus a built-in scanner is illustrated at **1212**, **1214**, FIG. **34**. Such a display would have the ability to use icons (pictorial images) as labels for keyboard locations, and to change them as the application requires.

A core module such as shown in FIGS. **34** and **35** could have a housing comprised of two die cast magnesium shells, glued together. Preferably there are no holes through the housing, so that the unit is submergible. It is ideal for meter reading, package tracking, timber inventory, or any environmentally demanding application. Internal construction is preferably of one continuous flexible printed circuit board. This eliminates connectors, weight, and sources of failure. Preferably even the batteries are soldered in. The core module may withstand being dropped to a concrete surface from seven feet without functional damage. A minimum number of integrated circuits will reduce the cost and increase the reliability of the core module.

Where the graphics type keyboard displays icons representing physical objects, it will be apparent that such physical objects may be represented by a single code word such as utilized to represent any other keyboard entry. Such code may be translated into a corresponding graphical icon type display by means of a suitable read only memory or the like. A similar situation can prevail for example where shorthand characters are input to respective receiving regions such as indicated at **1240-1** and **1240-2** in FIG. **36**. Spoken words related to a given application may likewise be represented by single code words in random access memory, and translated via read only memory or the like into corresponding strings of characters for display, or for synthesized speech output. As previously mentioned, if the letter P is related to a number of objects for a given user application, the user may input the letter "P" at a region such as **1240-1** or **1240-2**, FIG. **36**, whereupon the input strokes may be repeated at a corresponding location in row **1242**, and possible interpretations, either graphically, or as character strings, may be sequentially presented, e.g. at row **1244**. When the correct interpretation is displayed, the user may touch a suitable region of the display such as indicated at **1310** to indicate approval of the current displayed interpretation.

In preferred hardware for implementing the illustrated embodiments, all memory and input/output accesses are allowed when the system is in the supervisor or system mode. On the other hand, any access by an application program to any area outside of its work and program areas (as assigned by the system) must immediately return control to the operating system for proper action. A microcomputer such as the V25 is advantageous because of its non-multiplexed bus, and built-in software-controlled power down. It would also be advantageous to have a built in hardware boundary checking of applications being run (as in the 80286). A digital semi-custom chip can accommodate this function externally.

A V25 internal timer may be used as the VRTX tick. Entrance to VRTX is through the NMI input of the V25. This is the only input (besides reset) that not only can wake the chip up if it's in a sleep mode, but also cannot be shut off by an application (thus disabling VRTX). Many sources may logically OR into NMI. The real-time clock, serial channels, charge indicator, and keyboard are some of these. Most of these should be programmable as to whether they can activate NMI.

The random access memory can be built as a separate module. For example eight 128 kilobyte chips and decoding may be in the module. A module select line should also be included since the module is expected to be useful in other product lines in multiple configurations. Standby currents of fifteen microamperes at two volts are being presently considered.

As real-time clock, an Intersil 7170 may be used since it is guaranteed to operate at two volts, the same as for RAM. The RTC and RAM are all battery backed up once low battery condition is entered.

For a shell module containing a display, a plastic LCD dot matrix display from Polaroid Corporation may be used. A display size of 64×128 pixels with eighteen mil pitch gives eight lines of twenty-one characters each (5×7 font). The controller may be the Epson E-1330. This is a graphics controller that can support three separate planes or pages for the screen and can combine them in many different ways. The planes can be graphic or characters. The characters can come from the internal ROM or RAM loaded by the application. A graphics plane could create boxes and a character plane could put legends in them. The E-1330 uses S-MOS **1180** and **1190** drivers to run the columns and rows (respectively) of the display. They apply a ten to fifteen volt bias on the display. This may be obtained from a plus five volt supply in the core module in combination with a variable minus twelve volt supply in the shell module and providing two to three milliamperes for the display. This supply is controlled by the E-1330 as for on-off but the V25 will be responsible for controlling the actually used voltage based on the temperature of the core module and user input information. A fast recovery crystal is preferred to minimize the time delay upon release of pressure (e.g. by the manual entry stylus or finger). Using a fast recovery plastic LCD display enables the user to press through the display and activate a keyboard behind it. The display is used to define the keyboard or provide the "overlay". This gives the advantage of not only being able to continually change the keyboard as the application requires, but if the display is programmed in a foreign language such as Ethiopian, the keyboard is in the same language. Putting the keyboard behind the display allows for an opaque design of low contact resistance. The keyboard may be a 5×10 matrix (fifty keys) software configurable to be combined for any shape or icon style key defined by the display.

A soft (but tough) electroluminescent panel is preferred for backlighting, the keyboard being activated by pressing through the display and the electroluminescent panel. A tremendous advantage here is that not only is the display operable at night, but so is the keyboard (which is further programmable!)

A built-in wand scanner such as indicated in FIG. **34** preferably has a sapphire lens in a stainless steel or other hard metallic housing. Testing has shown that sapphire tipped wands will chip concrete before they break. It is preferable to make the chip very rugged rather than to make it easily replaceable. The wand housing is preferably clamped (and glued) right into a casing such as **1201**. The light source may be a near infrared visible LED to be able to read non-carbon inks and let the user know it is on, yet take advantage of the infrared capacity to read through many stains and smudges. Preferably the scanner is capable of reading in direct sunlight, and in this connection reference may be made to an application of Eric J. Danstrom, U.S. Ser. No. 07/044,820 filed Apr. 30, 1987, now abandoned, the disclosure including the drawings of which being incorporated herein by reference in its entirety.

An initial approach of a four N-cell nickel cadmium battery pack with each cell treated individually is now less preferred than a one cell "battery pack". The one cell pack requires a converter to boost the voltage. The single cell has many more advantages. No cell matching is required. No conditioning cycles are required, and it is not necessary to be concerned about cell voltage depression. A single converter to step up the voltage for a shell display module would be suitable, with a single switching regulator (current mode) to charge the cell from a much wider input range (e.g. from four to twenty volts). Fast charging on the order of 1C (or perhaps 2C) can be achieved since continuous monitoring of cell voltage and temperature curves (with respect to previous cell conditions) will allow proper charging with no risk of overcharge. This same monitoring applied to discharge as well, provides a very accurate "fuel gauge". Rechargeable lithium batteries may be considered, but the general recommended operating requirements do not match the preferred embodiment as described herein as well as nickel cadmium batteries. The charging line will have a diode blocking reverse current flow and inserted prior to the input/output terminal (for protection). This same single battery pack may also serve as the backup battery. The operating system may operate to equate ten percent or twenty percent of remaining capacity in the battery pack to "zero" on the "fuel gauge" being displayed to the user.

In a preferred embodiment a surface type connector as used in smart cards has advantages in that it takes up very little space and cannot clog with dirt (can be wiped clean, e.g., during interconnecting of respective modules). Further, a surface type connector avoids the use of a cable. To maintain input/output protection and immunity from the environment, each core module may have all of its programmable input/output terminals disabled. The charge pin of a core module may be used to determine the presence of a peripheral shell. Each peripheral may have its own power supply and may or may not provide charge to the core. A peripheral module must at least provide a logic ONE (greater than one volt) to the charge pin in order to signal its presence. If such a logic ONE is present, the core module will determine if the peripheral module can charge it by enabling the charge regulator on the charge pin. If the level pulls low, it will indicate that the peripheral module is meant to only communicate with the core module but not charge it.

Preferably immediately inside of the case of a module will be an electrostatic discharge (ESD) resistor/diode clamp

protection scheme. From there the I/O lines may go to a crosspoint type multiplexing circuit. Since in a preferred embodiment any of the six remaining pins can be inputs or outputs and connect to A/D channels in the module, voltage measurements could be made in a peripheral, e.g., by the core module and appropriate messages displayed to the user as to peripheral readiness and power levels.

The eight contacts of each module could be gold plated or the like such that they would be very conductive and yet tough. The contacts may be molded in a plastic insert that is glued into a hole at a location such as indicated at **1280**, FIG. **37**, for example.

A case such as indicated at **1201** in FIG. **34** can be in two pieces a front half and a back half, and the back half may have one rectangular flanged hole in which to glue the oppositely flanged I/O contact plate. The back half may be glued with conductive epoxy glue to the top case half, The top case half may have a large rectangular opening in which the display/electroluminescent panel/keyboard assembly fits. There may be a shelf behind this assembly for support with a glued-in bezel to seal the display and other components into the depression.

In an embodiment such as FIG. **34**, preferably the mating corner portions of both halves may be specially molded to clamp around the scanner housing. When finally glued together, the resulting casing **1201** may be completely sealed. It may be water and gas tight, but preferably not hermetically sealed where the display plastic is permeable. Purging the casing such as **1201** with dry nitrogen at the time of assembly and sealing may increase reliability. Operation may be from somewhat below sea level (e.g. actually under water) up to 10,000 feet. The case such as **1201** may have a size a little over three inches long by a little over two inches deep by about three-fourths inch thick, for example.

A module such as indicated in FIGS. **34, 35** and **36** would be suitable by itself for fields such as package tracking, price checking, inventory control, meter reading, consumer comparative shopping, et cetera. Various countries may require individually designed modules to couple with the module or module assembly of FIGS. **34, 35** and **36**, in order to meet national requirements and the like, e.g., with respect to such peripheral devices as modems, power supplies and so on.

The core module previously referred to as being insertable into a space such as **1300**, FIG. **37**, may also be insertable into a similar space in the module of FIGS. **34, 35** and **36**, and may represent a standardized basic processing module having the real-time multi-tasking operating system and other characteristics previously described herein.

It will be apparent that many modifications and variations may be effected without departing from the scope of the teachings of the present disclosure. For example, scanner tips such as indicated at **1060**, FIG. **28**, or at **1214**, FIG. **34**, may be adapted to left-handed users, by inverting the contents of the display. Thus, if tip **1214**, FIG. **36**, would be at the lower left with an upright display as shown in FIG. **36** for right-handed manual data entry, the module **1200** might be turned by a left-handed user so that the tip **1214** was at the upper right, and the contents of the display inverted.

Description of FIG. **41**

Reference is made pursuant to 35 U.S.C. Section 120 to Arvin D. Danielson and Dennis A. Durbin application for patent Ser. No. 07/894,689 filed Aug. 8, 1986, now U.S. Pat. No. 4,877,949, issued Oct. 31, 1989, and the disclosure of the specification, including the claims, and the drawings of said application are hereby incorporated herein by reference.

A module such as shown at **1200B** in FIG. **41** may have a non-contact essentially instantaneous bar code scanner, e.g., at a long edge such as **1311X** in FIG. **41**. Flash illumination where needed for the instantaneous bar code reader could be provided by a receiving shell **1260B** such as shown in FIG. **41**. The shell could contain the battery power for the flash illumination means in the shell and also for any LED marker light sources associated with the photodiode array of the processor module. A series of light emitting diodes at locations indicated at **1313B** in FIG. **41** could be used for each of the flash illumination sources of the second and third figures of the incorporated patent application Ser. No. 07/894,689, and such LEDs could all be energized with simultaneous electric pulses, or the pulses could be supplied in quick succession to essentially simulate an instantaneous flash. Where the long edge **1311X** in FIG. **41** contains the scanner window for receiving a reflected bar code image, the receptacle **1261B** in FIG. **41** could be shaped so that edge **1311X** in FIG. **41** faces frontally, and a frontal face (of a greater dimension than in FIG. **37**) such as **1312B** of the shell module **1260B** in FIG. **41**, would contain the flashable light source means, located as at **1313B** in FIG. **41**, for example. The processor module and shell, when assembled, would be hand held in operation, and could be of overall size to fit in a shirt pocket.

It will be apparent that many further modifications and variations may be effected without departing from the teachings and concepts of the present disclosure.

What is claimed is:

1. A portable battery-powered hand-held data processing device, comprising:

(a) a user interface system, located on the portable battery-powered hand-held data processing device;

(b) an indicia reader input system, located on the portable battery-powered hand-held data processing device; and

(c) a processing system, comprising

(i) a computerized processor, located within a housing of the portable battery-powered hand-held data processing device, for controlling said user interface system and said indicia reader input system, and

(ii) a multitasking operating system designed to run on said computerized processor and capable of executing essentially concurrently a wide range of computer processes.

2. The portable battery-powered hand-held data processing device according to claim **1**, wherein said multitasking operating system executes battery monitoring instructions and diagnostic routines, at fixed priority levels, while concurrently executing application programs under extended portable operating conditions.

3. The portable battery-powered hand-held data processing device according to claim **1**, wherein said multi-tasking operating system executes battery monitoring instructions.

4. The portable battery-powered hand-held data processing device according to claim **1**, wherein said multi-tasking operating system executes diagnostic routines.

5. The portable battery-powered hand-held data processing device according to claim **1**, wherein said indicia reader input system is an optical indicia reader.

6. The portable battery-powered hand-held data processing device according to claim **1**, wherein said indicia reader input system is a laser scanner.

7. The portable battery-powered hand-held data processing device according to claim **1**, further comprising a removable smart card.

8. The portable battery-powered hand-held data processing device according to claim **1**, wherein the data processing device is of a size so as to be readily contained in a shirt pocket.

9. The portable battery-powered hand-held data processing device according to claim 1, wherein said user interface system further comprises a digitizer input receiving input from movement of a stylus.

10. The portable battery-powered hand-held data processing device according to claim 1, further comprising a shell module giving the data processing device additional functionality.

11. The portable battery-powered hand-held data processing device according to claim 1, wherein said user interface is a graphical user interface displaying graphical information to a user.

12. The portable battery-powered hand-held data processing device according to claim 1, wherein said indicia reader input system is a non-contact reader reading data without coming into physical contact with the indicia being read.

13. The portable battery-powered hand-held data processing device according to claim 3, further comprising a fuel gauge.

14. The portable battery-powered hand-held data processing device according to claim 10, wherein said shell module comprises a printer.

15. The portable battery-powered hand-held data processing device according to claim 9, wherein said digitizer input accepts handwritten input.

16. The portable battery-powered hand-held data processing device according to claim 15, wherein the data processing device interprets handwritten input.

17. The portable battery-powered hand-held data processing device according to claim 9, wherein said digitizer input comprises a learning mode adapting the data processing device to the handwriting style of a given user.

18. The portable battery-powered hand-held data processing device according to claim 1, wherein the data processing device serves as a computing engine to any of a family of peripheral devices.

19. The portable battery-powered hand-held data processing device according to claim 1, wherein said indicia reader input system is an instant-type reader.

* * * * *

JS 44 (Rev. 11/04)

CIVIL COVER SHEET

The JS 44 civil cover sheet and the information contained herein neither replace nor supplement the filing and service of pleadings or other papers as required by law, except as provided by local rules of court. This form, approved by the Judicial Conference of the United States in September 1974, is required for the use of the Clerk of Court for the purpose of initiating the civil docket sheet. (SEE INSTRUCTIONS ON THE REVERSE OF THE FORM.)

I. (a) PLAINTIFFS
Intermec Technologies Corp.

DEFENDANTS
Palm, Inc.

(b) County of Residence of First Listed Plaintiff _____
(EXCEPT IN U.S. PLAINTIFF CASES)

County of Residence of First Listed Defendant _____
(IN U.S. PLAINTIFF CASES ONLY)
NOTE: IN LAND CONDEMNATION CASES, USE THE LOCATION OF THE LAND INVOLVED.

(c) Attorney's (Firm Name, Address, and Telephone Number)
Jack B. Blumenfeld (I.D. 1014)
MORRIS, NICHOLS, ARSHT & TUNNELL LLP, 1201 North Market Street, P.O. Box 1347, Wilmington, DE 19899-1347, (302) 658-9200

Attorneys (If Known)

II. BASIS OF JURISDICTION (Place an "X" in One Box Only)

- ☐ 1 U.S. Government Plaintiff
- ☒ 3 Federal Question (U.S. Government Not a Party)
- ☐ 2 U.S. Government Defendant
- ☐ 4 Diversity (Indicate Citizenship of Parties in Item III)

III. CITIZENSHIP OF PRINCIPAL PARTIES (Place an "X" in One Box for Plaintiff and One Box for Defendant)
(For Diversity Cases Only)

	PTF	DEF		PTF	DEF
Citizen of This State	☐ 1	☐ 1	Incorporated *or* Principal Place of Business In This State	☐ 4	☐ 4
Citizen of Another State	☐ 2	☐ 2	Incorporated *and* Principal Place of Business In Another State	☐ 5	☐ 5
Citizen or Subject of a Foreign Country	☐ 3	☐ 3	Foreign Nation	☐ 6	☐ 6

IV. NATURE OF SUIT (Place an "X" in One Box Only)

CONTRACT
- ☐ 110 Insurance
- ☐ 120 Marine
- ☐ 130 Miller Act
- ☐ 140 Negotiable Instrument
- ☐ 150 Recovery of Overpayment & Enforcement of Judgment
- ☐ 151 Medicare Act
- ☐ 152 Recovery of Defaulted Student Loans (Excl. Veterans)
- ☐ 153 Recovery of Overpayment of Veteran's Benefits
- ☐ 160 Stockholders' Suits
- ☐ 190 Other Contract
- ☐ 195 Contract Product Liability
- ☐ 196 Franchise

REAL PROPERTY
- ☐ 210 Land Condemnation
- ☐ 220 Foreclosure
- ☐ 230 Rent Lease & Ejectment
- ☐ 240 Torts to Land
- ☐ 245 Tort Product Liability
- ☐ 290 All Other Real Property

TORTS

PERSONAL INJURY
- ☐ 310 Airplane
- ☐ 315 Airplane Product Liability
- ☐ 320 Assault, Libel & Slander
- ☐ 330 Federal Employers' Liability
- ☐ 340 Marine
- ☐ 345 Marine Product Liability
- ☐ 350 Motor Vehicle
- ☐ 355 Motor Vehicle Product Liability
- ☐ 360 Other Personal Injury

PERSONAL INJURY
- ☐ 362 Personal Injury - Med. Malpractice
- ☐ 365 Personal Injury - Product Liability
- ☐ 368 Asbestos Personal Injury Product Liability

PERSONAL PROPERTY
- ☐ 370 Other Fraud
- ☐ 371 Truth in Lending
- ☐ 380 Other Personal Property Damage
- ☐ 385 Property Damage Product Liability

CIVIL RIGHTS
- ☐ 441 Voting
- ☐ 442 Employment
- ☐ 443 Housing/ Accommodations
- ☐ 444 Welfare
- ☐ 445 Amer. w/Disabilities - Employment
- ☐ 446 Amer. w/Disabilities - Other
- ☐ 440 Other Civil Rights

PRISONER PETITIONS
- ☐ 510 Motions to Vacate Sentence

Habeas Corpus:
- ☐ 530 General
- ☐ 535 Death Penalty
- ☐ 540 Mandamus & Other
- ☐ 550 Civil Rights
- ☐ 555 Prison Condition

FORFEITURE/PENALTY
- ☐ 610 Agriculture
- ☐ 620 Other Food & Drug
- ☐ 625 Drug Related Seizure of Property 21 USC 881
- ☐ 630 Liquor Laws
- ☐ 640 R.R. & Truck
- ☐ 650 Airline Regs.
- ☐ 660 Occupational Safety/Health
- ☐ 690 Other

LABOR
- ☐ 710 Fair Labor Standards Act
- ☐ 720 Labor/Mgmt. Relations
- ☐ 730 Labor/Mgmt.Reporting & Disclosure Act
- ☐ 740 Railway Labor Act
- ☐ 790 Other Labor Litigation
- ☐ 791 Empl. Ret. Inc. Security Act

BANKRUPTCY
- ☐ 422 Appeal 28 USC 158
- ☐ 423 Withdrawal 28 USC 157

PROPERTY RIGHTS
- ☐ 820 Copyrights
- ☒ 830 Patent
- ☐ 840 Trademark

SOCIAL SECURITY
- ☐ 861 HIA (1395ff)
- ☐ 862 Black Lung (923)
- ☐ 863 DIWC/DIWW (405(g))
- ☐ 864 SSID Title XVI
- ☐ 865 RSI (405(g))

FEDERAL TAX SUITS
- ☐ 870 Taxes (U.S. Plaintiff or Defendant)
- ☐ 871 IRS—Third Party 26 USC 7609

OTHER STATUTES
- ☐ 400 State Reapportionment
- ☐ 410 Antitrust
- ☐ 430 Banks and Banking
- ☐ 450 Commerce
- ☐ 460 Deportation
- ☐ 470 Racketeer Influenced and Corrupt Organizations
- ☐ 480 Consumer Credit
- ☐ 490 Cable/Sat TV
- ☐ 810 Selective Service
- ☐ 850 Securities/Commodities/ Exchange
- ☐ 875 Customer Challenge 12 USC 3410
- ☐ 890 Other Statutory Actions
- ☐ 891 Agricultural Acts
- ☐ 892 Economic Stabilization Act
- ☐ 893 Environmental Matters
- ☐ 894 Energy Allocation Act
- ☐ 895 Freedom of Information Act
- ☐ 900Appeal of Fee Determination Under Equal Access to Justice
- ☐ 950 Constitutionality of State Statutes

V. ORIGIN (Place an "X" in One Box Only)

☒ 1 Original Proceeding ☐ 2 Removed from State Court ☐ 3 Remanded from Appellate Court ☐ 4 Reinstated or Reopened ☐ 5 Transferred from another district (specify) ☐ 6 Multidistrict Litigation ☐ 7 Appeal to District Judge from Magistrate Judgment

VI. CAUSE OF ACTION
Cite the U.S. Civil Statute under which you are filing **(Do not cite jurisdictional statutes unless diversity)**:
35 U.S.C. Section 101, et seq.
Brief description of cause:
Patent infringement

VII. REQUESTED IN COMPLAINT: ☐ CHECK IF THIS IS A **CLASS ACTION** UNDER F.R.C.P. 23 **DEMAND $** CHECK YES only if demanded in complaint: **JURY DEMAND:** ☒ Yes ☐ No

VIII. RELATED CASE(S) IF ANY (See instructions): JUDGE Robinson DOCKET NUMBER 05cv147 (SLR)

DATE 5/18/07 SIGNATURE OF ATTORNEY OF RECORD [signature] (#3778)

FOR OFFICE USE ONLY

RECEIPT # _____ AMOUNT _____ APPLYING IFP _____ JUDGE _____ MAG. JUDGE _____

JS 44 Reverse (Rev. 11/04)

INSTRUCTIONS FOR ATTORNEYS COMPLETING CIVIL COVER SHEET FORM JS 44

Authority For Civil Cover Sheet

The JS 44 civil cover sheet and the information contained herein neither replaces nor supplements the filings and service of pleading or other papers as required by law, except as provided by local rules of court. This form, approved by the Judicial Conference of the United States in September 1974, is required for the use of the Clerk of Court for the purpose of initiating the civil docket sheet. Consequently, a civil cover sheet is submitted to the Clerk of Court for each civil complaint filed. The attorney filing a case should complete the form as follows:

I. (a) Plaintiffs-Defendants. Enter names (last, first, middle initial) of plaintiff and defendant. If the plaintiff or defendant is a government agency, use only the full name or standard abbreviations. If the plaintiff or defendant is an official within a government agency, identify first the agency and then the official, giving both name and title.

(b) County of Residence. For each civil case filed, except U.S. plaintiff cases, enter the name of the county where the first listed plaintiff resides at the time of filing. In U.S. plaintiff cases, enter the name of the county in which the first listed defendant resides at the time of filing. (NOTE: In land condemnation cases, the county of residence of the "defendant" is the location of the tract of land involved.)

(c) Attorneys. Enter the firm name, address, telephone number, and attorney of record. If there are several attorneys, list them on an attachment, noting in this section "(see attachment)".

II. Jurisdiction. The basis of jurisdiction is set forth under Rule 8(a), F.R.C.P., which requires that jurisdictions be shown in pleadings. Place an "X" in one of the boxes. If there is more than one basis of jurisdiction, precedence is given in the order shown below.

United States plaintiff. (1) Jurisdiction based on 28 U.S.C. 1345 and 1348. Suits by agencies and officers of the United States are included here.

United States defendant. (2) When the plaintiff is suing the United States, its officers or agencies, place an "X" in this box.

Federal question. (3) This refers to suits under 28 U.S.C. 1331, where jurisdiction arises under the Constitution of the United States, an amendment to the Constitution, an act of Congress or a treaty of the United States. In cases where the U.S. is a party, the U.S. plaintiff or defendant code takes precedence, and box 1 or 2 should be marked.

Diversity of citizenship. (4) This refers to suits under 28 U.S.C. 1332, where parties are citizens of different states. When Box 4 is checked, the citizenship of the different parties must be checked. (See Section III below; federal question actions take precedence over diversity cases.)

III. Residence (citizenship) of Principal Parties. This section of the JS 44 is to be completed if diversity of citizenship was indicated above. Mark this section for each principal party.

IV. Nature of Suit. Place an "X" in the appropriate box. If the nature of suit cannot be determined, be sure the cause of action, in Section VI below, is sufficient to enable the deputy clerk or the statistical clerks in the Administrative Office to determine the nature of suit. If the cause fits more than one nature of suit, select the most definitive.

V. Origin. Place an "X" in one of the seven boxes.

Original Proceedings. (1) Cases which originate in the United States district courts.

Removed from State Court. (2) Proceedings initiated in state courts may be removed to the district courts under Title 28 U.S.C., Section 1441. When the petition for removal is granted, check this box.

Remanded from Appellate Court. (3) Check this box for cases remanded to the district court for further action. Use the date of remand as the filing date.

Reinstated or Reopened. (4) Check this box for cases reinstated or reopened in the district court. Use the reopening date as the filing date.

Transferred from Another District. (5) For cases transferred under Title 28 U.S.C. Section 1404(a). Do not use this for within district transfers or multidistrict litigation transfers.

Multidistrict Litigation. (6) Check this box when a multidistrict case is transferred into the district under authority of Title 28 U.S.C. Section 1407. When this box is checked, do not check (5) above.

Appeal to District Judge from Magistrate Judgment. (7) Check this box for an appeal from a magistrate judge's decision.

VI. Cause of Action. Report the civil statute directly related to the cause of action and give a brief description of the cause. **Do not cite jurisdictional statutes unless diversity.** Example: U.S. Civil Statute: 47 USC 553
Brief Description: Unauthorized reception of cable service

VII. Requested in Complaint. Class Action. Place an "X" in this box if you are filing a class action under Rule 23, F.R.Cv.P.

Demand. In this space enter the dollar amount (in thousands of dollars) being demanded or indicate other demand such as a preliminary injunction.

Jury Demand. Check the appropriate box to indicate whether or not a jury is being demanded.

VIII. Related Cases. This section of the JS 44 is used to reference related pending cases if any. If there are related pending cases, insert the docket numbers and the corresponding judge names for such cases.

Date and Attorney Signature. Date and sign the civil cover sheet.

AO FORM 85 RECEIPT (REV. 9/04)

United States District Court for the District of Delaware

Civil Action No. 07-272-
07-2

ACKNOWLEDGMENT OF RECEIPT FOR AO FORM 85

NOTICE OF AVAILABILITY OF A UNITED STATES MAGISTRATE JUDGE TO EXERCISE JURISDICTION

I HEREBY ACKNOWLEDGE RECEIPT OF 1 COPIES OF AO FORM 85.

MAY 18 2007
(Date forms issued)

(Signature of Party or their Representative)

Aaron Johnston
(Printed name of Party or their Representative)

Note: Completed receipt will be filed in the Civil Action