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(54) **COMPUTER-IMPLEMENTED SYSTEM AND METHOD FOR TAGGED AND RECTANGULAR DATA PROCESSING**

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(73) Assignee: **SAS INSTITUTE INC.**, Cary, NC (US)

(21) Appl. No.: **14/625,437**

(22) Filed: **Feb. 18, 2015**

Related U.S. Patent Documents

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(51) **Int. Cl.**
G06F 3/048 (2013.01)
G06F 16/25 (2019.01)

(52) **U.S. Cl.**
CPC ***G06F 16/258*** (2019.01)

(58) **Field of Classification Search**
CPC G06F 17/30569; G06F 17/30
USPC 715/249, 234, 239, 760, 805
See application file for complete search history.

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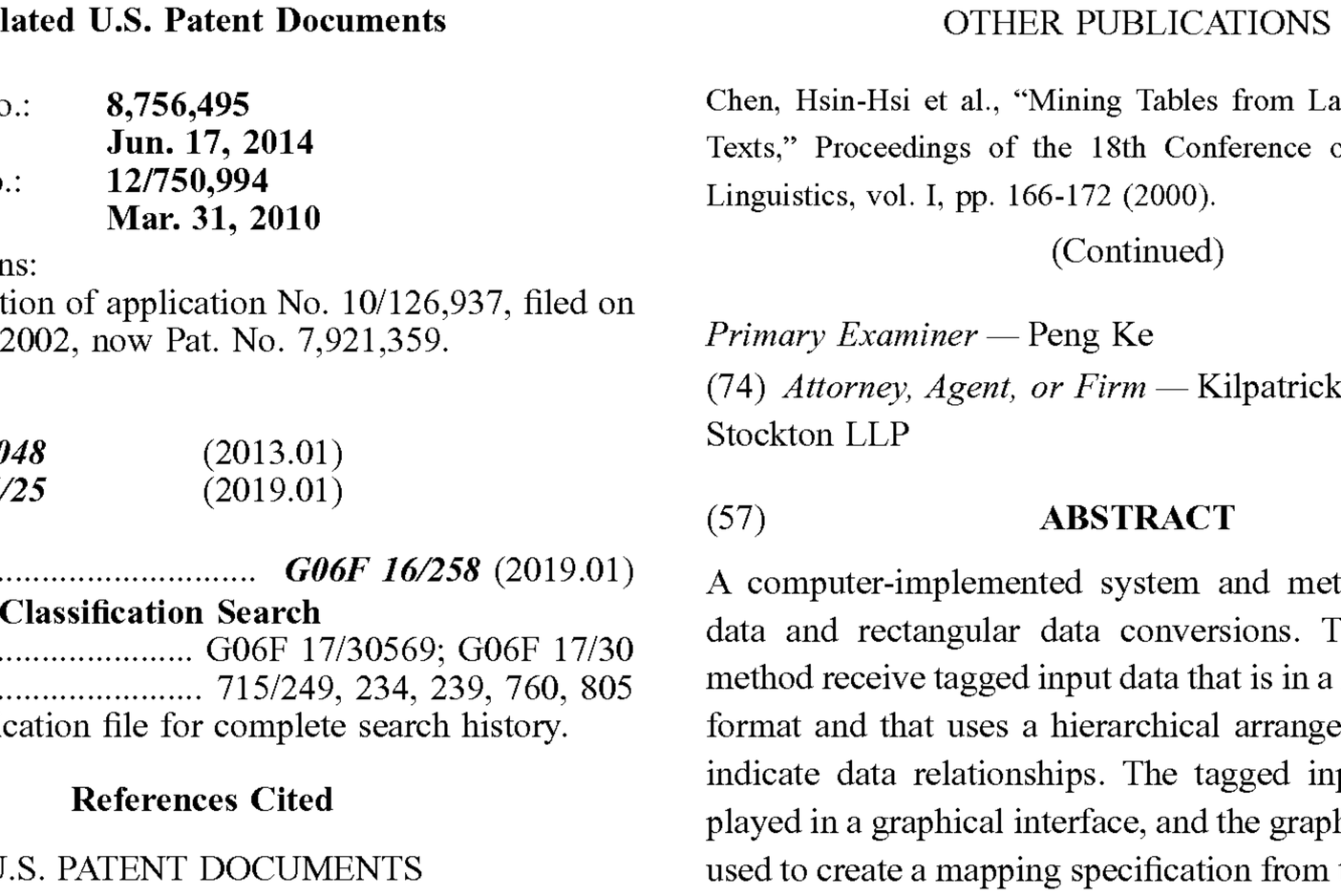
Primary Examiner — Peng Ke

(74) *Attorney, Agent, or Firm* — Kilpatrick Townsend & Stockton LLP

(57) **ABSTRACT**

A computer-implemented system and method for tagged data and rectangular data conversions. The system and method receive tagged input data that is in a non-rectangular format and that uses a hierarchical arrangement of tags to indicate data relationships. The tagged input data is displayed in a graphical interface, and the graphical interface is used to create a mapping specification from the tagged input data.

141 Claims, 29 Drawing Sheets



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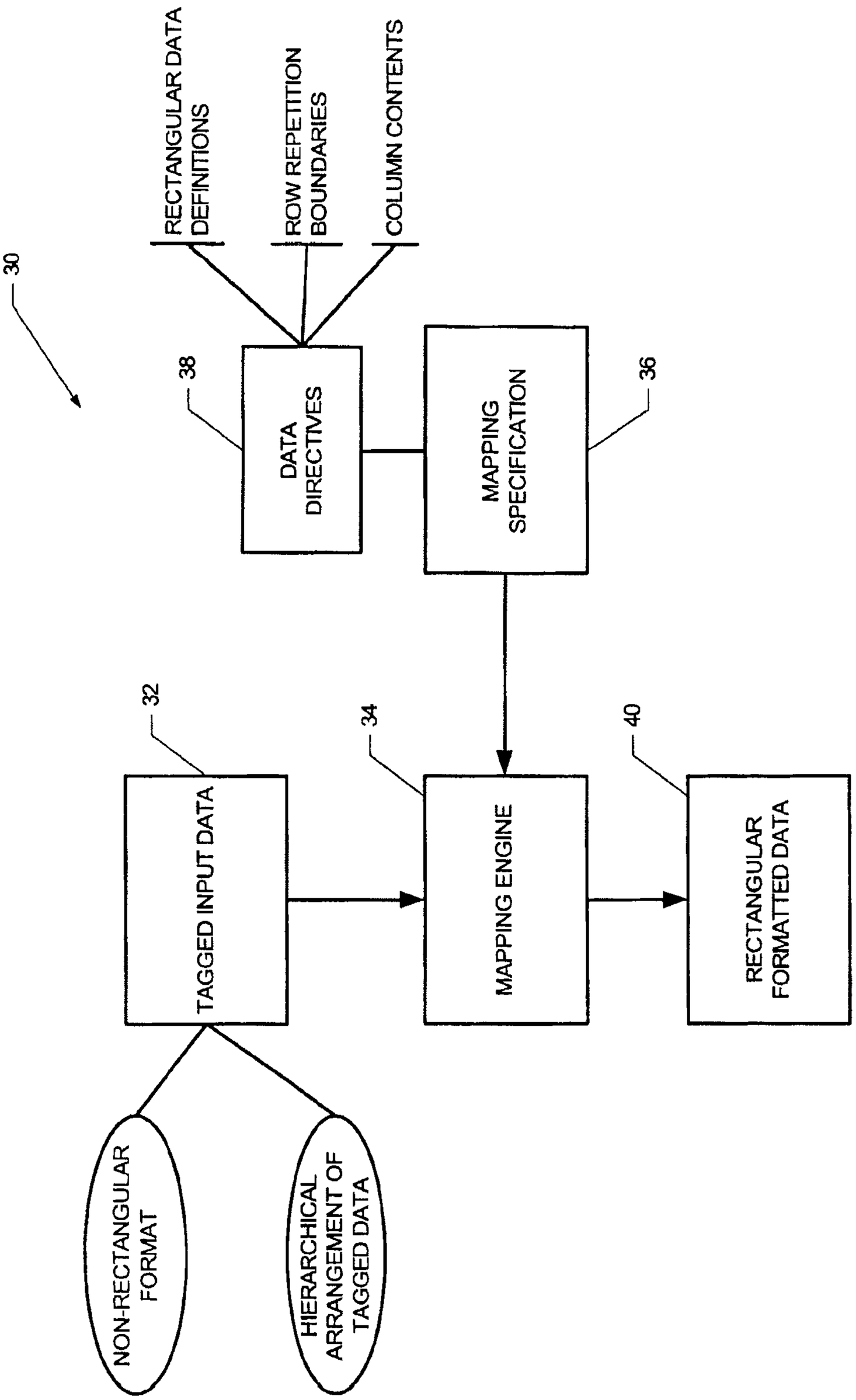

30
RECTANGULAR DATA DEFINITIONS
ROW REPETITION BOUNDARIES
COLUMN CONTENTS
38
DATA DIRECTIVES
MAPPING SPECIFICATION
36
32
TAGGED INPUT DATA
34
MAPPING ENGINE
40
RECTANGULAR FORMATTED DATA
NON-RECTANGULAR FORMAT
HIERARCHICAL ARRANGEMENT OF TAGGED DATA

FIG. 1

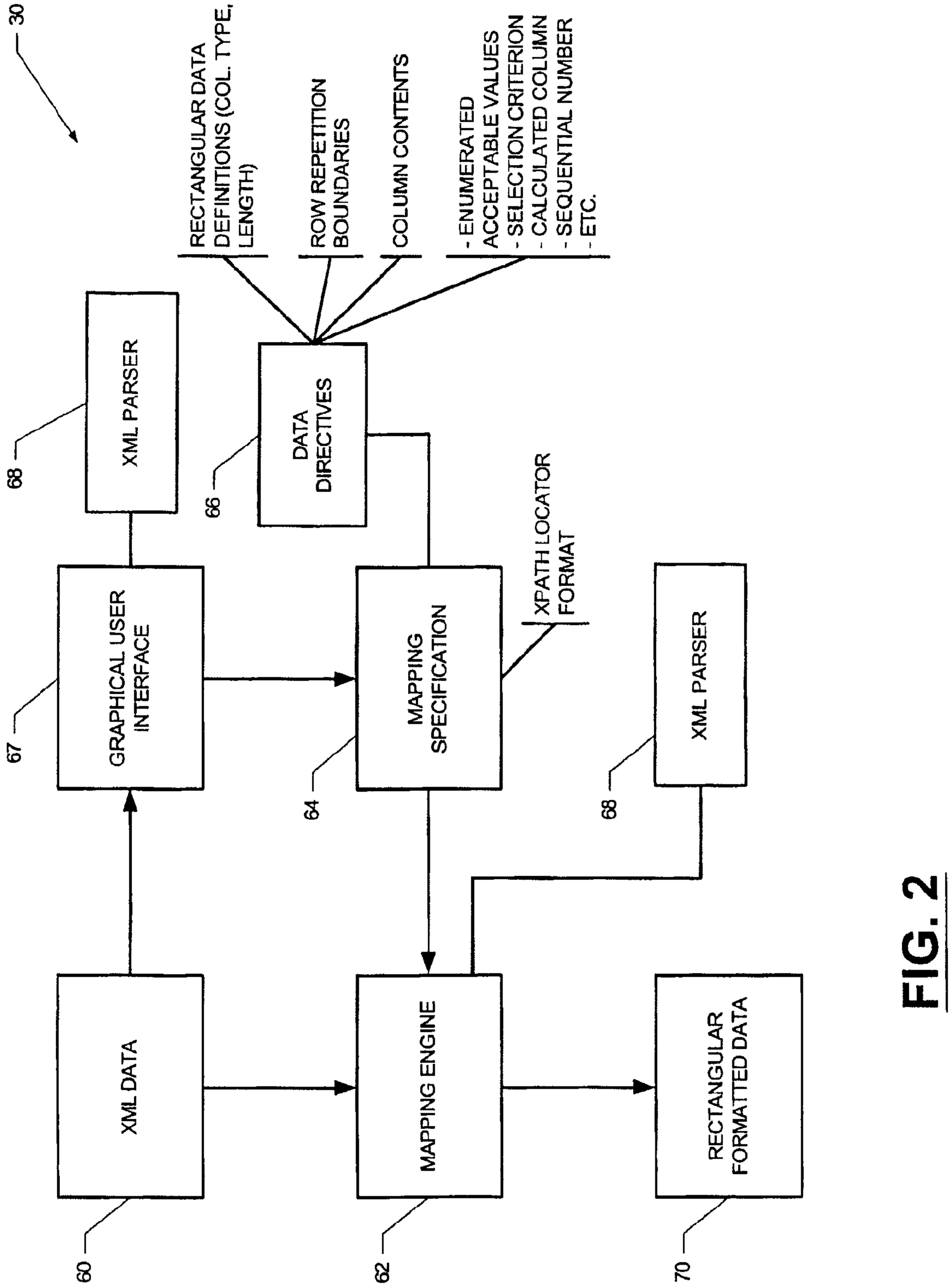

30
RECTANGULAR DATA DEFINITIONS (COL. TYPE, LENGTH)
ROW REPETITION BOUNDARIES
COLUMN CONTENTS
- ENUMERATED ACCEPTABLE VALUES
- SELECTION CRITERION
- CALCULATED COLUMN
- SEQUENTIAL NUMBER
- ETC.
XML PARSER
68
DATA DIRECTIVES
66
GRAPHICAL USER INTERFACE
67
MAPPING SPECIFICATION
64
XPATH LOCATOR FORMAT
XML PARSER
68
XML DATA
60
MAPPING ENGINE
62
RECTANGULAR FORMATTED DATA
70

FIG. 2

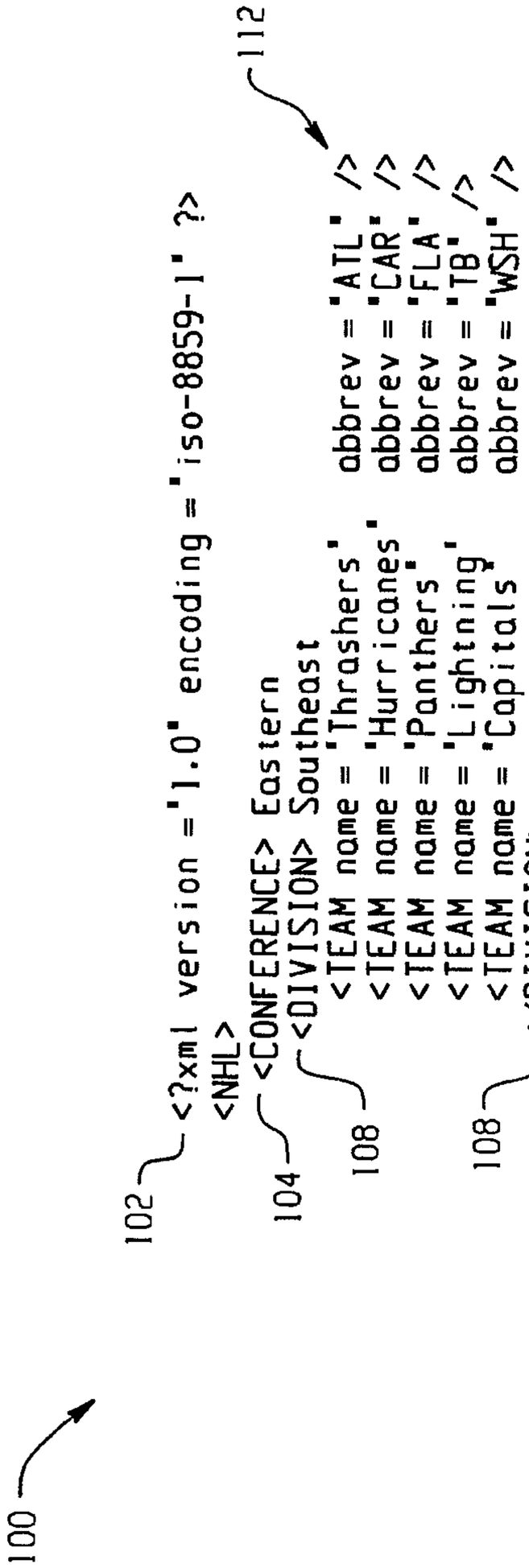

100
102
<?xml version ='1.0' encoding ='iso-8859-1'
<NHL>
104
<CONFERENCE> Eastern
108
<DIVISION> Southeast
<TEAM name = 'Thrashers' abbrev = 'ATL' />
<TEAM name = 'Hurricanes' abbrev = 'CAR' />
<TEAM name = 'Panthers' abbrev = 'FLA' />
<TEAM name = 'Lightning' abbrev = 'TB' />
108
</DIVISION>
<TEAM name = 'Capitals' abbrev = 'WSH' />
104
</CONFERENCE>
106
<CONFERENCE> Western
110
<DIVISION> Pacific
<TEAM name = 'Stars' abbrev = 'DAL' />
<TEAM name = 'Kings' abbrev = 'LA' />
<TEAM name = 'Ducks' abbrev = 'ANA' />
<TEAM name = 'Coyotes' abbrev = 'PHX' />
110
<TEAM name = 'Sharks' abbrev = 'SJ' />
</DIVISION>
106
</CONFERENCE>
102
</NHL>
112

Fig. 3

```
<?xml version = '1.0' ?>                                          150
<SXLEMAP version = '1.0'>
152 <TABLE name = 'TEAMS'>
      156 <TABLE_XPATH>
            /NHL/CONFERENCE/DIVISION/TEAM                          154
      156 </TABLE_XPATH>
            <COLUMN name = 'name'>                                 160
        162 <XPATH>
              /NHL/CONFERENCE/DIVISION/TEAM/@name
        162 </XPATH>
      164 <TYPE>character</TYPE>                                   164
      166 <DATATYPE>STRING</DATATYPE>                              166
      168 <LENGTH>30</LENGTH>                                      168
          </COLUMN>                                                160

170   <COLUMN name = 'abbrev'>
        172 <XPATH>
              /NHL/CONFERENCE/DIVISION/TEAM/@abbrev
        172 </XPATH>
        174 <TYPE>character</TYPE>                                 174
        176 <DATATYPE>STRING</DATATYPE>                            176
            <LENGTH>3</LENGTH>                                     178
170   </COLUMN>

180   <COLUMN name = "CONFERENCE" retain = 'YES'>
        182 <XPATH>/NHL/CONFERENCE</XPATH>                         182
        184 <TYPE>character</TYPE>                                 184
        186 <DATATYPE>STRING</DATATYPE>                            186
            <LENGTH>10</LENGTH>
180   </COLUMN>                                                    188  188

190   <COLUMN name = 'DIVISION' retain = 'YES'>
        192 <XPATH>
              /NHL/CONFERENCE/DIVISION
        192 </XPATH>
      194 <TYPE>character</TYPE>                                   194
        196 <DATATYPE>STRING</DATATYPE>                            196
            <LENGTH>10</LENGTH>
190   </COLUMN>                                                    198  198
    </TABLE>
</SXLEMAP>                                                         152
```

Fig. 4

200

TEAMS 202

204 CONFERENCE	206 DIVISION	208 name	210 abbrev
Eastern	Southeast	Thrashers	ATL
Eastern	Southeast	Hurricanes	CAR
Eastern	Southeast	Panthers	FLA
Eastern	Southeast	Lightning	TB
Eastern	Southeast	Capitals	WSH
Western	Pacific	Stars	DAL
Western	Pacific	Kings	LA
Western	Pacific	Ducks	ANA
Western	Pacific	Coyotes	PHX
Western	Pacific	Sharks	SJ

Fig. 5

250

```
<?xml version = '1.0' encoding = 'iso-8859-1' ?>
<Library>                                                    252
  <Publication>                                              254
    <Title>Developer&apos;s Almanac</Title>                  260
    <Acquired>12-11-2000</Acquired>
    <Topic Major = 'Y'>JAVA</Topic>                          262
  </Publication>                                             254
  <Publication>                                              256
    <Title>Inside Visual C++</Title>                         264
    <Acquired>06-19-1998</Acquired>                          266
    <Topic Major = 'Y'>C</Topic>                             272
    <Topic>Reference</Topic>                                 274
  </Publication>                                             256
  <Publication>                                              258
    <Title>Core Servlets</Title>                             268
    <Acquired>05-30-2001</Acquired>
    <Topic Major = 'Y'>JAVA</Topic>                          270
    <Topic>Servlets</Topic>
    <Topic>Reference</Topic>                                 274
  </Publication>                                             258
</Library                                                    252
```

Fig. 6

```
<?xml version = '1.0' ?>
<SXLEMAP version = '1.0'>
<TABLE name = 'Publication'>
    <TABLE_XPATH>
        /Library/Publication/Topic
    </TABLE_XPATH>
    <COLUMN name = 'Title' retain = 'YES'>
        <XPATH>
            /Library/Publication/Title
        </XPATH>
        <TYPE>character</TYPE>
        <DATATYPE>STRING</DATATYPE>
        <LENGTH>19</LENGTH>
    </COLUMN>
    <COLUMN name = 'Acquired' retain = 'YES'>
        <XPATH>
            /Library/Publication/Acquired
        </XPATH>
        <TYPE>numeric</TYPE>
        <DATATYPE>FLOAT</DATATYPE>
        <LENGTH>10</LENGTH>
        <FORMAT width = '10' >mmddyy</FORMAT>
        <INFORMAT width = '10' >mmddyy/INFORMAT>
    </COLUMN>
    <COLUMN name = 'TOPIC'>
        <XPATH>
            /Library/Publication/Topic</XPATH>
        <TYPE>character<TYPE>
        <DATATYPE>STRING</DATATYPE>
        <LENGTH>9</LENGTH>
    </COLUMN>
    <COLUMN name = 'Major'>
        <XPATH>
            /Library/Publication/Topic/@Major
        </XPATH>
        <TYPE>character<TYPE>
        <DATATYPE>STRING</DATATYPE>
        <LENGTH>1</LENGTH>
        <ENUM>
            <VALUE>Y</VALUE>
            <VALUE>N</VALUE>
        </ENUM>
        <DEFAULT>N</DEFAULT>
    </COLUMN>
</TABLE>
</SXLEMAP>
```

300, 302, 304, 306, 310, 312, 314, 316, 318, 320, 322, 324, 326, 327, 328, 329, 330, 332, 334, 336, 338, 340, 342, 344, 346, 348, 350, 352, 354, 356

Fig. 7

370	372	374	376	378	380
	Publication	Title	Acquired	Topic	Major
	12/11/2000	Developer's Almanac	JAVA		Y
	06/19/1998	Inside Visual C++	C		Y
	06/19/1998	Inside Visual C++	Reference		N
	05/30/2001	Core Servlets	JAVA		Y
	05/30/2001	Core Servlets	Servlets		N
	05/30/2001	Core Servlets	Reference		N

Fig. 8

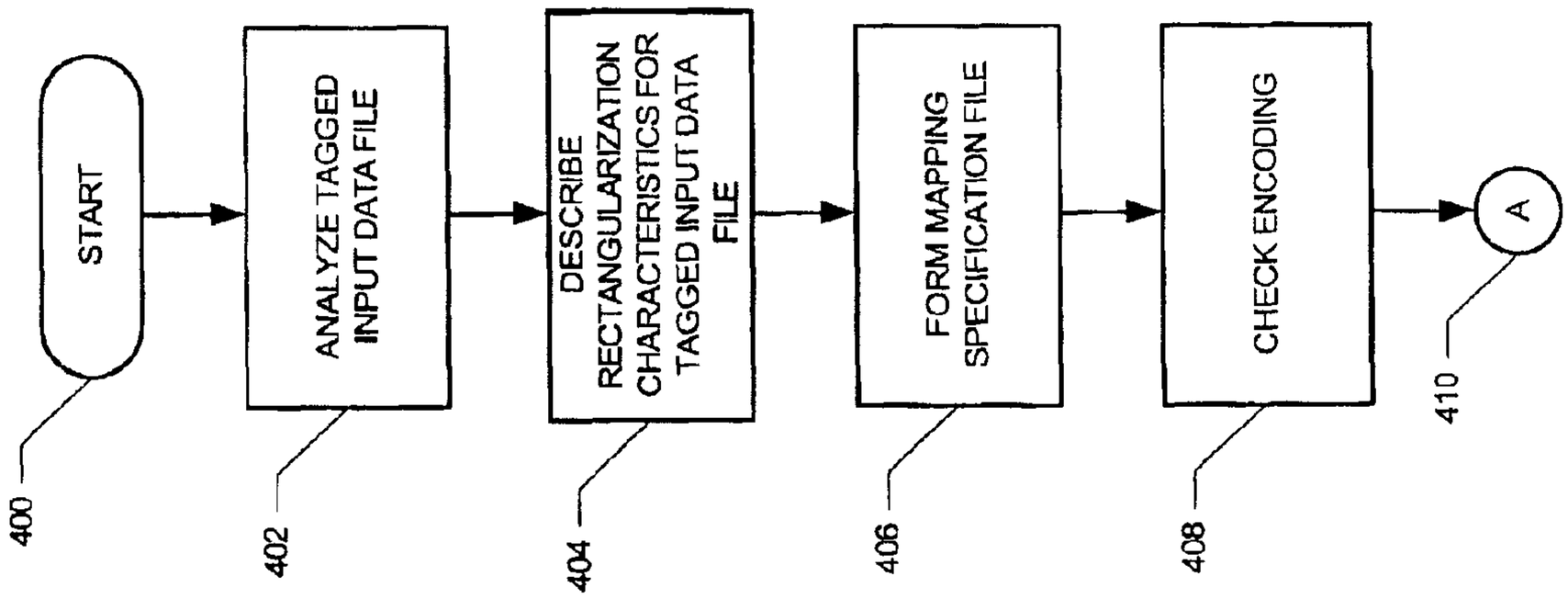
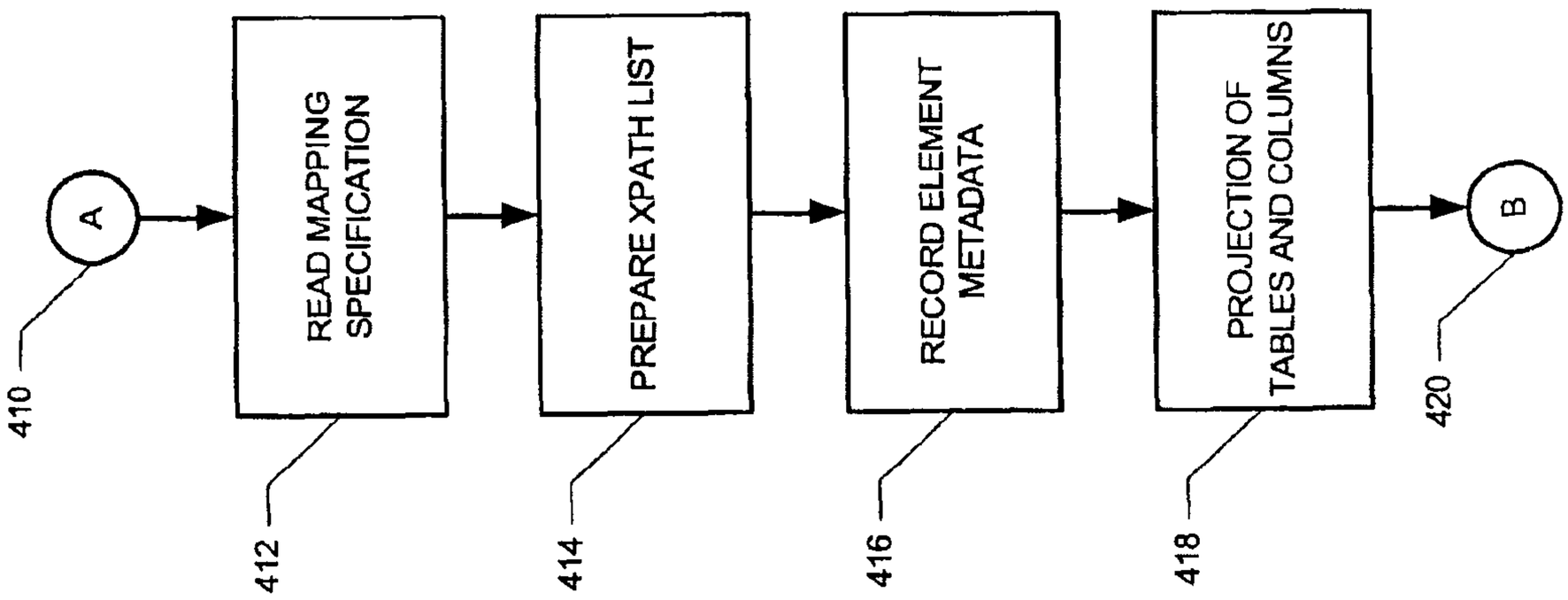

START
ANALYZE TAGGED INPUT DATA FILE
DESCRIBE RECTANGULARIZATION CHARACTERISTICS FOR TAGGED INPUT DATA FILE
FORM MAPPING SPECIFICATION FILE
CHECK ENCODING
A
400
402
404
406
408
410

FIG. 9

FIG. 10


410
A
READ MAPPING SPECIFICATION
412
PREPARE XPATH LIST
414
RECORD ELEMENT METADATA
416
PROJECTION OF TABLES AND COLUMNS
418
420
B

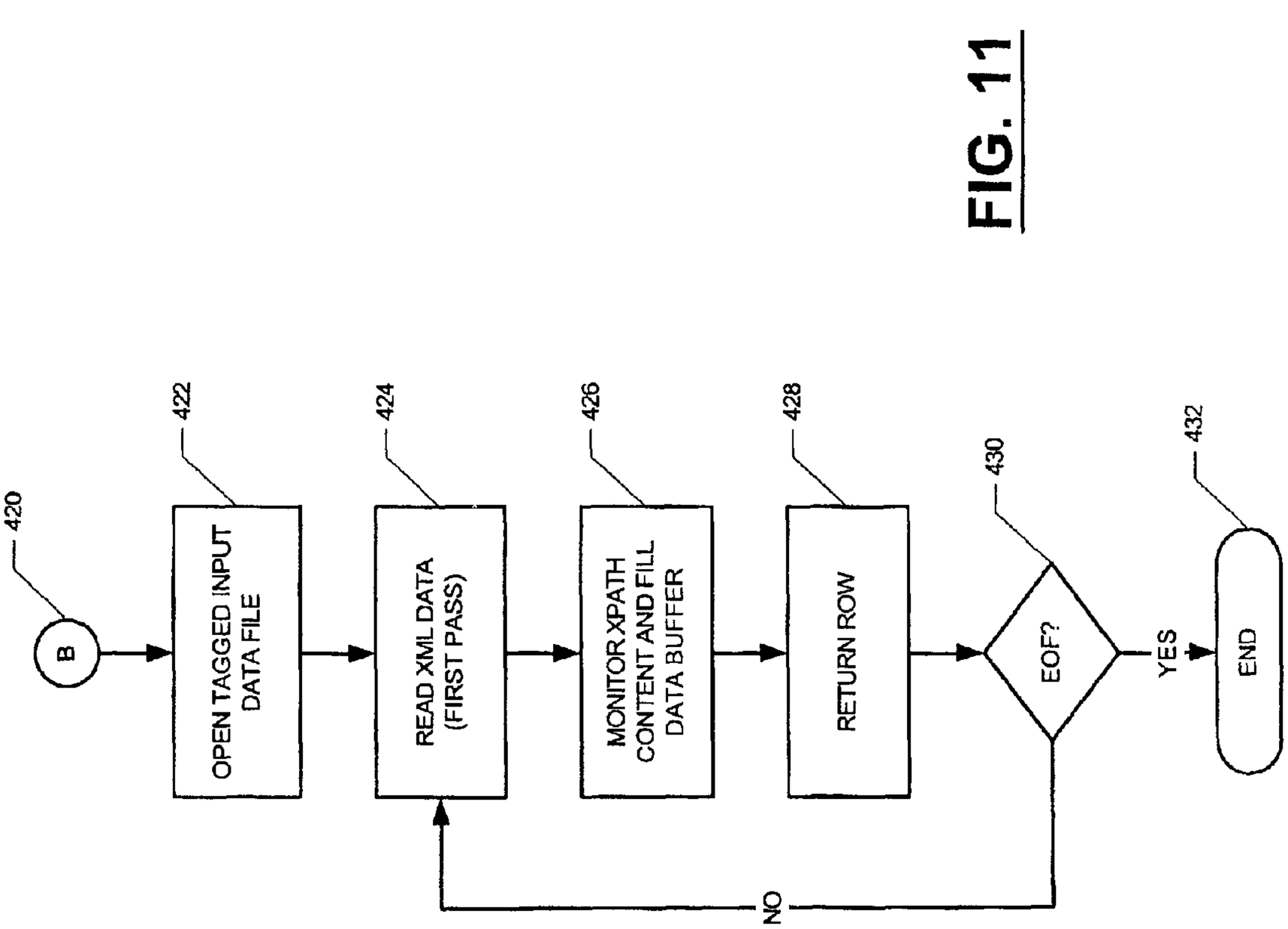
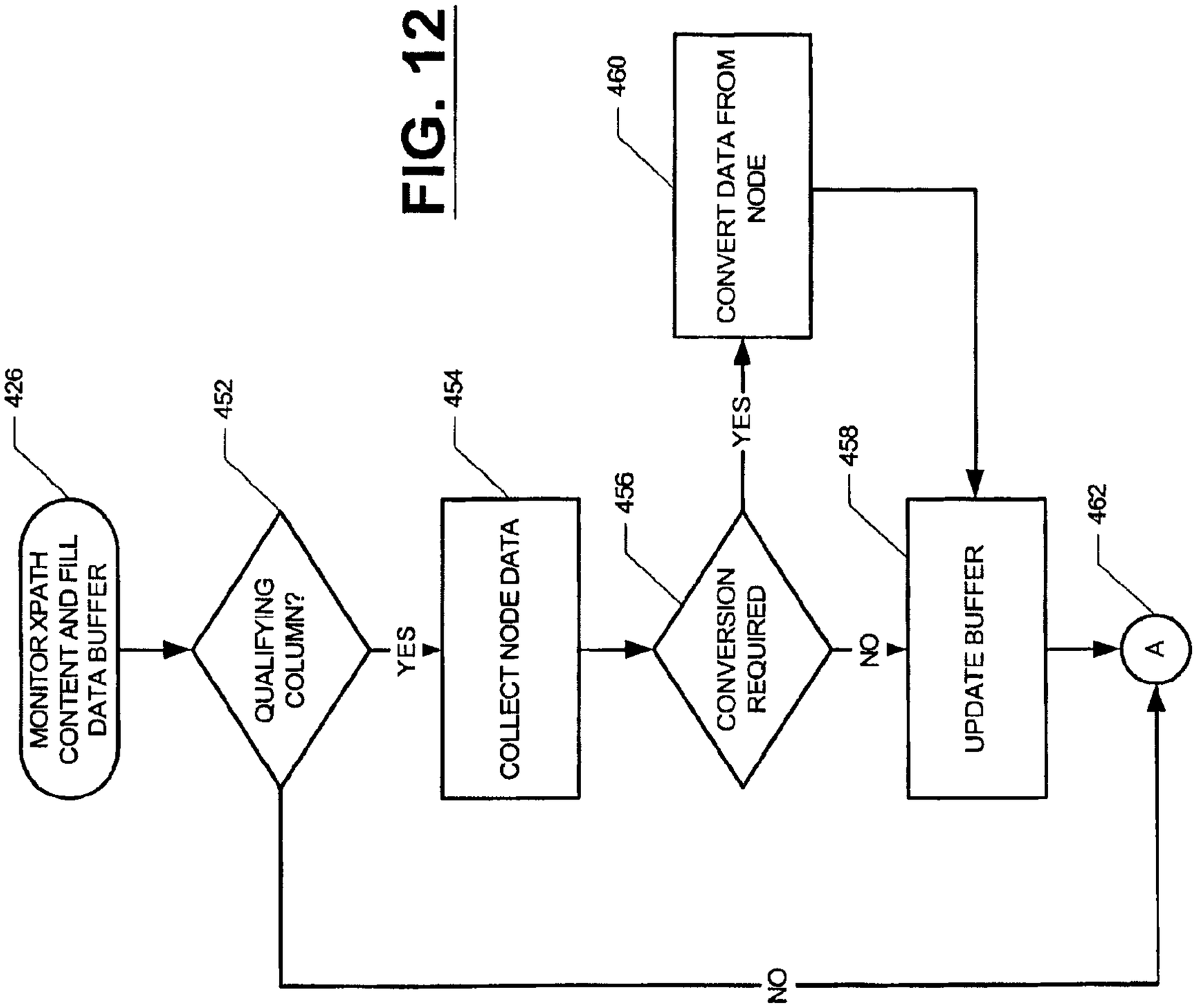

420
B
422
OPEN TAGGED INPUT DATA FILE
424
READ XML DATA (FIRST PASS)
426
MONITOR XPATH CONTENT AND FILL DATA BUFFER
428
RETURN ROW
430
EOF?
YES
NO
432
END

FIG. 11

FIG. 12


426
MONITOR XPATH CONTENT AND FILL DATA BUFFER
452
QUALIFYING COLUMN?
YES
454
COLLECT NODE DATA
456
CONVERSION REQUIRED
YES
460
CONVERT DATA FROM NODE
NO
458
UPDATE BUFFER
462
A
NO

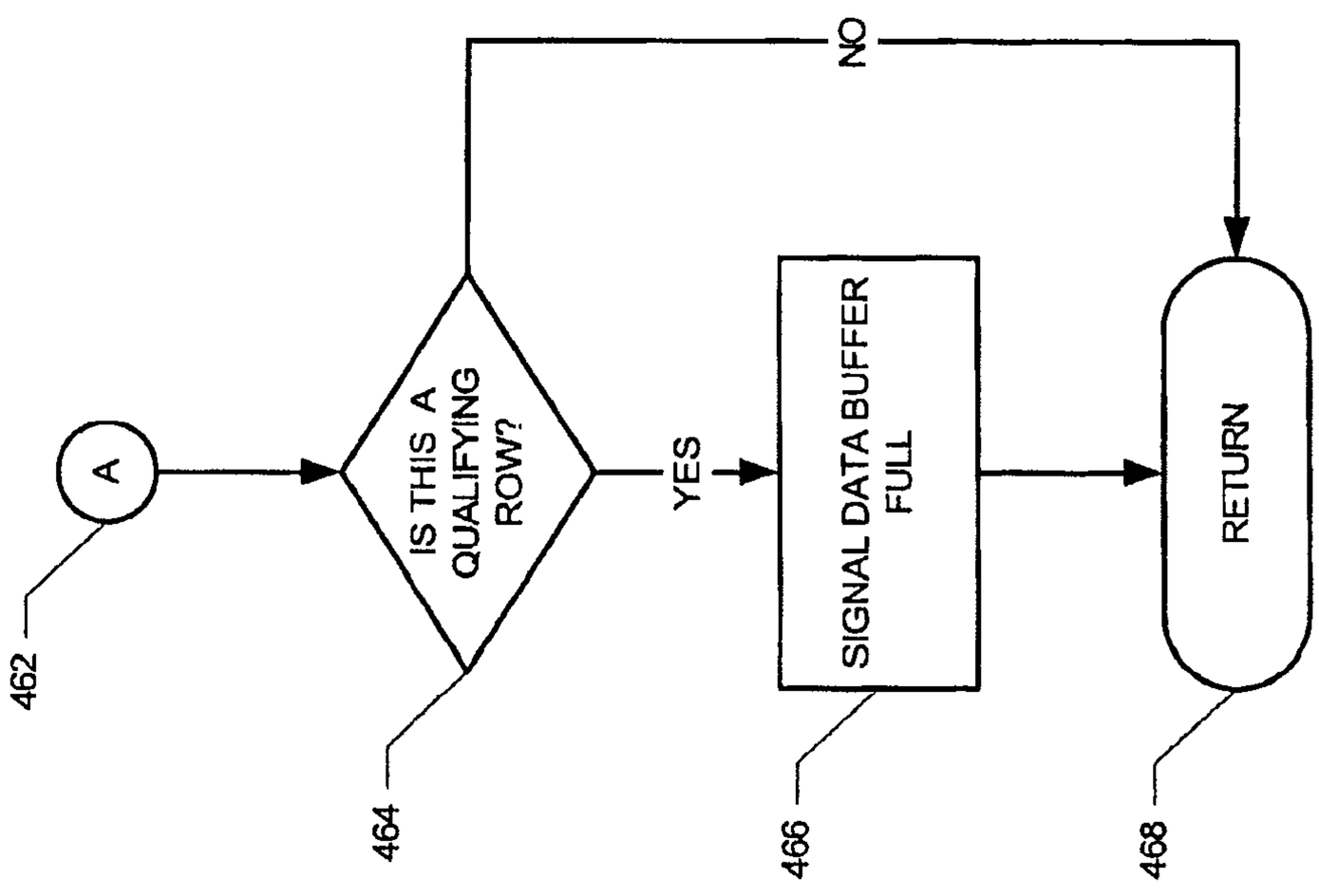

462
A
IS THIS A QUALIFYING ROW?
464
YES
NO
SIGNAL DATA BUFFER FULL
466
RETURN
468

FIG. 13

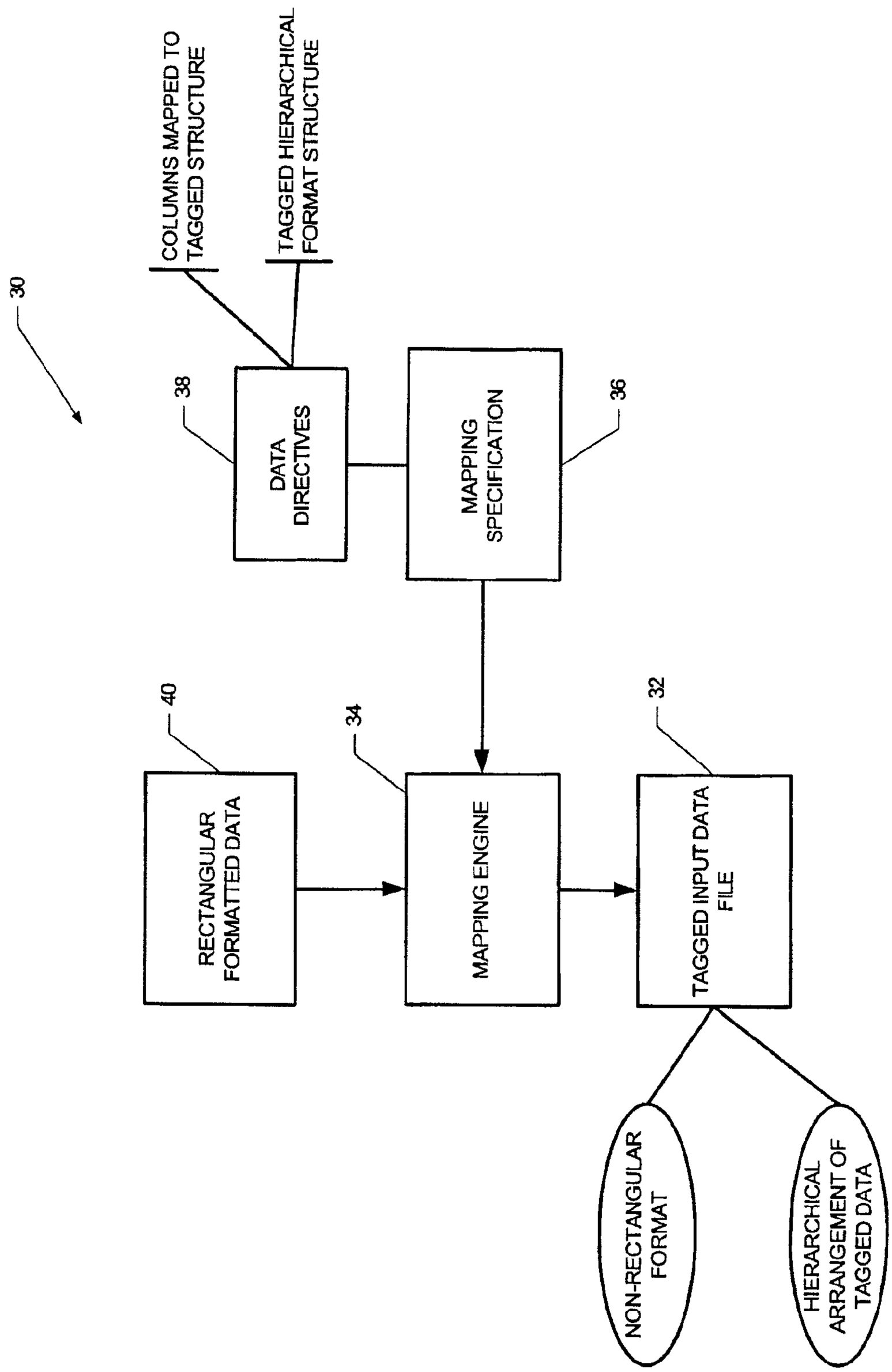

30
COLUMNS MAPPED TO TAGGED STRUCTURE
TAGGED HIERARCHICAL FORMAT STRUCTURE
38
DATA DIRECTIVES
MAPPING SPECIFICATION
36
40
RECTANGULAR FORMATTED DATA
34
MAPPING ENGINE
32
TAGGED INPUT DATA FILE
NON-RECTANGULAR FORMAT
HIERARCHICAL ARRANGEMENT OF TAGGED DATA

FIG. 14

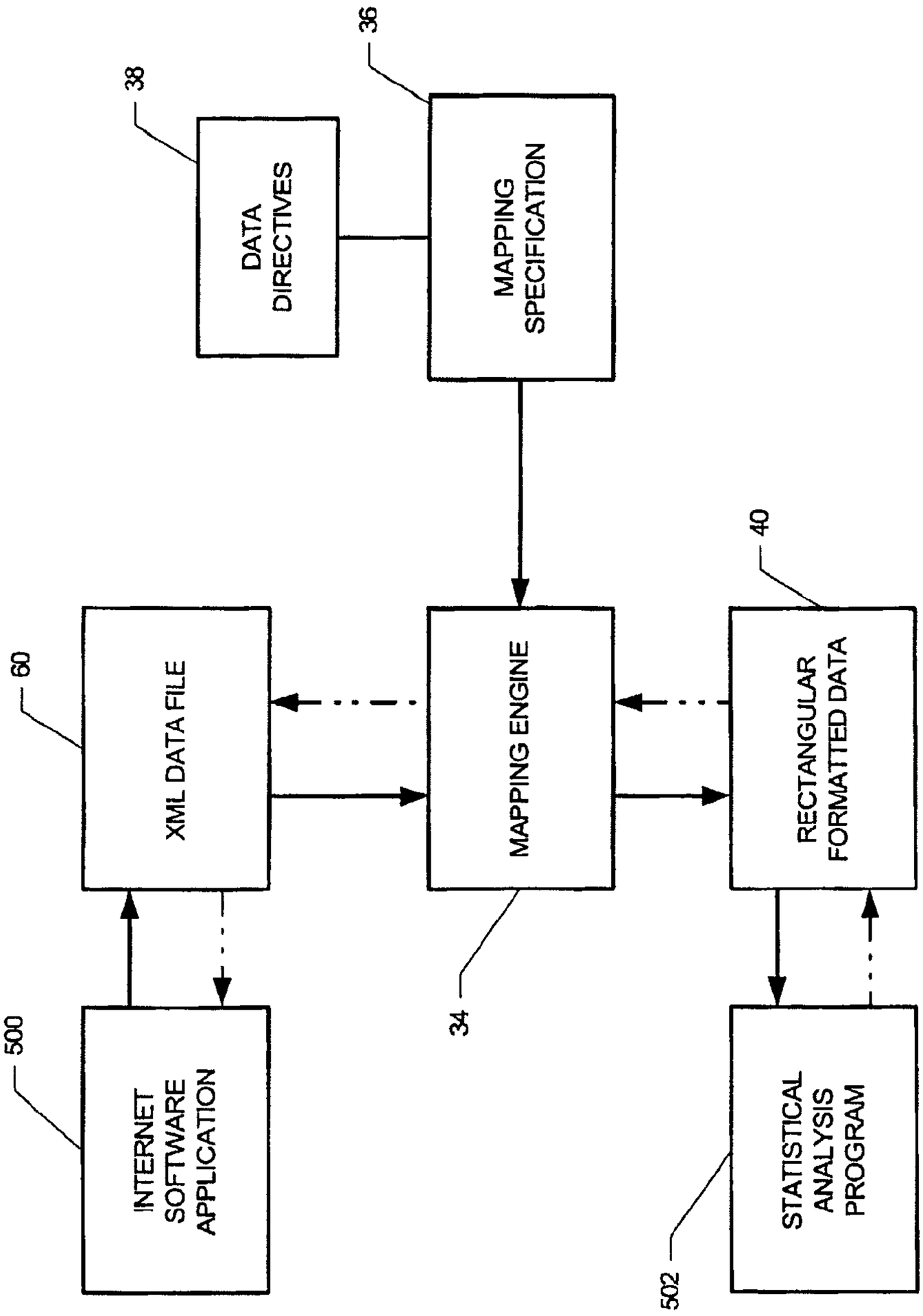

38
DATA DIRECTIVES
36
MAPPING SPECIFICATION
60
XML DATA FILE
MAPPING ENGINE
40
RECTANGULAR FORMATTED DATA
34
500
INTERNET SOFTWARE APPLICATION
502
STATISTICAL ANALYSIS PROGRAM

FIG. 15

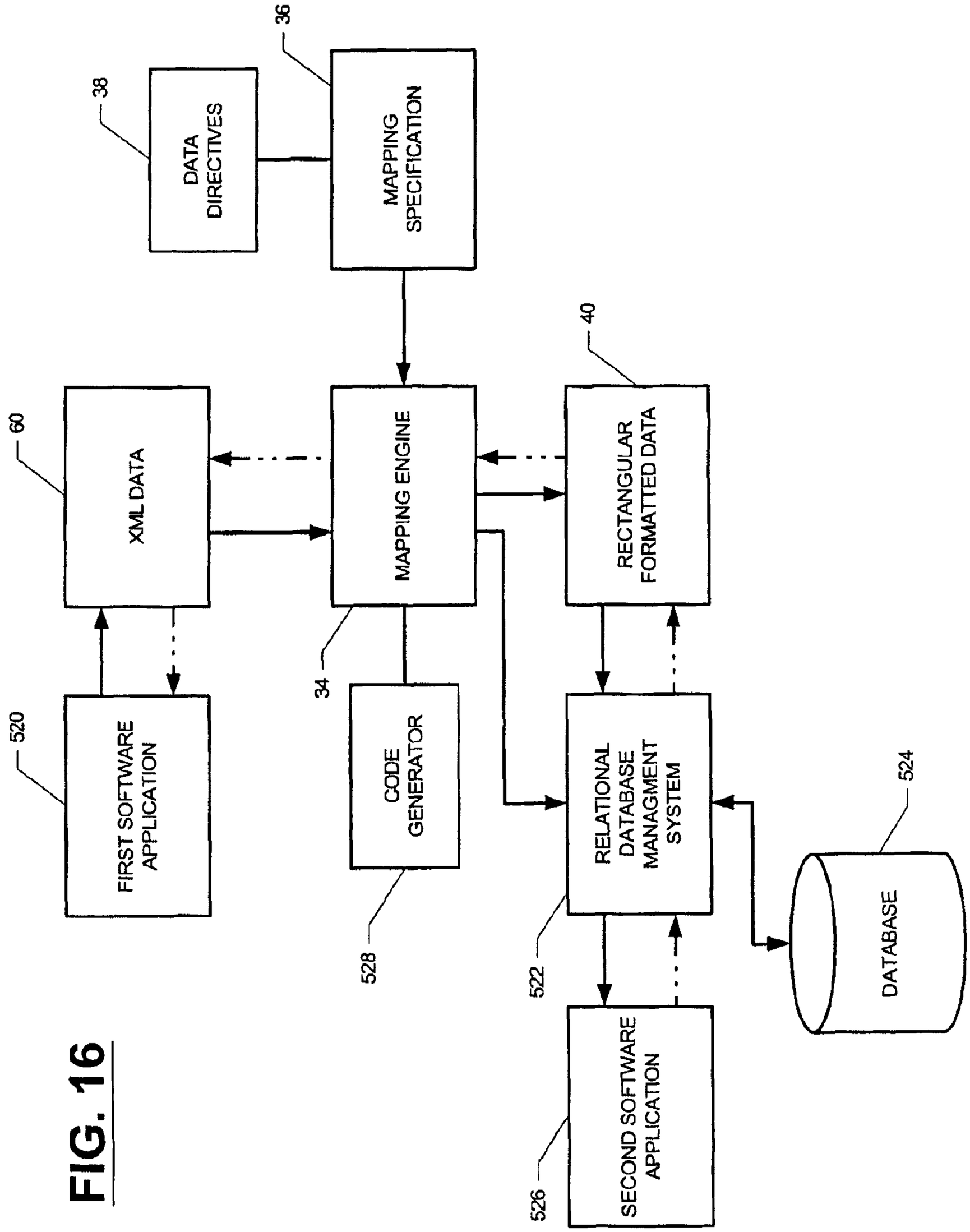

36
38
DATA DIRECTIVES
MAPPING SPECIFICATION
40
60
XML DATA
MAPPING ENGINE
RECTANGULAR FORMATTED DATA
520
FIRST SOFTWARE APPLICATION
34
CODE GENERATOR
RELATIONAL DATABASE MANAGMENT SYSTEM
524
528
522
526
SECOND SOFTWARE APPLICATION
DATABASE

FIG. 16

600

```
<?xml version="1.0" encoding="iso-8859-1" ?>
<NHL>
  <CONFERENCE> Eastern
    <DIVISION> Atlantic
      <TEAM name="New Jersey Devils" abbrev="NJ" />
      <TEAM name="New York Islanders" abbrev="NYI" />
      <TEAM name="New York Rangers" abbrev="NYR" />
      <TEAM name="Philadelphia Flyers" abbrev="PHI" />
      <TEAM name="Pittsburgh Penguins" abbrev="PGH" />
    </DIVISION>
  </CONFERENCE>
</NHL>
```

FIG. 17

620

```
<?xml version="1.0" encoding="iso-8859-1" ?>
<SXLEMAP version="1.2" name="Section42"
                description="String Functions Example">
  <TABLE name="concat">
    <TABLE-PATH> /NHL/CONFERENCE/DIVISION/TEAM </TABLE-PATH>
    <COLUMN name="concatpostfix">
      <TYPE> character </TYPE>
      <DATATYPE> string </DATATYPE>
      <PATH function="concat" string="(NHL)">
        /NHL/CONFERENCE/DIVISION/TEAM/@name
      </PATH>
    </COLUMN>
    <COLUMN name="concatprefix">
      <TYPE> character </TYPE>
      <DATATYPE> string </DATATYPE>
      <PATH function="concat" pattern="2001-2002 ">
        /NHL/CONFERENCE/DIVISION/TEAM/@name
      </PATH>
    </COLUMN>
    <COLUMN name="concat">
      <TYPE> character </TYPE>
      <DATATYPE> string </DATATYPE>
      <PATH function="concat" pattern="2001-2002 " string="(NHL)">
        /NHL/CONFERENCE/DIVISION/TEAM/@name
      </PATH>
    </COLUMN>
  </TABLE>

  <TABLE name="starts-with">
    <TABLE-PATH> /NHL/CONFERENCE/DIVISION/TEAM </TABLE-PATH>
    <COLUMN name="newyork">
      <TYPE> character </TYPE>
      <DATATYPE> string </DATATYPE>
      <PATH function="starts-with" pattern="New York">
        /NHL/CONFERENCE/DIVISION/TEAM/@name
      </PATH>
    </COLUMN>
  </TABLE>
```

630

630

640

640

FIG. 18A

620

650 <TABLE name="contains">
<TABLE-PATH> /NHL/CONFERENCE/DIVISION/TEAM </TABLE-PATH>
<COLUMN name="new">
<TYPE> character </TYPE>
<DATATYPE> string </DATATYPE>
<PATH function="contains" pattern="New">
/NHL/CONFERENCE/DIVISION/TEAM/@name
</PATH>
</COLUMN>
650 </TABLE>

660 <TABLE name="substring-before">
<TABLE-PATH> /NHL/CONFERENCE/DIVISION/TEAM </TABLE-PATH>
<COLUMN name="york">
<TYPE> character </TYPE>
<DATATYPE> string </DATATYPE>
<PATH function="substring-before" pattern="York">
/NHL/CONFERENCE/DIVISION/TEAM/@name
</PATH>
</COLUMN>
660 </TABLE>

670 <TABLE name="substring-after">
<TABLE-PATH> /NHL/CONFERENCE/DIVISION/TEAM </TABLE-PATH>
<COLUMN name="new">
<TYPE> character </TYPE>
<DATATYPE> string </DATATYPE>
<PATH function="substring-after" pattern="New">
/NHL/CONFERENCE/DIVISION/TEAM/@name
</PATH>
</COLUMN>
670 </TABLE>

FIG. 18B

620

680 <TABLE name="substring">
<TABLE-PATH> /NHL/CONFERENCE/DIVISION/TEAM </TABLE-PATH>
<COLUMN name="first-five">
<TYPE> character </TYPE>
<DATATYPE> string </DATATYPE>
<PATH function="substring" index="1" length="5">
/NHL/CONFERENCE/DIVISION/TEAM/@name
</PATH>
</COLUMN>
<COLUMN name="fifth-on">
<TYPE> character </TYPE>
<DATATYPE> string </DATATYPE>
<PATH function="substring" index="5">
/NHL/CONFERENCE/DIVISION/TEAM/@name
</PATH>
</COLUMN>
<COLUMN name="fifth-eight">
<TYPE> character </TYPE>
<DATATYPE> string </DATATYPE>
<PATH function="substring" index="5" length="4">
/NHL/CONFERENCE/DIVISION/TEAM/@name
</PATH>
</COLUMN>
680 </TABLE>

680 <TABLE name="string-length">
690 <TABLE-PATH> /NHL/CONFERENCE/DIVISION/TEAM </TABLE-PATH>
<COLUMN name="strlen">
<TYPE> numeric </TYPE>
<DATATYPE> integer </DATATYPE>
<PATH function="string-length">
/NHL/CONFERENCE/DIVISION/TEAM/@name
</PATH>
</COLUMN>
690 </TABLE>

FIG. 18C

620

700 <TABLE name="normalize">
<TABLE-PATH> /NHL/CONFERENCE/DIVISION/TEAM </TABLE-PATH> <COLUMN name="space">
<TYPE> character </TYPE>
<DATATYPE> string </DATATYPE>
<PATH function="normalize-space">
/NHL/CONFERENCE/DIVISION/TEAM/@name
</PATH>
</COLUMN>
700 </TABLE>

710 <TABLE name="translate">
<TABLE-PATH> /NHL/CONFERENCE/DIVISION/TEAM </TABLE-PATH>
<COLUMN name="original">
<TYPE> character </TYPE>
<DATATYPE> string </DATATYPE>
<PATH> /NHL/CONFERENCE/DIVISION/TEAM/@name </PATH>
</COLUMN>
<COLUMN name="result">
<TYPE> character </TYPE>
<DATATYPE> string </DATATYPE>
<PATH function="translate" pattern="New" string="Old">
/NHL/CONFERENCE/DIVISION/TEAM/@name
</PATH>
</COLUMN>
</TABLE>
710 </SXLEMAP>

FIG. 18D

FIG. 19A

	concatprefix	concat
	2001-2002 New Jersey Devils	2001-2002 New Jersey Devils (NHL)
	2001-2002 New York Islanders	2001-2002 New York Islanders (NHL)
	2001-2002 New York Rangers	2001-2002 New York Rangers (NHL)
	2001-2002 Philadelphia Flyers	2001-2002 Philadelphia Flyers (NHL)
	2001-2002 Pittsburgh Penguins	2001-2002 Pittsburgh Penguins (NHL)

concat

concatpostfix
New Jersey Devils (NHL)
New York Islanders (NHL)
New York Rangers (NHL)
Philadelphia Flyers (NHL)
Pittsburgh Penguins (NHL)

750

starts-with

newyork
false
true
true
false
false

760

contains

new
true
true
true
false
false

770

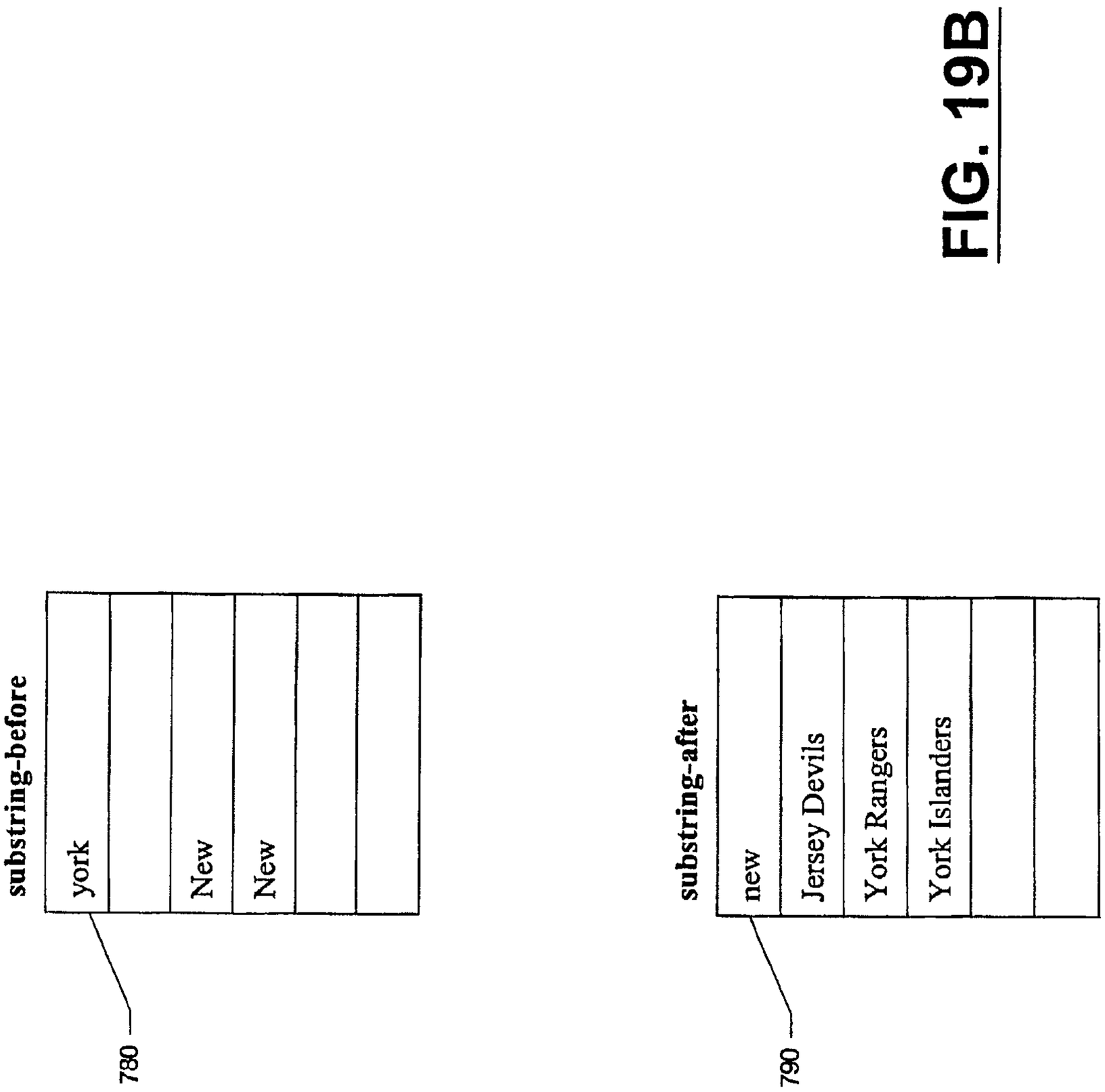

substring-before
york
New
New
780
substring-after
new
Jersey Devils
York Rangers
York Islanders
790

FIG. 19B

substring	fifth-on	five-eight
first-five	fifth-on	five-eight
New J	Jersey Devils	Jers
New Y	York Islanders	York
New Y	York Rangers	York
Phila	adelphia Flyers	adel
Pitts	sburgh Penguins	sbur

800

string-length
strlen
17
18
16
19
19

810

FIG. 19C

normalize

space
New Jersey Devils
New York Islanders
New York Rangers
Philadelphia Flyers
Pittsburgh Penguins

820

translate

original	result
New Jersey Devils	Old JIrsly Dlvils
New York Islanders	Old York IslaOdlrs
New York Rangers	Old York RaOglrs
Philadelphia Flyers	Philadllphia Flylrs
Pittsburgh Penguins	Pittsburgh PlOguiOs

830

FIG. 19D

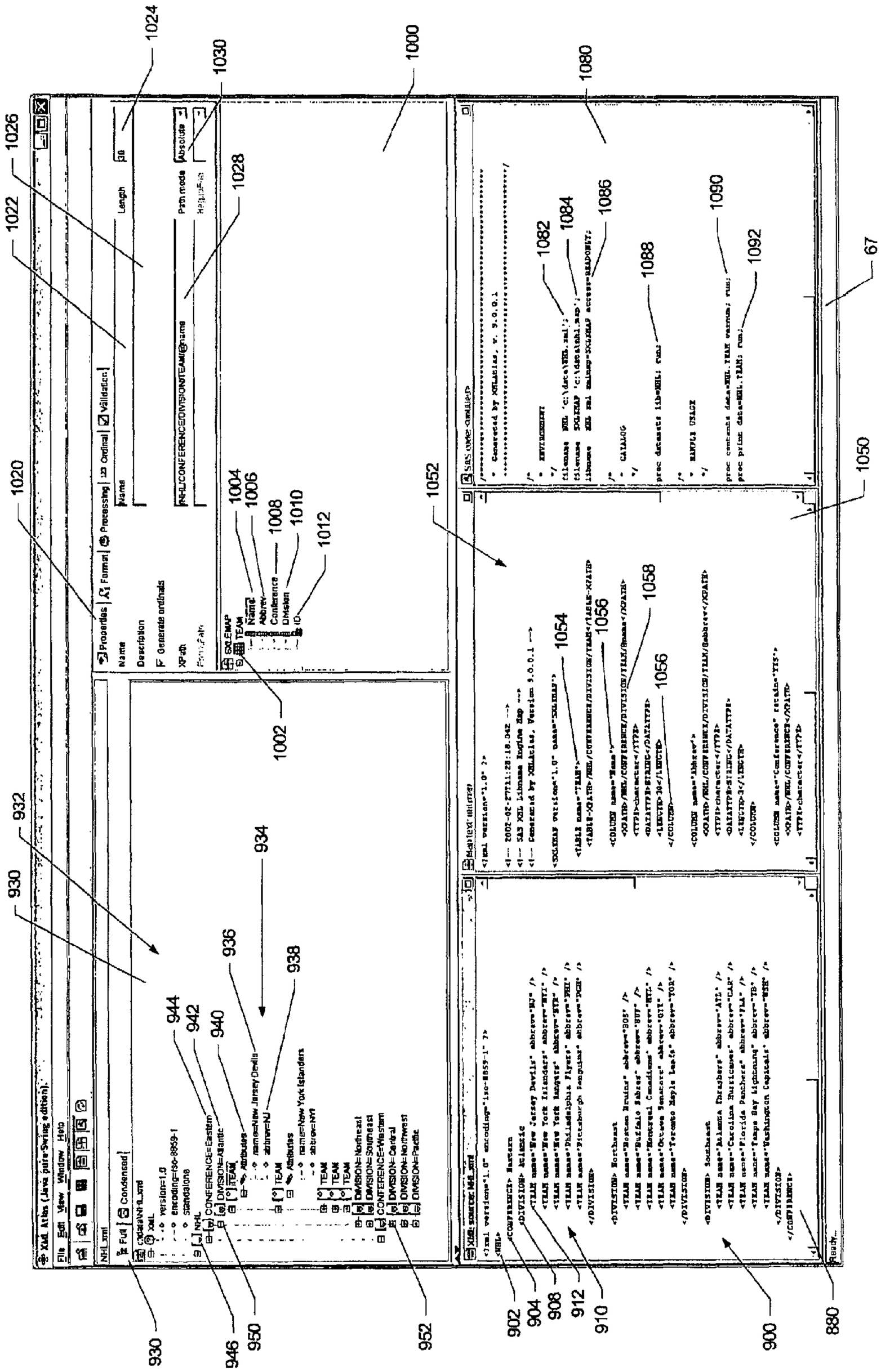
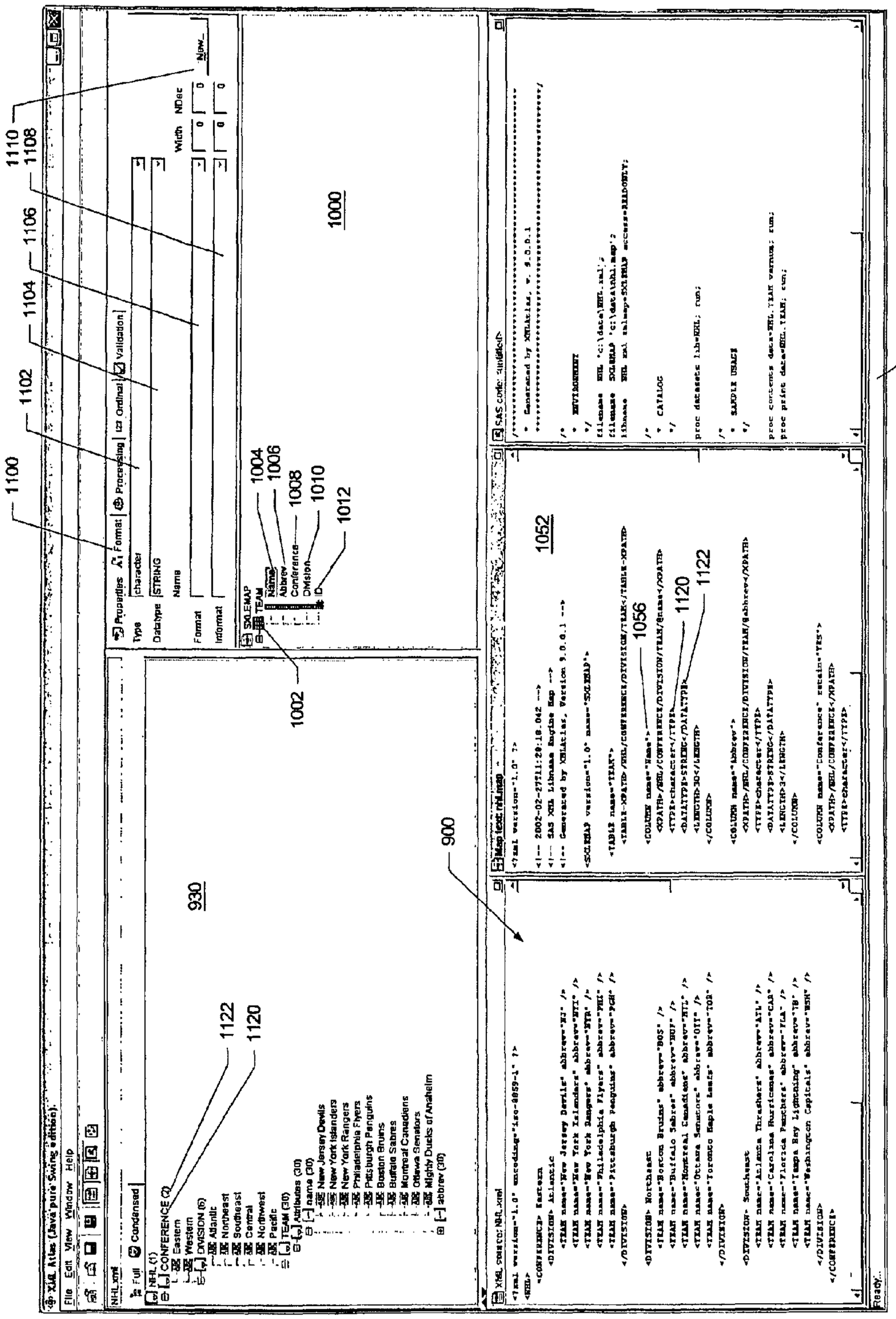

1024
1030
1000
1080
1026
1022
1028
1020
1082
1084
1086
1090
1088
1092
67
1004
1006
1008
1010
1012
1002
1052
1050
930
932
934
936
938
944
942
940
946
950
952
902
904
908
912
910
900
880

FIG. 20


1000
1100
1102
1104
1106
1108
1110
930
900
1002
1004
1006
1008
1010
1012
1052
1056
1120
1122
67
XML Atlas (Java pure Swing edition)
File Edit View Window Help
NHL.xml
Full
Condensed
NHL (1)
CONFERENCE (2)
Eastern
Western
DIVISION (6)
Atlantic
Northeast
Southeast
Central
Northwest
Pacific
TEAM (30)
Attributes (30)
name (30)
New Jersey Devils
New York Islanders
New York Rangers
Philadelphia Flyers
Pittsburgh Penguins
Boston Bruins
Buffalo Sabres
Montreal Canadiens
Ottawa Senators
Mighty Ducks of Anaheim
abbrev (30)
XML source: NHL.xml
Ready...
Properties
Format
Processing
Ordinal
Validation
Type
Datatype
Name
Format
Informat
SXLEMAP
TEAM
Name
Abbrev
Conference
Division
ID
Map test: nhl.map
SAS code: Untitled
FIG. 21

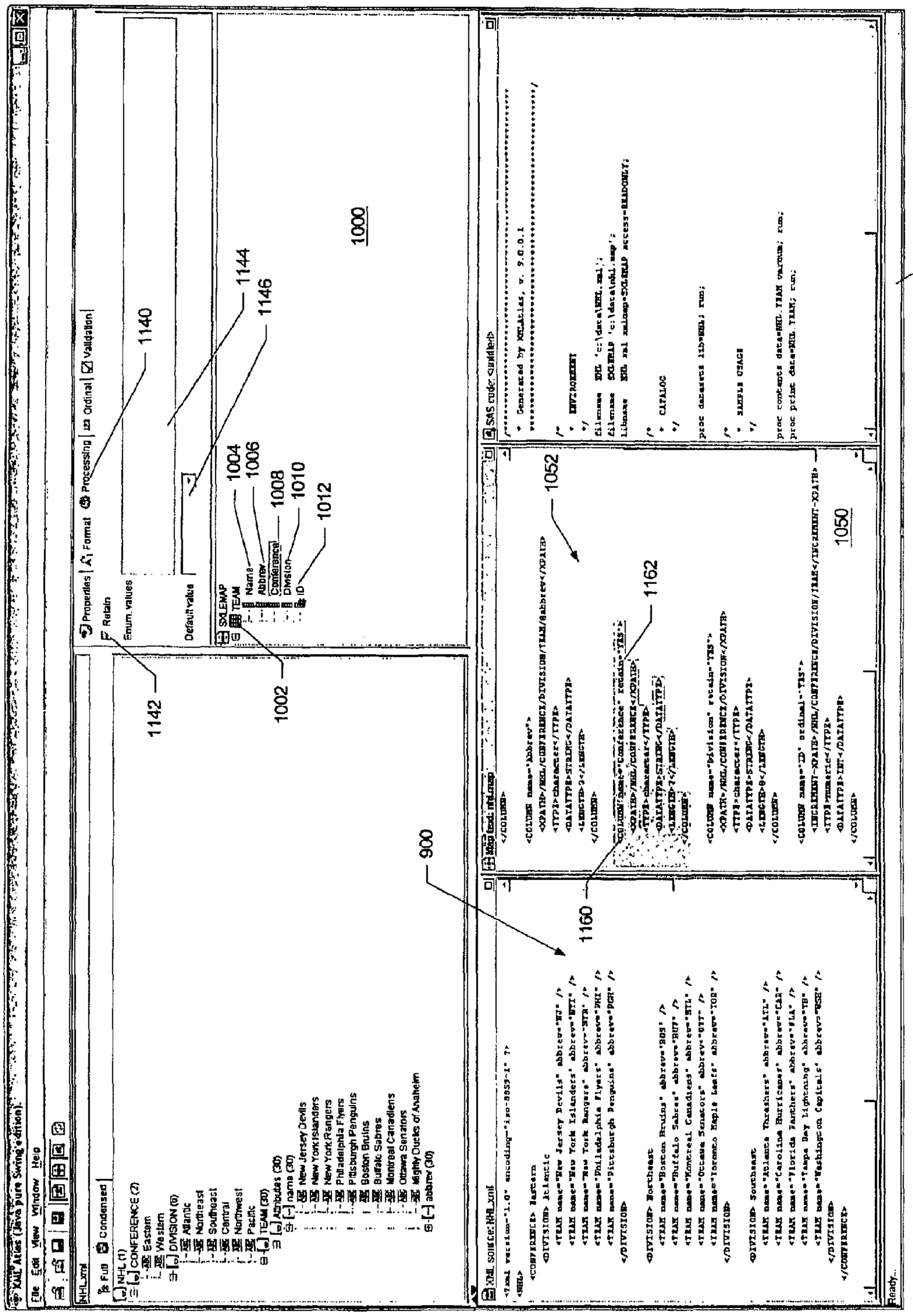

1000
1140
1142
1144
1146
1002
1004
1006
1008
1010
1012
900
1160
1162
1050
1052
67
XML Atlas (Java pure Swing edition)
File Edit View Window Help
NHL.xml
XML source: NHL.xml
Ready...

FIG. 22

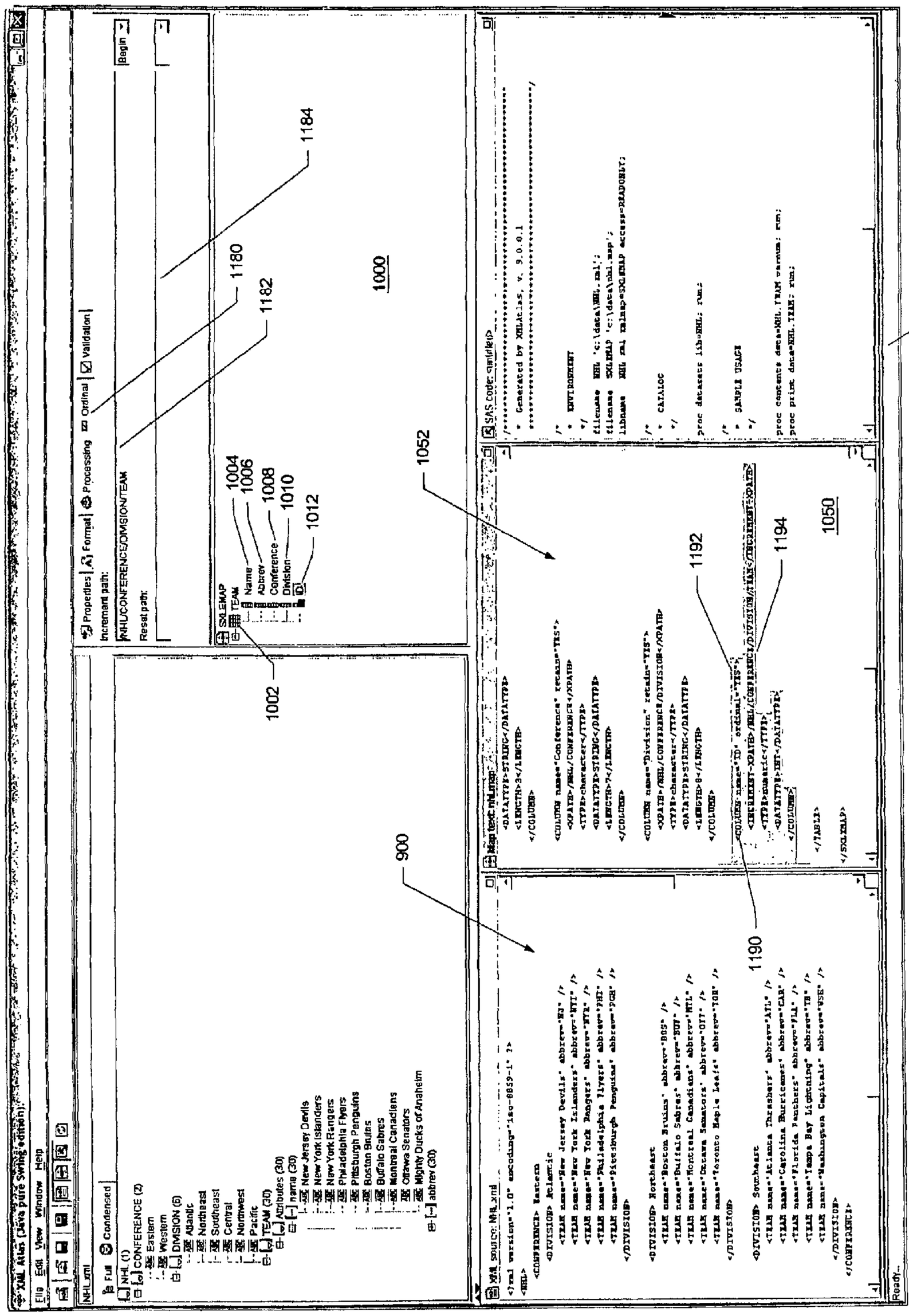

1184
1180
1182
1000
1004
1006
1008
1010
1012
1052
1002
900
1190
1192
1194
1050
67

FIG. 23

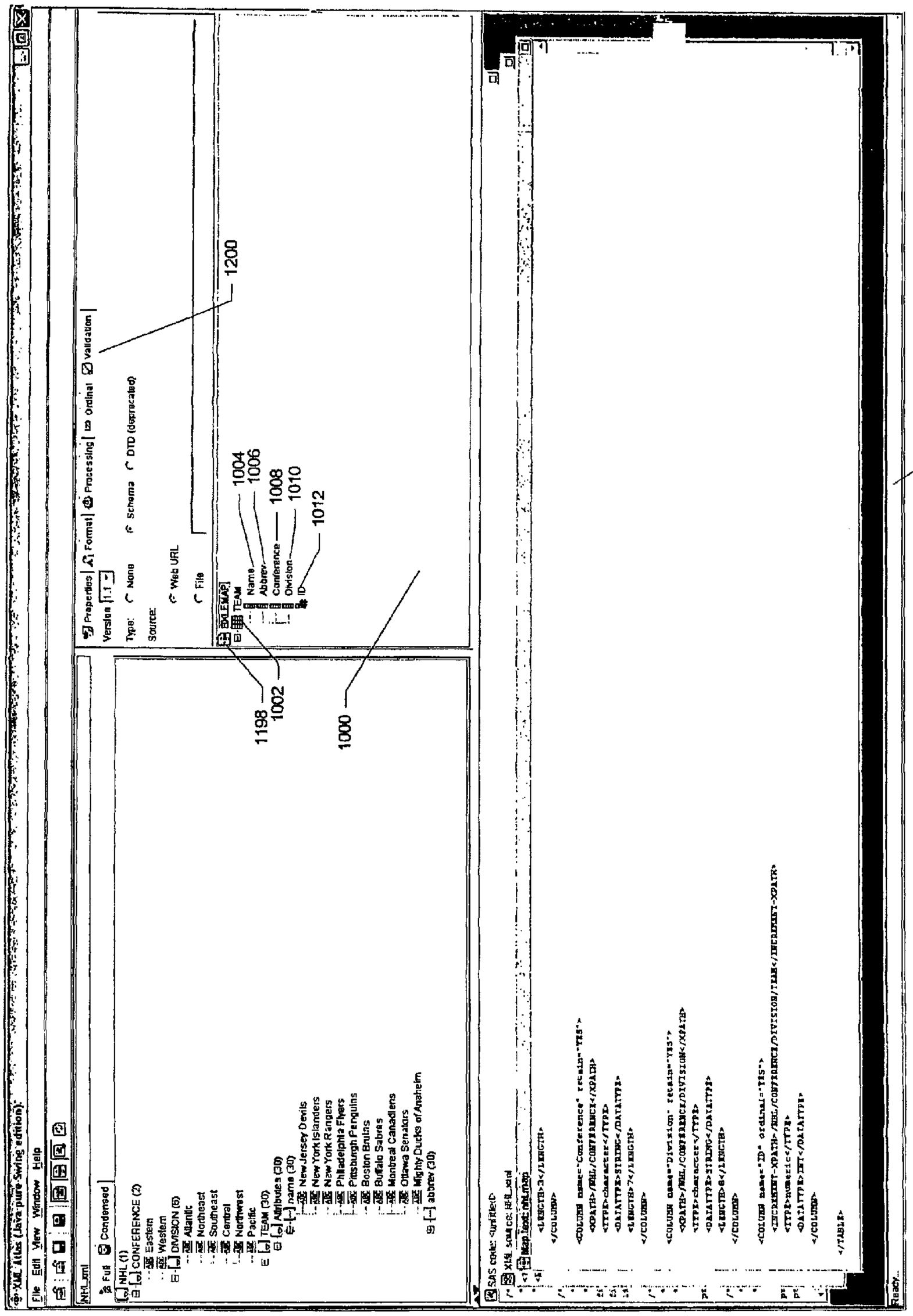


FIG. 24

COMPUTER-IMPLEMENTED SYSTEM AND METHOD FOR TAGGED AND RECTANGULAR DATA PROCESSING

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue; a claim printed with strikethrough indicates that the claim was canceled, disclaimed, or held invalid by a prior post-patent action or proceeding.

[RELATED APPLICATION] *CROSS-REFERENCE TO RELATED APPLICATIONS*

[This application is a continuation of U.S. patent application Ser. No. 10/126,937, filed on Apr. 19, 2002, now U.S. Pat. No. 7,921,359 which is incorporated by reference.]

This application is a reissue application of its parent U.S. patent application Ser. No. 12/750,994 filed on Mar. 31, 2010, now U.S. Pat. No. 8,756,495 B2 issued on Jun. 17, 2014, which is a continuation of U.S. patent application Ser. No. 10/126,937 filed on Apr. 19, 2002, now U.S. Pat. No. 7,921,359 B2 issued on Apr. 5, 2011.

The entire contents of each of these applications are hereby incorporated by reference in their entirety.

FIELD OF THE INVENTION

The present invention relates generally to computer-implemented data conversions and more particularly to tagged and rectangular data processing.

BACKGROUND AND SUMMARY

Software applications exchange data in a variety of formats. Two of the more prevalent formats are the tagged hierarchical data format and the rectangular data format. Tagged hierarchical data formats, such as the eXtensible Markup Language (XML) format, are becoming increasingly popular as they provide a useful data exchange medium for Internet software applications. Rectangular data formats are also widely used as their tabular format is the cornerstone of most database systems.

Incompatibility difficulties arise when software systems using different formats seek to exchange data. The present invention overcomes such difficulties and others by providing a computer-implemented system and method for tagged data and rectangular data conversions. The system and method receive tagged input data that is in a non-rectangular format and that uses a hierarchical arrangement of tags to indicate data relationships. The tagged input data is displayed in a graphical interface, and the graphical interface is used to create a mapping specification from the tagged input data.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a block diagram depicting software and computer components utilized in processing a tagged input data file;

FIG. **2** is a block diagram depicting software and computer components utilized in a different embodiment for processing a tagged input data file;

FIG. **3** is a data structure diagram depicting an example of an input tagged data file;

FIG. **4** is a data structure diagram depicting an example of a mapping specification;

FIG. **5** is a data structure diagram depicting an example of output rectangular formatted data;

FIG. **6** is a data structure diagram depicting a second example of an input tagged data file;

FIG. **7** is a data structure diagram depicting a second example of a mapping specification;

FIG. **8** is a data structure diagram depicting a second example of output rectangular formatted data;

FIGS. **9-13** are flowcharts depicting an operational scenario for processing a tagged input data file;

FIG. **14** is a block diagram depicting software and computer components utilized in processing rectangular formatted data;

FIGS. **15** and **16** are block diagrams depicting exemplary applications involving tagged and rectangular data processing;

FIG. **17** is a data structure diagram depicting another example of an input tagged data file;

FIGS. **18**A-**18**D are data structure diagrams depicting another example of a mapping specification;

FIGS. **19**A-**19**D are data structure diagrams depicting another example of output rectangular formatted data; and

FIGS. **20-24** depict graphical user interfaces for processing tagged data files and rectangular formatted data.

DETAILED DESCRIPTION

FIG. **1** depicts a computer-implemented system **30** that handles tagged and rectangular data formats. In the example of FIG. **1**, the system **30** converts non-rectangular formatted data **32** into rectangular formatted data **40**. The conversion can serve many uses, such as to import the converted input data into one or more tables within a relational database management system (RDBMS).

The input data **32** may be considered non-rectangular due to a number of reasons, such as its data items being arranged in a "columnless" tagged hierarchical format. The tags in the hierarchy show how one data item relates to another data item. Data in an eXtensible Markup Language (XML) format is an example of a tagged hierarchical format.

The system **30** uses a mapping specification **36** to determine how the rectangular formatted output data **40** is to be formed from the tagged input data **32**. The mapping specification **36** includes data directives **38** to define how the rectangular output **40** is to be constructed. This may include what columns are to be formed from the tagged input data items; when is a new row in the output to be initiated; and what format the output columns are to assume.

A software mapping engine **34** reads the tagged input data **32** and the mapping specification **36**. The mapping engine **34** parses the tagged input data **32** in accordance with the data directives **38** contained in the mapping specification **36**. The mapping engine **36** assembles the parsed information into the column format dictated by the data directives **38**. The assembled columns are then placed in an output file **40**.

FIG. **2** shows a different embodiment for processing a tagged input data file **60** that is in an XML data format. In this different embodiment, the mapping specification **64** indicates through an XPath locator format the locations of the tagged input data **60** that is to form the rectangular formatted output **70**. For example, if the tagged input data **60** indicates what sport teams are in which conferences and divisions in the National Hockey League (NHL), the mapping specification **64** can use the following XPath locator to identify where the team data is located in the input tagged

file: /NHL/CONFERENCE/DIVISION/TEAM. This XPath locator specifies that team information can be collected from the following hierarchical data structure: Teams are contained in Divisions which are contained in Conferences which are contained in the NHL. Based upon the XPath locator, the mapping engine **62** uses an off the shelf XML parser **68** to locate and extract the team data from the tagged input data file **60**. The mapping specification **64** may also specify through other XPath locators how to extract other data from the tagged input data file **60**, such as data for the other output columns.

In this different embodiment, the mapping specification **64** may be supplemented with additional data directives **66**, such as enumerating what are acceptable values to be placed in the rectangular formatted output data **70**. For example, a data directive may specify that only "YES" or "NO" values are acceptable for a particular output column. The data directive may also use a selection criterion to filter the values being placed in the rectangular formatted output data **70**. In the NHL situation, a selection criteria may specify that only NHL teams whose names begin with the letter "S" are to part of the output. Thus, the teams "Sharks" and "Stars" will be included, but not the team "Thrashers". Other data directives **66** include deriving an output value based upon two or more data items contained in the tagged input data file **60**, or associating a sequential counter value with each new row in the output **70**.

A graphical user interface **67** may help a user create the data directives **66**. Through the graphical user interface **67**, a user can see the data items and their relationships contained in the tagged input data file **60**. In the NHL example, the user can ascertain more efficiently the mechanism needed to access the teams data within the XML data hierarchy. To generate data for the graphical user interface **67**, the data items and their relationships in the XML data file **60** are parsed via an off-the-shelf XML parser **68**. Via the graphical user interface **67**, the user can select which data items in the XML data file **60** are to form columns in the rectangular output data file **70**. The user can also specify column format, selection criteria and other data directives for the column formation.

It should be understood that the system **30** may accept a data stream of XML data instead of a file. In such a situation, the system **30** parses and stores the tagged information as it is received via the data stream and creates new rows when it has received sufficient information from the data stream to form a new row. Moreover, it should be understood that the system **30** may provide its output as a data stream when it creates new rows.

FIGS. **3-5** show an example where the system converts XML data into rectangular formatted data. FIG. **3** shows the input XML data structure **100** for this example. The XML data structure **100** contains tagged hierarchical data about National Hockey League (NHL) teams, such as what teams are in which divisions, and what divisions are in which conferences. NHL tags **102** enclose NHL conference, division, and team data as well their data relationships. The first conference tags **104** contain the Eastern conference data, and the second conference tags **106** contain the Western conference data. The first division tags **108** contain the Southeast division data, and the second division tags **110** contain the Pacific division data. Name and abbreviation attributes within team tags respectively provide the names and abbreviations of the teams. For example, team tag **112** contains the name attribute "Thrashers" and the team abbreviation attribute "ATL".

To convert the XML data into a rectangular format, a mapping specification is constructed. FIG. **4** shows an example of a mapping specification **150** to form a Teams table. The table tags **152** specify that the name of the output table is "TEAMS". The Teams table is to be formed with separate columns for conference data, division data, name data, and abbreviation data. With reference to both FIGS. **3** and **4**, the XML data structure **100** is examined to determine where in the XML hierarchy the various data items to form the desired table are located. The mapping specification **150** via XPath locators identify the location where the team data is located in the XML data structure **100**. For example, the XPath locator for the teams data is shown at **154** in an XPath specification format. The XPath specification **154** is enclosed within the table_xpath tags **156**. The table_xpath tags indicate that a new observation in the output table is to be generated each time a <TEAM> element tag is processed.

The mapping specification **150** is supplemented with column definitions for the desired output Teams table. Column tags within the mapping specification **150** indicate what columns the output table will contain. Column tags **160** indicate the "name" column is to be formed, and they enclose information to form the "name" column. The enclosed information includes: XPath tags **162** to locate the name information within the XML data structure **100**; type tags **164** and data type tags **166** to indicate what type the name values will be; and length tags **168** to indicate the variable size. The type for the "name" column is character, and the data type is string. The maximum length of the string within the column is thirty characters. It is noted that the XPath specification within the XPath tags **162** reflects that "name" is an attribute within the XML data structure **100**.

Column tags **170** indicate the "abbrev" column is to be formed, and they enclose information to form the "abbrev" column. The enclosed information includes: XPath tags **172** to locate the abbreviation information within the XML data structure **100**; type tags **174** and data type tags **176** to indicate what type the abbreviation values will be; and length tags **178** to indicate the variable size. The type for the "abbrev" column is character, and the data type is string. The maximum length of the string within the column is three characters. It is noted that the XPath specification within the XPath tags **172** reflects that "abbrev" is an attribute within the XML data structure **100**.

Certain output columns add information about other output column entries, such as foreign keys or external context. Conference column tags **180** and division column tags **190** specify that such supplemental information is to be placed in the output table. Column tags **180** indicate the "conference" column is to be formed, and they enclose information to form the "conference" column. The enclosed information includes: XPath tags **182** to locate the conference information within the XML data structure **100**; type tags **184** and data type tags **186** to indicate what type the conference values will be; and length tags **188** to indicate the variable size. The type for the "conference" column is character, and the data type is string. The maximum length of the string within the column is ten characters. It is noted that the XPath specification within the XPath tags **182** reflects that "conference" is a pcdata field within the XML data structure **100**.

Column tags **190** indicate the "division" column is to be formed, and they enclose information to form the "division" column. The enclosed information includes: XPath tags **192** to locate the division information within the XML data structure **100**; type tags **194** and data type tags **196** to indicate what type the division values will be; and length tags **198** to indicate the variable size. The type for the

"division" column is character, and the data type is string. The maximum length of the string within the column is ten characters. It is noted that the XPath specification within the XPath tags **192** reflects that "division" is a pcdata field within the XML data structure **100**.

Both the conference column tags **180** and division column tags **190** include a retain attribute. When the retain attribute is set to "YES", it forces the retention of processed data values after an observation is written to the output data set. Because the foreign key fields occur outside the observation boundary (i.e., they are more sparsely populated in the hierarchical XML data than in the output data set), their values are retained for additional rows as they are encountered.

Application of the mapping specification **150** upon the data contained in the XML data structure **100** produces the tabular output **200** shown in FIG. **5**. With reference to FIGS. **4** and **5**, the output table **202** is labeled "Teams" as dictated by the mapping specification's table tags **152**. The table **202** contains the conference column **204**, division column **206**, name column **208**, and abbreviation column **210** as dictated by the mapping specification column tags **160**, **170**, **180** and **190**. The data contained within the columns **204**, **206**, **208**, and **210** reflect the data contained within the input XML data file.

It should be understood that while this example includes only string values, the mapping specification can handle any type of value (including user-defined data types). For example, FIGS. **6-8** depict processing an XML data structure **250** having date fields.

With reference to FIG. **6**, the XML data structure **250** contains data about published books in a public library. The XML data structure **250** has publication title information, the date upon which the library acquired the publication, and the topic of the publication. The library tags **252** enclose data about the publications. The publication tags **254**, **256**, and **258** indicate that there are three publications within the library tags **252**. Publication tag **254** has title tag **260** and acquisition date tag **262**; publication tag **256** has title tag **264** and acquisition date tag **266**; and publication tag **258** has title tag **268** and acquisition date tag **270**. The publication tags **254**, **256**, and **258** also contain tags to indicate the topic of a book. Because a book may cover multiple topics, a publication tag may include multiple topic tags. For example, publication tag **256** includes a first topic tag **272** and a second topic tag **274**. The publication entitled "Inside Visual C++" has a first topic "C" and a second topic "Reference". An attribute is included in the first topic tag **272** to indicate that the first topic is the major topic for the publication.

To convert the XML data into a rectangular format, a mapping specification is constructed. FIG. **7** shows an example of a mapping specification **300** to form a Publication table having separate columns for title data, acquisition date data, topic data, and major topic data. With reference to both FIGS. **6** and **7**, the XML data structure **250** is examined to determine where in the XML hierarchy the various data items to form the desired table are located. The table tags **302** specify that the name of the output table is "Publication". The mapping specification **300** locates within the XML data structure **250** where the publication data items are located. The table_xpath tags **306** contain this location information at **304** in an XPath specification format.

The mapping specification **300** is supplemented with the column definitions for the desired output Publication table. Column tags (**310**, **320**, **330**, and **340**) within the mapping specification **300** indicate what columns the table will contain. Column tags **310** indicate the "Title" column is to be formed, and they enclose information to form the "Title" column. The enclosed information includes: XPath tags **312** to locate the name information within the XML data structure **250**; type tags **314** and data type tags **316** to indicate what type the Title values will be; and length tags **318** to indicate the variable size. The type for the "Title" column is character, and the data type is string. The maximum length of the string within the column is nineteen characters.

Column tags **320** indicate the "Acquired" column is to be formed, and they enclose information to form the "Acquired" column. The enclosed information includes: XPath tags **322** to locate the acquisition date information within the XML data structure **250**; type tags **324** and data type tags **326** to indicate what type the date values will be; and length tags **327** to indicate the variable size. The type for the "Acquired" column is numeric, and the data type is float. Format tags **328** indicate for the output a width of ten and a "mmddyy" format. The informat tags **327** specify the input format for the field. The field is constructed using format/informat controls of the mapping specification. These controls are useful for situations where data (such as dates) must be converted for use by the system. User written formats and informats are supported, and they may be used independently of each other.

Column tags **330** indicate the "Topic" column is to be formed, and they enclose information to form the "Topic" column. It is noted that in this example a publication data item may enclose an arbitrary number of topics. The publication tags **254** enclose one topic data item, while publication tags **256** enclose two topic data items. A new observation is generated in the output each time a <topic> element is encountered in the input file. The information enclosed by tags **330** includes: XPath tags **332** to locate the topic information within the XML data structure **250**; type tags **334** and data type tags **336** to indicate what type the topic values will be; and length tags **338** to indicate the variable size. The type for the "Topic" column is character, and the data type is string. The maximum length of the string within the column is nine characters.

Column tags **340** indicate the "Major" topic column is to be formed, and they enclose information to form the "Major" topic column. The enclosed information includes: XPath tags **342** to locate the major topic information within the XML data structure **250**; type tags **344** and data type tags **346** to indicate what type the major topic values will be; and length tags **346** to indicate the variable size. The type for the "Major" topic column is character, and the data type is string. The maximum length of the string within the column is one character. Enumerations are also located within the "Major" topic column tags **340**. Here, the values expected of the major topic attribute must be either "Y" or "N" as shown by tags **352** and **354**. Incoming data values not contained within the ENUM tags **350** are set to MISSING. The MISSING value is the default for data which does not occur in the input file processing unless specifically overridden by a non-MISSING default value as specified by a <DEFAULT> element (e.g., tag **356**).

Both the Title column tags **310** and Acquired column tags **320** include a retain attribute. When the retain attribute is set to "YES", it forces the retention of processed data values after an observation is written to the output data set. Because the foreign key fields occur outside the observation boundary (i.e., they are more sparsely populated in the hierarchical XML data than in the output data set), their values are retained for additional rows as they are encountered.

Application of the mapping specification **300** upon the data contained in the XML data structure **250** produces the tabular output **370** shown in FIG. **8**. With reference to FIGS. **7** and **8**, the output table **372** is labeled "Publication" as dictated by the mapping specification's table tags **302**. The table **372** contains the Title column **374**, Acquired column **376**, Topic column **378**, and Major column **380** as dictated by the mapping specification column tags **310**, **320**, **330** and **340**. The data contained within the columns **374**, **376**, **378**, and **380** reflect the data stored within the input XML data file.

It should be understood that a mapping specification may contain multiple table tags so that multiple tables can be formed from the mapping specification. Each table specified in the mapping specification may have different table contents.

FIGS. **9-13** are flowcharts depicting an operational scenario for processing a tagged input data file. With reference to FIG. **9**, start indicator **400** indicates that at process block **402**, a tagged input data file is to be converted. In this operational scenario, the graphical user interface is used to more easily discern what data items and data relationships are found within the tagged input data file. With this knowledge, a user describes the rectangularization characteristics for the input tagged data file. This description which is to form the mapping specification involves identifying what tables are to be generated from the tagged input data file. Repeating patterns for the data are also identified as well as the output table's column definition. The user may also wish to add any foreign keys or external context. XPath locators are created in order to identify positions in the tagged input data file to extract the data.

Based upon the description of process block **404**, the data directives are formed and stored in the mapping specification at process block **406**. At process block **408**, the encoding contained in the mapping specification is checked to ensure that the encoding of the mapping specification conforms to the data hierarchy of the input tagged data file. Processing continues on FIG. **10** as indicated by continuation block A.

With reference to FIG. **10**, the mapping engine reads the mapping specification and prepares at process block **414** the XPath list. The XPath list is prepared in order to specify what data items are to be extracted from the tagged input data.

At process block **416**, the element metadata is recorded in order to collect and properly convert data types from source to destination formats, align column length and prioritize data buffering for projection. At process block **418**, the tables and columns are projected in order to provide a data storage location as observations are created from the tagged input data file. Processing continues at process block **422** as indicated by the continuation block **420**.

With reference to FIG. **11**, process block **422** opens the input tagged data file and process block **424** reads the XML data in its first pass through the tagged input data file. The XPath content is monitored and its data buffer is filled with the data from the input tagged data file that corresponds to the XPath specifications. Process block **428** returns a row after the data buffer has been filled in a pass through the tagged input data file. If the end of the input tagged data file has not been reached, then processing returns to process block **424** so that additional XML data from the input file may be read and subsequently processed by process block **426** and **428**. However, if the end of the file has been reached, then processing terminates at end block **432**. It is noted that a first pass may be used to build the map (e.g., to collect the data types, such as date, strings, etc.). A second pass may then be used to complete the process to construct the output observations. However, it should be understood that one or any number of passes may be used to map and to generate output observations.

FIGS. **12** and **13** depict flowcharts that describe in greater detail process block **426** wherein the XPath content is monitored and the data buffer is filled. With reference to FIG. **12**, decision block **452** examines if an XML node qualifies as containing data needed for creating the output table. If it does qualify, then process block **454** collects the XML node data, and decision block **456** examines whether conversion is required for the node data. If conversion is required (e.g., to convert a date value to a different format), then the data from the node is converted at process block **460** and processing continues at **458**. If conversion is not required for the node data as determined by decision block **456**, then process block **458** is executed wherein the buffer is updated to reflect the collected node data. Processing continues at the continuation indicator **462** either after the buffer has been updated by process block **458** or after decision block **452** has determined that this was not a qualifying XML node. Processing continues on FIG. **13** as indicated by the continuation indicator **462**.

With reference to FIG. **13**, decision block **464** examines whether an XML node contains data that qualifies as a new row (e.g., it examines whether it is a table XPath tag). If it does not, then processing returns via the return block **468**. However if it does, then process block **466** signals that the data buffer is full before allowing the processing to return to the calling program at return block **468**.

FIG. **14** depicts a different embodiment of the system **30** wherein rectangular formatted data is converted into a tagged input data file **32**. In this way, software applications that converse through tagged data formats can access the rectangular formatted data **40** through the created tagged input data file **32**.

During the conversion process, the mapping specification **36** dictates how the columnar data interrelate with each other. This may include specifying hierarchical relationships for the data items contained in the rectangular formatted data **40**. The data directives may also differentiate between which rectangular data items are pcdata fields and which are attributes. For example, to create a tagged input data file filled with NHL team data, the data items in a team column would be specified in the data directives **38** as being subordinate in the tagged data hierarchy to the data items in the division column. Moreover, the team names and abbreviation data items would be specified in the data directives **38** as creating attributes for team element fields.

The mapping engine **34** uses the data directives **38** stored in the mapping specification **36** to generate the tagged input data file **32** based upon the rectangular formatted input data **40**. In this way, the system **30** is able to go back and forth automatically between the two data formats. Exemplary applications utilizing this interchangeability are shown in FIGS. **15** and **16**.

FIG. **15** depicts an Internet software application **500** being conversant only with XML formatted data **60**. The Internet software application **500** may present a survey questionnaire to users regarding certain products. The compiled survey results are stored by the Internet software application **500** in the XML data file **60** so that the results may be analyzed through a sophisticated statistical analysis program **502**.

Because the statistical analysis program **502** reads data sets in a rectangular format, the mapping engine **34** must act as a "go between" for the Internet software application **500**

and the statistical analysis program **502**. The mapping specification **36** contains data directives **38** to parse content from the XML data file **60** and format the parsed content into rectangular formatted data **40**. The rectangular formatted data **40** is then analyzed by the statistical analysis program **502**.

The statistical analysis program **502** may also wish to communicate all or a portion of its analysis back to the Internet software application **500**. For example, the Internet software application **500** may wish to show a user how the user compared statistically to other users in answering the survey questionnaire. To accomplish this, the statistical analysis program **502** first generates its analysis as rectangular formatted data **40**. The mapping engine **34** then utilizes the mapping specification **36** to specify how an XML data file **60** is to be created from the rectangular formatted data **40**. The created XML data file **60** containing the analysis results is then provided to the Internet software application **500**.

FIG. **16** depicts another application where a first software application **520** wishes to interact with a relationship database management system **522** (possibly to persist its information). However, the first software application **520** converses only through XML data **60** (which is not compatible with the input rectangular data format for the relational database management system **522**). The mapping engine **34** parses and converts the XML data **60** from the first software application into rectangular formatted data **40**. The relational database management system **522** imports the rectangular formatted data **40** into a table within database **524**. The imported data is then accessible by other applications, such as a second software application **526**.

The second software application **526** may also store its own information in the database **524**. The first software application **526** may wish to access the information stored by the second software application **526**. To effect this access, the stored information may be exported through the relational database management system **522** as rectangular formatted data **40**. The mapping engine **34** utilizes the mapping specification **36** to create for the first software application XML data **60** based upon the rectangular formatted data **40**. In this way, bi-directional data communication is achievable between two or more applications having different data formats.

The mapping engine **34** may also use a code generator **528** to generate structured query language (SQL) commands. The SQL commands may create tables within the RDBMS **522** based upon the mapping specification **36**. The code generator **528** may also generate SQL insert commands to insert columnar data into the created tables. It should be understood that the mapping engine **34** may be used with many different types of code generators **528**. For example, a code generator may create instructions to create datasets within a statistical software application and then populate the datasets with data from the input XML data **60**. The generated code could also contain instructions to execute statistical programs to analyze the populated datasets.

While examples have been used to disclose the invention, including the best mode, and also to enable any person skilled in the art to make and use the invention, the patentable scope of the invention is defined by the claims, and may include other examples that occur to those skilled in the art. For example, the data directives may include many functions to indicate how input data (whether tagged or rectangular) is be processed. This may include XPath specifications for axes in order to access data that is less tightly tied to true hierarchical arrangement structures or any other non-rectangular design characteristics and input file may contain.

Other exemplary functions include XML node set functions for such operations as: returning the namespace URI (where URI stands for uniform resource identifier) of the expanded-name of the node; returning the expanded-name of the node; returning a number equal to the current parsing line; returning a number equal to the offset position into the current parsing line; or returning the namespace prefix of the expanded-name of the node. Still further, other functions may include such string functions as described in FIGS. **17-19**D.

FIG. **17** depicts an XML data structure **600** whose NHL team data is to be parsed via the mapping specification **620** of FIGS. **18**A-**18**D.

FIGS. **18**A-**18**D show a sample mapping specification that creates a table for different string functions. The mapping specification **620** includes table tags **630** to generate a table entitled "concat". The generated table "concat" is shown in FIG. **19**A at **750**. The columns of table **750** illustrate different concatenations performed by the functions contained within the table tags **630**. The first column demonstrates a concatenation postfix where a string is appended to an input XML data item; the second column depicts a concatenation prefix where a string is prefixed to an input XML data item; and the third column depicts both a prefix and a postfix concatenation.

With reference back to FIG. **18**A, the mapping specification **620** includes table tags **640** to generate a table entitled "starts-with". The generated table "starts-with" is shown in FIG. **19**A at **760**. The column of table **760** shows the boolean results of testing whether an input XML team data item (from FIG. **17**) starts with a particular string (which in this example is the string "new york").

With reference to FIG. **18**B, the mapping specification **620** includes table tags **650** to generate a table entitled "contains". The generated table "contains" is shown in FIG. **19**A at **770**. The column of table **770** shows the results of testing whether an input XML data item contains a particular string (which in this example is the string "new").

With reference back to FIG. **18**B, the mapping specification **620** includes table tags **660** to generate a table entitled "substring-before". The generated table "substring-before" is shown in FIG. **19**B at **780**. The column of table **780** shows what string occurs in an input XML data item before the string "york". Note that selected data which does not contain the pattern string returns a blank/MISSING value. This behavior may be subsequently altered by having the column definition contain <DEFAULT> and/or <ENUM> elements.

With reference back to FIG. **18**B, the mapping specification **620** includes table tags **670** to generate a table entitled "substring-after". The generated table "substring-after" is shown in FIG. **19**B at **790**. The column of table **790** shows what string occurs in an input XML data item after the string "york". Note that selected data which does not contain the pattern string returns a blank/MISSING value. This behavior may be subsequently altered by having the column definition contain <DEFAULT> and/or <ENUM> elements.

With reference to FIG. **18**C, the mapping specification **620** includes table tags **680** to generate a table entitled "substring". The generated table "substring" is shown in FIG. **19**C at **800**. The first column of table **800** shows for each input XML data item what characters appear as the first five characters; the second column of table **800** shows for each input XML data item what characters appear in the fifth character position and on; and the third column of table **800**

shows for each input XML data item what characters appear in the fifth through eighth character positions.

With reference back to FIG. **18**C, the mapping specification **620** includes table tags **690** to generate a table entitled "string-length". The generated table "string-length" is shown in FIG. **19**C at **810**. The column of table **810** shows the string length of each input XML data item.

With reference to FIG. **18**D, the mapping specification **620** includes table tags **700** to generate a table entitled "normalize". The generated table "normalize" is shown in FIG. **19**D at **820**. The column of table **820** shows each input XML data item having any extraneous spaces (i.e., duplicate ASCII code 32 characters appearing between words) in its string removed.

With reference back to FIG. **18**D, the mapping specification **620** includes table tags **710** to generate a table entitled "translate". The generated table "translate" is shown in FIG. **19**D at **830**. The first column of table **830** shows the original input XML data item; and the second column of table **830** shows results of a character search and replace operation (where the string "New" in the input XML data item was replaced with the string "Old"). However, note that this is character-for-character, global scope, replace operation. Thus the character "N" was replaced with the character "O"; the character "e" was replaced with the character "l"; and the character "w" was replaced with the character "d".

A graphical user interface **67** may help a user create mapping specifications as shown in FIGS. **20-24**. FIGS. **20-24** depict a graphical user interface **67** for processing tagged formatted data and rectangular formatted data. FIG. **20** depicts an exemplary interface **67** for creating a mapping specification from tagged input data. In this example, input XML data items **900** are shown within interface region **880**. The XML data items **900** contain tagged hierarchical data about NHL conferences, divisions, and teams.

For example, NHL tags **902** enclose NHL conference, division, and team data as well as their data relationships. Conference tags **904** contain Eastern Conference data. Division tags **908** contain Atlantic Division data. Name and abbreviation attributes within team tags **910** provide the names and abbreviations of teams within the Atlantic Division. For example, team tag **912** contains the name attribute "New Jersey Devils" and the team abbreviation attribute "NJ".

Interface region **930** displays for the convenience of the user either a full or condensed hierarchical view of the XML data items **900**. In the full view, the hierarchy of the XML data items **900** and their values are displayed. For example, the team tag **912** that depicts information about the New Jersey Devils is represented within the hierarchy **932** at **934**. More specifically, the team name attribute "New Jersey Devils" is shown within the hierarchy **932** at **936**, and the abbreviation "NJ" is shown at **938**.

As shown by the indented hierarchy **932**, the New Jersey Devils' attributes **940** are contained within the Atlantic Division **942** which is within the Eastern Conference **944**. The Eastern Conference **944** is contained within the NHL indicator **946**.

The user may expand or collapse the hierarchy **932** to show as much detail as the user desires. Indicators show the user whether a hierarchical data element is in a collapsed or expanded state. For example, a fully expanded indicator is shown at **950** to indicate that all of the data associated with the Atlantic Division is shown, while the data hierarchy for the Central Division may still be expanded as indicated by the expansion indicator **952**.

In order to create a mapping specification for the input XML data **900**, interface region **1000** allows the user to specify which data items within the input XML data **900** are to be a data source for the columns of rectangular formatted data. Within interface region **1000**, the user creates a table which in this example is shown at **1002** and is labeled "TEAM". The user specifies the columns the table is to have. In this example, the team table **1002** contains a name column **1004**, abbreviation column **1006**, conference column **1008**, division column **1010**, and identification column **1012**.

The interface region **1000** allows the user to select a column so that properties, formatting and other information associated with a column may be specified. In this situation, the name column **1004** is selected. With the properties tag **1020** selected, a user may specify or modify the name of the column within field **1022** as well as length at **1024** and a description of the column at **1026**. The user may also specify the XPath value at field **1028** so that the team name data may be located within the raw XML data **900**. The user may analyze the XML data hierarchy through the interface region **930** to more easily determine the proper XPath specification. The user may select at **1030** whether the XPath specification is in an absolute or relative mode.

Interface region **1050** depicts a mapping specification **1052** that has been generated based upon the information provided by the user through the interface region **1000**. The mapping specification **1052** contains XML data item tags **1052** that have been generated through interface region **1000**. For example, the XML data items tags **1052** contain a table tag **1054** that specifies that a table is to be created labeled "TEAM". This tag was generated in accordance with the user having specified the table name through interface region **1000** at **1002**.

Also in accordance with the information specified through interface **1000**, data item tags were generated at **1056** that is to create a name column. An XPath data item tag **1058** within tags **1056** specifies the source of the information for this column. The XPath specification value contained within the XPath data item tag **1058** is in accordance with the XPath information supplied through interface **1000** at **1028**.

Interface region **1080** shows generation of code that is to create rectangular formatted datasets based upon the mapping specification **1052**. In other situations, code may also contain other types of instructions, such as structured query language (SQL) instructions. Such SQL instructions may be used to create and insert data within a relational database management system.

The code within interface region **1080** indicates the source of data and the statistical procedures to analyze the data. The code contains at **1082** the instructions to access files with the input data: the instruction that indicates the location of the input XML information is shown at **1082**; the instruction that indicates the location of the NHL mapping specification is shown at **1084**; and the instruction to access a library is specified at **1086**. In this example, the library performs the following: definition of reference name for the library, processing being assigned to and conducted by the XML libname engine, a binding of the XMLMap definition to the XML input file and engine assignment, and an access setting of READONLY (non-update) on the input XML file.

At instruction **1088**, a procedure is automatically executed to process the data contained within the input XML file in accordance with the XML mapping specification. Instructions **1090** and **1092** depict exemplary usages of the input data, such as performing statistical analyses at instruction **1090** and printing out the results at instruction **1092**.

FIG. **21** shows an example where the name column **1004** and the format column tab **1100** have been activated so that the user may specify the format of a column. By activating the format column tab **1100**, a user can specify such formatting items as the type, data type, format, informat, or even a new type of format as shown at **1110**. In this situation, the user has specified that the name column **1004** has a character type and a string data type. Specification of this information through interface **1000** is used to create mapping specification information. This information is reflected within the mapping specification **1052** at tags **1120** and **1122**. Type tags **1120** specify as a data directive that the column name **1056** has a character type. This is in accordance with the user having specified such a type at type field **1102**. Similarly, the data type tags **1122** specify that the name column has a data type of string in accordance with the data type field **1104** within interface **1000**.

The graphical user interface **67** also shows a condensed view of the input XML data within interface region **930**. The condensed view shows the unique values an element has. For example, the conference element **1120** shows underneath it the unique values that the conference element has (i.e., Eastern and Western conference values). The fact that the conference element contains two unique values is shown by the number "2" located at **1122**.

FIG. **22** depicts a graphical user interface **67** where the conference column **1008** and the processing tab **1140** have been activated. Within interface region **1000**, the user may specify whether the conference values contained within the XML data **900** are to be retained as shown by check box **1142**. The user may choose to enumerate values for the conference column **1008** within field **1144** and/or specify a default value at field **1146** for when a conference value is missing.

Data directives are created and placed within the mapping specification **1052** in accordance with the information provided through interface **1000** for the conference column **1008**. For example, the data directive that the conference values are to be retained is shown within conference column tag **1160** at **1162**.

FIG. **23** shows an example where the identification column **1012** and the ordinal tab **1180** are activated. The ordinal tab **1180** is used to indicate that a column's value is to be incremented. In this situation, the user has specified through the increment path at field **1182** how values within this column are to be incremented. The increment path field **1182** indicates that the identification number is to be incremented whenever a new team value is found within the XML data **900**.

For the mapping specification **1052**, data directives are generated based upon the information supplied through interface **1000** so that the identification column may be provided with proper increment values. Identification column tag **1190** of the mapping specification **1052** specifies that this column is to be incremented as shown at **1192**. This increment data directive is set in the mapping specification at **1194** in accordance with the increment path specified at **1182**. It is noted that at **1184** a user may specify when an increment value is to be reset.

FIG. **24** shows where the SXLEMAP indicator **1198** and the validation tab **1200** have been activated. The SXLEMAP indicator **1198** is used to denote all the tables that are to be constructed. It should be understood that while this example shows one table being processed, the graphical user interface **67** may be used to designate and construct multiple tables within interface region **1000** at the same time.

Selection of the validation tab **1200** allows a user to validate one or more aspects of the table(s) to be constructed. For example, the user may specify that the schema for the table(s) shown within interface **1000** is to be validated with respect to the input XML data. It should be understood that other types of validation may be performed, such as "DTD" (deprecated) which allows the following to be done: tag name conventions, tag order validation, and appropriate attribute usage.

The user may also designate the source as either a web uniform resource locator (URL) or as a file. The user may do this in order to access a personal (or modified) copy of the validation file from a local file system should the user be unable to otherwise access a web-based URL, perhaps due to a corporate firewall restriction, etc.

It should be understood that the graphical user interface may be implemented in many ways, such as in separate windows within a window-based system, or as a series of web pages that a user may access, or through a number of other ways. Moreover, the graphical user interface can be utilized to accept rectangular formatted data as input. In this way, mapping specifications may be created to transform the input rectangular data into non-rectangular formatted data. Interface regions are used to show the raw input columnar data, the table structure and format, as well as interface regions to allow the user to designate the tagged data hierarchy. This information may then be used to construct and display a mapping specification that will transform the rectangular formatted input data into a tagged hierarchical format.

It is claimed:

1. A **[**computer-implemented method,**]** *system for transforming a first data file, including a hierarchically arranged tagged input data structure, to an output data structure in rectangular format, using a mapping specification in a second data file for use in a procedure, the system* comprising:

[receiving, using one or more processors, tagged input data that is in a non-rectangular format, wherein the tagged input data is organized such that a hierarchical arrangement of tags indicates data relationships between one or more parent tags and one or more child tags, and wherein each parent tag is associated with one or more child tags;

using the data relationships to determine rectangularization characteristics for the tagged input data;

displaying the tagged input data in a graphical interface;

receiving, through the graphical interface, an interaction with the tagged input data;**]**

one or more processors;

one or more computer readable storage mediums containing instructions to cause the one or more processors to perform operations including:

generating **[**a**]** *the second data file, wherein the second data file includes the* mapping specification **[**from the tagged input data, wherein the mapping specification is generated based upon the rectangularization characteristics and the interaction, and**]**, wherein the mapping specification **[**identifies one or more tables;**]***:*

includes one or more data directives that indicate relationships between data in the first data file, wherein the data directives are used to parse content from the first data file and to format the parsed content into rectangular formatted data, wherein the data directives include one or more XPath specifications specifying data items and

locations associated with the data items that are to be extracted from hierarchically arranged tagged input data for use in generating output data in rectangular format,

is based on rectangularization characteristics for the hierarchically arranged tagged input data, wherein the rectangularization characteristics are based on one or more data relationships between one or more parent tags and one or more child tags, wherein each parent tag is associated with two or more child tags and wherein each association between a parent tag and two or more child tags forms a single corresponding table specific to that association, and

[generating**]** *identifies* a single table corresponding to each data relationship between a parent tag and one or more child tags, wherein *the format of* the single table is **[**generated**]** *determined* using the **[**mapping specification**]** *data directives*;

[receiving rectangular formatted input data that uses columns and rows to indicate data relationships;

generating tagged output data using the rectangular formatted input data and the mapping specification, wherein the tagged output data is in a non-rectangular format, wherein the tagged output data uses a hierarchical arrangement of tags to indicate data relationships between one or more parent tags and one or more child tags, and wherein each parent tag is associated with one or more child tags; and**]**

receiving a set of program instructions including:

an indication of a location of the first data file, the first data file including a hierarchically arranged tagged input data structure in non-rectangular format configured to be transformed into rectangular format;

an indication of a location of the second data file, the second data file different than the first data file;

a libname statement identifying the first data file, the second data file, and an XML libname engine; and

an indication of a procedure to process a data file and an indication of the data file to process, wherein the procedure requires data in rectangular format and the indication of the data file to process indicates the first data file in non-rectangular format;

using the indication of the location of the first data file to access the first data file;

displaying the tagged input data in a graphical interface;

receiving, through the graphical interface, an interaction with the tagged input data;

transforming the first data file to an output data structure in rectangular format compatible with the procedure, by:

parsing the hierarchically arranged tagged input data in accordance with the data directives, including the one or more XPath specifications;

generating the output data structure in rectangular format by assembling the parsed hierarchically arranged tagged input data into rectangular format; and

generating an output of the procedure using the output data structure in rectangular format; and

coordinating bi-directional communication between a software application that uses a hierarchical data format and a software application that uses a rectangularized data format, wherein coordinating bi-directional communication includes using the single table and the **[**tagged**]** output data *structure*.

2. The computer-implemented method of claim **[1]** *17*, wherein a generating the **[**mapping specification**]** *second data file* further includes identifying repeating patterns in the tagged input data.

[3. The computer-implemented method of claim **1**, further comprising:

creating one or more XPath locators, wherein an XPath locator identifies a place to extract data items from the tagged input data.**]**

4. The computer-implemented method of claim **[1]** *17*, further comprising:

using a mapping engine to read the mapping specification and prepare an XPath list, wherein the XPath list specifies particular data items for extraction from the tagged input data.

5. The computer-implemented method of claim **[1]** *17*, further comprising:

recording metadata associated with the tagged input data; and

using the recorded metadata to provide one or more data storage locations by projecting one or more tables.

6. The computer-implemented method of claim **[1]** *17*, wherein the graphical interface includes one or more tabs, the one or more tabs including at least one of a properties tab, a format tab, a processing tab, an ordinal tab, and a validation tab.

7. The computer implemented method of claim **6**, further comprising:

using the one or more tabs to specify *the* one or more data directives.

8. The computer implemented method of claim **7**, further comprising:

using the one or more data directives to process one or more tagged data items of the tagged input data into rectangular formatted data; and

using the one or more data directives to process rectangular formatted input data into one or more tagged data items of **[**tagged**]** output data.

9. A **[**system, comprising:

one or more processors;

one or more computer readable storage mediums containing instructions to cause the one or more processors to perform operations including:**]** *non-transitory computer program product for transforming a first data file, including a hierarchically arranged tagged input data structure, to an output data structure in rectangular format, using a mapping specification in a second data file for use in a procedure, the non-transitory computer program product tangibly embodied in a non-transitory machine readable storage medium, including instructions operable to cause a data processing apparatus to:*

[receiving tagged input data that is in a non-rectangular format, wherein the tagged input data is organized such that a hierarchical arrangement of tags indicates data relationships between one or more parent tags and one or more child tags, and wherein each parent tag is associated with one or more child tags;

using the data relationships to determine rectangularization characteristics for the tagged input data;

displaying the tagged input data in a graphical interface;

receiving, through the graphical interface, an interaction with the tagged input data;**]**

generating a *generate the second data file, wherein the second data file includes the* mapping specification **[**from the tagged input data, wherein the mapping

specification is generated based upon the rectangularization characteristics and the interaction, and], wherein the mapping specification [identifies one or more tables;]:

includes one or more data directives that indicate relationships between data in the first data file, wherein the data directives are used to parse content from the first data file and to format the parsed content into rectangular formatted data, wherein the data directives include one or more XPath specifications specifying data items and locations associated with the data items that are to be extracted from hierarchically arranged tagged input data for use in generating output data in rectangular format,

is based on rectangularization characteristics for the hierarchically arranged tagged input data, wherein the rectangularization characteristics are based on one or more data relationships between one or more parent tags and one or more child tags, wherein each parent tag is associated with two or more child tags and wherein each association between a parent tag and two or more child tags forms a single corresponding table specific to that association, and

[generating] *identifies* a single table corresponding to each data relationship between a parent tag and one or more child tags, wherein *the format of* the single table is [generated] *determined* using the [mapping specification] *data directives*;

[receiving rectangular formatted input data that uses columns and rows to indicate data relationships;

generating tagged output data using the rectangular formatted input data and the mapping specification, wherein the tagged output data is in a non-rectangular format, wherein the tagged output data uses a hierarchical arrangement of tags to indicate data relationships between one or more parent tags and one or more child tags, and wherein each parent tag is associated with one or more child tags; and]

receive a set of program instructions including:

an indication of a location of the first data file, the first data file including a hierarchically arranged tagged input data structure in non-rectangular format configured to be transformed into rectangular format;

an indication of a location of the second data file, the second data file different than the first data file;

a libname statement identifying the first data file, the second data file, and an XML libname engine; and

an indication of a procedure to process a data file and an indication of the data file to process, wherein the procedure requires data in rectangular format and the indication of the data file to process indicates the first data file in non-rectangular format;

use the indication of the location of the first data file to access the first data file;

display the tagged input data in a graphical interface;

receive, through the graphical interface, an interaction with the tagged input data;

transform the first data file to an output data structure in rectangular format compatible with the procedure, by:

parsing the hierarchically arranged tagged input data in accordance with the data directives, including the one or more XPath specifications;

generating the output data structure in rectangular format by assembling the parsed hierarchically arranged tagged input data into rectangular format; and

generating an output of the procedure using the output data structure in rectangular format; and

[coordinating] *coordinate* bi-directional communication between an application that uses a hierarchical data format and a software application that uses a rectangularized data format, wherein coordinating bi-directional communication includes using the single table and the [tagged] output data *structure*.

10. The system of claim [**9**] *1*, wherein the one or more computer readable storage mediums further comprise instructions to cause the one or more processors to perform operations including generating the [mapping specification] *second data file* by identifying repeating patterns in the tagged input data.

[**11**. The system of claim **9**, wherein the one or more computer readable storage mediums further comprise instructions to cause the one or more processors to perform operations including creating one or more XPath locators, wherein an XPath locator identifies a place to extract data items from the tagged input data.]

12. The system of claim [**9**] *1*, wherein the one or more computer readable storage mediums further comprise instructions to cause the one or more processors to perform operations including using a mapping engine to read the mapping specification and prepare an XPath list, wherein the XPath list specifies particular data items for extraction from the tagged input data.

13. The system of claim [**9**] *1*, wherein the one or more computer readable storage mediums further comprise instructions to cause the one or more processors to perform operations including:

recording metadata associated with the tagged input data; and

using the recorded metadata to provide one or more data storage locations by projecting one or more tables.

14. The system of claim [**9**] *1*, wherein the graphical interface includes one or more tabs, the one or more tabs including at least one of a properties tab, a format tab, a processing tab, an ordinal tab, and a validation tab.

15. The system of claim **14**, wherein the one or more tabs are configured to specify *the* one or more data directives.

16. The system of claim **15**, wherein the one or more data directives are configured to process one or more tagged data items of the tagged input data into rectangular formatted data, and wherein the one or more data directives are configured to process rectangular formatted input data into one or more tagged data items of [tagged] output data.

17. A non-transitory computer program product *for transforming a first data file, including a hierarchically arranged tagged input data structure, to an output data structure in rectangular format, using a mapping specification in a second data file for use in a procedure, the non-transitory computer program product* tangibly embodied in a non-transitory machine readable storage medium, including instructions operable to cause a data processing apparatus to:

[receive tagged input data that is in a non-rectangular format, wherein the tagged input data is organized such that a hierarchical arrangement of tags indicates data relationships between one or more parent tags and one or more child tags, and wherein each parent tag is associated with one or more child tags;

use the data relationships to determine rectangularization characteristics for the tagged input data;

display the tagged input data in a graphical interface;

receive, through the graphical interface, an interaction with the tagged input data;]

generate [a] *the second data file, wherein the second data file includes the* mapping specification [from the tagged input data, wherein the mapping specification is generated based upon the rectangularization characteristics and the interaction, and], wherein the mapping specification [identifies one or more tables]:

includes one or more data directives that indicate relationships between data in the first data file, wherein the data directives are used to parse content from the first data file and to format the parsed content into rectangular formatted data, wherein the data directives include one or more XPath specifications specifying data items and locations associated with the data items that are to be extracted from hierarchically arranged tagged input data for use in generating output data in rectangular format,

is based on rectangularization characteristics for the hierarchically arranged tagged input data, wherein the rectangularization characteristics are based on one or more data relationships between one or more parent tags and one or more child tags, wherein each parent tag is associated with two or more child tags and wherein each association between a parent tag and two or more child tags forms a single corresponding table specific to that association, and

[generate] *identifies* a single table corresponding to each data relationship between a parent tag and one or more child tags, wherein *the format of* the single table is [generated] *determined* using the [mapping specification] *data directives*;

[receive rectangular formatted input data that uses columns and rows to indicate data relationships;

generate tagged output data using the rectangular formatted input data and the mapping specification, wherein the tagged output data is in a non-rectangular format, wherein the tagged output data uses a hierarchical arrangement of tags to indicate data relationships between one or more parent tags and one or more child tags, and wherein each parent tag is associated with one or more child tags; and]

receive a set of program instructions including:

an indication of a location of the first data file, the first data file including a hierarchically arranged tagged input data structure in non-rectangular format configured to be transformed into rectangular format;

an indication of a location of the second data file, the second data file different than the first data file;

a libname statement identifying the first data file, the second data file, and an XML libname engine; and

an indication of a procedure to process a data file and an indication of the data file to process, wherein the procedure requires data in rectangular format and the indication of the data file to process indicates the first data file in non-rectangular format;

use the indication of the location of the first data file to access the first data file;

display the tagged input data in a graphical interface;

receive, through the graphical interface, an interaction with the tagged input data;

transform the first data file to an output data structure in rectangular format compatible with the procedure, by:

parsing the hierarchically arranged tagged input data in accordance with the data directives, including the one or more XPath specifications;

generating the output data structure in rectangular format by assembling the parsed hierarchically arranged tagged input data into rectangular format; and

generating an output of the procedure using the output data structure in rectangular format; and

coordinate bi-directional communication between [an] *a software* application that uses a hierarchical data format and a software application that uses a rectangularized data format, wherein coordinating bi-directional communication includes using the single table and the [tagged] output data *structure*.

18. The computer program product of claim **[17]** *9*, further comprising instructions to generate the [mapping specification] *second data file* by identifying repeating patterns in the tagged input data.

[19. The computer program product of claim **17**, further comprising instructions to create one or more XPath locators, wherein an XPath locator is configured to identify a place to extract data items from the tagged input data.**]**

20. The computer program product of claim **[17]** *9*, further comprising instructions to use a mapping engine to read the mapping specification and prepare an XPath list, wherein the XPath list is configured to specify particular data items for extraction from the tagged input data.

21. The computer program product of claim **[17]** *9*, further comprising instructions to:

record metadata associated with the tagged input data; and

use the recorded metadata to provide one or more data storage locations by projecting one or more tables.

22. The computer program product of claim **[17]** *9*, wherein the graphical interface includes one or more tabs, the one or more tabs including at least one of a properties tab, a format tab, a processing tab, an ordinal tab, and a validation tab.

23. The computer program product of claim **22**, wherein the one or more tabs are configured to specify *the* one or more data directives.

24. The computer program product of claim **23**, wherein the one or more data directives are configured to process one or more tagged data items of the tagged input data into rectangular formatted data, and wherein the one or more data directives are configured to process rectangular formatted input data into one or more tagged data items of the [tagged] output data.

25. A system for transforming a first data file, including a hierarchically arranged tagged input data structure, to an output data structure in rectangular format, using a mapping specification in a second data file for use in a procedure, the system comprising:

one or more processors;

a computer-readable storage medium containing instructions configured to cause the one or more processors to perform operations, including:

forming the second data file, wherein the second data file includes a mapping specification, wherein the mapping specification:

includes one or more data directives, which indicate relationships between data in the first data file, wherein the data directives are used to parse content from the first data file and to format the parsed content into rectangular formatted data, wherein the data directives include one or more XPath specifications specifying data items and locations associated with the data items that are to be extracted from the hierarchically arranged tagged input data for use in generating output data in rectangular format; and

is based on rectangularization characteristics for the hierarchically arranged tagged input data, wherein the rectangularization characteristics are based on one or more data relationships between one or more parent tags and one or more child tags, wherein each parent tag is associated with two or more child tags and wherein each association between a parent tag and two or more child tags forms a single corresponding table specific to that association, and

identifies one or more tables that will be generated from the hierarchically arranged tagged input data, and wherein each association between a parent tag and two or more child tags forms a single corresponding table specific to that association;

receiving a set of program instructions including:

an indication of a location of the first data file, the first data file including a hierarchically arranged tagged input data structure in non-rectangular format configured to be transformed into rectangular format, wherein the tagged input data is in an eXtensible Markup Language (XML) format;

an indication of a location of the second data file, the second data file different than the first data file;

a libname statement identifying the first data file, the second data file, and an XML libname engine; and

an indication of a procedure to process a data file and an indication of the data file to process, wherein the procedure requires data in rectangular format and the indication of the data file to process indicates the first data file in non-rectangular format;

using the indication of the location of the first data file to access the first data file;

transforming the first data file to an output data structure in rectangular format compatible with the procedure, by:

parsing the hierarchically arranged tagged input data in accordance with the data directives, including the one or more XPath specifications; and

generating the output data structure in rectangular format by assembling the parsed hierarchically arranged tagged input data into rectangular format; and

generating an output of the procedure using the output data structure in rectangular format.

26. The system of claim 25, the computer-readable storage medium further containing instructions configured to cause the one or more processors to perform operations, including:

checking encoding contained in the mapping specification to ensure the encoding conforms to a tagged input data.

27. The system of claim 25, the computer-readable storage medium further containing instructions configured to cause the one or more processors to perform operations, including:

recording metadata, the metadata facilitating data conversion from source data formats to destination data formats, column length alignment, and data buffering prioritization for projection.

28. The system of claim 27, the computer-readable storage medium further containing instructions configured to cause the one or more processors to perform operations, including:

projecting one or more tables and one or more columns.

29. The system of claim 25, wherein the tagged input data includes one or more pcdata fields within the tags of the tagged input data, and wherein the tagged input data includes one or more attributes within the tags of the tagged input data.

30. The system of claim 25, wherein the one or more data directives include a hierarchical arrangement of tags indicating one or more relationships among conversion operations and attributes corresponding to the one or more data directives.

31. The system of claim 30, wherein the one or more data relationships provide information about how the conversion operations and the attributes corresponding to the one or more data directives are used to automatically parse the tagged input data.

32. The system of claim 25, wherein the one or more data directives include one or more definitions.

33. The system of claim 32, wherein the one or more definitions include a column length.

34. The system of claim 32, wherein the one or more definitions include a column data type.

35. The system of claim 32, wherein the one or more definitions include a column type.

36. The system of claim 32, wherein the one or more definitions include acceptable values for a column.

37. The system of claim 32, wherein the one or more definitions include an indication that a value for a data item within the tagged input data is retained until a new value for the data item is encountered in the tagged input data.

38. The system of claim 32, wherein the one or more definitions include a selection criterion for filtering one or more data items contained within the tagged input data.

39. The system of claim 32, wherein the one or more definitions include a string function.

40. The system of claim 32, wherein the one or more definitions include an axes function.

41. The system of claim 32, wherein the one or more definitions include a node-related function.

42. The system of claim 25, wherein a default value is specified and applied when a value for a data item within the tagged input data is missing.

43. The system of claim 25, wherein column content of the output data structure is generated based upon one or more data items contained within the tagged input data.

44. The system of claim 25, wherein an XML parser is used to automatically parse the tagged input data based upon the one or more data directives.

45. The system of claim 25, wherein the tagged input data includes one or more tagged hierarchical paths, and wherein a specific tagged hierarchical path uses an XML path descriptor to identify which of the tags in the tagged input data is to be used as an indicator.

46. A computer-program product, tangibly embodied in a machine-readable storage medium, including instructions configured to cause a data processing apparatus to:

forming the second data file, wherein the second data file includes a mapping specification, wherein the mapping specification:

includes one or more data directives, which indicate relationships between data in the first data file, wherein the data directives are used to parse content from the first data file and to format the parsed content into rectangular formatted data, wherein the data directives include one or more XPath specifications specifying data items and locations associated with the data items that are to be extracted from the hierarchically arranged tagged input data for use in generating output data in rectangular format; and

is based on rectangularization characteristics for the hierarchically arranged tagged input data, wherein the rectangularization characteristics are based on one or more data relationships between one or more parent

tags and one or more child tags, wherein each parent tag is associated with two or more child tags and wherein each association between a parent tag and two or more child tags forms a single corresponding table specific to that association, and

identifies one or more tables that will be generated from the hierarchically arranged tagged input data, and wherein each association between a parent tag and two or more child tags forms a single corresponding table specific to that association;

receive a set of program instructions including:

an indication of a location of the first data file, the first data file including a hierarchically arranged tagged input data structure in non-rectangular format configured to be transformed into rectangular format, wherein the tagged input data is in an eXtensible Markup Language (XML) format;

an indication of a location of the second data file, the second data file different than the first data file;

a libname statement identifying the first data file, the second data file, and an XML libname engine; and

an indication of a procedure to process a data file and an indication of the data file to process, wherein the procedure requires data in rectangular format and the indication of the data file to process indicates the first data file in non-rectangular format;

use the indication of the location of the first data file to access the first data file;

transform the first data file to an output data structure in rectangular format compatible with the procedure, by:

parsing the hierarchically arranged tagged input data in accordance with the data directives, including the one or more XPath specifications; and

generating the output data structure in rectangular format by assembling the parsed hierarchically arranged tagged input data into rectangular format; and

generate an output of the procedure using the output data structure in rectangular format.

47. The computer-program product of claim 46, further comprising instructions configured to cause a data processing apparatus to:

check encoding contained in the mapping specification to ensure the encoding conforms to a tagged input data.

48. The computer-program product of claim 46, further comprising instructions configured to cause a data processing apparatus to:

record metadata, the metadata facilitating data conversion from source data formats to destination data formats, column length alignment, and data buffering prioritization for projection.

49. The computer-program product of claim 48, further comprising instructions configured to cause a data processing apparatus to:

project one or more tables and one or more columns.

50. The computer-program product of claim 46, wherein the tagged input data includes one or more pcdata fields within the tags of the tagged input data, and wherein the tagged input data includes one or more attributes within the tags of the tagged input data.

51. The computer-program product of claim 46, wherein the one or more data directives include a hierarchical arrangement of tags indicating one or more relationships among conversion operations and attributes corresponding to the one or more data directives.

52. The computer-program product of claim 51, wherein the one or more data relationships provide information about how the conversion operations and the attributes corresponding to the one or more data directives are used to automatically parse the tagged input data.

53. The computer-program product of claim 46, wherein the one or more data directives include one or more definitions.

54. The computer-program product of claim 53, wherein the one or more definitions include a column length.

55. The computer-program product of claim 53, wherein the one or more definitions include a column data type.

56. The computer-program product of claim 53, wherein the one or more definitions include a column type.

57. The computer-program product of claim 53, wherein the one or more definitions include acceptable values for a column.

58. The computer-program product of claim 53, wherein the one or more definitions include an indication that a value for a data item within the tagged input data is retained until a new value for the data item is encountered in the tagged input data.

59. The computer-program product of claim 53, wherein the one or more definitions include a selection criterion for filtering one or more data items contained within the tagged input data.

60. The computer-program product of claim 53, wherein the one or more definitions include a string function.

61. The computer-program product of claim 53, wherein the one or more definitions include an axes function.

62. The computer-program product of claim 53, wherein the one or more definitions include a node-related function.

63. The computer-program product of claim 46, wherein a default value is specified and applied when a value for a data item within the tagged input data is missing.

64. The computer-program product of claim 46, wherein column content of the output data structure is generated based upon one or more data items contained within the tagged input data.

65. The computer-program product of claim 46, wherein an XML parser is used to automatically parse the tagged input data based upon the one or more data directives.

66. The computer-program product of claim 46, wherein the tagged input data includes one or more tagged hierarchical paths, and wherein a specific tagged hierarchical path uses an XML path descriptor to identify which of the tags in the tagged input data is to be used as an indicator.

67. A data structure conversion method to transform a data structure into a format compatible with one or more procedures, the method comprising:

receiving a set of program instructions including:

an indication of a location of a first data file, the first data file including a hierarchically arranged tagged input data structure in non-rectangular format configured to be transformed into rectangular format;

an indication of a location of a second data file different than the first data file, wherein the second data file includes a mapping specification used to transform the hierarchically arranged tagged input data structure into rectangular format;

a libname statement identifying the first data file, the second data file, and an XML libname engine; and

an indication of a procedure to process a data file and an indication of the data file to process, wherein the procedure requires data in rectangular format and the indication of the data file to process indicates the first data file in non-rectangular format;

using the indication of the location of the first data file to access the first data file; using the indication of the location of the second data file, accessing the second

data file, the second data file including the mapping specification, wherein the mapping specification:

includes one or more data directives that indicate relationships between data in the first data file, wherein the data directives are used to parse content from the first data file and to format the parsed content into rectangular formatted data, wherein the data directives include one or more XPath specifications specifying data items and locations associated with the data items that are to be extracted from the hierarchically arranged tagged input data for use in generating output data in rectangular format,

is based on rectangularization characteristics for the hierarchically arranged tagged input data, wherein the rectangularization characteristics are based on one or more data relationships between one or more parent tags and one or more child tags, wherein each parent tag is associated with two or more child tags and wherein each association between a parent tag and two or more child tags forms a single corresponding table specific to that association, and

identifies one or more tables to be generated from the hierarchically arranged tagged input data, wherein the format of the one or more tables is determined using the data directives;

transforming the first data file to an output data structure in rectangular format compatible with the procedure, by:

parsing the hierarchically arranged tagged input data in accordance with the data directives, including the one or more XPath specifications;

generating the output data structure in rectangular format by assembling the parsed hierarchically arranged tagged input data into rectangular format; and

generating an output of the procedure using the output data structure in rectangular format.

68. The method of claim 67, further comprising:

checking encoding contained in the mapping specification to ensure the encoding conforms to a data hierarchy of the tagged input data.

69. The method of claim 67, further comprising:

recording metadata, the metadata facilitating data conversion from source data formats to destination data formats, column length alignment, and data buffering prioritization for projection.

70. The method of claim 69, further comprising:

projecting one or more tables and one or more columns.

71. The method of claim 67, wherein the tagged input data is in an eXtensible Markup Language (XML) format.

72. The method of claim 67, wherein the tagged input data includes one or more pcdata fields within the tags of the tagged input data, and wherein the tagged input data includes one or more attributes within the tags of the tagged input data.

73. The method of claim 67, wherein the one or more data directives include a hierarchical arrangement of tags indicating one or more relationships among conversion operations and attributes corresponding to the one or more data directives.

74. The method of claim 73, wherein the one or more data relationships provide information about how the conversion operations and the attributes corresponding to the one or more data directives are used to automatically parse the tagged input data.

75. The method of claim 67, wherein the one or more data directives include one or more definitions.

76. The method of claim 75, wherein the one or more definitions include a column length.

77. The method of claim 75, wherein the one or more definitions include a column data type.

78. The method of claim 75, wherein the one or more definitions include a column type.

79. The method of claim 75, wherein the one or more definitions include acceptable values for a column.

80. The method of claim 75, wherein the one or more definitions include an indication that a value for a data item within the tagged input data is retained until a new value for the data item is encountered in the tagged input data.

81. The method of claim 75, wherein the one or more definitions include a selection criterion for filtering one or more data items contained within the tagged input data.

82. The method of claim 75, wherein the one or more definitions include a string function.

83. The method of claim 75, wherein the one or more definitions include an axes function.

84. The method of claim 75, wherein the one or more definitions include a node-related function.

85. The method of claim 67, wherein a default value is specified and applied when a value for a data item within the tagged input data is missing.

86. The method of claim 67, wherein column content of the output data structure is generated based upon one or more data items contained within the tagged input data.

87. The method of claim 67, wherein an XML parser is used to automatically parse the tagged input data based upon the one or more data directives.

88. The method of claim 67, wherein the tagged input data includes one or more tagged hierarchical paths, and wherein a specific tagged hierarchical path uses an XML path descriptor to identify which of the tags in the tagged input data is to be used as an indicator.

89. A system, comprising:

one or more processors;

a computer-readable storage medium containing instructions configured to cause the one or more processors to perform operations, including:

receiving a set of program instructions including:

an indication of a location of a first data file, the first data file including a hierarchically arranged tagged input data structure in non-rectangular format configured to be transformed into rectangular format;

an indication of a location of a second data file different than the first data file, wherein the second data file includes a mapping specification used to transform the hierarchically arranged tagged input data structure into rectangular format;

a libname statement identifying the first data file, the second data file, and an XML libname engine; and

an indication of a procedure to process a data file and an indication of the data file to process, wherein the procedure requires data in rectangular format and the indication of the data file to process indicates the first data file in non-rectangular format;

using the indication of the location of the first data file to access the first data file; using the indication of the location of the second data file, accessing the second data file, the second data file including the mapping specification, wherein the mapping specification:

includes one or more data directives that indicate relationships between data in the first data file, wherein the data directives are used to parse content from the first data file and to format the parsed content into rectangular formatted data, wherein the data directives

include one or more XPath specifications specifying data items and locations associated with the data items that are to be extracted from the hierarchically arranged tagged input data for use in generating output data in rectangular format,

is based on rectangularization characteristics for the hierarchically arranged tagged input data, wherein the rectangularization characteristics are based on one or more data relationships between one or more parent tags and one or more child tags, wherein each parent tag is associated with two or more child tags and wherein each association between a parent tag and two or more child tags forms a single corresponding table specific to that association, and

identifies one or more tables to be generated from the hierarchically arranged tagged input data, wherein the format of the one or more tables is determined using the data directives;

transforming the first data file to an output data structure in rectangular format compatible with the procedure, by:

parsing the hierarchically arranged tagged input data in accordance with the data directives, including the one or more XPath specifications;

generating the output data structure in rectangular format by assembling the parsed hierarchically arranged tagged input data into rectangular format; and

generating an output of the procedure using the output data structure in rectangular format.

90. The system of claim 89, the computer-readable storage medium further containing instructions configured to cause the one or more processors to perform operations, including:

checking encoding contained in the mapping specification to ensure the encoding conforms to a data hierarchy of the tagged input data.

91. The system of claim 89, the computer-readable storage medium further containing instructions configured to cause the one or more processors to perform operations, including:

recording metadata, the metadata facilitating data conversion from source data formats to destination data formats, column length alignment, and data buffering prioritization for projection.

92. The system of claim 91, the computer-readable storage medium further containing instructions configured to cause the one or more processors to perform operations, including:

projecting one or more tables and one or more columns.

93. The system of claim 89, wherein the tagged input data is in an eXtensible Markup Language (XML) format.

94. The system of claim 89, wherein the tagged input data includes one or more pcdata fields within the tags of the tagged input data, and wherein the tagged input data includes one or more attributes within the tags of the tagged input data.

95. The system of claim 89, wherein the one or more data directives include a hierarchical arrangement of tags indicating one or more relationships among conversion operations and attributes corresponding to the one or more data directives.

96. The system of claim 95, wherein the one or more data relationships provide information about how the conversion operations and the attributes corresponding to the one or more data directives are used to automatically parse the tagged input data.

97. The system of claim 89, wherein the one or more data directives include one or more definitions.

98. The system of claim 97, wherein the one or more definitions include a column length.

99. The system of claim 97, wherein the one or more definitions include a column data type.

100. The system of claim 97, wherein the one or more definitions include a column type.

101. The system of claim 97, wherein the one or more definitions include acceptable values for a column.

102. The system of claim 97, wherein the one or more definitions include an indication that a value for a data item within the tagged input data is retained until a new value for the data item is encountered in the tagged input data.

103. The system of claim 97, wherein the one or more definitions include a selection criterion for filtering one or more data items contained within the tagged input data.

104. The system of claim 97, wherein the one or more definitions include a string function.

105. The system of claim 97, wherein the one or more definitions include an axes function.

106. The system of claim 97, wherein the one or more definitions include a node-related function.

107. The system of claim 89, wherein a default value is specified and applied when a value for a data item within the tagged input data is missing.

108. The system of claim 89, wherein column content of the output data structure is generated based upon one or more data items contained within the tagged input data.

109. The system of claim 89, wherein an XML parser is used to automatically parse the tagged input data based upon the one or more data directives.

110. The system of claim 89, wherein the tagged input data includes one or more tagged hierarchical paths, and wherein a specific tagged hierarchical path uses an XML path descriptor to identify which of the tags in the tagged input data is to be used as an indicator.

111. A computer-program product tangibly embodied in a non-transitory machine-readable storage medium, including instructions configured to cause a data processing apparatus to:

receive a set of program instructions including:

an indication of a location of a first data file, the first data file including a hierarchically arranged tagged input data structure in non-rectangular format configured to be transformed into rectangular format;

an indication of a location of a second data file different than the first data file, wherein the second data file includes a mapping specification used to transform the hierarchically arranged tagged input data structure into rectangular format;

a libname statement identifying the first data file, the second data file, and an XML libname engine; and

an indication of a procedure to process a data file and an indication of the data file to process, wherein the procedure requires data in rectangular format and the indication of the data file to process indicates the first data file in non-rectangular format;

use the indication of the location of the first data file to access the first data file; use the indication of the location of the second data file, accessing the second data file, the second data file including the mapping specification, wherein the mapping specification:

includes one or more data directives that indicate relationships between data in the first data file, wherein the data directives are used to parse content from the first data file and to format the parsed content into rectan-

gular formatted data, wherein the data directives include one or more XPath specifications specifying data items and locations associated with the data items that are to be extracted from the hierarchically arranged tagged input data for use in generating output data in rectangular format,

is based on rectangularization characteristics for the hierarchically arranged tagged input data, wherein the rectangularization characteristics are based on one or more data relationships between one or more parent tags and one or more child tags, wherein each parent tag is associated with two or more child tags and wherein each association between a parent tag and two or more child tags forms a single corresponding table specific to that association, and

identifies one or more tables to be generated from the hierarchically arranged tagged input data, wherein the format of the one or more tables is determined using the data directives;

transform the first data file to an output data structure in rectangular format compatible with the procedure, by:

parsing the hierarchically arranged tagged input data in accordance with the data directives, including the one or more XPath specifications;

generating the output data structure in rectangular format by assembling the parsed hierarchically arranged tagged input data into rectangular format; and

generate an output of the procedure using the output data structure in rectangular format.

112. The computer-program product of claim 111, further comprising instructions configured to cause a data processing apparatus to:

check encoding contained in the mapping specification to ensure the encoding conforms to a data hierarchy of the tagged input data.

113. The computer-program product of claim 111, further comprising instructions configured to cause a data processing apparatus to:

record metadata, the metadata facilitating data conversion from source data formats to destination data formats, column length alignment, and data buffering prioritization for projection.

114. The computer-program product of claim 113, further comprising instructions configured to cause a data processing apparatus to:

project one or more tables and one or more columns.

115. The computer-program product of claim 111, wherein the tagged input data is in an eXtensible Markup Language (XML) format.

116. The computer-program product of claim 111, wherein the tagged input data includes one or more pcdata fields within the tags of the tagged input data, and wherein the tagged input data includes one or more attributes within the tags of the tagged input data.

117. The computer-program product of claim 111, wherein the one or more data directives include a hierarchical arrangement of tags indicating one or more relationships among conversion operations and attributes corresponding to the one or more data directives.

118. The computer-program product of claim 117, wherein the one or more data relationships provide information about how the conversion operations and the attributes corresponding to the one or more data directives are used to automatically parse the tagged input data.

119. The computer-program product of claim 111, wherein the one or more data directives include one or more definitions.

120. The computer-program product of claim 119, wherein the one or more definitions include a column length.

121. The computer-program product of claim 119, wherein the one or more definitions include a column data type.

122. The computer-program product of claim 119, wherein the one or more definitions include a column type.

123. The computer-program product of claim 119, wherein the one or more definitions include acceptable values for a column.

124. The computer-program product of claim 119, wherein the one or more definitions include an indication that a value for a data item within the tagged input data is retained until a new value for the data item is encountered in the tagged input data.

125. The computer-program product of claim 119, wherein the one or more definitions include a selection criterion for filtering one or more data items contained within the tagged input data.

126. The computer-program product of claim 119, wherein the one or more definitions include a string function.

127. The computer-program product of claim 119, wherein the one or more definitions include an axes function.

128. The computer-program product of claim 119, wherein the one or more definitions include a node-related function.

129. The computer-program product of claim 111, wherein a default value is specified and applied when a value for a data item within the tagged input data is missing.

130. The computer-program product of claim 111, wherein column content of the output data structure is generated based upon one or more data items contained within the tagged input data.

131. The computer-program product of claim 111, wherein an XML parser is used to automatically parse the tagged input data based upon the one or more data directives.

132. The computer-program product of claim 111, wherein the tagged input data includes one or more tagged hierarchical paths, and wherein a specific tagged hierarchical path uses an XML path descriptor to identify which of the tags in the tagged input data is to be used as an indicator.

133. The method of claim 67, wherein determining the second data file includes receiving the second data file or generating the second data file.

134. The method of claim 67, wherein a first pass through the first data set is used to access the first data file and transform the first data file to an output data structure in rectangular format, and a second pass through the first data set is used to generate the output of the procedure using the output data structure in rectangular format.

135. The method of claim 67, wherein the procedure is invoked by a SAS proc statement.

136. The method of claim 67, wherein the mapping specification comprises mapping specification controls including one or more format tags and one or more informat tags that indicate characteristics of the output data structure.

137. The system of claim 89, wherein determining the second data file includes receiving the second data file or generating the second data file.

138. The system of claim 89, wherein a first pass through the first data set is used to access the first data file and transform the first data file to an output data structure in rectangular format, and a second pass through the first data

set is used to generate the output of the procedure using the output data structure in rectangular format.

139. The system of claim 89, wherein the procedure is invoked by a SAS proc statement.

140. The system of claim 89, wherein the mapping specification comprises mapping specification controls including one or more format tags and one or more informat tags that indicate characteristics of the output data structure.

141. The computer-program product of claim 111, wherein determining the second data file includes receiving the second data file or generating the second data file.

142. The computer-program product of claim 111, wherein a first pass through the first data set is used to access the first data file and transform the first data file to an output data structure in rectangular format, and a second pass through the first data set is used to generate the output of the procedure using the output data structure in rectangular format.

143. The computer-program product of claim 111, wherein the procedure is invoked by a SAS proc statement.

144. The computer-program product of claim 111, wherein the mapping specification comprises mapping specification controls including one or more format tags and one or more informat tags that indicate characteristics of the output data structure.

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