US007710598B2

(12) **United States Patent**
Harrison, Jr.

(10) **Patent No.: US 7,710,598 B2**
(45) **Date of Patent: May 4, 2010**

(54) **POLYCHROMATIC ENCODING SYSTEM, METHOD AND DEVICE**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 1251 days.

(21) Appl. No.: **11/205,986**

(22) Filed: **Aug. 17, 2005**

(65) **Prior Publication Data**

US 2006/0039016 A1 Feb. 23, 2006

Related U.S. Application Data

(60) Provisional application No. 60/603,964, filed on Aug. 23, 2004.

(51) **Int. Cl.**
G06F 15/00 (2006.01)

(52) **U.S. Cl.** **358/1.9**; 358/518; 235/462.04

(58) **Field of Classification Search** 358/518, 358/1.9; 235/462.04, 462; 386/100
See application file for complete search history.

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Assistant Examiner—Michael Burleson

(57) **ABSTRACT**

Disclosed is a polychromatic barcode or portable data file symbology, image, system, method, and apparatus enabling virtually unlimited information density. In a preferred embodiment, ASCII characters are assigned to unique identifiers, which identifiers are in turn assigned to unique colors. Color blots are sequentially arranged in a symbol so as to match the sequence of corresponding identifiers to be encoded, and then the symbol is applied to a surface. To decode, the symbol is scanned, colors translated into identifiers, and identifiers translated into content. Also disclosed are blots dedicated to calibration. Information density is further enhanced through an external reference function achieved through commands included in the barcode itself, by which function infinitely high information density is achieved. Licensing information is available through www-.inventerprise.com.

28 Claims, 27 Drawing Sheets

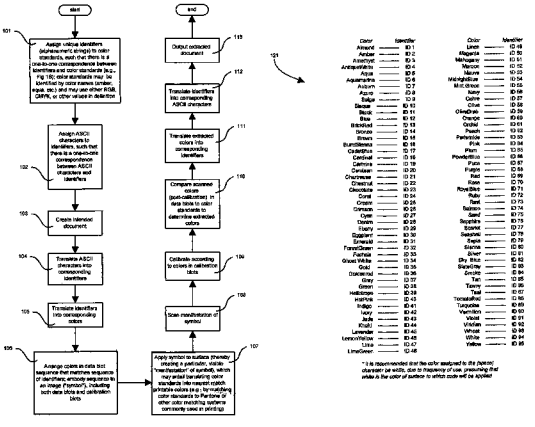

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FIG. 1A

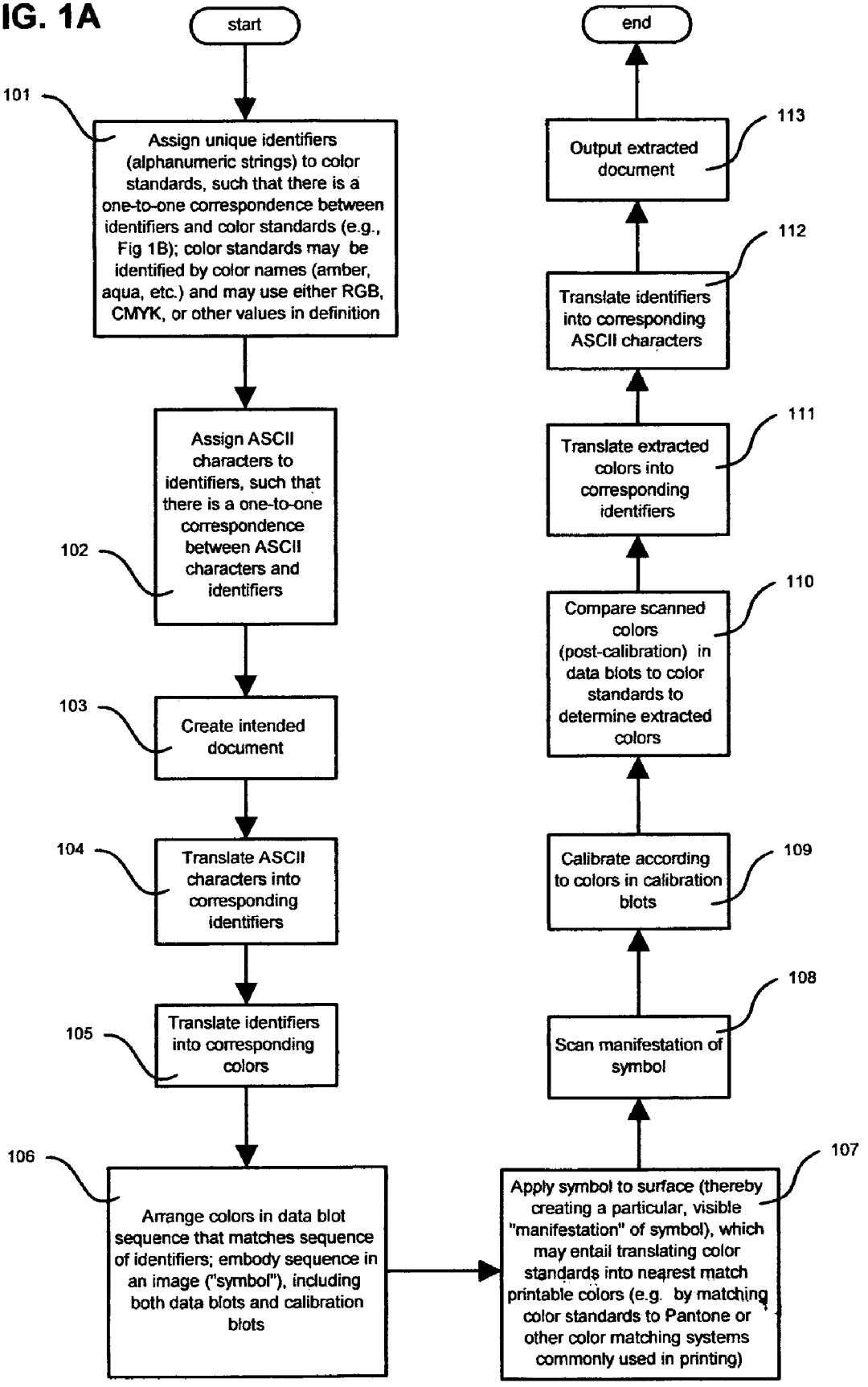

start
101
Assign unique identifiers (alphanumeric strings) to color standards, such that there is a one-to-one correspondence between identifiers and color standards (e.g., Fig 1B); color standards may be identified by color names (amber, aqua, etc.) and may use either RGB, CMYK, or other values in definition
Assign ASCII characters to identifiers, such that there is a one-to-one correspondence between ASCII characters and identifiers
102
Create intended document
103
Translate ASCII characters into corresponding identifiers
104
Translate identifiers into corresponding colors
105
Arrange colors in data blot sequence that matches sequence of identifiers; embody sequence in an image ("symbol"), including both data blots and calibration blots
106
Apply symbol to surface (thereby creating a particular, visible "manifestation" of symbol), which may entail translating color standards into nearest match printable colors (e.g. by matching color standards to Pantone or other color matching systems commonly used in printing)
107
Scan manifestation of symbol
108
Calibrate according to colors in calibration blots
109
Compare scanned colors (post-calibration) in data blots to color standards to determine extracted colors
110
Translate extracted colors into corresponding identifiers
111
Translate identifiers into corresponding ASCII characters
112
Output extracted document
113
end

FIG. 1B

Color	Identifier
Almond	ID 1
Amber	ID 2
Amethyst	ID 3
AntiqueWhite	ID 4
Aqua	ID 5
Aquamarine	ID 6
Auburn	ID 7
Azure	ID 8
Beige	ID 9
Bisque	ID 10
Black	ID 11
Blue	ID 12
BrickRed	ID 13
Bronze	ID 14
Brown	ID 15
BurntSienna	ID 16
CadetBlue	ID 17
Cardinal	ID 18
Carmine	ID 19
Cerulean	ID 20
Chartreuse	ID 21
Chestnut	ID 22
Chocolate	ID 23
Coral	ID 24
Cream	ID 25
Crimson	ID 26
Cyan	ID 27
Denim	ID 28
Ebony	ID 29
Eggplant	ID 30
Emerald	ID 31
ForestGreen	ID 32
Fuchsia	ID 33
Ghost White	ID 34
Gold	ID 35
Goldenrod	ID 36
Gray	ID 37
Green	ID 38
Heliotrope	ID 39
HotPink	ID 40
Indigo	ID 41
Ivory	ID 42
Jade	ID 43
Khaki	ID 44
Lavender	ID 45
LemonYellow	ID 46
Lime	ID 47
LimeGreen	ID 48

Color	Identifier
Linen	ID 49
Magenta	ID 50
Mahogany	ID 51
Maroon	ID 52
Mauve	ID 53
MidnightBlue	ID 54
Mint Green	ID 55
Navy	ID 56
Ochre	ID 57
Olive	ID 58
OliveDrab	ID 59
Orange	ID 60
Orchid	ID 61
Peach	ID 62
Periwinkle	ID 63
Pink	ID 64
Plum	ID 65
PowderBlue	ID 66
Puce	ID 67
Purple	ID 68
Red	ID 69
Rose	ID 70
RoyalBlue	ID 71
Ruby	ID 72
Rust	ID 73
Salmon	ID 74
Sand	ID 75
Sapphire	ID 76
Scarlet	ID 77
Seashell	ID 78
Sepia	ID 79
Sienna	ID 80
Silver	ID 81
Sky Blue	ID 82
SlateGray	ID 83
Smoke	ID 84
Tan	ID 85
Tawny	ID 86
Teal	ID 87
TomatoRed	ID 88
Turquoise	ID 89
Vermilion	ID 90
Violet	ID 91
Viridian	ID 92
Wheat	ID 93
White	ID 94
Yellow	ID 95

** it is recommended that the color assigned to the [space] character be white, due to frequency of use, presuming that white is the color of surface to which code will be applied*

FIG. 1C

Character	Identifier
0	ID 0
1	ID 1
2	ID 2
3	ID 3
4	ID 4
5	ID 5
6	ID 6
7	ID 7
8	ID 8
9	ID 9
=	ID 10
!	ID 11
'	ID 12
-	ID 13
"	ID 14
_	ID 15
#	ID 16
$	ID 17
%	ID 18
&	ID 19
*	ID 20
+	ID 21
<	ID 22
>	ID 23
@	ID 24
\	ID 25
^	ID 26
	ID 27
|	ID 28
~	ID 29
,	ID 30
.	ID 31
/	ID 32
:	ID 33
;	ID 34
?	ID 35
(	ID 36
)	ID 37
[	ID 38
]	ID 39
{	ID 40
}	ID 41
A	ID 42
a	ID 43
B	ID 44
b	ID 45
C	ID 46
c	ID 47
D	ID 48

Character	Identifier
d	ID 49
E	ID 50
e	ID 51
F	ID 52
f	ID 53
G	ID 54
g	ID 55
H	ID 56
h	ID 57
I	ID 58
i	ID 59
J	ID 60
j	ID 61
K	ID 62
k	ID 63
L	ID 64
l	ID 65
M	ID 66
m	ID 67
N	ID 68
n	ID 69
O	ID 70
o	ID 71
P	ID 72
p	ID 73
Q	ID 74
q	ID 75
R	ID 76
r	ID 77
S	ID 78
s	ID 79
T	ID 80
t	ID 81
U	ID 82
u	ID 83
V	ID 84
v	ID 85
W	ID 86
w	ID 87
X	ID 88
x	ID 89
Y	ID 90
y	ID 91
Z	ID 92
z	ID 93
[space]	ID 94
[new line]	ID 95

FIG. 1D

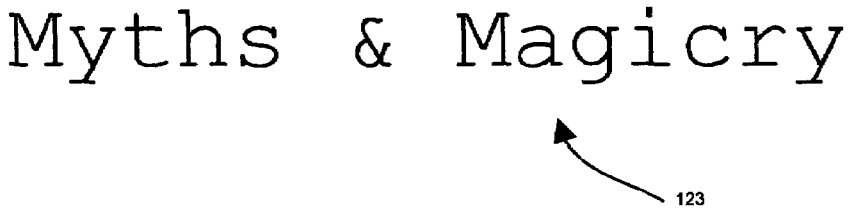

Myths & Magicry
123

FIG. 1E

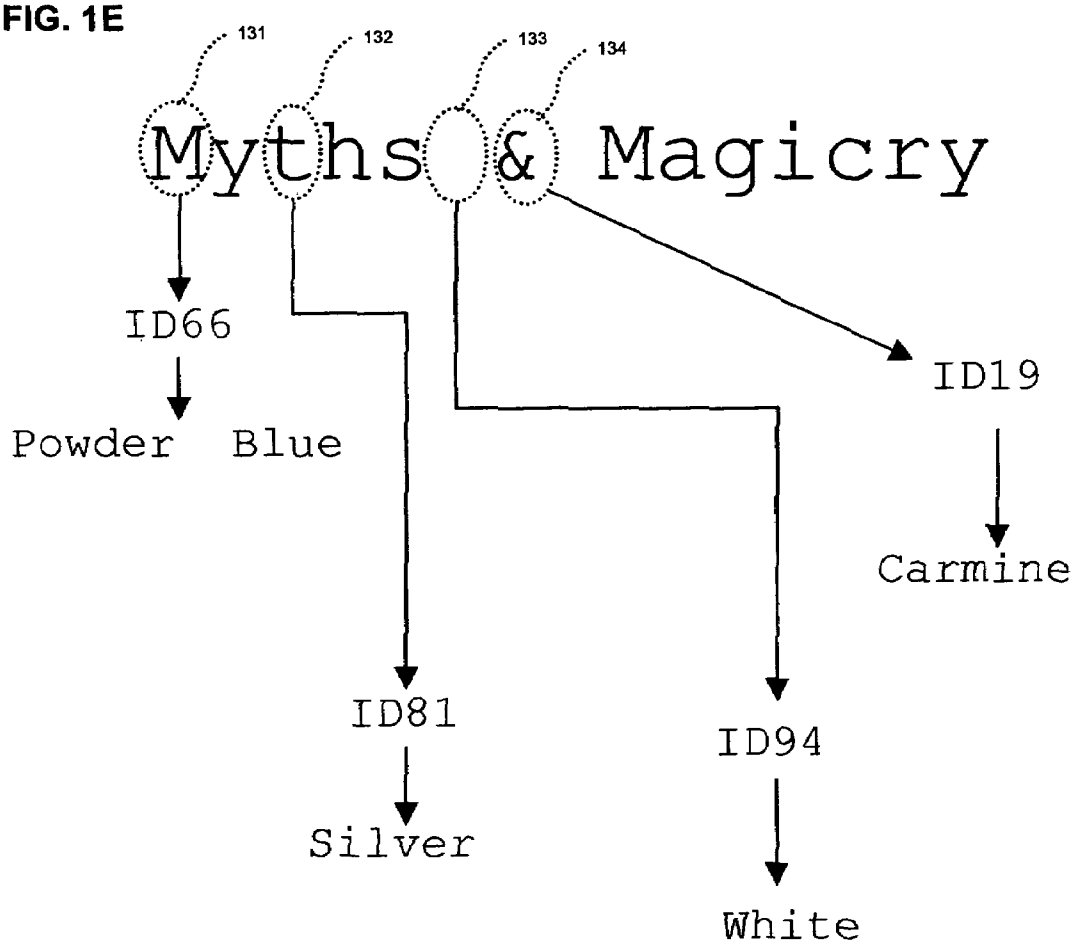

131
132
133
134
Myths & Magicry
ID66
Powder Blue
ID81
Silver
ID94
White
ID19
Carmine

FIG. 1F

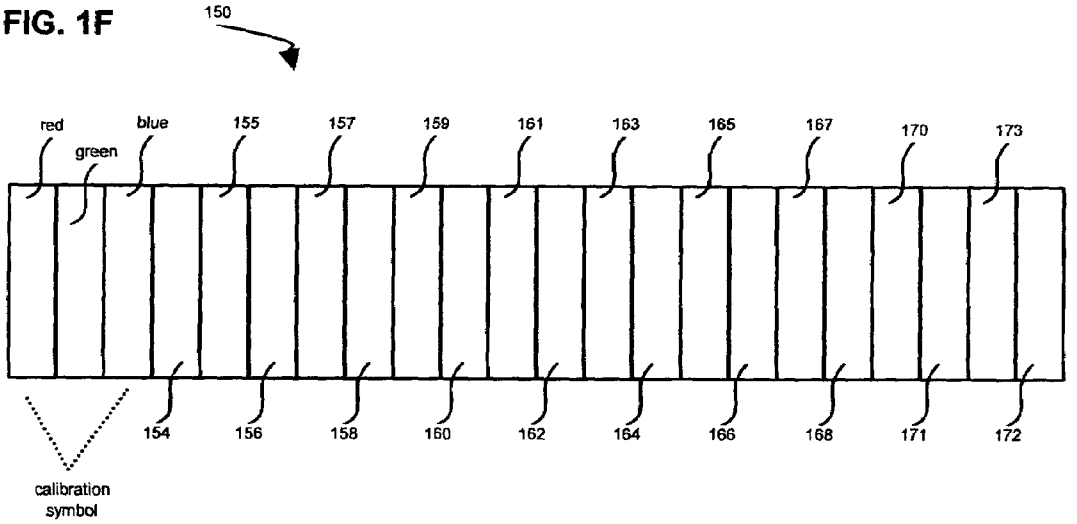

150
red
green
blue
155
157
159
161
163
165
167
170
173
154
156
158
160
162
164
166
168
171
172
calibration symbol

FIG. 1G

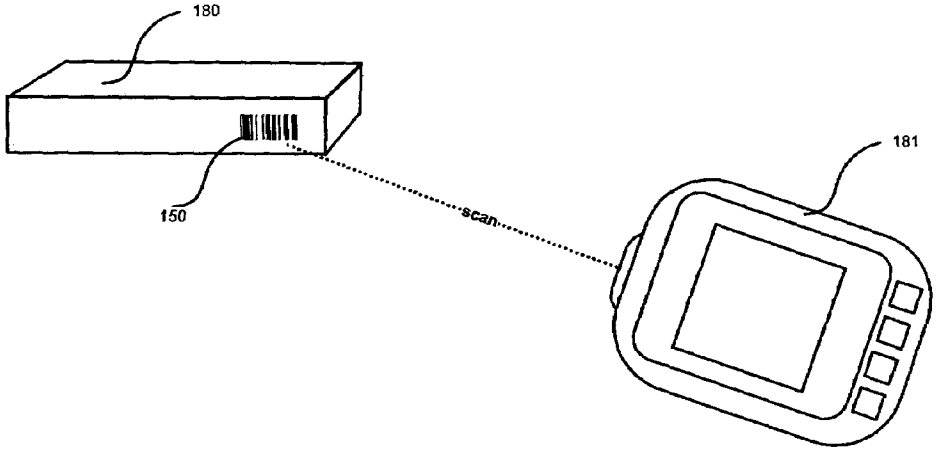

180
150
scan
181

FIG. 1H

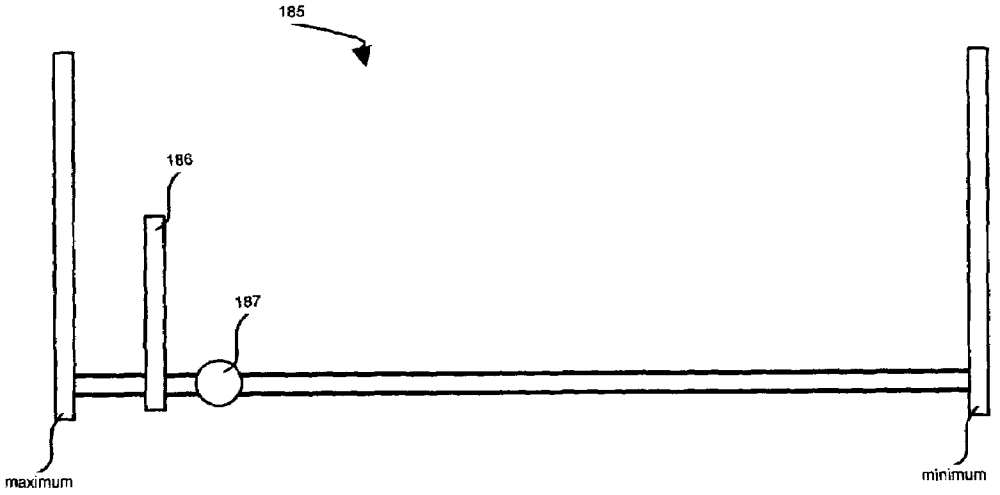


FIG. 1(I)

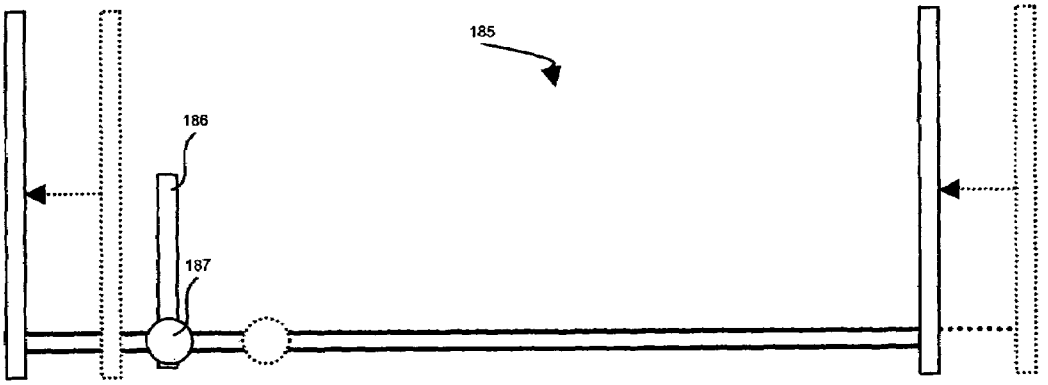


FIG. 1J

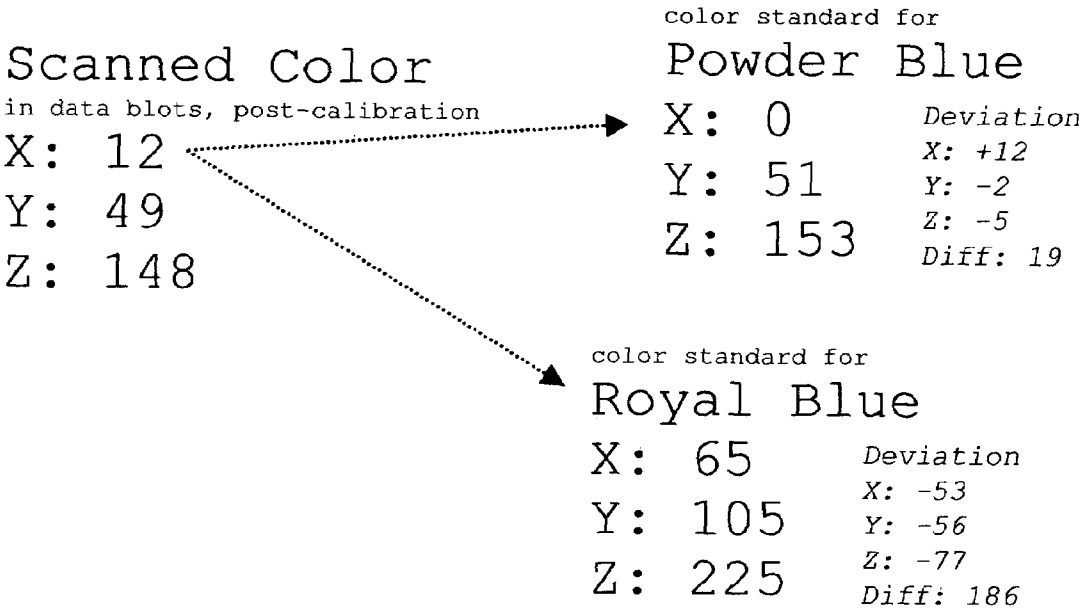

Scanned Color
in data blots, post-calibration
X: 12
Y: 49
Z: 148
color standard for
Powder Blue
X: 0
Y: 51
Z: 153
Deviation
X: +12
Y: -2
Z: -5
Diff: 19
color standard for
Royal Blue
X: 65
Y: 105
Z: 225
Deviation
X: -53
Y: -56
Z: -77
Diff: 186

FIG. 1K

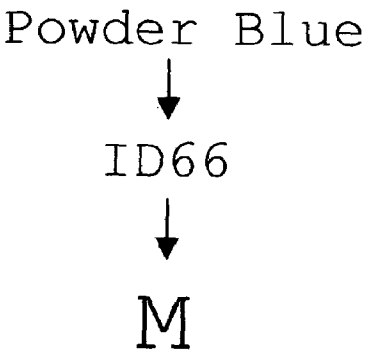

Powder Blue
ID66
M

FIG. 1L

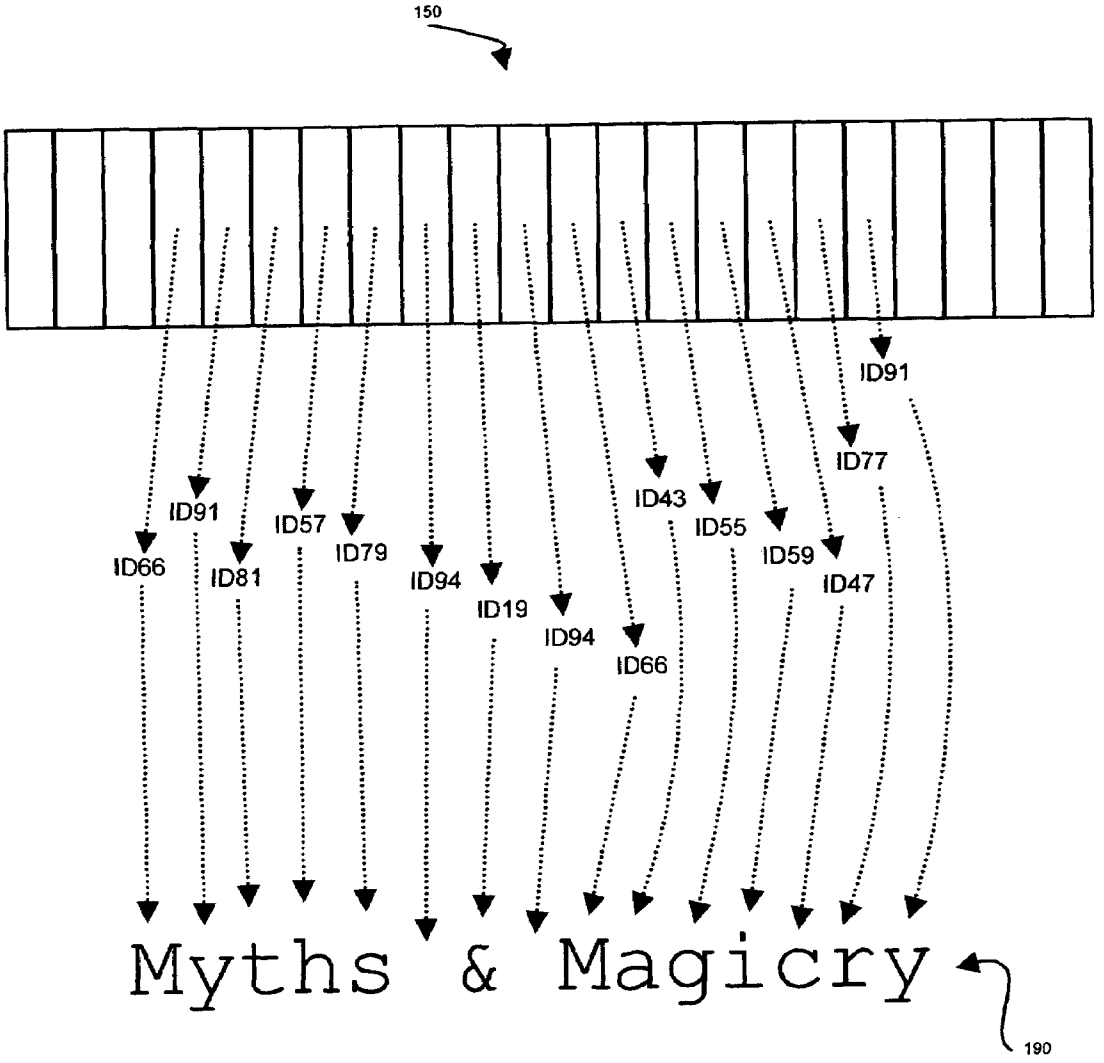

150
ID91
ID77
ID43
ID55
ID59
ID47
ID91
ID57
ID79
ID66
ID81
ID94
ID19
ID94
ID66
Myths & Magicry
190

FIG. 2A

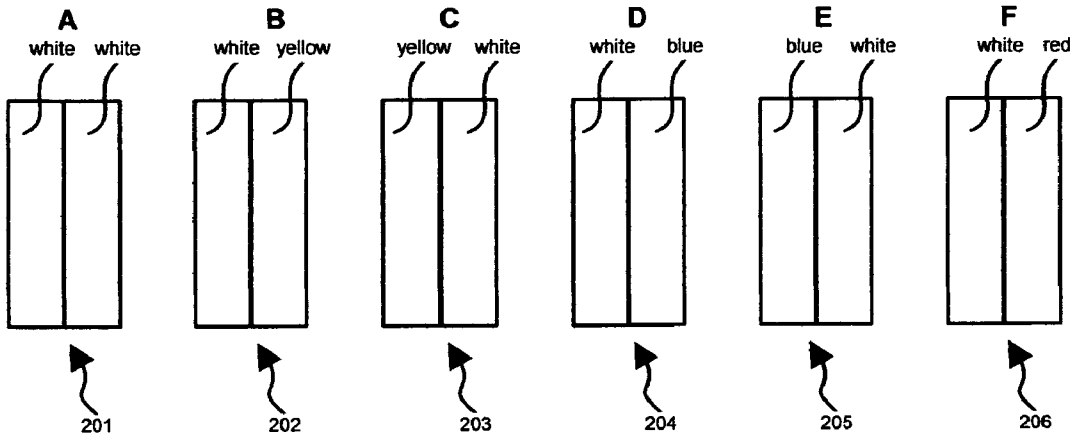


FIG. 2B

211

A	-------	White	White
B	-------	White	Yellow
C	-------	Yellow	White
D	-------	White	Blue
E	-------	Blue	White
F	-------	White	Red
G	-------	Red	White
H	-------	White	Green
I	-------	Green	White
J	-------	White	Black
K	-------	Black	White
L	-------	Yellow	Yellow
M	-------	Yellow	Blue
N	-------	Blue	Yellow
O	-------	Yellow	Red
P	-------	Red	Yellow
Q	-------	Yellow	Green
R	-------	Green	Yellow
S	-------	Yellow	Black
T	-------	Black	Yellow
U	-------	Blue	Blue
V	-------	Blue	Red
W	-------	Red	Blue
X	-------	Blue	Green
Y	-------	Green	Blue
Z	-------	Blue	Black
9	-------	Black	Blue
8	-------	Red	Red
7	-------	Red	Green
6	-------	Green	Red
5	-------	Red	Black
4	-------	Black	Red
3	-------	Green	Green
2	-------	Black	Green
1	-------	Green	Black
0	-------	Black	Black

FIG. 3A

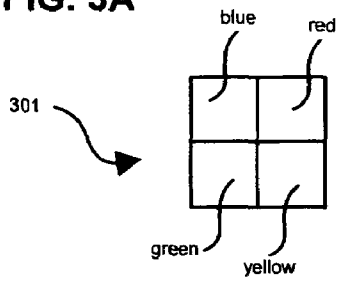


FIG. 3B

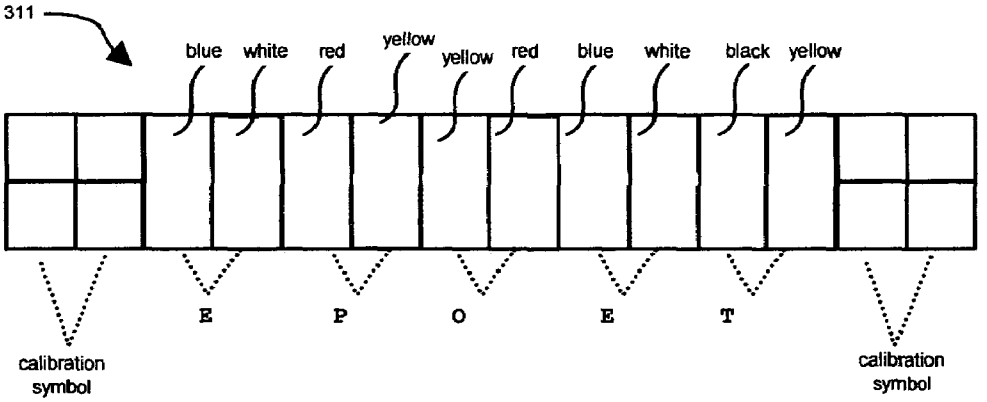
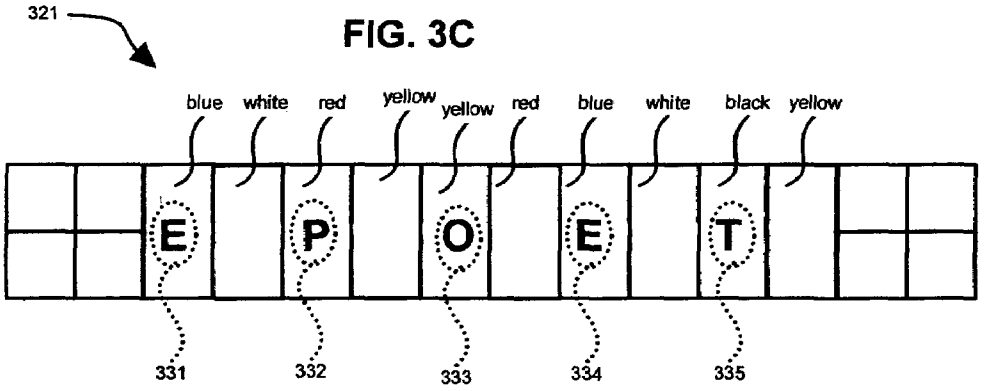


FIG. 3C



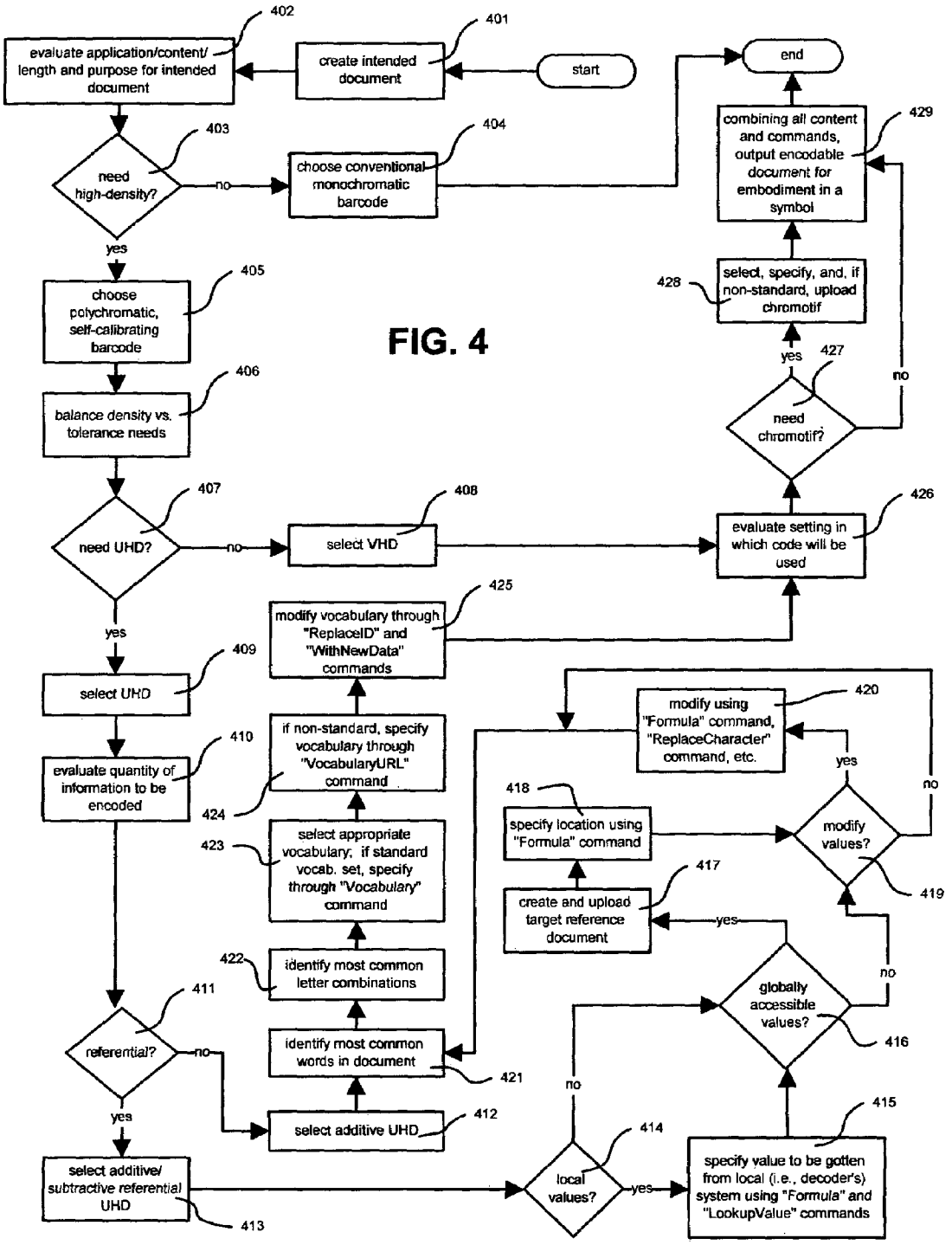

start
create intended document
evaluate application/content/ length and purpose for intended document
need high-density?
no
choose conventional monochromatic barcode
yes
choose polychromatic, self-calibrating barcode
balance density vs. tolerance needs
need UHD?
no
select VHD
yes
select UHD
evaluate quantity of information to be encoded
referential?
no
select additive UHD
yes
select additive/ subtractive referential UHD
local values?
yes
specify value to be gotten from local (i.e., decoder's) system using "Formula" and "LookupValue" commands
no
globally accessible values?
no
create and upload target reference document
yes
specify location using "Formula" command
modify values?
yes
modify using "Formula" command, "ReplaceCharacter" command, etc.
no
identify most common words in document
identify most common letter combinations
select appropriate vocabulary; if standard vocab. set, specify through "Vocabulary" command
if non-standard, specify vocabulary through "VocabularyURL" command
modify vocabulary through "ReplaceID" and "WithNewData" commands
evaluate setting in which code will be used
need chromotif?
yes
no
select, specify, and, if non-standard, upload chromotif
combining all content and commands, output encodable document for embodiment in a symbol
end
402
401
403
404
405
406
407
408
409
410
411
412
413
414
415
416
417
418
419
420
421
422
423
424
425
426
427
428
429

FIG. 4

FIG. 5A

	Conventional	*UHD*	*VHD*
Polychromatic		✓	✓
Referential / IHD		✓	✓*
Additive	✓	✓	✓
Subtractive		✓	✓*
Self-Defining		✓	✓*
Self-Calibrating		✓	✓
Chromotif Capable		✓	✓*
"Shift" Extension of Character Set		✓**	✓
Substitutive		✓	✓*

*These functions, while possible under VHD, are more appropriate for UHD.
**This function is possible but should typically be unnecessary under UHD; it may, however, be useful for word capitalization purposes (not shown).

FIG. 5B

Word	*Identifier*
The	ID 200
of	ID 201
and	ID 202
to	ID 203
in	ID 204
is	ID 205
[etc.]	

FIG. 5C

Diagraph	*Identifier*
th	ID 500
sh	ID 501
wh	ID 502
ou	ID 503
ch	ID 504
ph	ID 505
[etc.]	

FIG. 5D

Markup phrase	*Identifier*
	ID 96
	ID 97
http://	ID 98
.com	ID 99
<a href="	ID 100
www.	ID 101
[etc.]	

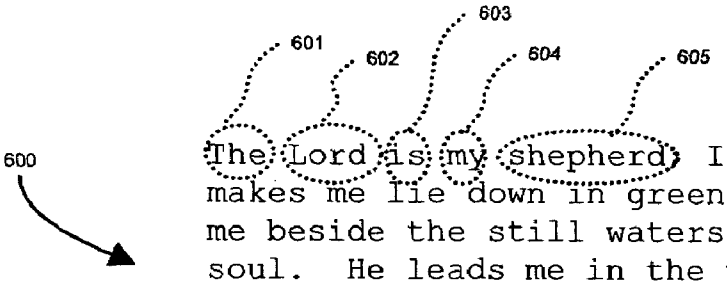
FIG. 5E

Command	*Identifier*
VocabularyURL	ID 700
ReplaceID	ID 701
WithNewData	ID 702
GetValue	ID 703
ChromotifURL	ID 704
variable1	ID 705
variable2	ID 706
[etc.]	

FIG. 5F

Data Modification Commands	*Identifier*
TreatVariableAsText	ID 800
ReplaceCharactersBegin	ID 801
ReplaceCharactersEnd	ID 802
SubstituteCharacters	ID 803
FormulaBegin	ID 805
InsertAfterCharacter	ID 807
Insert	ID 808
[etc.]	

FIG. 6


600
601
602
603
604
605
The Lord is my shepherd; I shall not want. He makes me lie down in green pastures; he leads me beside the still waters. He restores my soul. He leads me in the paths of righteousness for his name's sake. Yes, though I walk through the valley of the shadow of death, I will fear no evil, for you are with me. Your rod and your staff, they comfort me. You prepare a table before me in the presence of my enemies; you annoint my head with oil. My cup runs over. Surely goodness and mercy will follow me all the days of my life, and I will dwell in the house of the Lord forever.

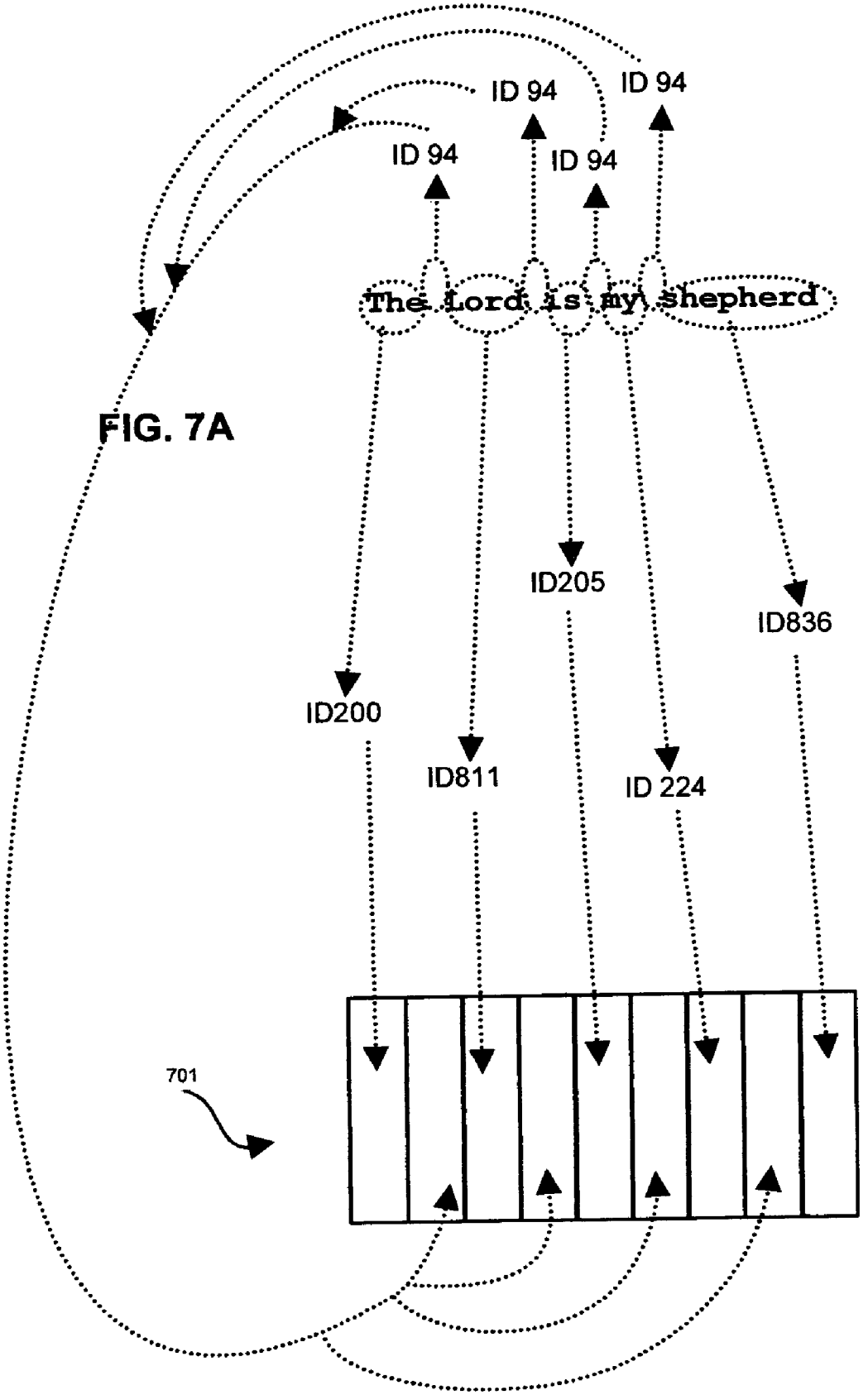

ID 94
ID 94
ID 94
ID 94
The Lord is my shepherd
ID205
ID836
ID200
ID811
ID 224
701

FIG. 7A

FIG. 7B

Color	*Identifier*
TerraCotta	ID 200
Garnet	ID 205
Beryl	ID 224
LapisLazuli	ID 811
Cobalt	ID 836

FIG. 7C

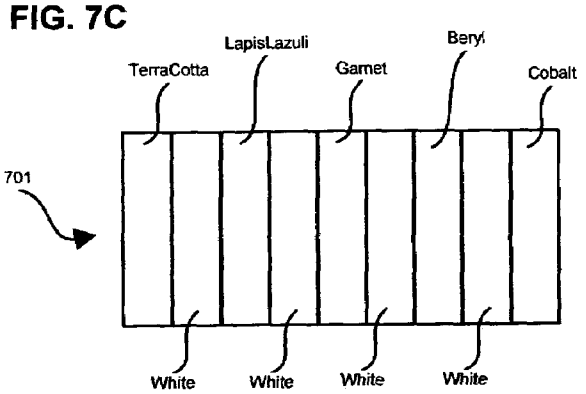


FIG. 7D

Data	*Identifier*
Lord	ID 811
shepherd	ID 836

FIG. 8

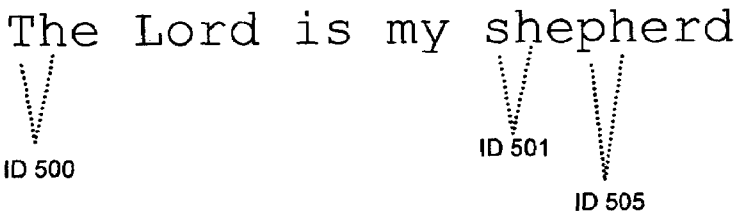


FIG. 9A

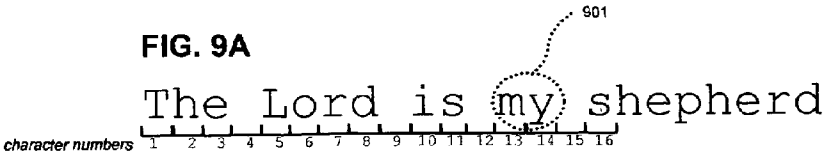
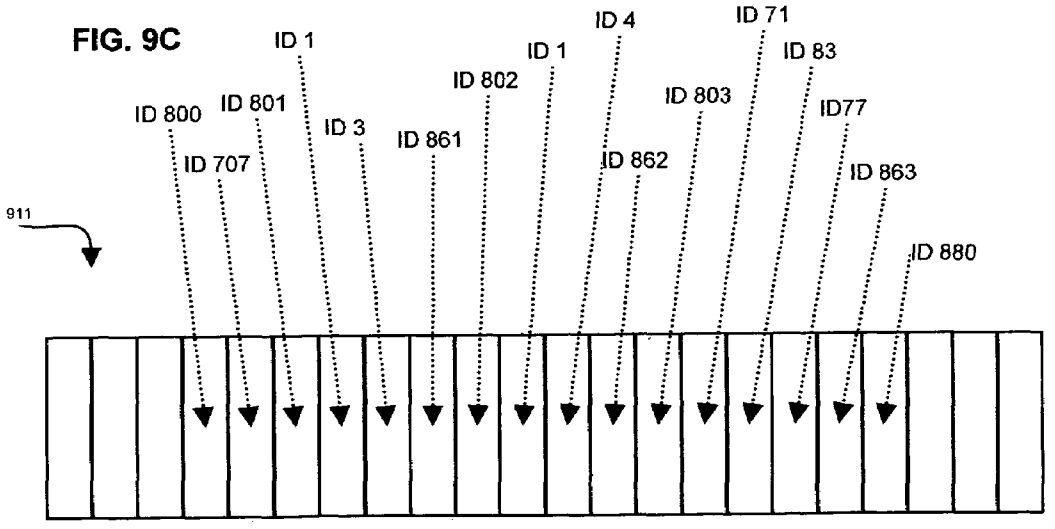


FIG. 9B

TreatVariableAsText	ID 800
Variable1	ID 707
ReplaceCharactersBegin	ID 801
1	ID 1
3	ID 3
/ReplaceCharactersBegin	ID 861
ReplaceCharactersEnd	ID 802
1	ID 1
4	ID 4
/ReplaceCharactersEnd	ID 862
SubstituteCharacters	ID 803
o	ID 71
u	ID 83
r	ID 77
/SubstituteCharacters	ID 863
/TreatVariableAsText	ID 880

FIG. 9C



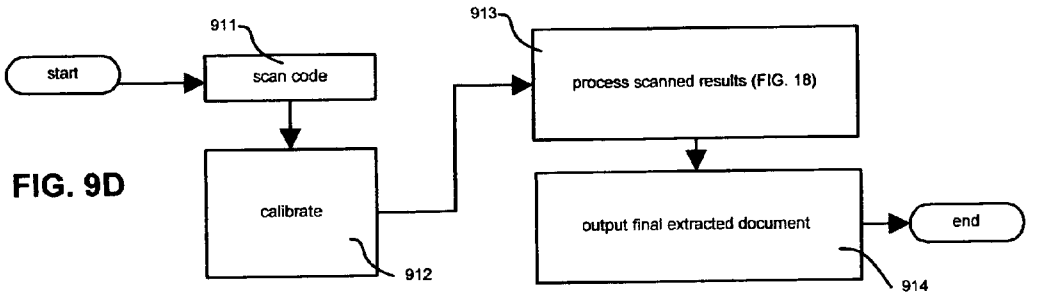


FIG. 9D

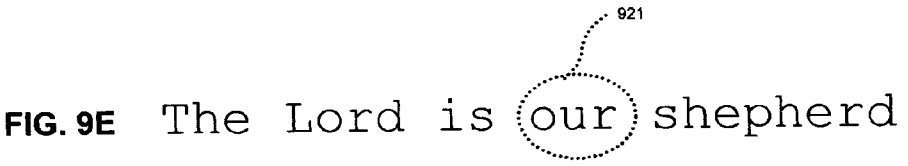


FIG. 9E

FIG. 10

VocabularyURL	ID 700
http://	ID 98
www.	ID 101
e	ID 51
p	ID 72
o	ID 71
e	ID 51
t	ID 81
.com	ID 99
/	ID 32
v	ID 85
o	ID 71
c	ID 47
/VocabularyURL	ID 770

FIG. 11

Formula	ID 805
Variable1	ID 707
=	ID 10
http://	ID 98
www.	ID 101
e	ID 51
p	ID 72
o	ID 71
e	ID 51
t	ID 81
.com	ID 99
/	ID 32
p	ID 73
s	ID 79
a	ID 43
l	ID 65
m	ID 67
/Formula	ID 855

FIG. 12

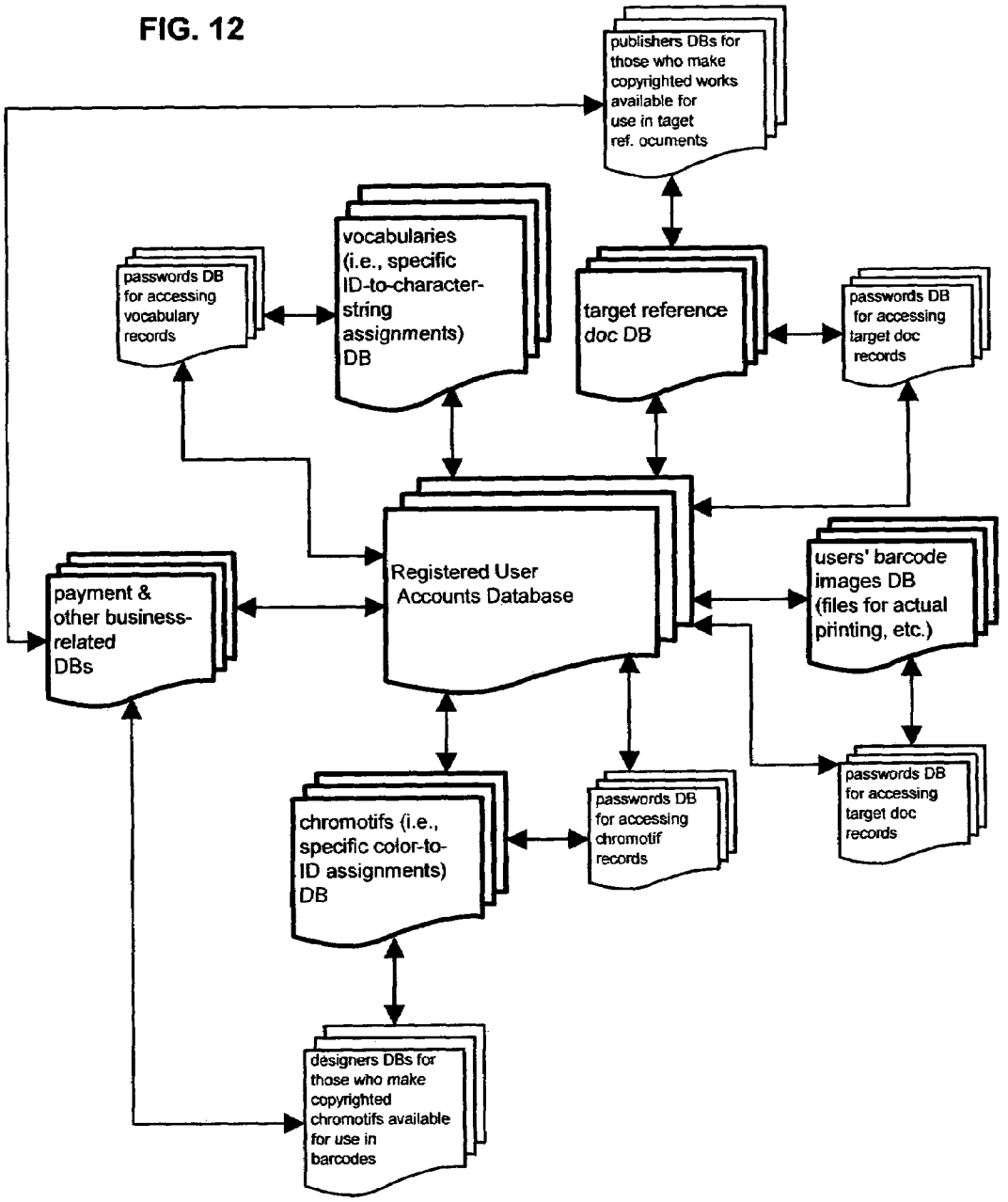

publishers DBs for those who make copyrighted works available for use in taget ref. ocuments
vocabularies (i.e., specific ID-to-character-string assignments) DB
passwords DB for accessing vocabulary records
target reference doc DB
passwords DB for accessing target doc records
Registered User Accounts Database
payment & other business-related DBs
users' barcode images DB (files for actual printing, etc.)
chromotifs (i.e., specific color-to-ID assignments) DB
passwords DB for accessing chromotif records
passwords DB for accessing target doc records
designers DBs for those who make copyrighted chromotifs available for use in barcodes

FIG. 13

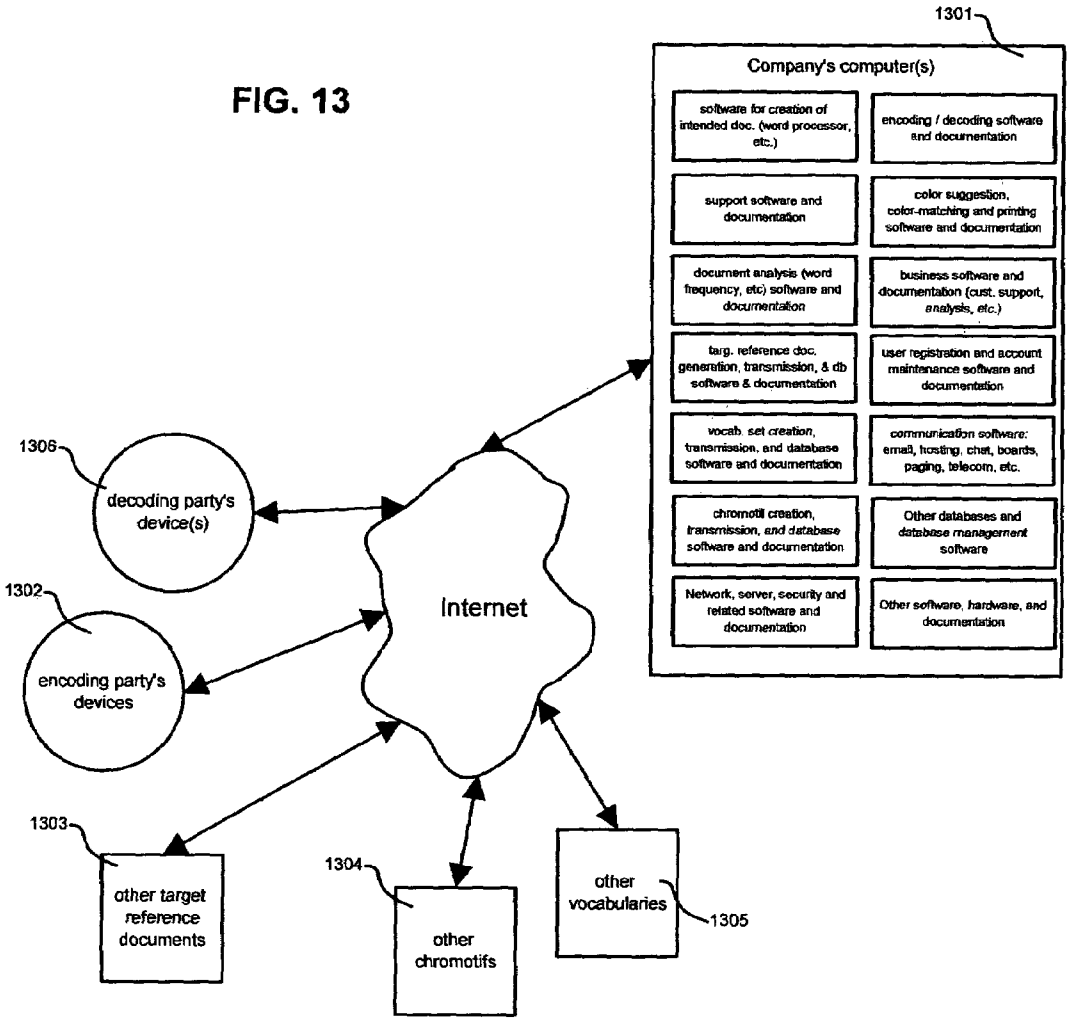

1301
Company's computer(s)
software for creation of intended doc. (word processor, etc.)
encoding / decoding software and documentation
support software and documentation
color suggestion, color-matching and printing software and documentation
document analysis (word frequency, etc) software and documentation
business software and documentation (cust. support, analysis, etc.)
targ. reference doc. generation, transmission, & db software & documentation
user registration and account maintenance software and documentation
vocab. set creation, transmission, and database software and documentation
communication software: email, hosting, chat, boards, paging, telecom, etc.
chromotif creation, transmission, and database software and documentation
Other databases and database management software
Network, server, security and related software and documentation
Other software, hardware, and documentation
1306
decoding party's device(s)
1302
encoding party's devices
Internet
1303
other target reference documents
1304
other chromotifs
other vocabularies
1305

FIG. 14

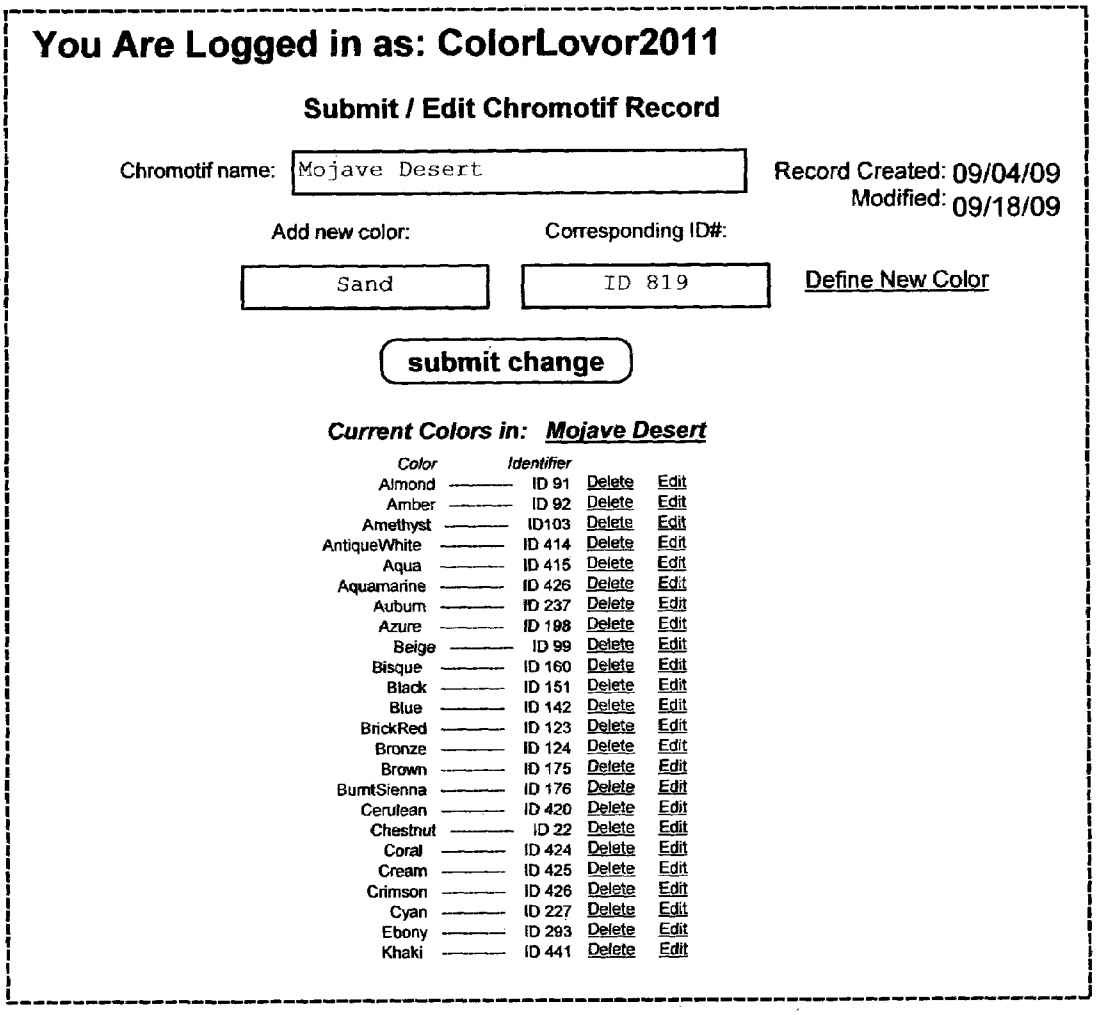

You Are Logged in as: ColorLovor2011
Submit / Edit Chromotif Record
Chromotif name: Mojave Desert
Record Created: 09/04/09
Modified: 09/18/09
Add new color:
Corresponding ID#:
Sand
ID 819
Define New Color
submit change
Current Colors in: Mojave Desert
Color Identifier
Almond ID 91 Delete Edit
Amber ID 92 Delete Edit
Amethyst ID103 Delete Edit
AntiqueWhite ID 414 Delete Edit
Aqua ID 415 Delete Edit
Aquamarine ID 426 Delete Edit
Auburn ID 237 Delete Edit
Azure ID 198 Delete Edit
Beige ID 99 Delete Edit
Bisque ID 160 Delete Edit
Black ID 151 Delete Edit
Blue ID 142 Delete Edit
BrickRed ID 123 Delete Edit
Bronze ID 124 Delete Edit
Brown ID 175 Delete Edit
BurntSienna ID 176 Delete Edit
Cerulean ID 420 Delete Edit
Chestnut ID 22 Delete Edit
Coral ID 424 Delete Edit
Cream ID 425 Delete Edit
Crimson ID 426 Delete Edit
Cyan ID 227 Delete Edit
Ebony ID 293 Delete Edit
Khaki ID 441 Delete Edit

FIG. 15A

1501

default value set -- trichomatic

char.	blot 1	blot 2	blot 3
A	White	White	Red
B	White	Red	White
C	Red	White	White
D	White	Red	Red
E	Red	Red	White
F	Red	Red	Red
G	White	White	Black
H	White	Black	White
I	Black	White	White
J	White	Black	Black
K	Black	Black	White
L	Black	Black	Black
M	Black	Black	Red
N	Black	Red	Black
O	Red	Black	Black
P	Black	Red	Red
Q	Red	Red	Black
R	White	Red	Black
S	White	Black	Red
T	Black	White	Red
U	Black	Red	White
V	Red	White	Black
W	Red	Black	White
X	Red	White	Red
Y	Red	Black	Red
Z	Black	White	Black
[shift]	White	White	White

FIG. 15B

1502

shifted value set -- trichomatic

char.	blot 1	blot 2	blot 3
1	White	White	Red
2	White	Red	White
3	Red	White	White
4	White	Red	Red
5	Red	Red	White
6	Red	Red	Red
7	White	White	Black
8	White	Black	White
9	Black	White	White
0	White	Black	Black
=	Black	Black	White
.	Black	Black	Black
,	Black	Black	Red
?	Black	Red	Black
!	Red	Black	Black
@	Black	Red	Red
/	Red	Red	Black
$	White	Red	Black
&	White	Black	Red
(	Black	White	Red
*	Black	Red	White
)	Red	White	Black
:	Red	Black	White
;	Red	White	Red
"	Red	Black	Red
[space]	Black	White	Black
[shift]	White	White	White

FIG. 15C

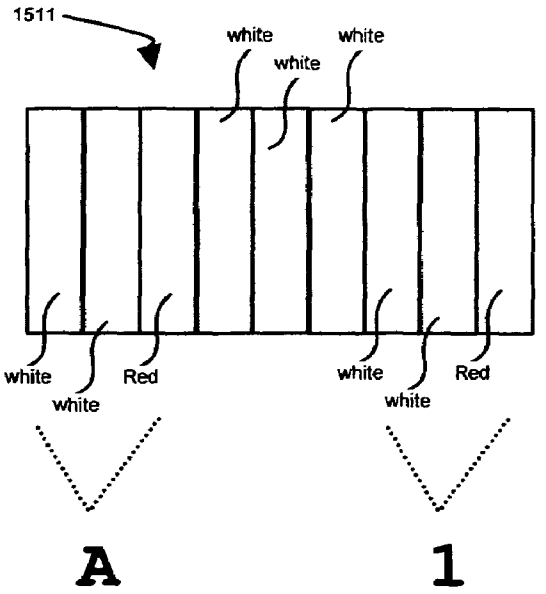


FIG. 15D

1521

colors	*bars*	*functionality notes*
6	2	ideal for use in ID-only application; no shift function
3	3	provides basic punctuation; requires shift; highest tolerance
5	2	provides basic punctuation; requires shift; excellent tolerance v. density balance (e.g., R, G, B, black and white)
4	3	provides basic punctuation without shift

FIG. 16

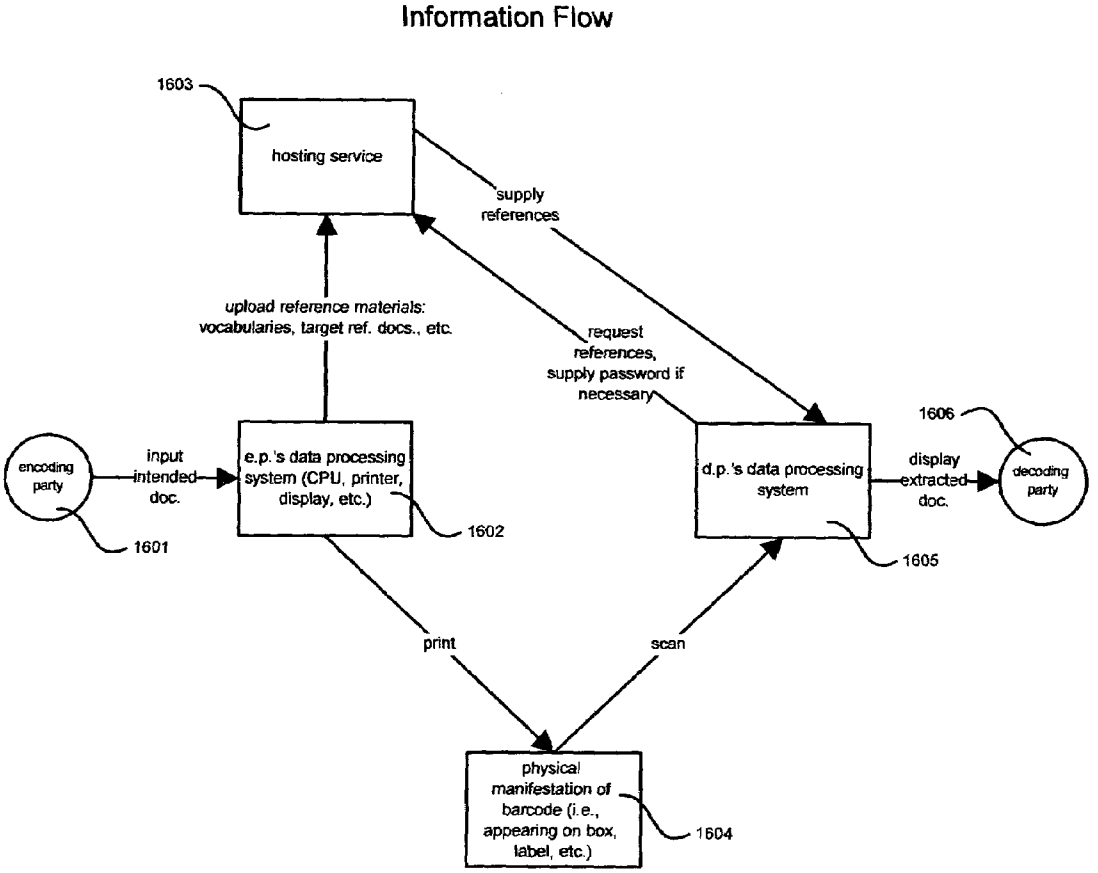

Information Flow
1603
hosting service
supply references
upload reference materials: vocabularies, target ref. docs., etc.
request references, supply password if necessary
encoding party
input intended doc.
e.p.'s data processing system (CPU, printer, display, etc.)
1602
1601
d.p.'s data processing system
1605
1606
display extracted doc.
decoding party
print
scan
physical manifestation of barcode (i.e., appearing on box, label, etc.)
1604

FIG. 17

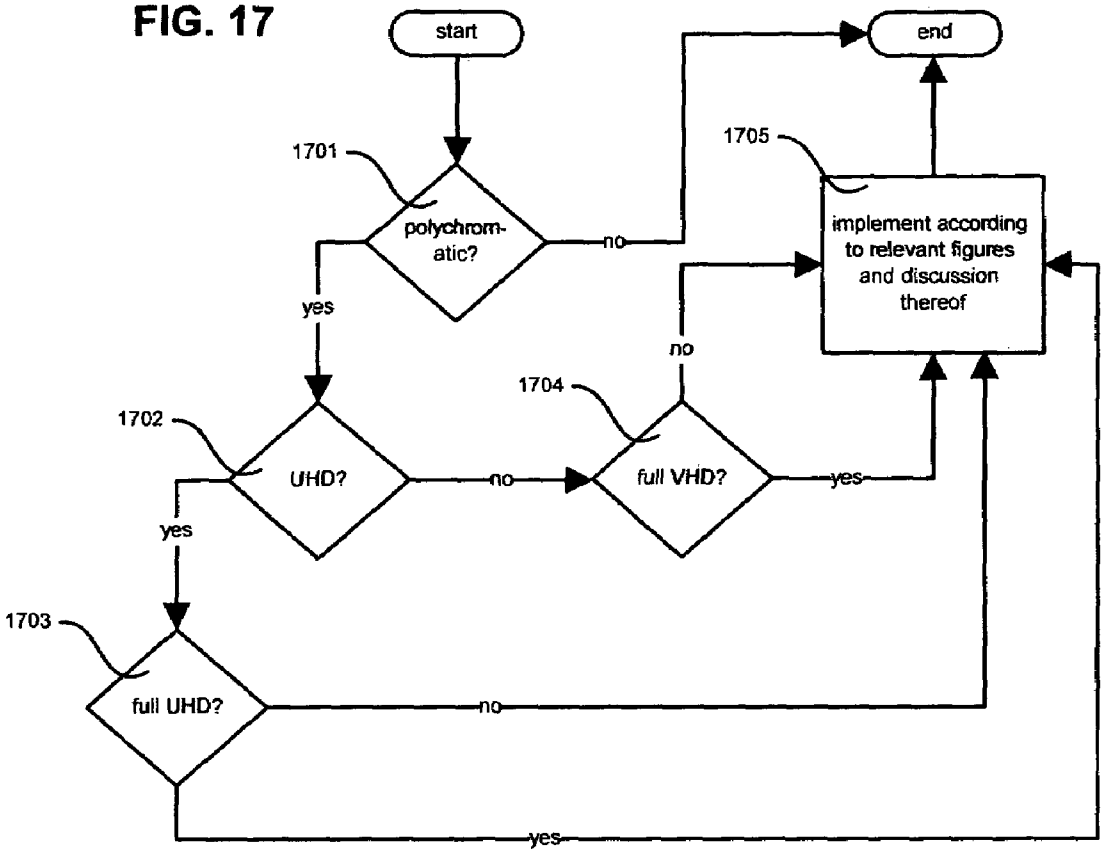

start
end
1701
polychrom-atic?
no
1705
implement according to relevant figures and discussion thereof
yes
no
1704
1702
UHD?
no
full VHD?
yes
yes
1703
full UHD?
no
yes

FIG. 18

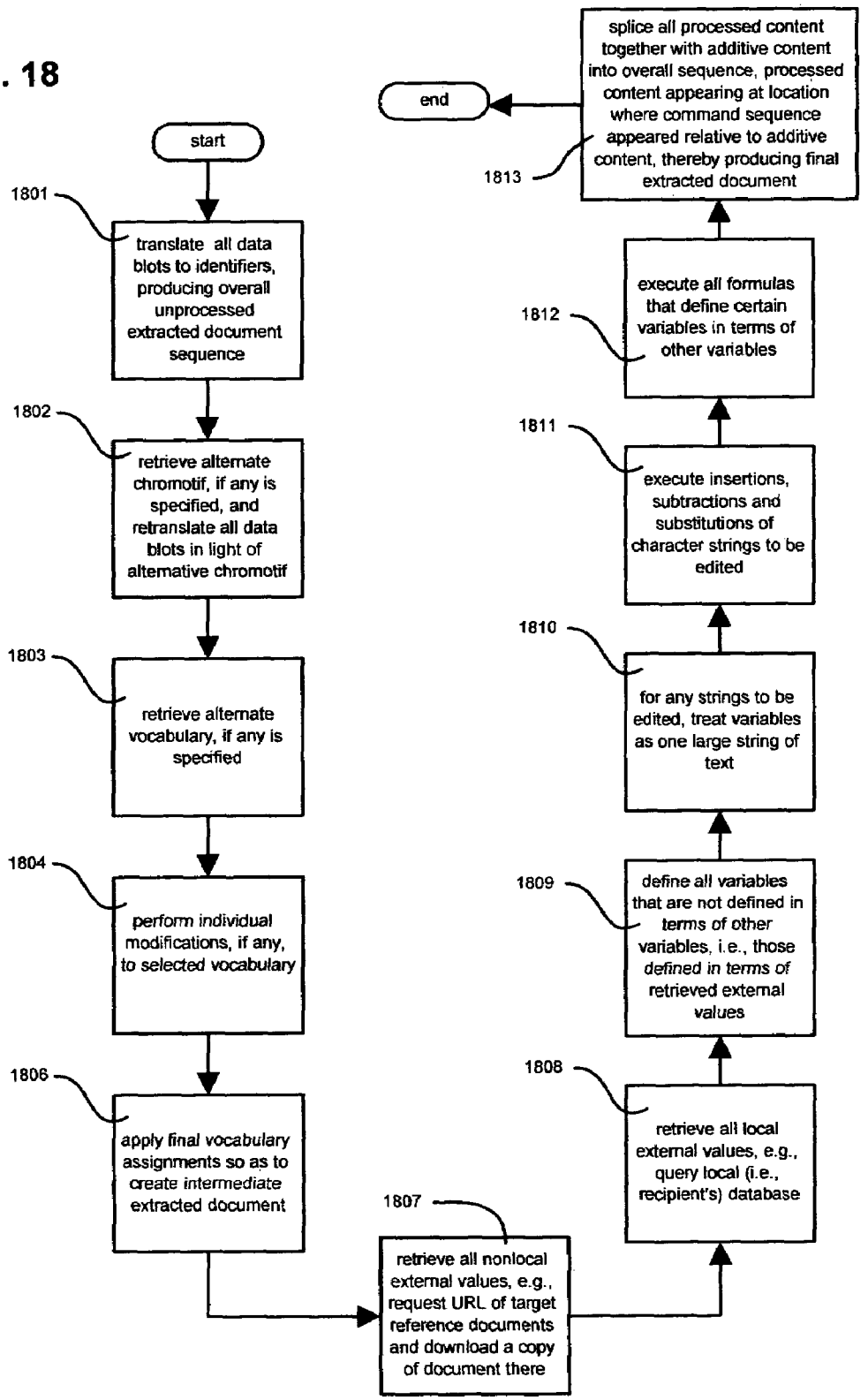

start
1801
translate all data blots to identifiers, producing overall unprocessed extracted document sequence
1802
retrieve alternate chromotif, if any is specified, and retranslate all data blots in light of alternative chromotif
1803
retrieve alternate vocabulary, if any is specified
1804
perform individual modifications, if any, to selected vocabulary
1806
apply final vocabulary assignments so as to create intermediate extracted document
1807
retrieve all nonlocal external values, e.g., request URL of target reference documents and download a copy of document there
1808
retrieve all local external values, e.g., query local (i.e., recipient's) database
1809
define all variables that are not defined in terms of other variables, i.e., those defined in terms of retrieved external values
1810
for any strings to be edited, treat variables as one large string of text
1811
execute insertions, subtractions and substitutions of character strings to be edited
1812
execute all formulas that define certain variables in terms of other variables
1813
splice all processed content together with additive content into overall sequence, processed content appearing at location where command sequence appeared relative to additive content, thereby producing final extracted document
end

FIG. 19

```
<VocabML>
<VocabName>Biblical Terms</VocabName>
<VocabAssignment>
<VocabID>ID811</VocabID>
<VocabData>Lord</VocabData>
</VocabAssignment>
<VocabAssignment>
<VocabID>ID836</VocabID>
<VocabData>shepherd</VocabData>
</VocabAssignment>
</VocabML>
```

FIG. 20A

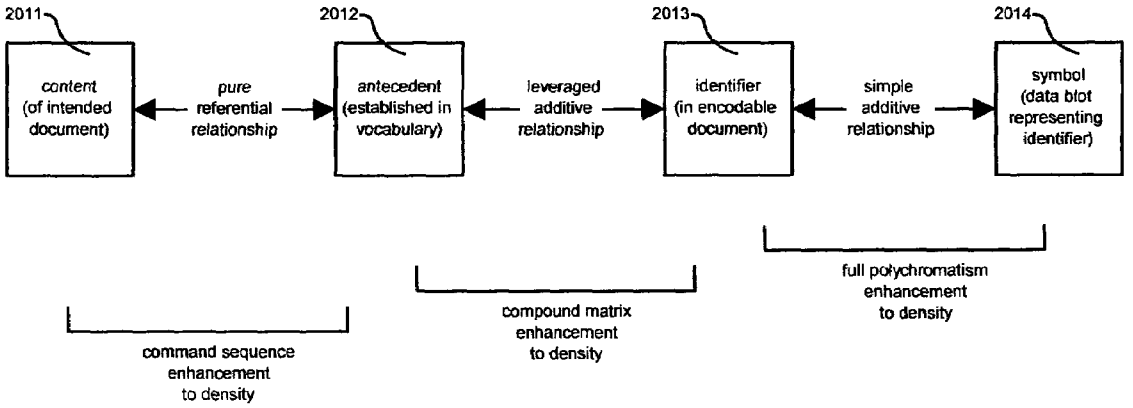
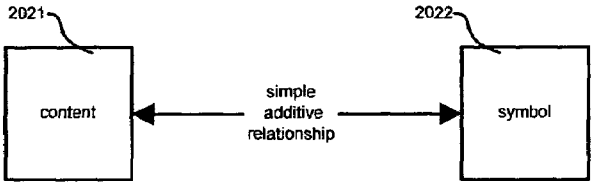


FIG. 20B

[prior art]



POLYCHROMATIC ENCODING SYSTEM, METHOD AND DEVICE

CROSS-REFERENCE TO RELATED APPLICATIONS

Priority filing of U.S. provisional patent application 60/603,964, filing date Aug. 23, 2004, entitled "Integrated Gaming Technology System, Method and Device" is claimed. Said provisional patent application is hereby incorporated by reference in its entirety into the present disclosure.

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 documents or patent disclosure, as it appears in the patent trademark office patent file or records, but otherwise reserves all rights whatsoever.

The inventor wishes to thank Nicole Theiss, Chris Chalsma, Susan Gorton, Robin Singh, and Steve Che.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH AND DEVELOPMENT

None.

REFERENCE TO SEQUENCE LISTING, A TABLE, OR A COMPUTER PROGRAM LISTING APPENDIX

None.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention relates to automatic identification, automatic data capture, and data storage technology, specifically, optical encoding.

2. Description of Related Art

Monochromatic barcodes and "2D" barcodes or portable data files, such as the Symbol PDF417 code, are known. But these symbologies uniformly suffer from extremely small information capacity per unit of area, i.e., information density.

Multicolor barcode solutions have been proposed in recognition of the potential for exponentially higher information density than the monochromatic approach allows. See, e.g., Saito, U.S. Patent Publication No. 2002/0066786 and related applications (hereinafter, collectively called "Saito"); Harrison, U.S. Patent Publication No. 2003/0209604 (hereinafter, "Harrison II"); see, also, Harrison, U.S. Patent Publication 2003/0193842 (using light phenomena to indicate time) (hereinafter, "Harrison I").

However, with the exceptions of Harrison I and II, these proposed polychromatic solutions are not ideal in that they suffer from:

- low tolerance for suboptimal conditions (e.g., imperfect lighting at the time of decoding, imperfect printing)
- lack of a comprehensive symbology for polychromatism
- failure to recognize or overcome the inherent limitations of additive coding
- rigidity: non-customizability of symbolic relationships
- information density and usability levels that are not compelling enough to create new markets or to ward off encroachment from competing solutions that offer other advantages, e.g., RFID
- inability to tailor barcode appearance to fashion and branding needs

- lack of high-level integration: failure to move beyond isolated building-blocks to fully deployable solutions
- inability to provide password protection for information in barcodes

Harrison I and II, meanwhile, fail to disclose a compound matrix structure, a command sequence reference mechanism, and numerous other novel features of the present invention.

What is needed, therefore, is a barcode or portable data file solution that (i) offers information density levels that are many times greater than those available under the most effective related art; (ii) is effective in diverse optical and commercial settings; (iii) is infinitely customizable; and (iv) otherwise overcomes many of the limiting factors that plague related art solutions.

It is an object of the present invention, therefore, to provide a fully integrated, polychromatic optical encoding solution which simultaneously achieves both unprecedented information density and a high degree of usability so that the system can be deployed under a wide variety of conditions.

The following definitions from Webopedia.com may be useful:

- "Pantone Matching System (PMS): A popular color matching system used by the printing industry to print spot colors. Most applications that support color printing allow you to specify colors by indicating the Pantone name or number. This assures that you get the right color when the file is printed, even though the color may not look right when displayed on your monitor. PMS works well for spot colors but not for process colors, which are generally specified using the CMYK color model."
- "color matching: The process of assuring that a color on one medium remains the same when converted to another medium. This is extremely difficult because different media use different color models. Color monitors, for example, use the RGB model, whereas process printing uses the CMYK model. As color desktop publishing matures, color matching is gaining more and more attention. The most recent Windows and Macintosh operating systems include a color management system (CMS) to assist in color matching."
- "spot color: Refers to a method of specifying and printing colors in which each color is printed with its own ink. In contrast, process color printing uses four inks (cyan, magenta, yellow, and black) to produce all other colors. Spot color printing is effective when the printed matter contains only one to three different colors, but it becomes prohibitively expensive for more colors. Most desktop publishing and graphics applications allow you to specify spot colors for text and other elements. There are a number of color specification systems for specifying spot colors, but Pantone is the most widely used."
- "process colors: Refers to the CMYK color model used in offset printing."
- "CMYK: Short for Cyan-Magenta-Yellow-Black . . . . CMYK is a color model in which all colors are described as a mixture of these four process colors. CMYK is the standard color model used in offset printing for full-color documents. Because such printing uses inks of these four basic colors, it is often called four-color printing. In contrast, display devices generally use a different color model called RGB, which stands for Red-Green-Blue. One of the most difficult aspects of desktop publishing in color is color matching—properly converting the RGB colors into CMYK colors so that what gets printed looks the same as what appears on the monitor."

Numerous distinct technologies from distinct industries are also relevant to the present disclosure, including: color

matching systems, such as those used to scan housepaint samples of an unknown color so as to produce a matching batch of paint; data processing equipment, including computers, and all related hardware and software, such as monitors, printers, scanners, spectrophotometers, database management software, and Web server and browser software; operating systems (the present invention is OS-agnostic) and programming, markup, scripting, and database query languages; color analysis and management hardware and software; automatic data capture hardware and software, particularly optical; and remaining relevant technologies. All documents which, as of the time of this writing, may be found through www.google.com, www.wikipedia.org, or www.yahoo.com are hereby incorporated by reference into the present disclosure in their entirety for the purpose of informing the reader about these and all other relevant technologies.

BRIEF SUMMARY OF THE INVENTION

The first of two alternative embodiments provides an ultra-high-density (UHD) barcode, symbology, method, device and system, thereby providing maximum information density—and in some cases, infinitely high density—but enjoying less tolerance for imperfection than the second alternative embodiment. The second alternative embodiment provides a very-high-density (VHD) barcode, symbology, method, device and system, thereby providing exponentially higher information density than related art barcode technology while also enjoying greater printability and tolerance for imperfection in real world environments than the UHD embodiment.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1**A is a flowchart depicting the basic process whereby a UHD barcode according to the present invention is created, deployed, and used.

FIG. **1**B is a chart depicting a matrix of color-to-identifier relationships according to the present invention.

FIG. **1**C is a chart depicting a matrix of identifier-to-antecedent relationships according to the present invention.

FIG. **1**D depicts a brief intended document to be encoded and decoded to demonstrate the present invention.

FIG. **1**E depicts relationships between example antecedents and corresponding identifiers and colors per the relationships depicted in FIGS. **1**B and **1**C according to the present invention.

FIG. **1**F depicts a polychromatic barcode according to the present invention.

FIG. **1**G depicts a scanner scanning a barcode according to the present invention.

FIG. **1**H depicts a continuum of color values, including a standard or ideal parameter value and a measured parameter value.

FIG. **1**(I) depicts the continuum of color values after it has been calibrated so as to compensate for the discrepancy between the standard value and the scanned value according to the present invention.

FIG. **1**J depicts the values of a scanned color being compared against the values of two standard colors according to the present invention.

FIG. **1**K depicts a relationship between an extracted color, i.e., a standard color which has been found to be the standard color closest in value to a scanned color, and the corresponding identifier and antecedent associated with the extracted color per the relationships depicted in FIGS. **1**B and **1**C according to the present invention.

FIG. **1**L depicts a barcode and the relationships between identifiers and antecedents represented in the barcode according to the present invention.

FIG. **2**A depicts six example pairs of color blots according to the present invention.

FIG. **2**B is a chart depicting a matrix of relationships between thirty-six unique alphanumeric characters and thirty-six unique pairs of color blots according to the present invention.

FIG. **3**A depicts an alternative calibration symbol according to the present invention.

FIG. **3**B depicts a barcode according to the present invention.

FIG. **3**C depicts a barcode, including human-readable alphanumeric characters visually superimposed upon corresponding color blot pairs according to the present invention.

FIG. **4** is a flowchart depicting a more complex embodiment of the process whereby a UHD barcode is created and used according to the present invention.

FIG. **5**A is a chart depicting criteria according to which an evaluation of the appropriateness of a UHD or VHD barcode as compared to a conventional barcode may be conducted according to the present invention.

FIGS. **5**B through **5**F are charts depicting additional matrices of relationships between identifiers and text according to the present invention.

FIG. **6** depicts a longer intended document for use in illustrating referential, subtractive, and substitutive functions of the present invention.

FIG. **7**A depicts the relationships between a portion of the intended document in FIG. **6** with identifiers corresponding to the words of this portion, including the barcode segment resulting from encoding this portion through the referential function according to the present invention.

FIG. **7**B is a chart depicting an additional matrix of relationships between identifiers and colors according to the present invention.

FIG. **7**C depicts the barcode depicted in FIG. **7**A in which are noted the colors of color blots as determined by the relevant matrices according to the present invention.

FIG. **7**D is a chart depicting a subject-specific vocabulary according to the present invention.

FIG. **8** depicts the portion of the intended document depicted in FIG. **7**A and relationships between included diagraphs and corresponding identifiers according to the present invention.

FIG. **9**A depicts the portion of the intended document depicted in FIG. **7**A along with numbering to be used in the editing, i.e., subtractive, substitutive, and insertive, functions of the present invention.

FIG. **9**B depicts a series of commands and data to be encoded so as to execute a modification of the portion of the intended document depicted in FIG. **9**A through subtraction and substitution according to the present invention.

FIG. **9**C depicts a barcode representing the series of commands and data depicted in FIG. **9**B according to the present invention.

FIG. **9**D is a flowchart depicting a process whereby the code in FIG. **9**C is scanned, decoded and modified according to the present invention.

FIG. **9**E depicts an extracted document resulting from modification of the portion of the intended document depicted in FIG. **9**A according to the series of commands depicted in FIG. **9**B and represented in the barcode depicted in FIG. **9**C according to the present invention.

FIG. **10** depicts a series of commands whereby an alternative vocabulary is specified according to the present invention so as to enable the self-defining function of the present invention.

FIG. **11** depicts a series of commands whereby a variable is defined by a reference to a target reference document according to the present invention so as to enable the referential function of the present invention.

FIG. **12** depicts the primary relationships between a series of databases according to the present invention, including those which enable the password-protection function of the present invention.

FIG. **13** depicts general system components of the present invention, including components of an apparatus used by a company.

FIG. **14** depicts an excerpt from a Web submission form whereby a user submits information for storage in a database according to the present invention, in particular a database comprising records of chromotifs.

FIG. **15**A is a chart showing a matrix of relationships between alphabetical characters and unique color blot triplets in the VHD embodiment of the present invention.

FIG. **15**B is a chart showing a matrix of relationships between the same unique color blot triplets depicted in FIG. **15**A and a different set of characters, namely, the characters assigned to these color blot triplets when they are immediately preceded by a "shift" triplet according to the present invention.

FIG. **15**C depicts a barcode in which a shift triplet is used so as to enable extraction according to the shifted character set rather than the default character set according to the present invention.

FIG. **15**D is a chart describing and comparing features of VHD options for use in deciding which embodiment is appropriate for a given barcode application according to the present invention.

FIG. **16** is a schematic diagram depicting an exemplary information flow of the UHD embodiment of the present invention.

FIG. **17** is a flowchart summarizing the present invention at a high level, the steps and parts of which are illustrated in other figures.

FIG. **18** is a flowchart depicting the process of acquiring and processing references and acquired content so as to yield a final extracted document according to the present invention.

FIG. **19** is an example vocabulary document to be uploaded to an Internet-accessible server for purposes of properly decoding barcodes that reference it according to the present invention.

FIGS. **20**A and **20**B depict the symbolic relationship tiers of the present invention and the prior art, respectively.

DETAILED DESCRIPTION OF THE INVENTION WITH REFERENCE TO THE DRAWINGS

1.1 Introduction

The present invention provides a barcode system, method and device that achieves superior information density and usability through a number of innovations, including:

- code self-definition, through which mechanism each individual code may be processed according to instructions uniquely created for and embedded in that code
- code self-calibration, enabling tolerances that are high enough to permit effective deployment of a polychromatic code under and for a wide variety of conditions and purposes
- target document reference, including full Internet integration, achieving virtually unlimited information density
- compound matrix structure, whereby infinite custom vocabularies and color schemes can be easily created, stored, retrieved and modified so as to maximize information density and usability
- subtractive, substitutive, and insertive processing of external references, allowing greater latitude in the use of external references
- full polychromatism, enabling a high number of discrete primary-tier symbolic relationships
- aesthetic flexibility sufficient to allow symbols to match almost any color context
- a full-service Web-based company system, through which any Internet user can create an account and create, securely store, and access vocabularies, chromotifs, target reference documents, and related tools
- "shift" character expansion of character sets
- alternate blot-to-identifier ratios
- numerous other supporting innovations

1.2 Definitions

Definitions for terms used in the present disclosure include:

- "UHD" signifies "ultra-high-density," which term is used to describe an embodiment of the present invention in which full polychromatism is used.
- "VHD" signifies "very-high-density," which term is used to describe an embodiment of the present invention in which limited polychromatism (approximately three to six highly distinguishable colors) is used.
- "Chromotif" signifies a matrix of relationships between colors and identifiers that has been tailored to a particular color environment. Notwithstanding the chromotif function, however, calibration symbols and the command sequences specifying any alternate chromotif or vocabulary should be encoded according to the default color-to-identifier and vocabulary matrices so that a starting point for self-definition exists.
- "Antecedent" signifies a discrete bundle of content (e.g., a single ASCII character, a multi-character text string, a word, a phrase, or a command) ultimately represented by a data blot or data blot pair or triplet; this representation can be direct or through an intermediate value, i.e., through an identifier. The latter (intermediary) route is inherent in the compound matrix structure of the UHD embodiment, while the former (direct) route is primarily used in the VHD embodiment.
- "Color standard" signifies a set of color parameter values which, taken as a whole, uniquely define a color in the abstract; for instance, the color "powder blue", according to the present disclosure, has a red value of "0", a green value of "51", and a blue value of "153". Color standards are compared against actual measured values of scanned colors so as to determine which color is most likely the one intended to be conveyed.
- "Limited" vs. "Full" embodiment. The limited UHD embodiment does not rely upon target reference documents, while the full UHD embodiment does. The limited VHD embodiment does not rely upon a shift function, while the full VHD embodiment does.
- "Unique identifier," or simply "identifier," signifies an alphanumeric character string, such as "ID 172," that is used as an intermediate value according to the compound matrix structure of the present invention so as to

facilitate establishment and manipulation of relationships between colors and antecedents.

"Vocabulary" signifies a matrix of relationships between identifiers, on the one hand, and antecedents on the other. While it is possible for an antecedent to be represented by more than one identifier (not recommended), each identifier represents only one antecedent so that there is no ambiguity in what an identifier symbolizes. A useful exception to this one-to-one rule may be achieved through the described "shift" function.

"Color blot" signifies an area of color appearing in a barcode symbol according to the present invention; a color blot can either be a "data blot" or a "calibration blot", the former being an indicator ultimately related to an antecedent and the latter serving as a means for comparing colors as they empirically appear in a particular manifestation, e.g., printed instance, of a barcode image against ideal color standards but having no symbolic value.

"Command" and "Command Sequence": a command is an antecedent that does not represent content of the intended document but rather indicates an action to be performed in acquiring or processing such content. A command sequence comprises both instructions that indicate steps to be performed and identity information that identifies the subject matter to be processed, location of information to be acquired, etc. Command sequences are ideally performed automatically through appropriate scripting and programming, but these instructions may be carried out by humans.

"External value" signifies content that does not explicitly and literally appear in a vocabulary as an antecedent, meaning that a source of information outside the symbol itself must be used to ascertain the full meaning of the symbol. There are two type of external values: "local," meaning content obtained by a query command sequence represented in the barcode and to be supplied by the recipient's system, and "nonlocal," meaning content obtained by requesting a document at a URL specified in the barcode.

"Intended document" signifies the document that the encoding party, i.e., the "sender," wants the decoding party to receive by way of a barcode.

"Extracted document" signifies the document actually received by the decoding party, i.e., the "recipient," through the decoding of a barcode. The final extracted document should match the intended document unless there has been an error in encoding or decoding.

"Encodable document" signifies the actual identifier sequence to be encoded into a barcode, including but not limited to identifiers corresponding to command antecedents and content antecedents.

"Infinitely-high-density" or "IHD" refers to a barcode according to the present invention that includes a command sequence referencing a target reference document such that there is no limit to the amount of information that can be conveyed through the barcode.

"Symbol" vs. "Image": for clarity, an attempt has been made in the present disclosure to use the term "symbol" to refer to a barcode when the barcode is being discussed primarily for its meaning, i.e., the content it represents, and to use the term "image" to refer to a barcode when the barcode is being discussed primarily for its physical and optical properties. Nonetheless, these discussions necessarily overlap.

"Prior" and "Preceding": for the purposes of the present disclosure, it is assumed that, where relevant, a barcode according to the present invention represents information horizontally in a left-to-right fashion, with left being first and right being last in a sequence. Separate barcodes may also be stacked vertically so that, after one code has been scanned, the next one down can be scanned to supplement information conveyed through the first, much as text is presented on a page in English, i.e., first-horizontal-then-vertical motion.

"Chromocode" signifies a barcode according to the present invention.

"Barcode" as used herein encompasses "portable data file" and other terms for machine-readable optical symbols.

2.1 Limited Ultra-High-Density (UHD) Embodiment

FIG. **1**A is a flowchart depicting the basic process whereby a limited UHD chromocode embodiment of the present invention is created, deployed, and used. First, a color-to-unique-identifier matrix is created **101**, such as the color-to-identifier matrix **121** depicted in FIG. **1**B. Next, an antecedent-to-identifier matrix (a vocabulary) is created **102**, such as the ASCII-only, monocharacter-only vocabulary **122** depicted in FIG. **1**C. The two depicted matrices are, as of the time of this writing, the default matrices for their respective purposes, i.e., in the absence of specification of (or, when processing a chromocode, prior to retrieval of) an alternate vocabulary or chromotif (per processes described below), the vocabulary **122** depicted in FIG. **1**C is that which is used to decode UHD chromocodes. Thus, in the UHD embodiment, the default values specified in these matrices are always in effect whenever not preempted by selection of alternate vocabularies, modification commands, etc., as described below.

Next, an intended document is created **103**, such as the brief intended document **123** depicted in FIG. **1**D. Next, the characters in the intended document are translated **104** into the unique identifiers that correspond to these characters in the vocabulary **122**. Next, the identifiers are translated **105** into the colors that correspond to these identifiers in the color-to-identifier matrix **121**, thereby creating a sequence of colors that correspond to the characters in the intended document. FIG. **1**E depicts the two-step translation of selected antecedents in the brief intended document **123** into corresponding identifiers and identifiers into colors according to the present invention per the relationships depicted in FIGS. **1**B and **1**C.

Next, an image is created **106** of a chromocode embodying a sequence of data blots, wherein the sequence of data blots matches the color sequence which has been determined by the above two-step translation of antecedents to identifiers to colors; such a chromocode **150** is depicted in FIG. **1**F. This image **150** also includes calibration blots prior to or following the data blots. The chromocode image **150** is then applied **107**, by printing or other means, to a surface, such as a box or label like the product package **180** depicted in FIG. **1**G.

When the chromocode is to be decoded, the recipient scans the image **150** with a scanner **181** in communication with data processing software suitable for analyzing and detecting differences in color. Each of the measured color parameter values of each scanned calibration blot fall along a continuum **185** of potential values for each color parameter such as the continuum depicted in FIG. **1**H. The actual measured value **187** for each parameter of each calibration blot is compared **109** against the ideal value **186** for the color standard that is supposed to be manifested in the given calibration blot, thereby producing a measure of deviation from the ideal for this parameter. Thereafter, when data blots are processed so as

to decode the chromocode, all scanned values, wherever they fall along the continuum, are shifted in accordance with measured deviation as depicted in FIG. **1**(I), thereby achieving calibration **109**.

The post-calibration values of each scanned data blot are compared **110** against the corresponding values of color standards so as to determine which color is supposed to be manifested in each data blot. An example of a comparison between the parameter values of a particular scanned color blot and the values of two potentially matching color standards is depicted in FIG. **1**J.

In the depicted example, the combined absolute values of the margin of deviation of the scanned color from the parameters (in the depicted case, RGB) of the color standard for "powder blue" is significantly lower than the combined absolute values of such margin of deviation from the color standard for "royal blue." Thus, the extracted color for the given color blot is interpreted to be powder blue, which corresponds to unique identifier "ID 66", which in turn corresponds to the capital letter "M" as depicted in FIG. **1**K, in accordance with the matrices depicted in FIGS. **1**B and **1**C.

When an extracted color has been determined for each data blot, extracted colors are translated into corresponding identifiers **111**, and the resulting identifiers are translated into corresponding antecedents **112**, which are individual ASCII characters in the default vocabulary **122**. FIG. **1**L depicts the final result of this two-step translation: a replication **190** of the intended document **123**. This extracted document **190** is then output for viewing, manipulation, or other use by the recipient.

3.1 Limited Very-High-Density (VHD) Embodiment

FIG. **2**A depicts six example pairs **201-206** of color blots for use in a limited VHD embodiment of the present invention. Under this embodiment, each of the twenty-six characters of the English alphabet and each of the ten Arabic numerals is assigned to a unique pairing of colors, the colors of which are drawn from a pool of six highly distinguishable colors, such as white, yellow, blue, red, green, and black (treating white and black as "colors"; see, Harrison I for more discussion of light phenomena perceived as colors by humans). Exactly thirty-six such pairings are possible, which allows for an exact match between the number of possible pairings and the number of alphanumeric characters to be assigned. A complete default matrix **211** of relationships between alphanumeric characters and color pairings according to the present invention appears in FIG. **2**B.

The highly distinguishable nature and limited number of the colors used in these pairings makes the VHD embodiment more tolerant of deviation from color standards than the UHD embodiment. This enhancement is accompanied by a sacrifice of information density. The basic alphanumeric-only set of characters in this code is well-suited for automatic ID applications.

FIG. **3**A depicts an alternate calibration symbol **301** for use in the limited VHD embodiment. While the calibration process is similar to that described above, this calibration symbol may alternately be used, providing four calibration blots in a space that is smaller than the space required for four data blots.

FIG. **3**B depicts a chromocode **311** according to the VHD embodiment symbolizing the word "EPOET".

FIG. **3**C depicts a chromocode according to the VHD embodiment of the present invention and including human-readable alphanumeric characters **331-335** superimposed upon one of the two color blots in the color blot pairs representing these characters. It is recommended that the color of the alphanumeric character be of a color that contrasts highly with the color of the color blot against which it is set; compare, Harrison II.

4.1 Full UHD Embodiment Overview

In the limited UHD embodiment, individual characters of the intended document are represented by individual data blots in the resulting chromocode such that one blot represents "M", another blot represents "y", and so on. Greater information density can be achieved, however, if entire words or groups of characters are represented by a single blot such that one blot represents "Myths", another blot represents "Magicry", and so on.

In order for a given blot to represent an entire word or character string, the identifier represented by the given blot must be assigned to the word or character string to be represented. Such an assignment requires definition and specification of additional vocabulary or modification of the default vocabulary.

FIG. **4** is a flowchart depicting the full functionality of the UHD embodiment, through which values may be modified and supplemented and numerous other disclosed techniques used to increase information density and usability. Steps may be implemented by human, computer, or both as desired.

First, an intended document is created **401** and evaluated **402**. This evaluation is made through consideration of the content of the intended document, the length thereof, and the application/objective for or context within which the resulting chromocode will be used. The criteria for this evaluation include those criteria listed in FIG. **5**A, which presents a chart detailing the relative merits of a UHD or VHD chromocode as compared to a conventional barcode under the specified criteria. For instance, if the context for the resulting barcode calls for a chromotif-capable barcode, a UHD chromocode will likely be preferable.

If a high-density barcode is unnecessary, a conventional monochromatic barcode may be used **404**. Otherwise, a polychromatic barcode should be used **405**. In the latter case, an additional evaluation must be made to determine whether UHD or VHD is preferable **406**. In this evaluation, the benefits of greater density are weighed against the benefits of higher tolerance for deviation from color standards **406**. If tolerance is preferred **407**, a VHD code should be used **408**. Otherwise, a UHD code should be used **409**.

If UHD is preferred **409**, the quantity of information in the intended document is further evaluated **410** to determine whether a referential code is appropriate. If not **411**, a strictly additive approach is taken **412**. If so, an approach is taken that allows for referential, subtractive, substitutive, and insertive encoding and decoding **413**.

Under the latter method path, local and nonlocal external values may be incorporated into the extracted document. If local values are to be incorporated into the extracted document **414**, command sequences specifying the values to be obtained from the recipient are generated **415** for inclusion in the encodable document; such a sequence may be in the form of a database query. If nonlocal external values are to be incorporated into the extracted document **416**, a target reference document is uploaded **417** to an Internet-accessible server, and a command sequence specifying the URL of this document is generated **418** for inclusion in the encodable document. An example excerpt from a vocabulary comprising sample assignments of identifiers to commands for use in a referential UHD code appears in FIG. **5**E. An example

excerpt from a vocabulary comprising commands for use in modifying external values after acquisition appears in FIG. **5**F.

Note that target reference documents should be simple text (.txt) files consisting solely of content which the user wishes to reference. By contrast, references that require structure, e.g., chromotifs and vocabularies, should be marked-up through use of markup tags (for instance, conforming to XML conventions, if desired). An example of such tagging appears in FIG. **19**, which is included as a suggestion, but, as will be apparent to one skilled in the art, alternate tag names and markup structures may be used. For automated processing, the decoding party's system should contain software suitable for parsing the tagged documents so as to import the appropriate vocabulary and chromotif relationships into memory for use in properly decoding a chromocode by reference to the vocabulary or chromotif so defined.

If any external values are to be modified **419** after acquisition per the processing discussion below, command sequences specifying operations to be performed on these external values are generated **420** for inclusion in the encodable document.

After performance of these steps, the referential, subtractive and substitutive path rejoins the additive path. Content not to be acquired by external reference is then analyzed to identify the most common terms **421** and most common letter combinations **422** therein. A base vocabulary is selected **423** that will provide the greatest information density in light of the results of the analysis of this internal data; if a nonstandard vocabulary is to be gathered from an external source, command sequences specifying the URL of this vocabulary are generated **424** (referential code only) for inclusion in the encodable document. An example excerpt of a vocabulary comprising the most common words in English appears in FIG. **5**B. An example excerpt from a vocabulary comprising the most common diagraphs in English appears in FIG. **5**C. A example excerpt from a vocabulary comprising the most common terms used in HTML documents appears in FIG. **5**D. Multiple vocabularies may be used in conjunction with each other so long as identifier assignments do not conflict.

Any modifications to the default or, if used, selected vocabulary are achieved through the use of vocabulary modification command sequences **425**; a vocabulary modification sequence uses a "ReplaceID" nest, within which is specified a particular identifier, and a "WithNewData" nest, within which is provided a new antecedent to be represented by the given identifier in lieu of the antecedent that would otherwise be represented, thereby.

After these steps, the final sequence of identifiers to be included in the encodable document has been determined, and the remaining steps pertain to appearance of the chromocode. The contextual setting in which the code will be used is evaluated **426**, taking into consideration such matters as the colors of the packaging to which the chromocode is to be applied. If the use of a chromotif is desirable **427**, the appropriate chromotif is selected and specified and any modifications thereto made through command sequences **428**; if necessary, the chromotif may be uploaded and referenced by URL.

Finally, the encodable document is reduced to an image comprising data blots colored according to the default color-to-indentifier set or selected chromotif, if any. Calibration blots are also included in the image **429**. The resulting final chromocode image may then be applied to a surface.

The process depicted in FIG. **4** can be more fully understood through the following examples illustrating the referential, self-defining, subtractive, substitutive, and other functions.

FIG. **6** depicts an example intended document **600**, including the first five words **601**-**605** of the document **600**. These words could be represented character-by-character using the limited UHD embodiment. However, under the full UHD embodiment, a special vocabulary tailored to the subject matter of the intended document is specified, such as the subject-matter-specific vocabulary in FIG. **7**D, so that individual color blots serve to represent entire words. Specification of an alternate or supplementary vocabulary can be achieved through a command sequence such as that depicted in FIG. **10**, which depicts a series of commands whereby the URL of an alternative vocabulary is specified according to the present invention so as to achieve self-definition.

To elaborate, such a command sequence itself, as depicted in FIG. **10**, proceeds as follows: a "VocabularyURL" command nest encompasses a URL that is the URL of the desired vocabulary document ("http://www.epoet.com/voc" in the example). FIG. **19** depicts an example of a document with markup at such a URL, which document can be retrieved and parsed to extract the vocabulary in FIG. **7**D.

FIG. **7**A presents an example of the use of multicharacter antecedents. Depicted are relationships between the first words **601**-**605** of the intended document **600** and unique identifiers that correspond to these words and the spaces between, which identifiers together form the relevant sequence segment of the encodable document; a corresponding sequence of color blots appears in a resulting symbol **701**. Specifically: the first word, "The", corresponds to unique identifier "ID 200", as specified in the sample "most common words" vocabulary depicted in FIG. **5**B. The blank space character corresponds to unique identifier "ID 94" as per the default vocabulary depicted in FIG. **1**C. The second word, "Lord", corresponds to unique identifier "ID 811" as specified in the subject-tailored vocabulary depicted in FIG. **7**D, and so on. Each unique identifier is in turn represented by a data blot in the resulting chromocode **701**.

Each data blot is of the color that has been assigned to the unique identifier that the data blot represents through a chromotif such as that depicted in FIG. **7**B. Given such color-to-identifier assignments, the colors of the resulting chromocode **701** in the present example appear as labeled in FIG. **7**C.

FIG. **8** depicts the same five words with notation of diagraphs and corresponding identifiers through which the two letters of these diagraphs can be represented by a single data blot by reference to a vocabulary such as that depicted in FIG. **5**C.

In allowing modifiable multicharacter antecedents, the unique identifier essentially serves as a fulcrum in the disclosed compound matrix structure, thereby further leveraging the encoding power of the present invention so as to yield even greater information density.

4.2 External Value Acquisition through Nonlocal Referencing and Local Querying: Infinitely High Density

Whenever antecedents correspond to blots, an additive approach is being used: the more antecedents there are to be encoded, the more blots are needed. While the limited UHD embodiment is extremely powerful relative to the related art, information density even under the limited UHD embodiment can only be increased by increasing the amount of

information assigned to each unique identifier, i.e., by developing ever more specific vocabularies and lengthier antecedents.

However, the inherent limitation of additive encoding—a limitation that appears to plague all the related art, both monochromatic and polychromatic, to some degree—is almost entirely bypassed through an external reference function of the present invention. This referential function may be understood in abstract terms through review of FIG. **20**A, which displays the novel four-tier information relationship structure of the present invention. This structure may be compared to the prior art, which is depicted in FIG. **20**B.

In practical terms, the referential function works as follows: when an external reference is used instead of additive representation of the content of an intended document, a target reference document is specified through a command sequence of antecedents such as that depicted in FIG. **11**. In decoding, the target reference document is requested, typically by HTTP request, by the recipient and replicated as a defined variable, which variable is in turn processed so as to be treated as though it appeared in the chromocode as simple additive matter. FIG. **11** depicts a series of commands whereby a variable is defined by reference to a target reference document according to the present invention.

To elaborate, the command sequence itself, as depicted in FIG. **11**, proceeds as follows: a "Formula" command nest encompasses antecedents presented in a sequence that conforms to a predetermined, expected syntax: (i) an identified variable, (ii) an "equals sign", and (iii) a URL that is the URL of the desired target reference document ("http://www.epo-et.com/psalm" in the example). As with the remaining examples, this command sequence and the elements thereof should only serve to illustrate a type of instruction that can be performed through the present invention, not to limit the invention to a particular form of instruction.

As shown in the flowchart in FIG. **9**D, with reference to FIG. **18**, when a chromocode is decoded by a recipient, the target reference document is retrieved by requesting the file at the URL specified in the command sequence. The processed results are then included in the extracted document as though this externally-derived content were additively represented in the chromocode in the location where the relevant variable appears relative to other additive information.

The end result is a UHD-IHD code.

4.3 Subtractive, Substitutive and Insertive Processing

While the information density of the UHD-IHD code is unrivaled, the usability of the external reference feature is still constrained by the necessity of creating, uploading, hosting on an Internet-accessible server, and modifying as necessary the target reference document. However, at least one of these constraints, that of modifying the target reference document, is overcome by three external value modification functions of the present invention: subtraction/deletion, substitution, and insertion.

For instance, a sender may wish to use an external reference in order to enjoy maximum information density yet may also desire that the reference-derived content appearing in the final extracted document partly differ from the content of the target reference document itself. In such a case, a user can use the external value modification functions to modify content derived from the target reference document without modifying the target reference document itself.

FIG. **9**A depicts text that has been retrieved from a target reference document, i.e., text that is an external value and has been replicated as the content of a defined variable. If the encoding party wishes for the extracted document to replace the fourth word **901** ("my") of this variable with another word ("our"), a command sequence such as that depicted in FIG. **9**B is used. Specifically, the content of the variable is treated as text and the thirteenth through fourteenth characters of this variable are replaced with the characters "o", "u", and "r".

To elaborate, the command sequence itself, as depicted in FIG. **9**B, proceeds as follows: a "TreatVariableAsText" command introduces the sequence; this command is expected to be immediately followed by the identifier of the variable to be modified. The characters to be replaced are immediately thereafter described through: (i) a "ReplaceCharactersBegin" command nest, within which is specified a character number ("13" in the example) that indicates the ordinal number (i.e., 13^{th}), relative to the entire text string, of the first character to be replaced; and (ii) a "ReplaceCharactersEnd" command nest, within which is specified the ordinal number of the last character to be replaced (i.e., the 14^{th} character, in the example).

Immediately thereafter follows a "SubstituteCharacters" command nest, within which are provided, in desired order, a sequence of antecedents ("o", "u" and "r" in the example); when the content of the given variable is included in the final extracted document, these replacement characters are to appear in the same relative location where the deleted characters would have appeared.

Note that the example command sequence has been depicted in this way in order to demonstrate the present invention in a fashion that can be easily understood. Clearly, different and additional command names and techniques can be used as appropriate without exceeding the scope of the present disclosure.

FIG. **9**C depicts the sequence segment of a chromocode **911** that symbolizes the identifiers depicted in FIG. **9**B such that, when the chromocode is decoded, the instructions indicated in the command sequence represented thereby can be executed. Thus, the final extracted document appears in relevant part as shown in FIG. **9**E, in which the fourth word **921** ("our") differs from the fourth word ("my") of the target reference document.

The synergistic results of the referential, subtractive, and substitutive functions when used in combination are dramatic: a 1000-page document—even one that is unique to the given chromocode—can be conveyed using a small number of color blots.

Insertive processing (not graphically shown) is similar: the character in a text string after which matter is to be inserted is identified through an "InsertAfterCharacter" command nest. Thereafter, the matter to be inserted is specified through an immediately following "Insert" command nest.

To delete characters (not graphically shown) without substituting any new characters, simply follow the command sequence for replacing characters but include no information in the "SubstituteCharacters" nest.

4.4 Comprehensive Internet Integration

Users can host vocabularies, target reference documents, chromotifs, and any other reference materials on their own websites if they wish. However, the present invention also gives rise to a commercial opportunity for a company to serve as a central location for all such hosting purposes.

FIG. **12** depicts the primary relationships between a series of relational databases which may be used by such a company. One useful feature is that of providing a password storage database related to other relevant databases so as to allow password-protection of target reference documents and other

reference materials. In this way, a decoding party must first log-in to a password-protected site to gain access to a URL that is the URL of a reference. Thus, an authorized recipient can properly decode such a referential chromocode, but an unauthorized party is unable to retrieve the references that give meaning to the chromocode.

Notably, although not graphically depicted, the company may also wish to charge users a fee to host documents or to access URLs for reference materials.

FIG. **13** depicts the general system components of the present invention. Internet integration can be done through a company, the computers **1301** of which comprise the depicted hardware and software components. Alternately, or additionally, an encoding user **1302** can host external references on its own computers or can take advantage of target reference documents **1303**, chromotif specifications **1304**, and vocabularies **1305** hosted by others. A decoding user **1306** accesses the Internet for any nonlocal external values and supplies local external values through its own data-processing equipment.

FIG. **14** depicts an excerpt from an example Web submission form whereby a user submits information for storage in a database according to the present invention, such as a database comprising records of chromotifs.

5.1 Full VHD Embodiment

In applications where the higher tolerances of a VHD embodiment are desirable but a larger character set than that of the limited embodiment is needed, the full VHD embodiment may be used so that selection of the total number of colors to be used and the ratio of color blots per antecedent is possible. This selection is made with reference to the options and advantages depicted in FIG. **15**D.

FIG. **15**A provides a matrix of relationships between alphabetical characters and unique color blot triplets. Only three different colors are used: black, white, and red. Distinguishing between these three colors is not difficult, even under adverse conditions. Meanwhile, the use of triplets enables each letter of the entire twenty-six-letter alphabet to be represented by a unique triplet. Exactly one unique triplet is left over to serve as a "shift" character.

The shift character serves to expand the character set that can be represented by the same trichromatic color triplets. Its function is straightforward: when a non-shift-character triplet is not preceded by the shift-character triplet, the antecedent represented by the non-shift-character triplet is the default antecedent (depicted in FIG. **15**A); when the non-shift-character triplet is preceded by the shift-character triplet, the antecedent represented by the non-shift-character triplet is the shifted antecedent assigned to the non-shift-character triplet in the matrix depicted in FIG. **15**B.

An example of two different antecedents represented by the same triplet is depicted in FIG. **15**C. The depicted chromocode has three triplets comprising nine data blots in total. The first triplet represents the letter "A"; the second triplet is the shift character; and the third triplet represents the numeral "1", since this triplet, identical in appearance to the first triplet, is preceded by the shift character.

FIG. **15**D is a chart describing and comparing options under the VHD embodiment for use in deciding which selection is appropriate for a given application. An indication should be provided to the recipient which VHD selection has been used in encoding a particular chromocode.

FIG. **16** depicts an example information flow when the UHD embodiment is used. The encoding party **1601** inputs the intended document into its data processing system **1602** for analysis and encoding. Reference materials, such as vocabularies, target reference documents, and chromotifs are uploaded to an Internet-accessible hosting service **1603**, and a chromocode is printed on a surface **1604**. A decoding party **1606** scans the chromocode using its data processing system **1605** and requests references from the hosting service **1603**, supplying a password if necessary. The references are returned to the decoding party's data processing system **1605** for use in processing scanned data and extracting an extracted document.

FIG. **17** is a flow chart providing an overview of the present invention. A decision is made whether to use a polychromatic code **1701**. If use of a polychromatic code is chosen, a decision is made whether to use UHD or VHD **1702**. If UHD is chosen, a decision is made whether to use the full embodiment or a limited embodiment **1703**. If VHD is chosen, a decision is made whether to use the full embodiment or a limited embodiment **1704**. Decisions are then implemented according to relevant figures and discussions thereof **1705** as disclosed herein.

FIG. **18** is a flow chart depicting a process whereby a UHD chromocode is decoded to yield a final extracted document. First, all data blots are translated to identifiers **1801**, resulting in an unprocessed extracted sequence. If an alternative chromotif or vocabulary is specified (which specification should be according to default rather than alternate matrices) all chromotifs and vocabularies are retrieved **1802** and **1803**; thereafter, all remaining data blots are retranslated into identifiers in light of the alternative chromotif. Any individual modifications to the selected vocabulary through command sequences are then performed **1804**. All remaining extracted identifiers are then translated to antecedents according to final vocabulary assignments **1806**. Command sequences specifying nonlocal external values are then executed to acquire all content to be acquired through nonlocal external reference **1807**. Command sequences specifying all local external values to be acquired are then executed **1808**. All variables to represent externally acquired content are then defined **1809**. If externally acquired content is to be edited, the variable to be edited is treated as a string of text **1810** and command sequences for subtraction/deletion, insertion, and substitution are executed **1811**. All formulas that define certain variables in terms of other variables are then executed **1812**. All processed referential content is then spliced together with additive content, with processed content appearing where the given variable antecedent representing this processed content appears relative to additive content antecedents in the unprocessed extracted sequence, so as to produce a final extracted document **1813**.

It should be noted that, after a final extracted document has been produced, this extracted document can then be further manipulated as the recipient wishes. For instance, if a final extracted document is an HTML document, this document can then be viewed in a browser so that the document is presented according to the HTML formatting. Similarly, an extracted document that is an XML document can be parsed and then the data described therein imported into a database.

6.1 Scope

Although the description above contains many specificities, these should not be construed as limiting the scope of the invention but as merely providing illustrations of some of the presently preferred embodiments of this invention. Accordingly, the scope of the invention should be determined by the appended claims and their legal equivalents, rather than by the examples given. For instance, as is plain to one skilled in

the art, it will be understood that features of one embodiment may be combined with features of other embodiments while other features may be omitted or replaced as being nonessential to the practice of the invention, regardless of whether such combination, omission or modification has been explicitly described.

It is expressly intended that users should supply custom and additional vocabularies, chromotifs, references, and related elaboration upon the present disclosure, and thus such matter falls clearly within the purview hereof. Additionally, the disclosed optical encoding techniques are applicable at any surface area size, and the disclosed symbolic structure may be employed through symbols that are non-optical. Thus, miniaturization of the surface area occupied by data blots or usage of the compound matrix and related structures disclosed herein in a non-optical encoding system falls clearly within the purview hereof.

Additionally, the techniques used herein can be used to create artworks of which the coloring, through custom chromotif, serves not only as art, but also as information-bearing matter.

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What is claimed is:

1. A code for representing encoded data and being capable of being decoded, said code comprising:

a first plurality of color blots, said first plurality of color blots comprising a second plurality of color blots and a third plurality of color blots, said second plurality of color blots being arranged so as to indicate a first url, wherein:

said first url identifies a first markup language document, said first markup language document being suitable to be parsed and comprising information, said information being suitable for use in determining how said third plurality of color blots is decoded.

2. The code in claim **1** wherein said first plurality of color blots comprises a fourth plurality of color blots, said fourth plurality of color blots being arranged so as to indicate editing instructions, said editing instructions being suitable for use in performing a first editing step, said editing step being selected from the group consisting of (i) inserting, (ii) deleting, and (iii) substituting.

3. The code in claim **1** wherein said first markup language document comprises a plurality of assignments of content to colors.

4. The code in claim **3** wherein said plurality of assignments comprises a first assignment of a first piece of content to a first color, said first assignment being by way of a first intermediate value to which both said first piece of content and said first color are assigned.

5. The code in claim **1** wherein at least one of said color blots symbolizes a first intermediate value, said first intermediate value being assigned to a first antecedent value.

6. The code in claim **5** wherein said first intermediate value is assigned to said first antecedent value in said first markup language document.

7. The code in claim **1** wherein said first plurality of color blots comprises a fourth plurality of color blots, said fourth plurality of color blots being suitable for indicating a first target reference document, said first target reference document being suitable for being included and edited.

8. The code in claim **1** wherein said first plurality of color blots comprises a fourth plurality of color blots, said fourth plurality of color blots being suitable for use in comparing against a first calibration standard.

9. A system for representing information, said system comprising:

a hosting device, said hosting device suitable for hosting a first markup language document;

a first code, said first code being suitable for representing said information and comprising a first portion and a second portion, wherein said first portion of said first code identifies said first markup language document;

said first markup language document, wherein said first markup language document comprises instructions for use in decoding said second portion of said first code; and

a first scanning device, said first scanning device suitable for scanning said first code.

10. The system in claim **9** wherein said instructions comprise at least a portion of said information.

11. The system in claim **9** wherein said first code further comprises at least one editing command.

12. The system in claim **9** wherein said instructions comprise a first assignment, said first assignment being selected from the group consisting of (i) an assignment of antecedent to identifier and (ii) an assignment of color to identifier.

13. The system in claim **9** additionally comprising a first color standard.

14. The system in claim **9** wherein, said first markup language document comprises markup tags, said markup tags being suitable for use in specifying at least a first antecedent value or a first intermediate value.

15. A method for representing information, said method comprising the following steps:

scanning a first code, a first portion of said first code being suitable for indicating a first location of, resource, a first resource, said first resource being hosted on a first computer and comprising decoding information, said decoding information being suitable for use in decoding;

retrieving said first resource; and

decoding a second portion of said first code, wherein said decoding is performed according to said decoding information.

16. The method in claim **15** additionally comprising the following step:

calibrating a first device by comparing a first color to a second color, wherein said first code comprises said first color and wherein said second color is a color standard.

17. The method in claim **15** wherein said decoding information comprises a first plurality of assignments, said first plurality of assignments being selected from the group consisting of (i) a second plurality of assignments, said second plurality of assignments comprising relationships between content and values, and (ii) a third plurality of assignments, said third plurality of assignments comprising relationships between colors and values.

18. The method in claim **15** additionally comprising the following step:

submitting a valid password or a fee.

19. The method in claim **15** wherein said first code comprises at least one of (i) editing instructions or (ii) a reference to a reference document.

20. The method in claim **15** wherein said step of decoding further comprises the following two steps:

translating colors into intermediate values; and

translating intermediate values into antecedents, wherein:

at least one of these two translation steps is performed according to said decoding information.

21. The code in claim **1** wherein:

said first plurality of color blots comprises a first blot, said first blot being of a first color, said first color being

selected from the group consisting of (i) black, (ii) white, (iii) red, (iv) yellow, (v) blue and (vi) green; and

said first markup language document is hosted on a first computer, said first computer being configured to provide said information only upon receipt of a password or a fee.

22. The method in claim **15** wherein said decoding information comprises a first plurality of assignments, said first plurality of assignments being selected from the group consisting of (i) a second plurality of assignments, said second plurality of assignments comprising relationships between content and values, and (ii) a third plurality of assignments, said third plurality of assignments comprising relationships between colors and values.

23. The method in claim **15** additionally comprising the following steps:

logging into a first account; and

submitting a first modification submission, said first modification submission being suitable for use in modifying said decoding information.

24. The method in claim **15** wherein said step of scanning said first code comprises a step of scanning a first color and wherein said method additionally comprises the following step:

comparing said first color to a color standard.

25. A symbol for use in conveying information comprising:

a first plurality of blots, said first plurality of blots being suitable for scanning and comprising (i) a second plurality of blots and (ii) a third plurality of blots, said second plurality of blots indicating a first url, wherein:

said first url is suitable for use in locating a first resource, said first resource being hosted on a first computer and comprising first data, said first data being suitable for use in ascertaining at least in part what said third plurality of blots means.

26. A method for communicating information, said method comprising the following steps:

providing a first code, said first code comprising a first portion of said first code and a second portion of said first code, said first portion of said first code comprising first information, said first information comprising a first location of a first resource;

providing a first computer, said first computer being connected to a first computer network; and

providing said first resource via said first computer network, said first resource comprising second information, said second information indicating at least in part how to decode said second portion of said first code.

27. The method in claim **26** additionally comprising the following step:

providing for receiving a valid password.

28. The method in claim **26** additionally comprising the following step:

providing for receiving a fee.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 7,710,598 B2
APPLICATION NO. : 11/205986
DATED : May 4, 2010
INVENTOR(S) : Shelton E. Harrison, Jr.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Col. 18, line 32, delete ", resource,".

Signed and Sealed this

Twenty-first Day of September, 2010

David J. Kappos

David J. Kappos
Director of the United States Patent and Trademark Office