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(54) Title: INTERCHANGEABLE PERSONALITY MODULES FOR A COMPUTER TERMINAL
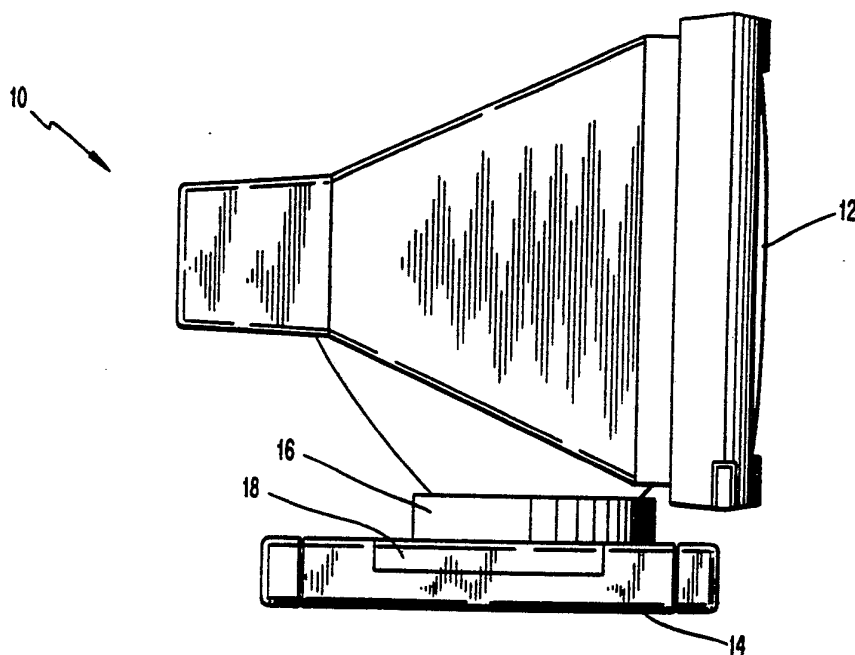
(57) Abstract

A versatile computer terminal (10) having those memory circuits (26) which include instructions which, when executed by the terminal's microprocessor (32), define the personality of the terminal arranged on a separate printed circuit board (24) that can be easily replaced through an access door (18) located on the base of the computer terminal (14).

Interchangeable Personality Modules for a

Computer Terminal

      The present application is related to
co-pending application Serial No. 922,669, filed
October 24, 1986 by Edward Knapton and Ernest
5 Vincent, the specification of which is
incorporated herein.

<div align="center">BACKGROUND OF THE INVENTION</div>

      The present invention relates to a
versatile computer terminal, and to a method of
10 using the same. More particularly, it relates to
a CRT terminal that can easily be modified to be
compatible with different computer systems.

      Modern display terminals are packaged
and sold as sophisticated equipment that is far
15 more complex than a simple cathode ray tube (CRT)
display unit. These terminals are frequently sold
together with a keyboard, a data link for
receiving data from a computer, and
microprocessors for carrying out the functions of
20 driving the CRT, monitoring the keyboard, and
controlling communications through the data link.
The microprocessors also control certain features
such as scrolling and cursor controls and other
controls that facilitate use of the terminal.
25 These microprocessors also allow the terminal to
perform limited data processing or word processing
functions, and include special modules containing
read-only memories.

      The inclusion of the above features (and
30 many features not discussed) has improved the
usefulness of the terminals, but does have certain
disadvantages. A primary disadvantage is that the
microprocessors require that each terminal be
specifically designed for use with a limited

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number of computer systems. For example, a
computer terminal that can be operated with a
Burroughs computer may not be usable with a Wang
computer.

5   The ability of a computer terminal to be
used with a computer system is generally referred
to as the compatibility (or personality) of the
terminal. If a computer terminal has the same
compatibility features as a different terminal,

10   that terminal is described as emulating the
different terminal.

          Prior to the present invention, computer
terminals were generally mounted on a base which
contained circuitry necessary to interface the

15   terminal with the host computer or system. This
circuitry was generally mounted on a large printed
circuit board encased within the base.

          If for some reason, the compatibility of
the terminal had to be changed, the base was

20   dismantled and the printed circuit was removed so
that the necessary modules could be replaced.
Such a process is relatively difficult and usually
was done only by trained technicians. Needless to
say, the compatibility or personality of such a

25   terminal was rarely changed.

          An attempt at simplifying this problem
is found in U.S. Patent No. 4,527,250 issued to
Galdun et al. on July 2, 1985. The Galdun et al.
patent discloses a computer terminal having an

30   "application module" which is removably connected
to the computer terminal. The application module
includes a keyboard, an application memory for
storing instructions that interpret keyboard
inputs, and interface means for coupling the

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application memory and the keyboard to a
controller portion of the terminal. A portion of
the personality of the computer terminal can be
changed by replacing the application module,
5   although the terminal can continue to function as
a CRT monitor even without the application module.
Instructions stored in a permanently installed
PROM continue to direct the operation of the
terminal even without an application module.
10   U.S. Patent No. 4,063,221 issued to
Watson et al. on December 13, 1977, and discloses
a programmable calculator that has a keyboard and
ROM receptacles. Plug-in ROM modules are inserted
in the receptacles and define the functions
15   assigned to the various keys of the calculator.
The application of this patent is limited to
calculators, and is not particularly relevant to
the interfacing of the calculator with a computer
system.
20   The prior art devices contain several
disadvantages. None of these devices enables a
user to change completely the personality of a
terminal by the convenient replacement of a small,
easy to ship and store element. They require
25   either the replacement of a large unit which is
comparatively bulky and expensive, or the
disassembly of the computer terminal base.
Further, the absence of complete changeability of
the attributes of the computer terminal limits the
30   variety of host computers compatible with the
terminal.
              SUMMARY AND OBJECTS OF THE INVENTION
              In view of the foregoing limitations and
shortcomings of the prior art, as well as other

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disadvantages not specifically mentioned above, it
should be apparent that, prior to the present
invention, there existed a need in the art for a
convenient and aesthetic means for modifying

5   computer terminals to alter their compatibility.
It is, therefore, a primary object of this
invention to fulfill that need by providing a
computer terminal having its case and electronic
components designed for easy replacement of

10   certain of the components.

        More particularly, it is an object of
the present invention to provide a computer
terminal wherein access may be easily had to the
internal components thereof.

15   A further object of the present
invention is to locate certain of the electronic
components of a computer terminal in such a manner
so as to facilitate their replacement.

        It is another object of the present

20   invention to locate in a specific area only the
electronic components of a computer terminal that
must be replaced in order to alter the personality
of the terminal.

25   Another object of the present invention
is to provide a computer terminal wherein the
electronic components of the terminal that must be
replaced in order to alter the personality of the
computer are located on a separate printed circuit

30   board to facilitate their replacement.

        It is yet another object of the present
invention to provide a computer terminal having a
personality which the end user is able to change
easily.

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It is yet another object of the present
invention to provide a computer terminal that has
the personality-altering components arranged on a
single unit that can be easily removed and shipped
5   to an end user.

Briefly described, the aforementioned
objects are accomplished according to the
invention by arranging the electronic components
necessary for defining the personality of the
10   terminal on a small printed circuit board that is
separate from the main printed circuit board on
which the remaining terminal components are
arranged. The small circuit board is equipped
with electrical connectors and is designed to be
15   removably plugged into like connectors on the main
circuit board. A special access door is
incorporated into the terminal base so
as to provide a convenient manner in which to
access the small circuit board.

20   With the foregoing and other objects,
advantages, and features of the invention that
will become hereinafter apparent, the nature of
the invention may be more clearly understood by
reference to the following detailed description of
25   the invention, the appended claims and to the
several views illustrated in the attached
drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a side view of a computer
30   terminal in accordance with the present invention;

Figure 2 is a top plan view of the base
of the computer terminal in accordance with the
present invention;

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Figure 3 is a top plan view of the
replacement circuit board of the present
invention;

Figure 4 is a block diagram of the
circuits used in the computer terminal; and

Figures 5A and 5B are schematic diagrams
of the circuits used in the personality module.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

Referring now in detail to the drawings,
wherein like parts are designated by like
reference numerals throughout, there is
illustrated in Figure 1 a computer terminal
according to the present invention designated by
reference numeral 10.

The terminal 10 includes a cathode ray
tube (CRT) display monitor 12 mounted on a base
14. A connecting stem 16 provides a connection
between the monitor 12 and the base 14, while
allowing the monitor to pivot with respect to the
base in a known manner.

The base 14 is provided with an access
door 18 that can be slid horizontally away from
the base in the direction of arrow A, as
illustrated in Figure 2. The access door 18 is
shown in Figure 2 removed from the base, exposing
the recess 20, in which the door fits.

The door is similar to those frequently
used to cover battery compartments in portable
radios. Preferably the door 18, like the base 14,
is made from rigid plastic. The base has tracks
19 on which the door 18 slides, and the door 18
may have releasable locking means, such as tabs 17
which engage in recesses (not shown) in the base
14.

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With reference to Figures 2 and 3,
mounted in the terminal is a personality module 22
which includes a small printed circuit board 24.
Mounted on the board 24 are Electronically

5   Programmable Read Only Memories (EPROMs), as well
as other integrated circuits as required. Other
types of Read Only Memories (ROMs) or Random
Access Memories (RAMs) may be installed on the
circuit board 24 as appropriate for the desired

10   personality. These circuits are designated
generally by reference numeral 26, and they are
incorporated into modules having different
personalities, each module being designed to allow
the computer terminal in which it is used to

15   emulate computer terminals such as the DEC VT220,
WYSE 50 plus, Lear Siegler, and Hazeltine 1500,
among others. Connectors 28 are mounted on the
printed circuit board 24 for providing address and
data busses, control signals and power to the

20   circuits 26. Jumper terminal pairs 30 are also
provided to allow rapid and efficient modification
of the personality module, as will be described in
greater detail below in connection with Figure 5.

The personality module 22 is a component

25   of the complete circuitry necessary for the
computer terminal 10. Figure 4 shows a block
diagram of the circuitry of a terminal according
to the present invention. It will be understood
by those skilled in the art that any suitable

30   microprocessor, including the MC68000 manufactured
by Motorola, may be used in the context of the
present invention with appropriate changes to the
circuitry.

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The main circuit board of the terminal, that is everything outside the personality module 22, includes a central processing unit (CPU) 32 which controls the operation of the terminal by
5   executing instructions stored in memory circuits, such as EPROMs, located in the personality module 22. As already known in the digital processing art, these instructions are communicated to the CPU 32 along a data bus 34 from memory locations
10 selected by the CPU through an address bus 36. The control signals and power required by the circuits in module 22 are indicated generally by conductor 35.

The CPU 32 directs the operation of the
15 other components of the terminal so as to form the desired alphanumeric characters or other information on the CRT display 42. These other components may include a separate CRT controller circuit 40 and additional memory circuits 44 and
20 46 which may be arranged to provide a bitmapped output display 42, as described in the aforementioned copending application.

In a computer terminal according to the present embodiment, a 1056 x 800 bit map for the
25 monitor 42 is effectively created in the memory circuit 44 which may advantageously be comprised of dynamic random access memory (DRAM) ICs. In a bit-mapped terminal the pixels on the display monitor are in one-to-one correspondence with the
30 bit locations in a memory. Data is written into the bit-map by the CPU 32 and is then read from the bit-map and written onto the CRT display 42 by the CRT controller 40. To avoid contention for the data bus 34 between the CPU 32 and controller

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40, tri-state latches 48 selectively isolate the
CPU from the controller thereby allowing the CPU
to communicate with the personality module 22
while the controller communicates with the bit-map
5   memory 44. The address lines 54 of the memory 44
are shared by the CPU 32 and controller 40 through
the well-known operation of a multiplexer 52.
        The CPU 32 and controller 40 may also
communicate with an attribute memory 46 which, in
10 one embodiment, may be CMOS static RAM ICs 46. To
enhance the writing speed of the terminal 10,
attributes of the characters to be written onto
the display 42 are stored in an attribute memory
46. These attributes include the grouping of bits
15 in the bit map which compose the alphanumeric
character positions on the display, as well as
blinking, reverse-video and highlighting of the
characters. The contents of the attribute memory
46 are accessed in the usual manner through a SRAM
20 data bus 60 and a SRAM address bus 62 by either
the CPU 32 or the CRT controller 40. The CPU 32
can both read and write data to the attribute
memory 46, while controller 40 only reads data
from the memory 46. During each horizontal
25 blanking interval of the CRT 42, the controller 40
reads one line of character attributes from the
memory 46.
        According to the present embodiment the
data comprising the bit-map is read from the
30 memory 44 in a sequence of 16-bit parallel words
which are converted to a serial bit stream by a
shift register 56. The output of the shift
register 56 is combined with the output of the
attribute memory 46 by a mixer 58. In this way

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the desired attributes of characters on the
display 42 are imposed on the contents of the bit-
map memory, thereby providing the versatility of a
bit-mapped terminal for alphanumeric applications
5   without requiring unreasonable memory capacity and
speed.

Also shown in Figure 4 are communication
interfaces 38 which control the input and output
of digital data from the terminal 10. The
10 interfaces 38 may include several universal
synchronous receiver transmitters (UARTs) for
providing several serial-data I/O ports to the
terminal. It is common to have at least three of
these ports, one each for a keyboard, a printer
15 and the host computer. Parallel-data I/O ports
may also be provided to the terminal 10.

The personality of the terminal 10 is
determined by the instructions stored in the
memory circuits of module 22 as they are executed
20 by the CPU 32. The particular printing font as
well as the size of the characters printed on the
CRT 42 are determined in a well-known manner by
the stored instructions. The creation of
underlining and blanks as well as the cursor
25 displayed on the CRT 42 is also determined by the
CPU's execution of the stored instructions.
Scrolling of the displayed information, whether
smooth or jump-wise, and various set-up parameters
of the terminal, such as 80-column or 132-column
30 modes, tabs and key functions are also part of the
terminal's personality and thus determinable by
the module 22.

Figure 5 shows a schematic diagram of
the circuitry mounted on PC board 24 in one

embodiment of the present invention. The module
circuit shown in Figures includes four EPROM ICs,
designated 26, which are connected to the data bus
34 and address bus 36. Depending on the
5   particular memory circuits and CPU employed, the
number and arrangement of the address lines and
data lines may vary. A terminal according to the
present invention which employs a MC 68000 CPU can
advantageously use a 16-bit wide address bus and a
10   16-bit wide data bus divided into an upper and
lower half. The bus signals, control signals and
power are connected to the circuits on the board
24 through two connectors 28 also mounted on the
board. These connectors mate with other similar
15   connectors on the main circuit board of the
terminal 10, providing for easy interchangeability
of the module 22.
           Control signals such as $\overline{\text{PROM-S}}$ and $\overline{\text{AS}}$
which aid in controlling the operation of the
20   memory circuits 26 are brought to the board 24
through the connectors 28. The PROM-select
signal, $\overline{\text{PROM-S}}$, enables the EPROMs 26. In the
present embodiment, this signal goes to logic low,
enabling the EPROMs, only when certain addresses
25   are present on the address bus 36. Those certain
addresses correspond to the memory locations of
the memory circuits in the personality module 22
only. The address-strobe signal, $\overline{\text{AS}}$, is logic low
when the voltage levels on the address bus 36 are
30   valid. The address-strobe signal is a standard
control signal generated by the MC 68000
microprocessor. One or more additional ICs such
as NAND gates 27 may also be provided in the
module 22 to derive additional memory control

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signals as required. As appropriate to the
desired personality for the terminal 10, other
signals and voltages may also be routed through
connectors 28 and modified by additional

5   components on the personality board 24 for use by
the main circuit board.

        Since EPROMs and other memory circuits
are manufactured with a range of storage
capacities, including for example 64K, 128K, 256K

10   and 512K, a common PC board design can be used in
the modules 22 by including a number of jumper
contact pairs 30. Depending on the particular
subset of pairs connected, the control signals
necessary for operating the different-size memory

15   circuits 26 can be derived. Table I shows various
memory capacities which can be provided by the
personality module 22 using particular standard
memory IC types for the circuits 26 (U1-U4), and
jumper conditions (W1-W14). NAND gates 27 are

20   provided by another standard IC (U5).

        In the terminal of the present
embodiment, memories having access times less than
250 nanosec are used to avoid slowing the
operation of the MC 68000 CPU. However, it will

25   be understood that any suitable type of memory can
be used in the module 22 by appropriate
modification of the instructions stored in the
memory for execution by the CPU.

        Also shown in Figure 5 is an array of

30   capacitors 29 which provide filtering and noise
rejection for the power supplied to the board 24.

        Besides accommodating different standard
memory ICs to provide the storage capacity
required by the instructions necessary to

TABLE: MODULE CONFIGURATIONS

Firmware Size	U1	U2	U3	U4	U5
16K	2764		2764		
32K	27128		27128		
64K	27256		27256		
80K	27256	2764	27256	2764	74LS00
96K	27256	27128	27256	27128	74LS00
128K	27256	27256	27256	27256	74LS00
128K	27512		27512		
144K	27512	2764	27512	2764	74LS00
160K	27512	27128	27512	27128	74LS00
196K	27512	27256	27512	27256	74LS00
256K	27512	27512	27512	27512	74LS00

Firmware Size	W2	W1	W10	W6	W5	W3	W4	W14	W13	W11	W12
16K			IN	IN		IN					
32K			IN	IN		IN					
64K			IN			IN					
80K	IN				IN	IN		IN		IN	
96K	IN				IN	IN		IN		IN	
128K	IN				IN					IN	
128K			IN		IN		IN		IN		
144K		IN			IN		IN	IN		IN	
160K		IN			IN		IN	IN		IN	
196K		IN			IN		IN		IN	IN	
256K		IN			IN		IN		IN		IN

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determine the personality of the terminal 10, the
personality module 22 may also include other
devices according to the capability desired for
the terminal. For example, additional RAM ICs may
5   be provided to allow the terminal itself to
perform data processing functions independent of
the host computer. These functions might include
controlling additional I/O ports, modems, etc. as
well as providing nonvolatile special function
10   keys on the keyboard attached to the terminal.
        The ease with which a personality module
may be replaced by untrained end users allows
significant flexibility to accommodate revisions
and improvements of the instructions stored in the
15   memory circuits of the module. Specific
requirements of individual end users may also be
addressed by providing user specific personality
modules.
        Without the personality module 22, the
20   terminal 10 cannot function as a terminal. Since
the personality module 22 contains all the
circuitry that makes the terminal compatible with
a system, all the basic terminals can be
manufactured alike. This is an advantage in that
25   it not only simplifies manufacturing, but also
greatly simplifies inventory and storage problems.
A supplier of computer terminals need only stock
the basic terminal 10 and maintain a supply of
personality modules 22. Since the personality
30   modules are significantly smaller and cheaper than
the terminals, a supplier can save space and money
by using the terminal of the present invention.
        End users can also benefit from the
present invention. If one has a computer terminal

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of the present invention and switches to a
different computer system, the user need only
replace the personality module with one compatible
with the new system. Such a replacement can be

5 effected merely by opening the access door 18,
removing the personality module 22 and exchanging
it by mail or in person for a different module.

Although only preferred embodiments are
specifically illustrated and described herein, it

10 will be appreciated that many modifications and
variations of the present invention are possible
in light of the above teachings and within the
purview of the appended claims without departing
from the spirit and intended scope of the
invention.

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CLAIMS

1. A computer terminal, comprising:
   means for displaying information;
   a base connected with said displaying
5 means;
   a first circuit board mounted within the
   base and electronically connected with the
   displaying means;
   first microprocessors arranged on the
10 first circuit board for controlling the displaying
   means in response to signals input to the
   terminal;
   a second circuit board removably
   connectable to the first circuit board so as to be
15 in electronic communication therewith;
   at least one memory circuit on the
   second circuit board associated with the first
   microprocessors, said at least one memory circuit
   including instructions defining the personality of
20 the computer terminal; and
   an access door arranged in the base
   through which the second circuit board may be
   removed.

2. A method of changing the personality
25 of a computer terminal, comprising the steps of:
   providing a computer terminal having a
   base with an access door in it, first
   microprocessors arranged on a first circuit board
   arranged within the base, and a personality module
30 which defines the personality of the computer,
   said personality module being removably connected
   to the first circuit board;
   opening the access door;
   removing the personality module; and

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plugging a different personality module onto the first circuit board.

3. The computer terminal of claim 1, wherein the at least one memory circuit includes at least one read only memory circuit.

4. The computer terminal of claim 3, wherein the at least one read only memory circuit is programmable.

5. The computer terminal of claim 1, wherein the at least one memory circuit stores instructions for determining at least one of a printing font, a character size, a set up parameter and a key function of the terminal.

6. The computer terminal of claim 1, wherein the at least one memory circuit includes at least one random access memory circuit.

7. The computer terminal of claim 1, wherein the first circuit board includes means for controlling a CRT display and means for storing a bit map for the CRT display, the storing means providing information to the controlling means.

8. The computer terminal of claim 7, wherein the storing means is a random access memory.

9. The computer terminal of claim 7, wherein the first microprocessors communicate with the at least one memory circuit simultaneously with the storing means providing information to the controlling means.

10. The computer terminal of claim 7, wherein the storing means stores at least one attribute of characters displayed by the computer terminal.

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11.   The computer terminal of claim 1,
wherein the at least one memory circuit defines
one of a plurality of personalities of the
computer terminal.

5   12. The computer terminal of claim 11,
wherein the second circuit board includes means
for selecting one of the plurality of
personalities defined by the at least one memory
circuit.

10   13.   A bit-mapped computer terminal for
displaying alphanumeric characters having a
selectively changeable personality comprising:
               processing means for controlling the
computer terminal in response to signals input to
15 the terminal;
               first means for storing data defining
the personality of the computer terminal, the
first storing means being in electrical
communication with the processing means;
20   a display for displaying the
alphanumeric characters;
               second means for storing a bit map of
the display;
               means for controlling the display in
25 response to the bit map in the second storing
means, the controlling means being in electrical
communication with the second storing means;
               third means for storing at least one of
a plurality of attributes of the characters, the
30 third storing means being selectively in
communication with the processing means and the
controlling means;

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means for imposing the at least one
attribute stored in the third storing means on the
bit map;

wherein the first storing means is
5   removably connected in the computer terminal.

14.   The bit-mapped computer terminal of
claim 13, wherein the first storing means includes
at least one read only memory circuit.

15.   The bit-mapped computer terminal of
10   claim 14, wherein the at least one read only
memory circuit is programmable.

16.   The bit-mapped computer terminal of
claim 13, wherein the first storing means stores
instructions for determining at least one of a
15   printing font, a character size, a set up
parameter and a key function.

17.   The bit-mapped computer terminal of
claim 13, wherein the first storing means includes
at least one random access memory circuit.

20   18.   The bit-mapped computer terminal of
claim 13, wherein the processing means
communicates with the first storing means
simultaneously with the controlling means
communicating with the second storing means.

25   19.   The bit-mapped computer terminal of
claim 13, further includes means for selecting one
of a plurality of personalities stored by the
first storing means.

20.   The bit-mapped computer terminal of
30   claim 13, wherein the plurality of attributes
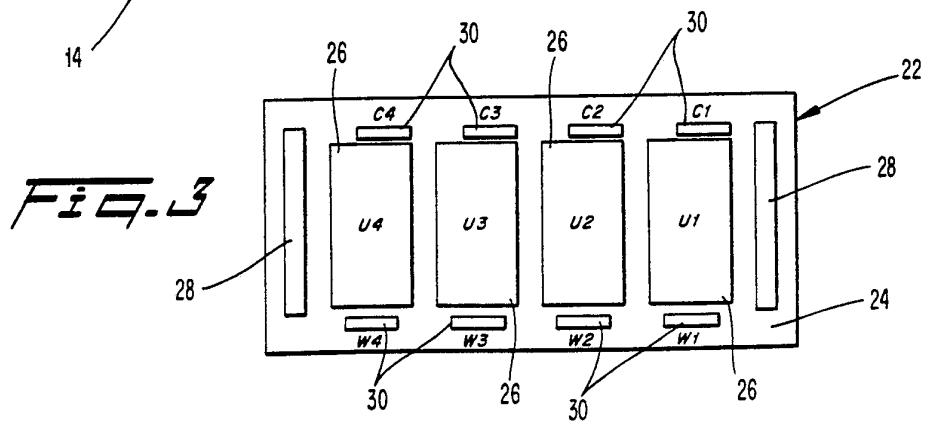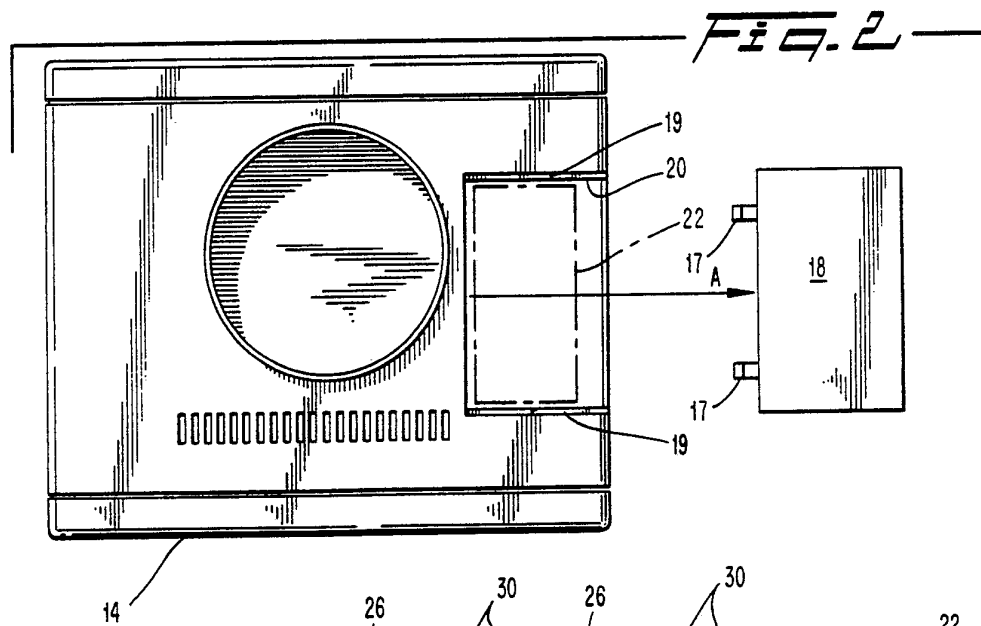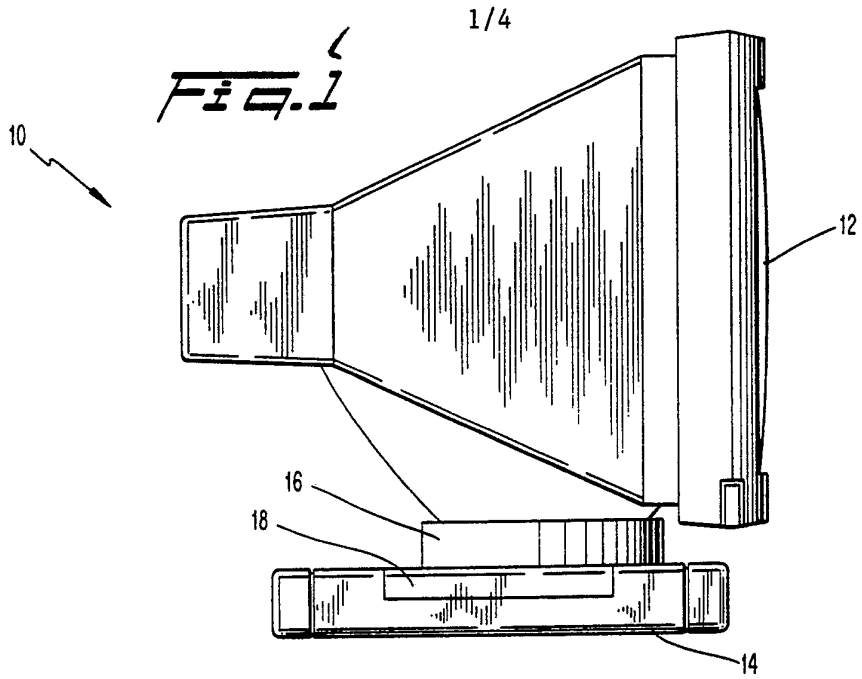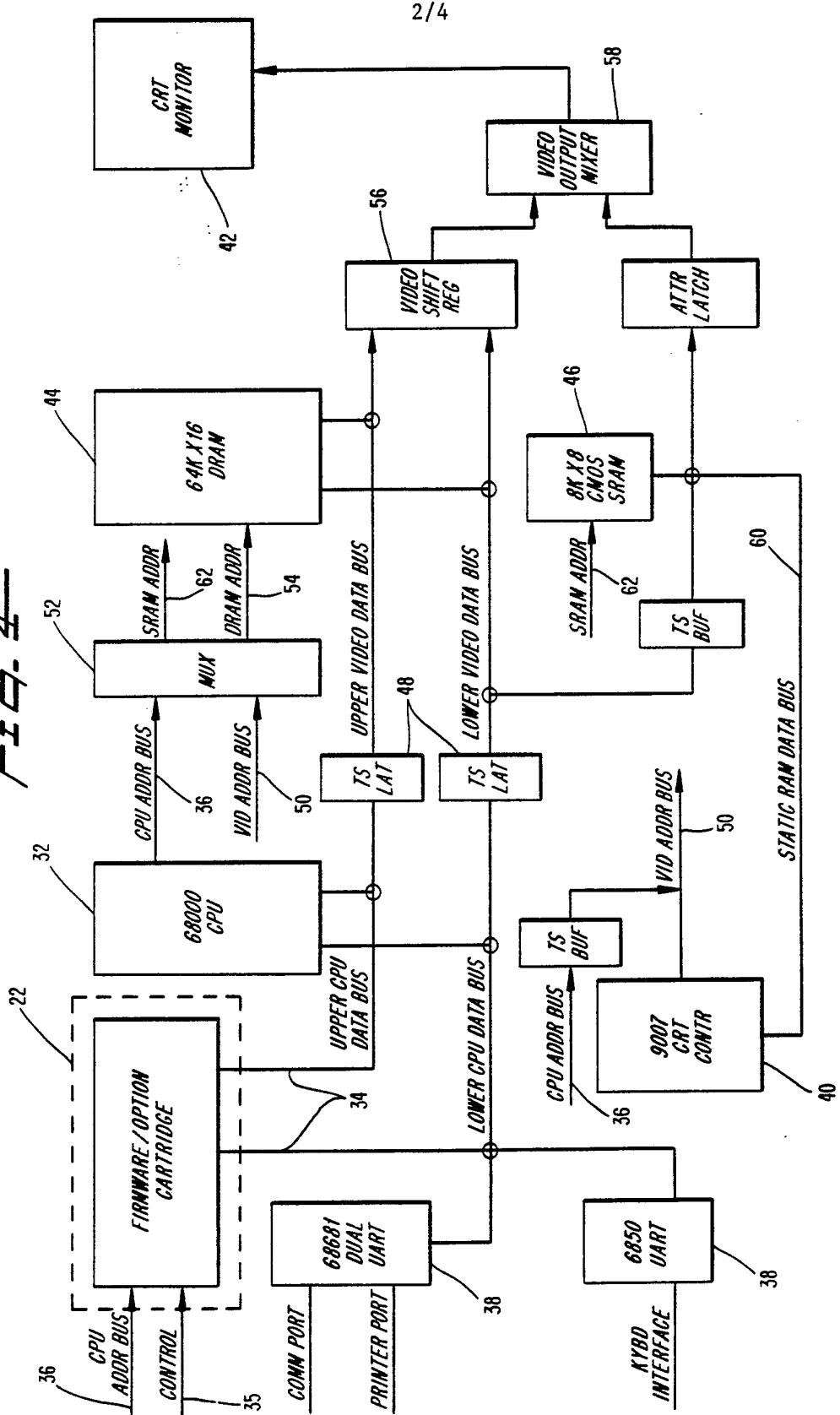include blinking, reverse video and highlighting.

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Fig.1

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Fig.2

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22

17 A

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19

14

Fig.3

26   30   26   30   22

C4   C3   C2   C1

28

U4   U3   U2   U1

28

24

W4   W3   W2   W1

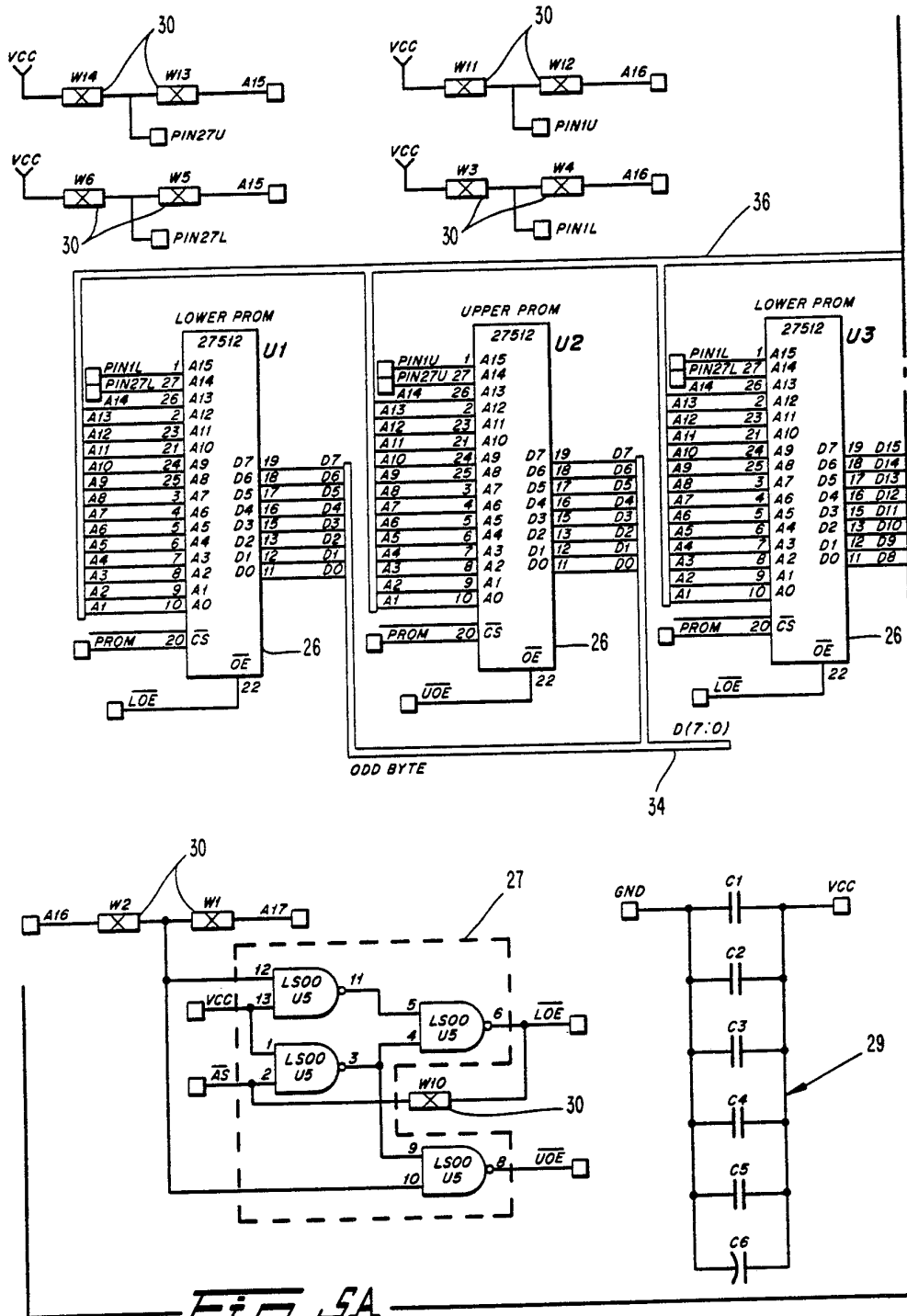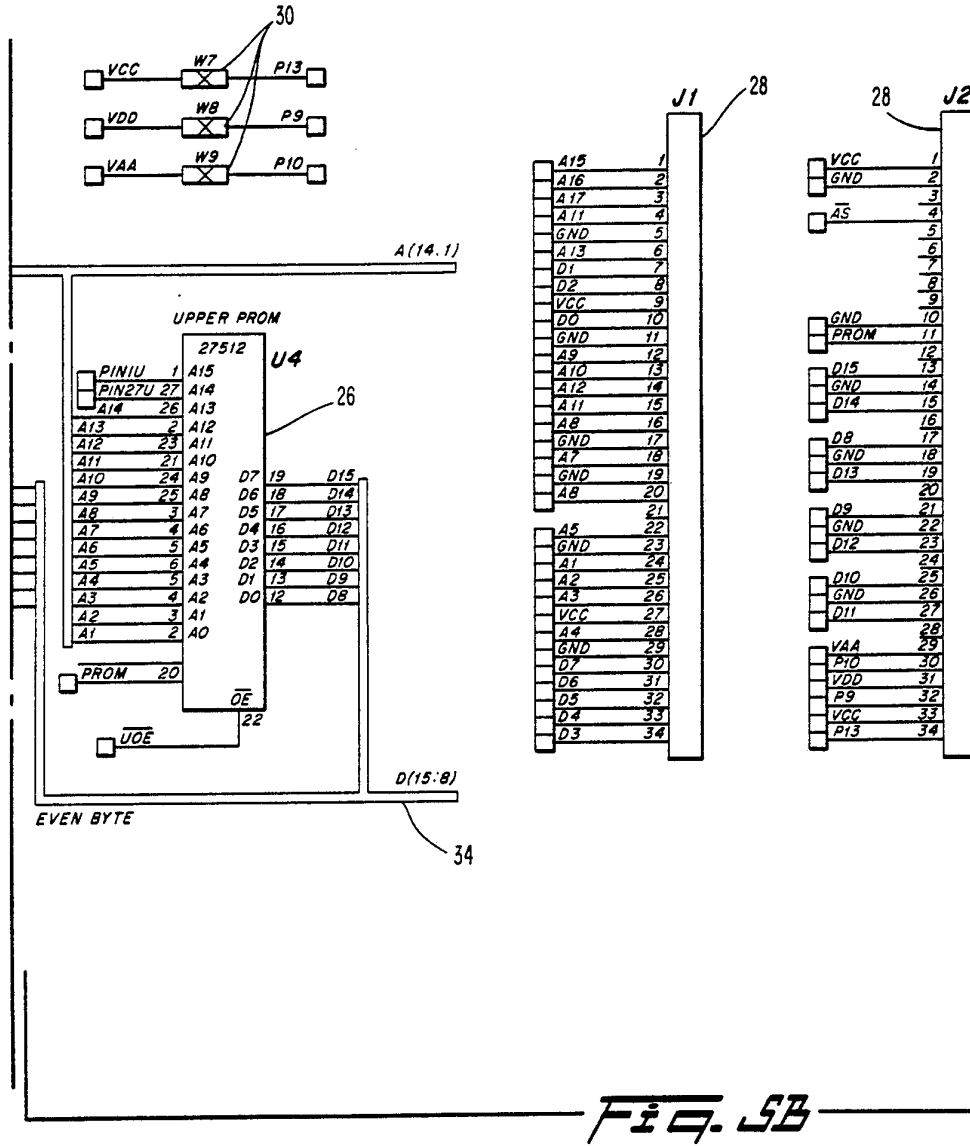30   26   30   26
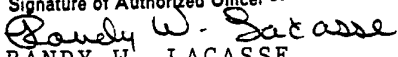
28

Fig. 4.

Fig. 5A

Fig. 5B

INTERNATIONAL SEARCH REPORT

International Application No PCT/US87/02794

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) ³

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC (4): G06F 3/14; G06F 9/00
U.S. CL. 364/900

II. FIELDS SEARCHED

Minimum Documentation Searched ⁴	
Classification System	Classification Symbols
U.S.	364/200,450,481,518,521,708,900 361/390-395,397,399,400,413 340/744-747

Documentation Searched other than Minimum Documentation
to the Extent that such Documents are Included in the Fields Searched ⁵

III. DOCUMENTS CONSIDERED TO BE RELEVANT ¹⁴

Category *	Citation of Document, ¹⁶ with indication, where appropriate, of the relevant passages ¹⁷	Relevant to Claim No. ¹⁸
Y	US,A, 4,410,841 (DUSARD et al.) 18 OCTOBER 1983 SEE ENTIRE DOCUMENT	1-4,7-9,11,12
Y	US,A 4,517,671 (LEWIS) 14 MAY 1985 SEE ENTIRE DOCUMENT	13-20
Y	US,A 4,555,763 (Dahme) 26 NOVEMBER 1985 SEE ENTIRE DOCUMENT	1-6,10
Y	US,A 4,513,378 (ANTKOWIAK) 23 APRIL 1985 SEE ENTIRE DOCUMENT	1-4,11,12
Y	US,A 4,535,409 (Jindrick et al.) 13 AUGUST 1985 SEE ENTIRE DOCUMENT	1-4,11,12
Y	US,A 4,084,242 (Conti) 11 APRIL 1978 SEE ENTIRE DOCUMENT	1-4,11,12
Y,P	US,A 4,323,979 (Johnston) 6 APRIL 1987 SEE ENTIRE DOCUMENT	1-4,11,12
A	US,A 3,964,591 (Hill et al.) 22 JUNE 1976 SEE ENTIRE DOCUMENT	1-12

* Special categories of cited documents: ¹⁵

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search ³	Date of Mailing of this International Search Report ³
12 December 1987	23 FEB 1988
International Searching Authority ¹	Signature of Authorized Officer ²⁰
ISA/US	RANDY W. LACASSE

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FURTHER INFORMATION CONTINUED FROM THE SECOND SHEET		
A	US,A 4,412,294 (WATTS et al.) 25 OCTOBER 1983 SEE ENTIRE DOCUMENT	1-12
A	US,A 4,084,250 (Alberetine et al.) 11 APRIL 1978 SEE ENTIRE DOCUMENT	1-12
A	US,A 4,530,066 (Ohwaki et al.) 16 JULY 1985 SEE ENTIRE DOCUMENT	1-12
A	US,A 4,401,351 (RECORD) 30 AUGUST 1983 SEE ENTIRE DOCUMENT	1-12
A,P	US,A 4,622,546 (Sfarti) 11 NOVEMBER 1986 SEE ENTIRE DOCUMENT	13-20

V.☐ OBSERVATIONS WHERE CERTAIN CLAIMS WERE FOUND UNSEARCHABLE [10]

This international search report has not been established in respect of certain claims under Article 17(2) (a) for the following reasons:

1.☐ Claim numbers........., because they relate to subject matter [12] not required to be searched by this Authority, namely:

2.☐ Claim numbers........., because they relate to parts of the international application that do not comply with the prescribed require-
ments to such an extent that no meaningful international search can be carried out [13], specifically:

VI.☐ OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING [11]

This International Searching Authority found multiple inventions in this international application as follows:

1.☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims
of the international application.

2.☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only
those claims of the international application for which fees were paid, specifically claims:

3.☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to
the invention first mentioned in the claims; it is covered by claim numbers:

4.☐ As all searchable claims could be searched without effort justifying an additional fee, the International Searching Authority did not
invite payment of any additional fee.

Remark on Protest

☐ The additional search fees were accompanied by applicant's protest.

☐ No protest accompanied the payment of additional search fees.

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Category*	Citation of Document,[16] with indication, where appropriate, of the relevant passages[17]	Relevant to Claim No[18]
A,P	US,A 4,633,142 (Marshall) 30 DECEMBER 1986 SEE ENTIRE DOCUMENT	13-20
A	US,A 4,603,330 (HORNE) 29 JULY 1986 SEE ENTIRE DOCUMENT	13-20

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

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