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(54) **GENERATING DIGITAL FILES FOR GARMENT PRODUCTION**

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**G06F 30/00** (2020.01)  
**G06F 119/18** (2020.01)

(52) **U.S. Cl.**  
CPC ..... **A41H 3/007** (2013.01); **G06F 30/00** (2020.01); **G06F 2119/18** (2020.01)

(58) **Field of Classification Search**  
CPC ..... A41H 3/007; G06F 30/00; G06F 2119/18  
See application file for complete search history.

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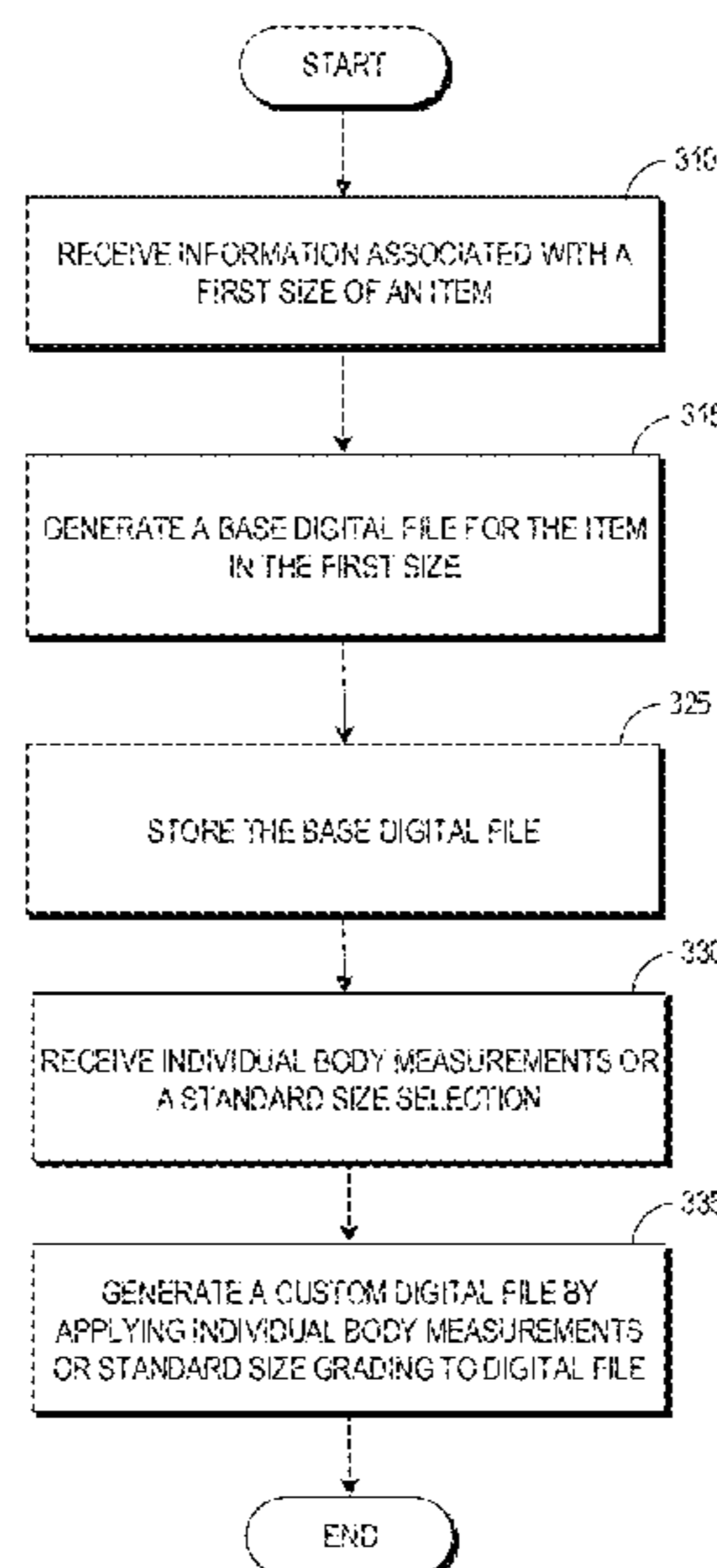
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(57) **ABSTRACT**

Methods and systems are provided to generate a base digital file for a garment and a custom digital file for the garment, which may be used in garment production. For example, a system may receive information providing various specifications for manufacturing a garment, generate a base digital file for the garment, receive a request to transform the garment from a first garment size to a second garment size, and then generate a custom digital file for the garment by applying custom user body measurements to the base digital file or by applying a grading scale.

**20 Claims, 10 Drawing Sheets**



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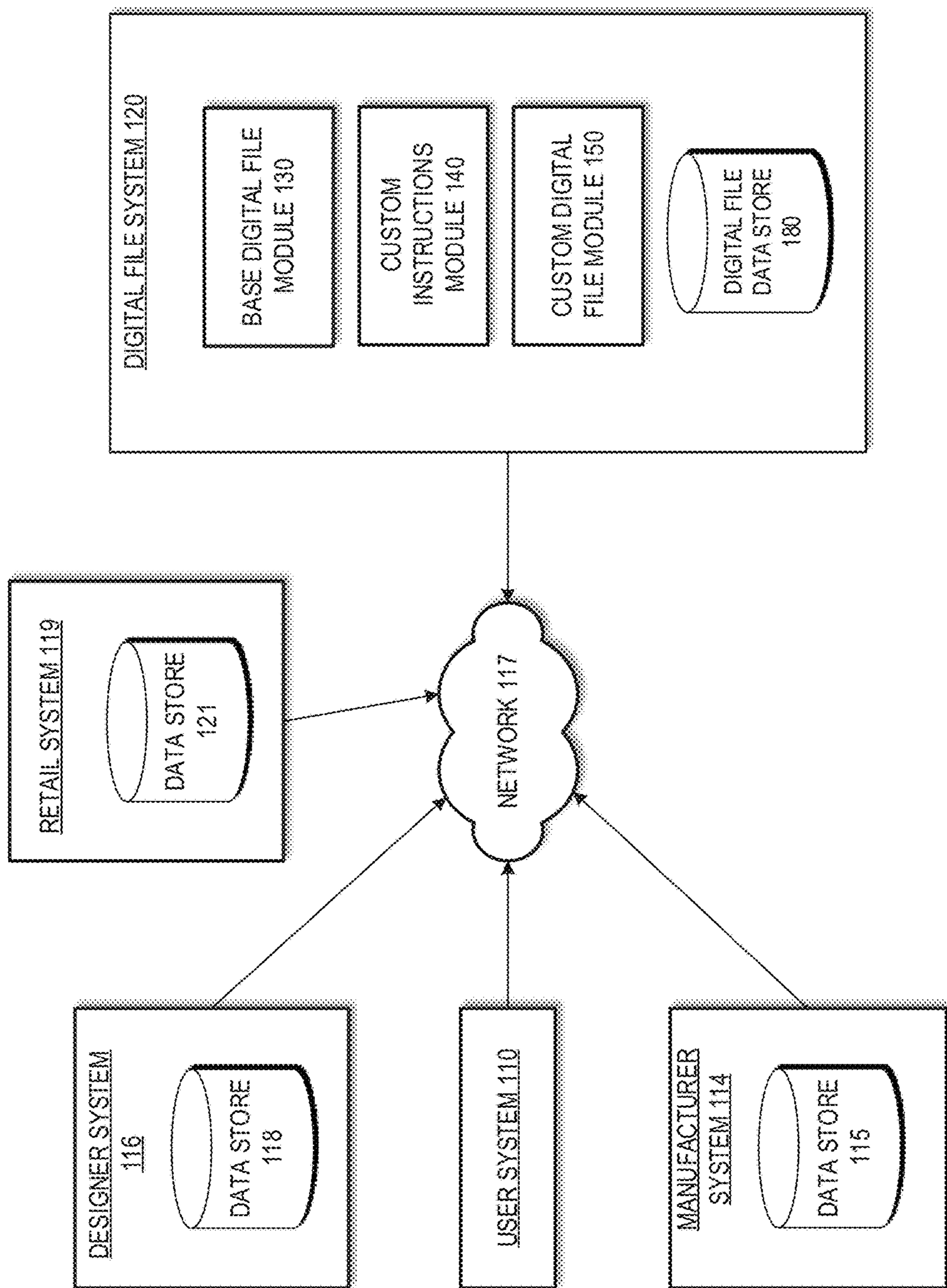


FIG. 1

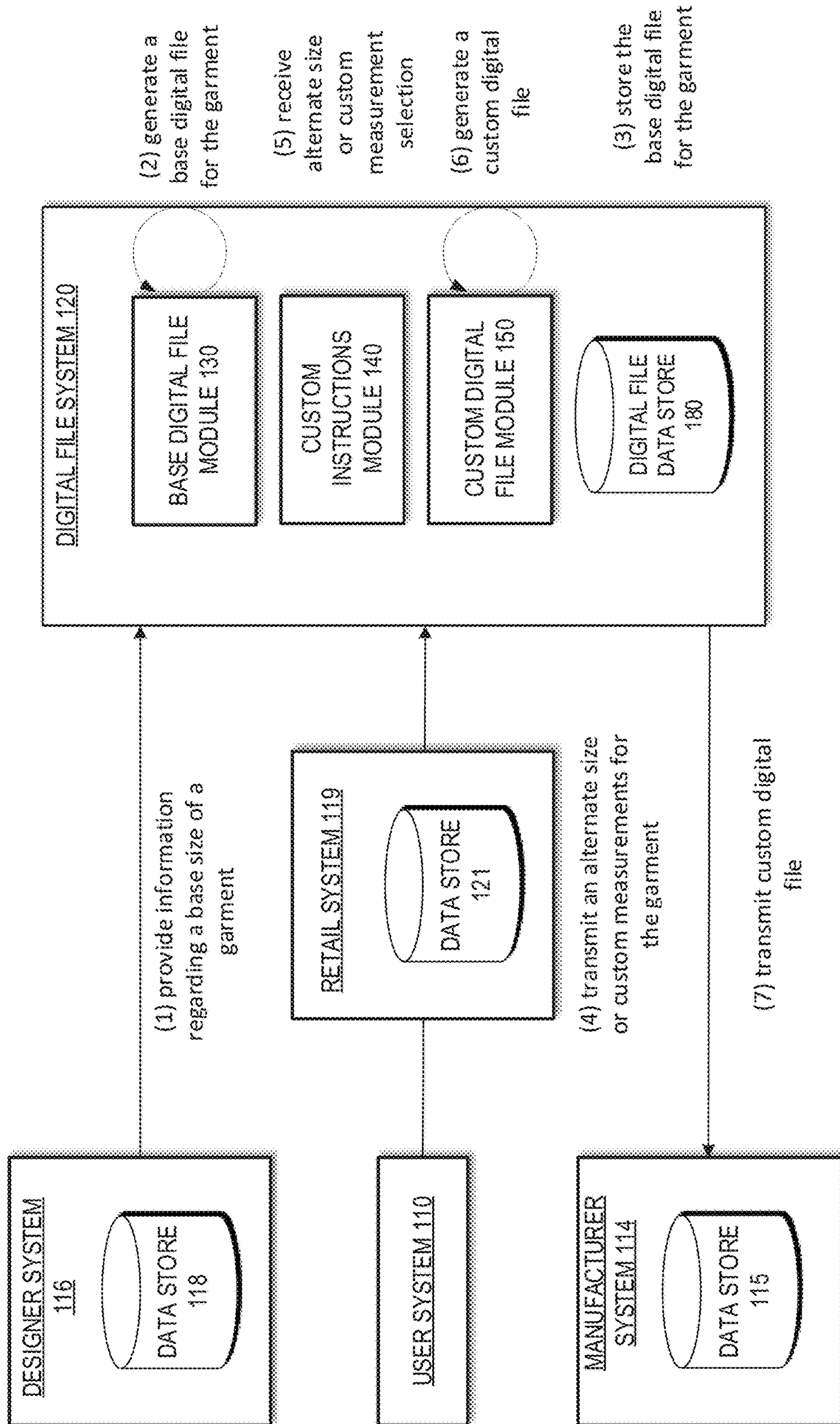


FIG. 2

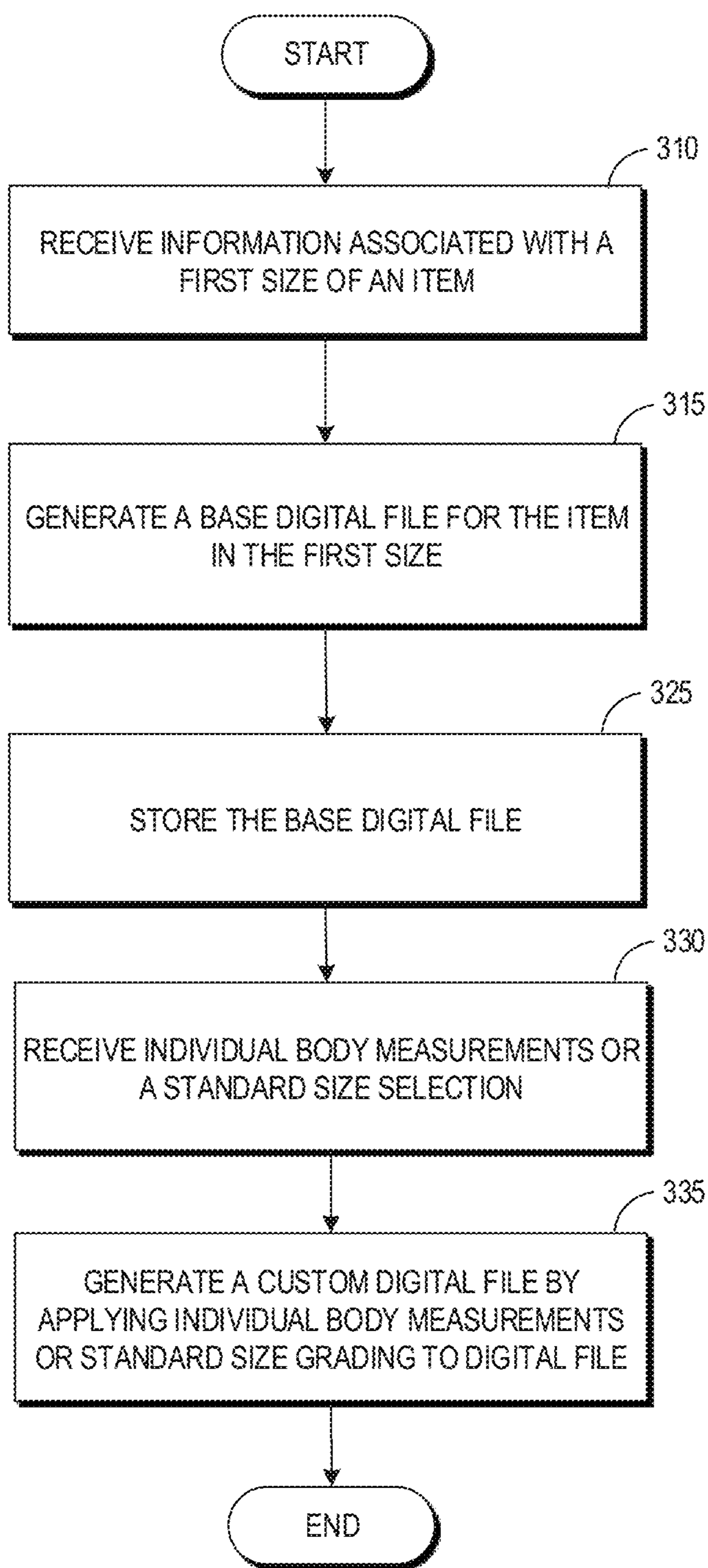


FIG. 3

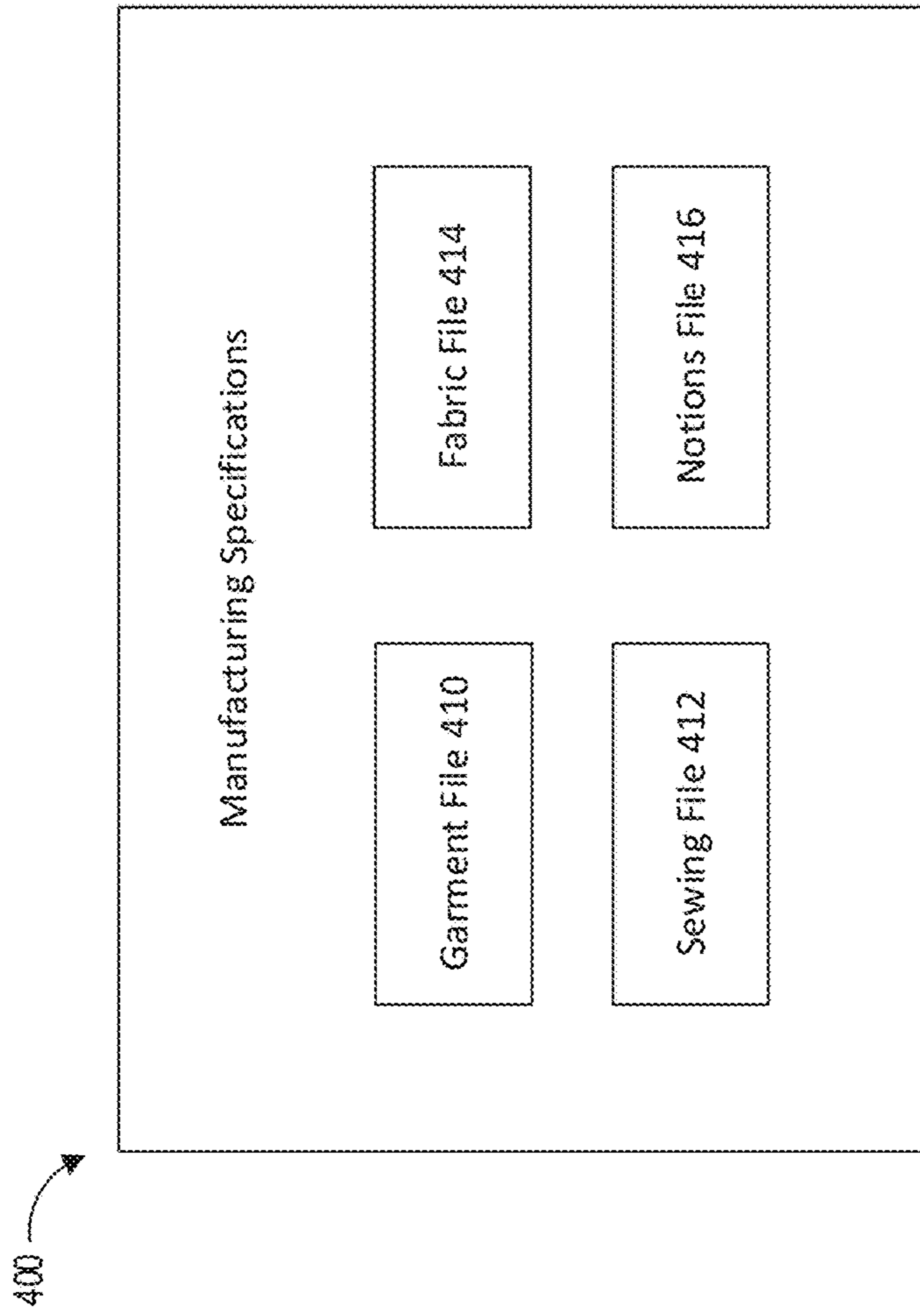


FIG. 4

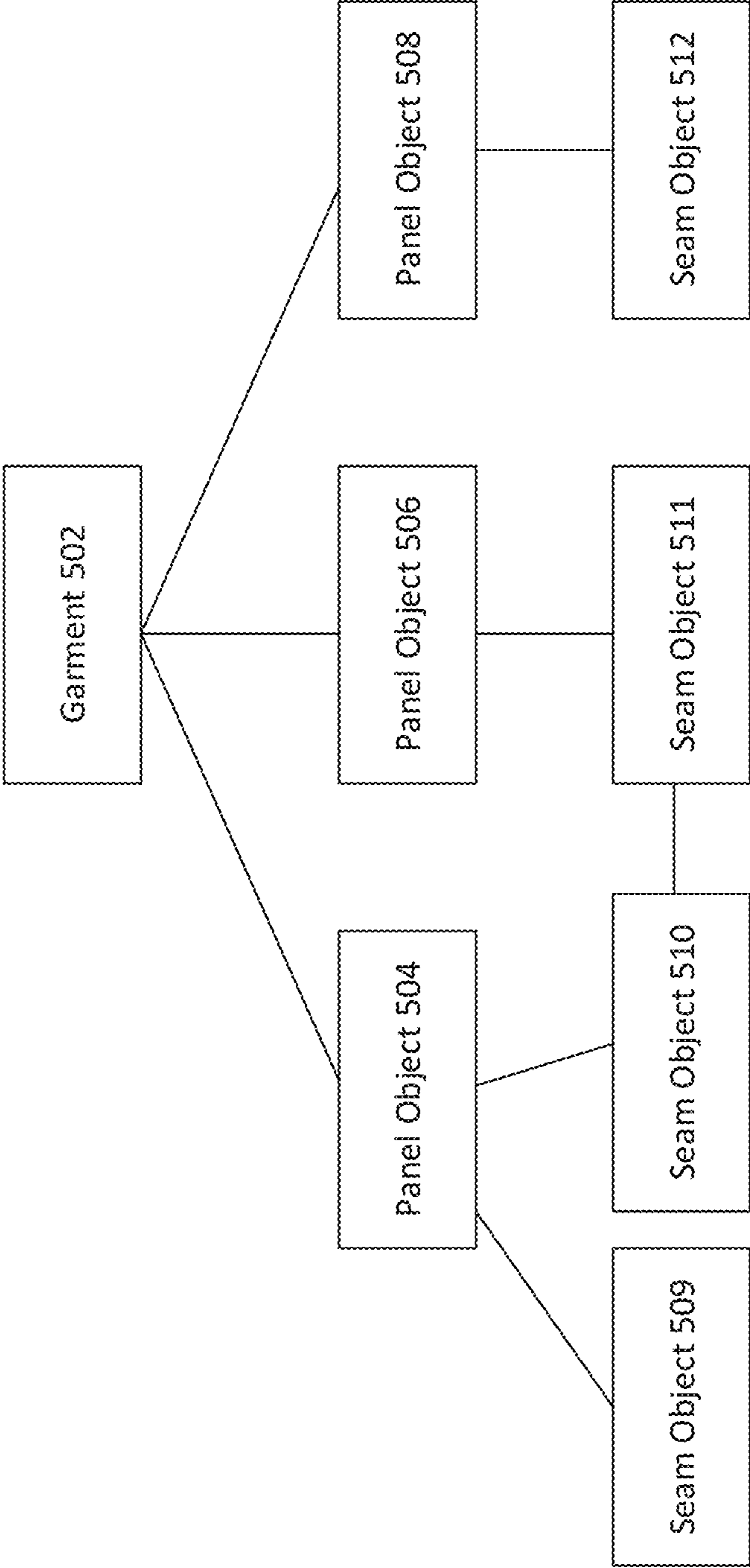


FIG. 5

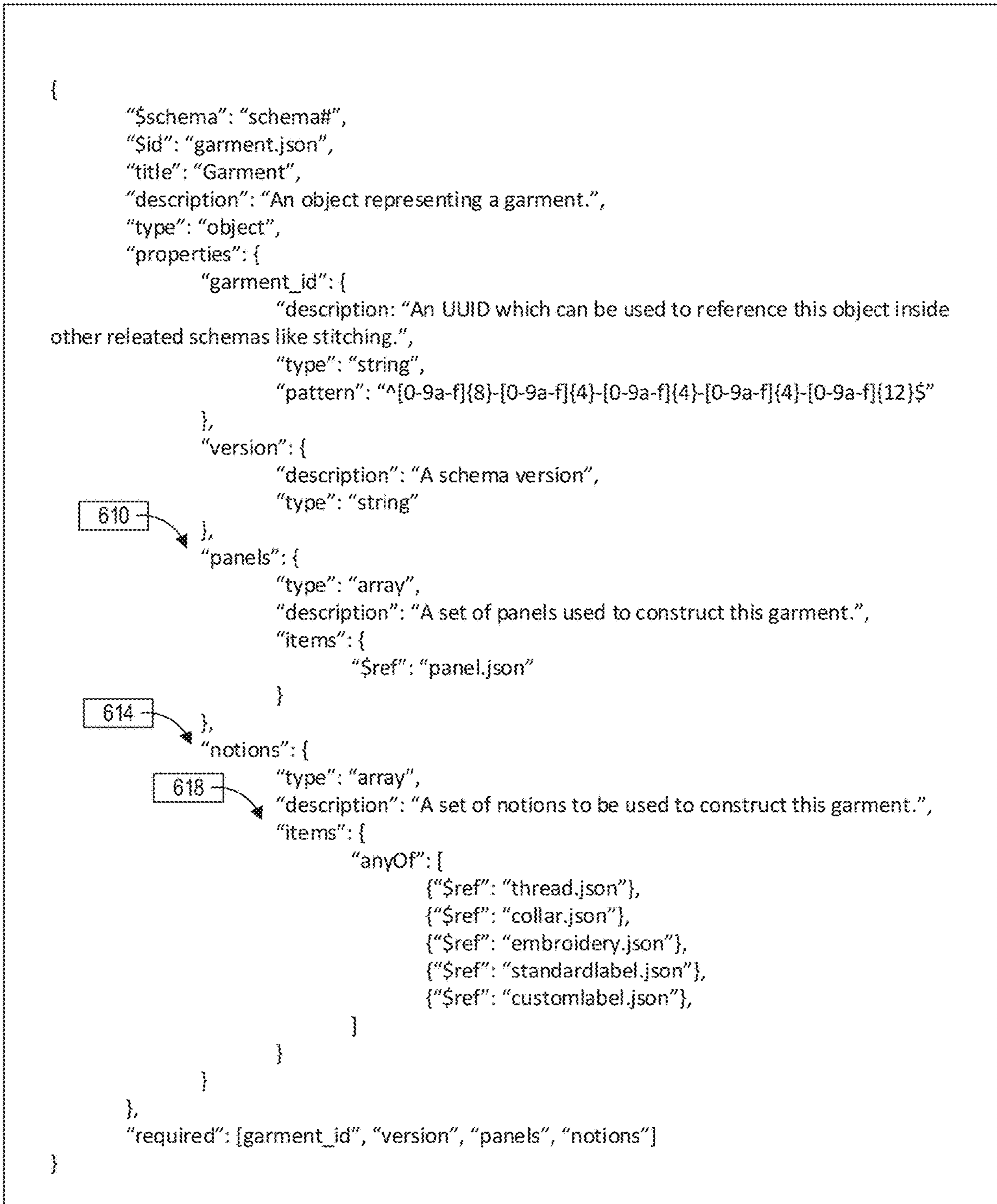


FIG. 6



```

{
  "$schema": "schema#",
  "$id": "panel.json",
  "title": "Panel",
  "description": "An object representing a panel of a garment.",
  "type": "object",
  "properties": {
    "panel_id": {
      "description": "An UUID which can be used to reference a panel.",
      "type": "string",
      "pattern": "^[0-9a-f]{8}-[0-9a-f]{4}-[0-9a-f]{4}-[0-9a-f]{4}-[0-9a-f]{12}$"
    },
    "panel_annotation": {
      "description": "A list of annotation properties to be added to the Panel
specification",
      "type": "array",
      "items": {
        "type": "object",
        "properties": {
          "key": {
            "type": "string",
            "description": "A key for the annotation, such as
description"
          },
          "value": {
            "type": "string",
            "description": "A value for the annotation, such as
description text"
          }
        },
        "required": ["key", "value"],
      }
    },
    "fabric_id": {
      "description": "This id is used for identifying what fabric this panel is made
off",
      "type": "string"
    },
    "seams": {
      "description": "This id is used for identifying what fabric this panel is made
off",
      "type": "string",
      "items": {"$ref": "seam.json"}
    }
  },
  "required": ["garment_id", "version", "panels", "notions"]
}

```

710



FIG. 7

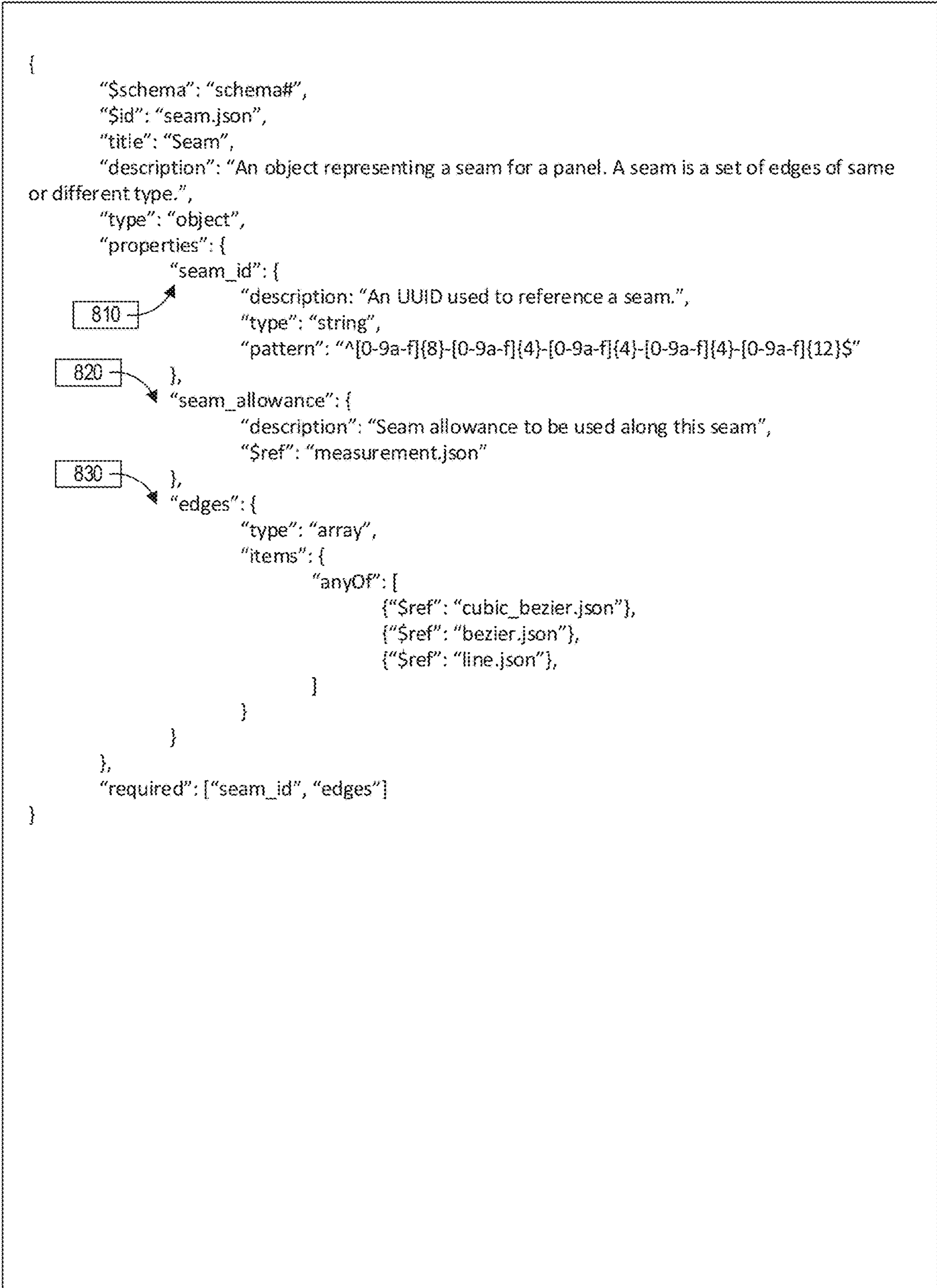


FIG. 8

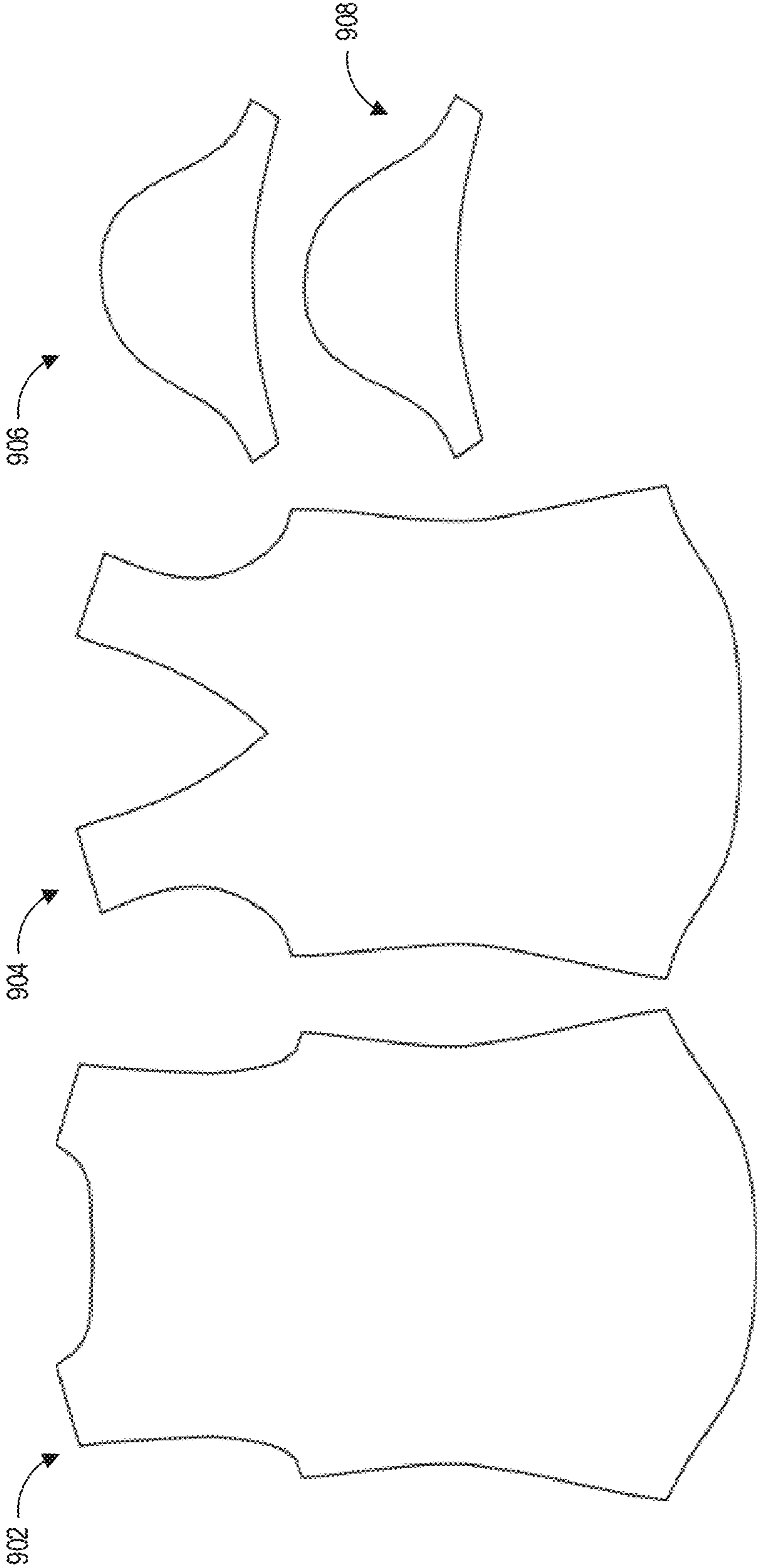


FIG. 9

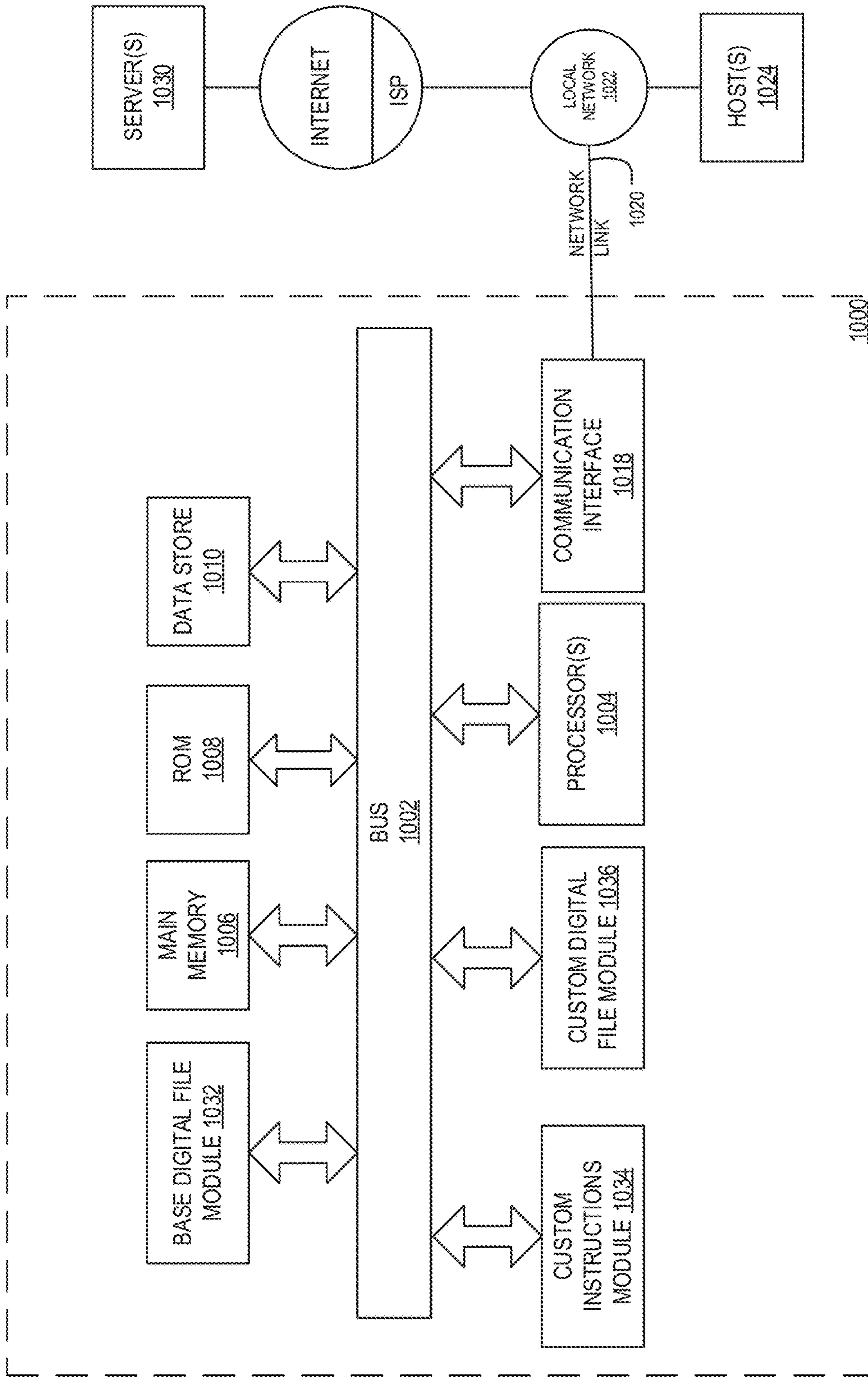


FIG. 10

## GENERATING DIGITAL FILES FOR GARMENT PRODUCTION

### BACKGROUND

A user may wish to use standards to effectively communicate ideas or instructions in a way that is readily understood by a recipient. For example, a clothing designer may use specific terminology, drawings, or labels to dictate how an article of clothing should be manufactured. However, in many clothing design situations, individual designers may use different wordings, formatting or methods to convey instructions, such that manufacturers often have to ask for clarification regarding the designer's instructions in order to create a document with the content and/or formatting that the manufacturer desires for actual production of a garment. To provide clarification for each and every set of instructions for each and every article of clothing would be prohibitively expensive in terms of labor, time, and cost, and introduces increasing levels of complexity and potential scaling problems as clothing lines increase in size and variety.

### BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of various inventive features will now be described with reference to the following drawings. Throughout the drawings, reference numbers may be re-used to indicate correspondence between referenced elements. The drawings are provided to illustrate example embodiments described herein and are not intended to limit the scope of the disclosure.

FIG. 1 is an illustrative networked environment and system architecture of a digital file system that may be used in association with garment production, according to some embodiments.

FIG. 2 is a data flow diagram depicting an example method of the digital file system for generating base digital files and custom digital files for use in garment production, according to some embodiments.

FIG. 3 is a flow diagram depicting an example method of generating a base digital file and custom digital file for garment production, according to some embodiments.

FIG. 4 is a visual representation of components of an example digital file utilized by the digital file system, according to some embodiments.

FIG. 5 is a visual representation depicting an example configuration of garment components in a digital file system, according to some embodiments.

FIG. 6 is example text for an example garment object utilized in a digital file system, according to some embodiments.

FIG. 7 is example text for an example panel object utilized in a digital file system, according to some embodiments.

FIG. 8 is an example text for an example seam object utilized in a digital file system, according to some embodiments.

FIG. 9 is a visual representation of panels utilized in a digital file system, according to one embodiment.

FIG. 10 is a diagram of an example computing system configured to perform the digital file generation and other methods described herein.

### DETAILED DESCRIPTION

Aspects of the present disclosure relate to utilizing a digital file system to provide complete manufacturing

instructions for any sort of garment via a digital file. Providing a digital file for manufacturing clothing may be accomplished in different manners, such as using different algorithms and/or different methodologies, as will be further described below.

As will be described herein, a digital file system may receive a set of information, documents, or selections for a first size of an item or garment, generate a digital file specific to the item in the first size, and store the digital file. The digital file system may then receive a user input comprising individual body measurements or a selection of a standard size of the garment, and generate a custom digital file by applying individual body measurements or a standard size grading rubric to the digital file. As will further be discussed below, the digital file system may divide the method and processes among various modules or system components.

The task of generating instructions to manufacture garments according to previously used methods typically involves generating a tech pack, where the tech pack typically comprises a specification sheet for a base size of a garment and a grading sheet which is used for transforming the base size into any other standard sizes (e.g., small, medium, and large). While there is some automation done where a designer shares a file (e.g., a digital exchange file), there are no semantics associated with the data in the file to help interpret coordinates in the file. Therefore, two different manufacturers may interpret the same tech pack differently if the two manufacturers each use different software (e.g., LibreCAD, AutoCAD) to analyze the received file. Furthermore, existing use of tech packs is not reliable when making made-to-measure clothing since no rule set is present when making customized clothing.

Furthermore, the task of ensuring that each tech pack is properly understood can be burdensome and time consuming for both manufacturers and designers, especially if the manufacturers need to repeatedly ask for clarification for each particular article of clothing. Typically, a designer will provide detailed instructions to a manufacturer to produce an article of clothing. Typically, however, the designer may use informal drawings, scribbles, or writing when conveying instructions in a traditional tech pack. Furthermore, while some designers may use a computer to help generate a tech pack, designers commonly submit informal instructions scribbled using pen and paper. Therefore, a designer's intent may not be effectively conveyed to the manufacturer due to a lack of understanding or insufficient detail. Further, in many cases, traditional tech packs do not allow a manufacturer to easily measure changes to an article of clothing if the article of clothing deviates from the size initially contemplated by the tech pack. Thus, the manufacturer or designer frequently has to manually check and add instructions when manufacturing an article of clothing.

Digital file methods and systems disclosed herein address these problems, allowing a system to generate a digital file to automatically consolidate instructions in a standardized digital format, which may be interpretable by both a human reader and a computer. For example, in some embodiments described herein, the digital file system may receive a user input comprising information associated with a first size of an item, generate a digital file for the item in the first size, store the digital file, receive individual body measurements or a standard size selection, and generate a custom digital file by applying individual body measurements or a standard size grading to various parameters within the digital file in a manner that creates set results that are not dependent on human guesswork.

There are many technical and practical benefits to utilizing the digital file system and methods described herein. By grouping various instructions into different specification objects within the digital file, the specification objects may tackle different parts of garment construction and can be pieced together to support different use cases. Furthermore, by using discrete objects to describe different instructions, it is possible to easily add additional variations to the digital file quickly and efficiently depending on the requirements of the particular article of clothing. In contrast, other methods may need to manually generate tech packs for each possible combination of features in a garment. By improving the ability to generate standardized digital files with instructions, the techniques described herein significantly reduce the inefficiencies of various types of garment construction, enabling production of garments in fewer steps and at scale.

FIG. 1 is an illustrative networked environment and system architecture of a digital file system, according to some embodiments. The illustrative environment includes a user system 110, a manufacturer system 114, a designer system 116, a retail system 119, a network 117, and a digital file system 120. In some embodiments, user system 110 may be a computer, handheld mobile computing device, or other computing system. In some embodiments, the user system 110 may comprise a processor configured to execute instructions to generate a user interface and transmit user input to digital file system 120.

In some embodiments, designer system 116 may be a computer, handheld mobile computing device, or other computing system utilized by a clothing designer to submit information regarding a garment to digital file system 120. In some embodiments, designer system 116 may comprise a data store 118 configured to store a plurality of garment information files as data entries.

In some embodiments, retail system 119 may be connected to, or in communication with, a data store 121 that stores item information regarding a number of items, such as items listed in an electronic catalog as available for browse and/or purchase via the retail system or service. Item data stored in data store 121 may include any information related to each item. For example, item data may include, but is not limited to, price, availability, title, item identifier, item feedback (e.g., user reviews, ratings, etc.), item image, item description, item attributes, keywords associated with the item, etc. In some embodiments, the data store 121 may store digital content items (e.g., audiobooks, electronic books, music, movies, etc.). In some embodiments, the retail system 119 may also be connected to, or in communication with, a user data store (not illustrated) that stores user data associated with users of the retail service, such as purchase history, browsing history, item reviews and ratings, personal information, user preferences, location information, body measurements, activity information, etc.

In some embodiments, manufacturer system 114 may be a computer, handheld mobile computing device, or other computing system utilized by a manufacturer to receive a digital file from digital file system 120. The manufacturer system 114 may then be utilized by manufacturing personnel and/or machines in producing a garment according to the digital file. In some embodiments, manufacturer system 114 may comprise a data store 115 configured to store a digital file as an entry.

It will be appreciated that any number of user systems 110, designer systems 116, retail systems 119 and manufacturer systems 114 may be utilized in the digital file system environment. In some embodiments, user system 110, manufacturer system 114, and designer system 116, retail system

119, and digital file system 120 may communicate with each other over a network 117, such as the Internet. As will be discussed in greater detail, in some embodiments, digital file system 120 may be in communication with user system 110, designer system 116, and manufacturer system 114 to generate and transmit one or more digital files. In some embodiments, digital file system 120 may comprise a base digital file module 130, a custom instructions module 140, a custom digital file module 150, and a digital file data store 180.

In some embodiments the digital file system 120 may utilize base digital file module 130 to generate a base digital file for a particular garment. As will be discussed below, in some embodiments, base digital file module 130 may receive information from designer system 116 regarding creating an article of clothing in a base size. In some embodiments, the base digital file module may receive the information, convert or otherwise process it, and divide it into components of a base digital file.

In some embodiments, the custom instructions module 140 may receive a user input from user system 110. For example, in some embodiments, a user may interact with a user interface associated with the retail system 119 to browse through an electronic catalog of items and to select an option to purchase a garment in a standard size. In some embodiments, the user may input, via the user interface, custom body measurements, which may be stored in data store 121. The retail system 119 may then forward the user custom body measurements to digital file system 120.

In some embodiments, the digital file system 120 may utilize custom digital file module 150 to generate a custom digital file. In some embodiments, the custom digital file module 150 may generate a custom digital file for an article of clothing based at least partly on the received custom instructions and the base digital file of the particular article of clothing. For example, the digital file system 120 may receive a request to purchase a first shirt in a standard large size, and the custom digital file module 150 may retrieve a base digital file from the digital file data store 180 corresponding to the first shirt, and apply a grading scale to transform the first shirt into the appropriate large size, assuming that the base digital file is not of the first shirt in a large size. The generated custom digital file may be stored in digital file data store 180 to be accessed or transmitted over network 117.

FIG. 2 is a data flow diagram depicting an example method of the digital file system that may be used in association with garment production, according to some embodiments. As part of the digital file method, designer system 116 may (1) provide information regarding a first size of a garment. For example, a designer may submit a drawing exchange format (dxf) file or a scalable vector graphics (svg) file depicting a garment in a first size (e.g., a garment in a medium size). In some embodiments, a clothing designer may provide information via a user interface associated with the digital file system 120. For example, a user interface may prompt the designer to draw a shape representing a panel of a garment. The designer may utilize the user interface to click on specific panels, reshape panels, select a seam to use on a particular panel via a drop-down menu, draw connections between panels, select a type of fabric to use when manufacturing a panel or garment, edit and view a specific panel, mark specific locations where embroidery should appear in a garment, etc.

The digital file system 120 may (2) generate a base digital file for the garment in the first size. In some embodiments, the digital file system 120 may divide the garment into a plurality of components. For example, the digital file system

5

**120** may receive information regarding a specific garment (e.g., a shirt) and may generate a plurality of panel objects to represent the components of the shirt. For example, the digital file system **120** may generate a front shirt panel object and a back shirt panel object to represent the front of the shirt and the back of the shirt respectively. As mentioned above, in some embodiments the digital file system **120** may generate a base digital file by receiving and processing the information that is selected or inputted by the designer via a user interface associated with the digital file system **120**. In some embodiments, the base digital file may define a plurality of objects that each represent physical components used in production of a garment. In some embodiments, each panel of a garment may be associated with a number of attributes. For example, a front panel of a shirt may be associated with a unique panel identifier to identify that particular panel in the garment as well as a fabric identifier to represent the type of fabric to be used for constructing the front shirt panel. Advantageously, a unique panel identifier may allow a manufacturer to easily and efficiently determine the proper location of a panel to be stitched or sewed in an article of clothing.

As will be discussed below, each of a number of different components of the base digital file may refer to one or more other components of the base digital file. For example, a base digital file of a shirt may comprise a front shirt panel object and a back shirt panel object connected by a seam object representing a sewed connection between the front shirt panel object and the back shirt panel object. In some embodiments, a panel object may also be associated with panel metadata. For example, a panel object may be associated with panel annotations, a mirror line along the panel indicating symmetric areas of the panel, a fold line indicating where a panel needs to be folded, and a grain line indicating a correct orientation to place the panel on a fabric. For example, panel metadata for a panel to be used for the sleeves of a shirt may contain a key value "panel type" and value "sleeves" as panel annotation metadata. In some embodiments, the digital file system may represent a garment using a coordinate system, where each panel of the garment may contain a unique set of coordinates in the coordinate system.

In some embodiments, the base digital file may also comprise instructions dictating how digital file component objects are arranged to form a garment. By way of example, the base digital file for a shirt may include sewing instructions dictating how seams represented by a seam object should stitch a front shirt panel object and a second shirt panel object together. Similarly, a base digital file may also comprise one or more edge objects representing an edge corresponding to a seam, and in turn, a panel. In some embodiments, an edge object may be an array of points and an edge type property. In some embodiments, the edge type property helps identify the type of edge (e.g., whether the edge is a straight line or a curve). In some embodiments, the type of edge used for a particular seam or panel may differ depending on the panel of garment itself. For example, a panel used for constructing a sleeve of a sweater may be associated with an edge object indicating a simple straight edge. On the other hand, a panel that constructs a portion of the neck of the sweater may instead be associated with a curved edge type.

In some embodiments, a curved edge in a panel may be represented using a Bezier curve. In some embodiments, the Bezier curve may be quadratic or cubic. In some embodiments, the quadratic Bezier curve may be defined by a vertex point and two handle points. In some embodiments, the

6

quadratic Bezier curve may also comprise one or more control points allowing one main Bezier curve to split into multiple smaller curves connected via the one or more control points. In some embodiments, a cubic Bezier curve may be defined using two vertex points and two handle points. It may also be possible to include one or more control points that allows for a main cubic Bezier curve to be split into smaller connected curves.

Once the digital file system **120** generates a base digital file for a garment in a first size, the digital file system **120** may (3) store the base digital file in digital file data store **180**. In some embodiments, the base digital file may be stored in an object-oriented format (e.g., JavaScript Object Notation (JSON) format). Since a product may have drastically different structures based on the customization options, in some embodiments the digital file system **120** may store multiple base digital files for the same product. For example, multiple base digital files may be generated for a shirt that could transform into a v-neck or crew neck depending on the cut of the cloth. Although both the v-neck and crew neck shirts are considered t-shirts, the patterns associated with the v-neck and the crew neck are drastically different and thus may justify having two different base digital files. In some embodiments, the digital file data store may be an array of base digital files, wherein each entry may also comprise a product identifier and a name. In some embodiments, the data store may also track whether a particular base digital file is considered a default option for the particular product. Furthermore, it will be appreciated that what is often described herein as individual objects within a single digital file (such as a panel object and a seam object) may instead be separate files, where at least one of the files refers to or references the other. Thus, in such embodiments, some files may be shared between two variations of a clothing item (such as the panels for sleeves of a v-neck shirt and crew neck shirt), while other files may differ (such as the front panel for the v-neck shirt versus the crew neck shirt).

Once the digital file system **120** generates a base digital file for a garment and stores the base digital file in digital file data store **180**, the user system **110** may (4) select an alternate size or custom measurements for the garment via a user interface associated with retail system **119**, and the digital file system may (5) receive the alternate size or custom measurement selection from the retail system **119**. For example, a user on a website of an electronic retailer may initiate a purchase order for a shirt and select a standard size option (e.g., medium) from a drop-down menu of standard sizes (e.g., small, medium, and large) on a website associated with retail system **119**. In some embodiments, a user may submit information regarding the user's body measurements to a profile stored with retail system **119**. In such a case, the digital file system **120** may automatically receive the user's body measurement information from retail system **119** whenever the user initiates a purchase order for a garment. In some embodiments, the user may directly provide body measurement information to the digital file system **120** rather than through retail system **119**.

The digital file system **120** may (6) generate a custom digital file upon receiving alternate size or custom measurement information or selections. In some embodiments, the custom digital file associated with an item may comprise the same components of the base digital file but with altered values. For example, if a base digital file for a pair of pants comprises panel objects of a standard small size, the custom digital file for the pair of pants in a standard medium size may comprise the same panel objects but sized for a standard

medium pair of pants. In some embodiments, when a user selects an alternate standard size that is different from the size associated with the base digital file, the digital file system **120** may apply a grading scale to convert the pair of pants from the base size to the alternate size. For example, a grading scale may include one or more formulas that mathematically converts the measurements of one size of a garment into an alternate size.

In some embodiments, the grading scale may be a table of measurements in standard sizes, which a manufacturer may refer to in order to manufacture a garment in a particular standardized size. In some embodiments, the digital file system **120** may replace measurements stored in the base digital file with custom measurements transmitted to digital file system **120** from a user system **110**, designer system **116**, or retail system **119**. For example, the digital file system **120** may replace a waist measurement associated with the base size of a pair of pants (e.g., 28 inches) with a custom waist measurement received from a user for the same pair of pants (e.g., 30 inches). This may also trigger various stored rules that cause changes or alterations in other values in the base digital file (besides the waist measurement itself) in order to keep desired proportions between components of the garment. The digital file system **120** may then (7) transmit the custom digital file to a manufacturer system **114**. The user of a manufacturer system **114** may then use the custom digital file to manufacture the garment according to the alternate size or custom body measurements. Therefore, the manufacturer may successfully manufacture a garment with an appropriate fit without requiring additional input from a designer or a user.

FIG. **3** is a flow diagram depicting an example method of generating a digital file, according to some embodiments. In block **310**, the digital file system may receive information associated with a first size of an item. For example, the digital file system may receive a dxf or svg file depicting an image of a jacket along with handwritten notes about certain specifics of the jacket (e.g., the length of the right sleeve, the number of buttons on the jacket, or the placement of zippers). In some embodiments, the digital file system may receive information from a designer via a user interface associated with the digital file system **120**. For example, a user interface may prompt the designer to draw a shape representing a panel of a garment. The designer may utilize the user interface to click on specific panels, reshape panels, select a seam to use on a particular panel via a drop-down menu, draw connections between panels, select a type of fabric to use when manufacturing a panel or garment, edit and view a specific panel, mark specific locations where embroidery should appear in a garment, etc.

In block **315**, the digital file system may generate a base digital file for the item in the first size. An example of a base digital file may be seen in FIG. **4**. The base digital file for the item may be generated based at least in part on the selections or input in a user interface associated with digital file system **120**. For example, the user interface may prompt a clothing designer to provide responses to specific questions (e.g., what type of fabric should be used for this panel?), and the digital file system **120** may populate the provided response or selection into the base digital file.

At block **325** the digital file system **120** may store the base digital file in digital file data store **180**. At block **330**, the digital file system **120** may receive individual body measurements or a standard size selection from a user computing device. For example, a user on a website of an electronic retailer may initiate a purchase order for a shirt and select a standard size option (e.g., medium) from a drop-down menu

of standard sizes (e.g., small, medium, and large). In some embodiments, a user may submit information regarding the user's body measurements to a profile stored with designer system **116** for a custom sized order rather than selecting a standard size. For example, a user may take a photograph of the user's body and submit the photograph to retail system **119**. The digital file system **120** may automatically receive the user's body measurement information whenever the user initiates a purchase order for a garment, or the user may manually provide body measurement information to the retail system or digital file system **120**. It will be appreciated that in other examples, the digital file system **120** may receive information other than an individual's body measurements or a standard size selection. For example, in some embodiments, the digital file system **120** may receive selections of specific patterns, embroidery, or fabrics to customize the garment.

In block **335**, the digital file system **335** may generate a custom digital file in response to receiving individual body measurements or a standard size selection. In some embodiments, the custom digital file may comprise the same files and/or objects as illustrated in FIG. **4**. As mentioned above, in some embodiments, the custom digital file associated with an item may comprise the same components of the base digital file but with altered values. For example, if a base digital file for a pair of pants comprises panel objects of a standard small size, the custom digital file for the pair of pants in a standard medium size may comprise the same panel objects but sized for a standard medium pair of pants. In some embodiments, when a user selects an alternate standard size that is different from the size associated with the base digital file, the digital file system **120** may apply a grading scale to convert the pair of pants from the base size to the alternate size. In some embodiments, the digital file system **120** may replace measurements stored in the base digital file with custom measurements transmitted to digital file system **120** from a user system **110** or retail system **119**. For example, in some embodiments, a panel may be associated with a unique identifier and an object representing a magnitude and unit associated with the panel. For example, a shirt panel may be associated with an object defining a unit of "centimeters" and a magnitude of "25" to indicate that the particular shirt panel should be 25 centimeters in length and width. In some embodiments, the digital file system **120** may replace the measurement associated with the base size (e.g., 25 centimeters) with a custom measurement received from a user for the same article of clothing (e.g., 30 centimeters), as well as alter measurements of nearby panels, seams and/or other objects of the garment according to preset rules or formulas.

FIG. **4** is a visual representation of components in an example digital file. Digital file **400** may be a text file comprising references to a garment file **410**, sewing file **412**, fabric file **414**, and notion file **416**. In other embodiments, digital file **400** may be a package that itself includes sub-files corresponding to garment file **410**, sewing file **412**, fabric file **414**, and notion file **416**. In still further embodiments, what are shown as different files or sub-files in FIG. **4** may instead all be included within a single file, such as a single text file, as different defined objects. In some embodiments, the digital file **400** may be used to manufacture a garment or create a digital visualization of the garment (such as a three-dimensional rendering of the garment worn by a virtual person).

In some embodiments, garment file **410** defines component parts of a garment. For example, garment file **410** may comprise a number of panel objects to create the garment. In



some embodiments, the garment file **410** may also comprise a set of instructions specifying how to cut each panel of the garment file **410**. For example, a front panel object associated with the front of a shirt may need to be cut at specific lengths to ensure the sleeves are of a certain size. In some 5 embodiments, garment file **410** may also comprise objects representing details to consider in constructing the garment. For example, garment file **410** may comprise a fabrics object dictating what specific fabrics are used to create the garment. For example, garment file **410** may comprise a text file 10 describing that a front panel object of a shirt and a back panel object for the same shirt are both created using a 90% cotton and 10% polyester fabric combination. In some embodiments, the garment file **410** may comprise a notions object identifying embellishments on the article of clothing. 15 For example, a garment file **410** for a jacket may comprise a notions object defining a number of buttons to include on the jacket, the placement of said buttons on the various panel objects associated with the jacket, or the inclusion of any other embellishments in the garment (e.g., zippers, tassels, 20 pockets).

In some embodiments, sewing file **412** may determine how different panels are sewed or stitched together. For example, a digital file for a pair of jeans may comprise a seam object identifying that cross-stitching should be used 25 to stitch an inseam of the pair of jeans. On the other hand, a digital file for a jacket may comprise a seam object identifying that a buttonhole stitch be used to stitch an embroidered pattern onto the right sleeve of the jacket. In some embodiments, sewing file **412** may comprise a list of 30 operations that may be performed on the panels. For example, sewing file **412** may reference the name of a JSON file associated with a specific operation to be performed in garment construction. For example, sewing file **412** may reference by name a “stitch” operation file defining how to 35 stitch two seams using a specific stitch type (e.g. lock stitch). It will be appreciated that sewing file **412** may not be limited to only sewing or stitching instructions. For example, sewing file **412** may comprise construction instructions that 40 define how to attach a patch or print onto a panel or how to include buttons or button holes on one or more panels. In some embodiments, each operation may be associated with parameters or other metadata. For example, a lock stitch operation may comprise a parameter called “length” which 45 may define the overall size of the stitch, an upper thread identifier defining what thread should be used for an upper thread of a stitch, and a lower thread identifier defining what thread should be used for a lower thread of a stitch. It will be appreciated that other operations may include other types of metadata. For example, a button placement operation may 50 comprise button spacing metadata defining the amount of space to include between each button on a particular panel.

In some embodiments, fabric file **414** may comprise information specific to different fabrics used in garment construction. For example, assuming that a garment file **410** 55 specifies that cotton should be used to create a t-shirt, the fabric file **414** may comprise a text file indicating that the t-shirt should specifically comprise cotton twill fabric. In some embodiments, notions file **416** may comprise information specific to different notions used in garment construction. For example, assuming that a digital file for a coat 60 may specify that the coat comprises five buttons ordered vertically down the center length of the coat, the notions file **416** may comprise a text file indicating that each button be made of brass. In some embodiments, the fabric file **414** may 65 contain metadata relevant to the fabrics used for constructing a garment. For example, in some embodiments fabric file

**414** may comprise a product identifier identifying the particular article of clothing, a panel identifier to identify a specific panel of the article of clothing, and an array of fabrics wherein each entry in the array indicates a particular 5 fabric to be used for constructing the panel associated with the panel identifier. In some embodiments, the fabric file **414** may also comprise color metadata identifying the color of specific fabrics used in a particular panel of the garment.

An individual may access digital file **400** in order to make 10 changes to the digital file. For example, if a clothing designer initially generates a digital file **400** to represent a shirt initially made with three distinct panels, the clothing designer may later edit the garment file **410** to change the number of panels from three to four panels. In some embodi- 15 ments, multiple people may access digital file **400**. For example, a digital file may be stored in a public or private repository accessible by a group of clothing designers so that the clothing designers may collaborate to create a unique or complex article of clothing. In such an example, each 20 clothing designer may have the ability to directly edit any of the garment file **410**, sewing file **412**, fabric file **414**, or notions file **416** in digital file **400**. In some embodiments, digital file **400** may be opened using a variety of software applications (e.g., LibreCAD or AutoCAD) for ease of 25 accessibility. For example, user interfaces accessible via a customized design application or a browser may enable a user to visually design and edit components of a garment (such as panels, annotations, fabrics and other features), which may then cause a computing system to automatically 30 edit the corresponding object data defined in a corresponding digital file.

In some embodiments, the digital file **400** may be generated based at least partly on information pulled from libraries or digital repositories. In some embodiments, the digital 35 file **400** may contain references to files stored in a remote library. For example, if a file stored in a public online repository lists general information regarding a type of cotton that may be used in clothing manufacturing, a fabric file **414** may reference the file by name or fabric identifier to 40 provide information regarding the specific type of cotton that may be used for a specific garment or panel in a garment. In some embodiments, the library may also comprise other information used for garment production (e.g., a type of curve to use for sewing). In some embodiments, the digital file **400** may contain multiple references from a 45 plurality of libraries, data sources, or files. For example, notions file **416** may contain references to a list of embroidery files stored in a first library while sewing file **412** may reference by name a sewing instructions file stored in a separate library in order to efficiently compile manufacturing information for a particular garment. In some embodi- 50 ments, digital file **400** may also contain copies of libraries or files that are initially stored in a remote library or data source. In some embodiments, the digital file **400** may be an extendable JSON file that permits a user to add, remove, or otherwise edit component files in the digital file **400**. For 55 example, a clothing designer may decide to implement additional embroidery to a pair of pants and may therefore either add a reference to a particular embroidery file in a remote repository or add a copy of a remote library containing the additional embroidery information. In some 60 embodiments, the copy of a library or file may be altered by the clothing designer without affecting the original file or library that may be stored in a remote repository.

FIG. 5 is a visual representation depicting an example configuration of garment components in a digital file system, 65 according to some embodiments. The objects illustrated as

## 11

visually connected in FIG. 5 may be associated with each other in one or more digital files by object-based notations that reference an object by identifier, name or other manner. In some embodiments, garment 502 may be an article of clothing (e.g., a hoodie) listed and sold on an electronic catalog. In some embodiments, garment 502 may comprise a plurality of panel objects 504, 506, and 508, where each panel object represents a discrete section or portion of the garment (such as a single portion of fabric cut to a certain shape). For example, if garment 502 is a hoodie, then panel object 504 may represent a front body portion of the hoodie, panel object 506 may represent a back portion of the hoodie, and panel object 508 may represent the hood of the hoodie. Panel objects 504, 506, and 508 may therefore be related portions of the overall garment. In some embodiments, the panel objects may comprise a number of seam objects. For example, panel object 504 may include or be associated with seam objects 509 and 510 (such as the panel object data for panel object 504 referencing the seam identifiers of seam objects 509 and 510, or seam object data for seam objects 509 and 510 referencing a panel identifier of panel object 504), panel object 506 may contain or be associated with seam object 511, and panel object 508 may contain or be associated with seam object 512. In some embodiments, seam objects may be joined together according to a specific set of sewing instructions. For example, sewing instructions referencing seam object 510 and seam object 511 may provide instructions for stitching together the panels represented by panel objects 504 and 506.

It will be appreciated that any number of panel objects or seam objects may be included in a particular garment. For example, a relatively simple t-shirt may only have panel objects representing a front and back side to the shirt, joined together by one set of stitches. On the other hand, many more panel objects and seam objects may be included under garment 502 if garment 502 is a complex piece of clothing (e.g., a fashionable jacket). Although the example of FIG. 5 displays panel objects and seam objects, it will be appreciated that other objects may be included in other embodiments. For example, garment 502 may also comprise a notions object branching out from panel object 504 indicating that a piece of embroidery is located on the portion of clothing represented by panel object 504. Similarly, other notions objects may be included to indicate the presence of other visual embellishments on the garment 502, such as buttons or zippers.

FIG. 6 is a visual representation of an example garment object utilized in a digital file system, according to some embodiments. As mentioned above, a garment may be represented as a file in an object notation format, such as a JSON file, wherein the JSON file comprises one or more panel objects. In some embodiments, each panel object may correspond to a discrete portion of an article of clothing. In some embodiments, each panel object may be an entry in an array of panel objects. In some embodiments, a garment object may further comprise an array of notions 614, wherein each entry in the array of notions 614 corresponds to an embellishment or visual personalization of the garment (e.g., buttons, or zippers). For example, an array of notions may comprise JSON files corresponding to threads, collars, embroidery, standardized labels, and custom labels to be included in the garment.

FIG. 7 is a visual representation of an example panel object utilized in a digital file system, according to some embodiments. In some embodiments, a panel object may be represented as a file in an object notation format, such as a JSON file, and may refer to other objects within the digital

## 12

file. For example, a panel object may include an array of seams 710, wherein each entry in the array of seams dictates a particular sewing or stitching method to generate a particular seam for the garment. In some embodiments, each panel object may comprise a garment ID to associate the panel to a particular article of clothing, and one or more notions objects specifying a number of enhancements or details to the garment.

FIG. 8 is a visual representation of an example seam object utilized in a digital file system, according to some embodiments. In some embodiments, a seam object may be represented as a file in an object notation format, such as a JSON file, and may comprise details to be used in garment manufacturing. For example, a seam object may include an array of edges 830, wherein each entry in the array of edges dictates a particular type of edge to generate a panel of the garment. In some embodiments, each seam object may comprise a seam ID 810 to associate the seam to a particular panel in the garment, and one or more notions objects specifying a number of enhancements or details to the garment. In some embodiments, the seam object may also include a seam allowance 820 which provides measurements for an area between a panel edge and a seam or stitching.

While FIGS. 6, 7, and 8 are described with reference to JSON files, it will be appreciated that many alternative formats may be employed for conveying object data for a garment in other embodiments. For example, according to some embodiments, a file format of a digital file as described herein may generally be one that uses human-readable text to transmit data objects consisting of attribute—value pairs, array data types and/or other attributes or parameters having associated values. These may be desirable traits of a format used in aspects of present disclosure because it enables humans (such as designers and/or manufacturers) to read and understand the object data, while also being easily capable of processing, parsing, and modification by software, hardware and/or firmware of a computer system (such as a system utilized by a retailer, a designer, and/or a manufacturer).

FIG. 9 is a visual representation of panels that may be defined by object data in a digital file system, according to some embodiments. A digital file may comprise a plurality of panels, wherein each panel represents a portion of the overall garment. For example, panel 904 may represent a front portion of a shirt, while panel 902 may represent a back portion of the same shirt. Furthermore, panels 906 and 908 may each represent a sleeve portion of the shirt. It will be appreciated that additional or fewer panels may be included in the garment depending on the overall complexity of the garment itself. Furthermore, panels 902, 904, 906, and 908 may each include a number of notions and seams to help a manufacturer properly construct the garment. The shapes of the illustrated panels may be defined, for example, in mathematical terms, such as with reference to measurements and curve specifications, within object data for the respective panel.

FIG. 10 is a diagram of an example computing system configured to perform the digital file method described herein. The computing system 1000 may be configured to perform all or some of the features of the digital file system 120. The computing system 1000 includes a bus 1002 or other communication mechanism for communicating information, and a hardware processor, or multiple processors, 1004 coupled with bus 1002 for processing information. Hardware processor(s) 1004 may be, for example, one or more general purpose microprocessors.

The computing system **1000** also includes a main memory **1006**, such as a random access memory (RAM), cache, or other dynamic storage devices, coupled to bus **1002** for storing information and instructions to be executed by processor **1004**. Main memory **1006** also may be used for storing temporary variables or other intermediate information during execution of instructions to be executed by processor **1004**. Such instructions, when stored in storage media accessible to processor **1004**, render the computing system **1000** into a special-purpose machine that is customized to perform the operations specified in the instructions.

The computing system **1000** further includes a read only memory (ROM) **1008** or other static storage device coupled to bus **1002** for storing static information and instructions for processor **1004**. Data storage device **1010**, such as a magnetic disk, optical disk, or a USB thumb drive (Flash drive), etc., is provided and coupled to bus **1002** for storing information and instructions.

The computing system **1000** may further, as described below, implement the techniques described herein using customized hard-wired logic, one or more application specific integrated circuits (ASICs) or field programmable gate arrays (FPGAs), firmware and/or program logic which in combination with the computer system causes or programs the computing system **1000** to be a special-purpose machine. According to one embodiment, the techniques herein may be performed by the computing system **1000** in response to processor(s) **1004** executing one or more sequences of one or more computer readable program instructions contained in main memory **1006**. Such instructions may be read into main memory **1006** from another storage medium, such as storage device **1010**. Execution of the sequences of instructions contained in main memory **1006** causes processor(s) **1004** to perform the process steps described herein. In alternative embodiments, hard-wired circuitry may be used in place of or in combination with software instructions.

As part of a special-purpose machine, the computing system **1000** may include base digital file module **1032**, custom instructions module **1034**, and custom digital file module **1036**. According to one embodiment, base digital file module **1032** may receive information regarding creating an article of clothing in a base size. In some embodiments, the base digital file module may receive the information and divide it into components and/or objects of a base digital file. In some embodiments, custom instructions module **1034** may receive a user input from a user system that includes a standard size selection or custom body measurements. In some embodiments, custom digital file module **1036** may generate a custom digital file by applying a grading scale to scale the measurements of the item associated with the base digital file to a new standard size. In some embodiments, custom digital file module may generate a custom digital file tailored to the standard size selection or custom body measurements by replacing any measurements stored in the base digital file with the custom body measurements. Digital files utilized by modules **1032**, **1034**, and **1036** may be stored in data store **1010**. According to one embodiment, instructions may be transmitted through communication interface **1018** to one or more servers **1030**. The instructions transmitted may be stored in ROM **1008** in one embodiment.

Various forms of computer readable storage media may be involved in carrying one or more sequences of one or more computer readable program instructions to processor **1004** for execution. For example, the instructions may initially be carried on a magnetic disk or solid state drive of a remote

computer. The bus **1002** may carry data to main memory **1006**, from which processor **1004** retrieves and executes the instructions.

The computing system **1000** also includes a communication interface **1018** coupled to bus **1002**. Communication interface **1018** provides a two-way data communication coupling to a network link **1020** that is connected to a local network **1022**. For example, communication interface **1018** may be an integrated services digital network (ISDN) card, cable modem, satellite modem, or a modem to provide a data communication connection to a corresponding type of telephone line. As another example, communication interface **1018** may be a local area network (LAN) card to provide a data communication connection to a compatible LAN (or WAN component to communicate with a WAN). Wireless links may also be implemented. In any such implementation, communication interface **1018** sends and receives electrical, electromagnetic or optical signals that carry digital data streams representing various types of information.

Network link **1020** typically provides data communication through one or more networks to other data devices. For example, network link **1020** may provide a connection through local network **1022** to a host computer **1024** or to data equipment operated by an Internet Service Provider (ISP). The ISP in turn provides data communication services through the Internet to a server **1030**.

Depending on the embodiment, certain acts, events, or functions of any of the processes or algorithms described herein can be performed in a different sequence, can be added, merged, or left out altogether (e.g., not all described operations or events are necessary for the practice of the algorithm). Moreover, in certain embodiments, operations or events can be performed concurrently, e.g., through multi-threaded processing, interrupt processing, or one or more computer processors or processor cores or on other parallel architectures, rather than sequentially.

The various illustrative logical blocks, modules, routines, and algorithm steps described in connection with the embodiments disclosed herein can be implemented as electronic hardware, or as a combination of electronic hardware and executable software. To clearly illustrate this interchangeability, various illustrative components, blocks, modules, and steps have been described above generally in terms of their functionality. Whether such functionality is implemented as hardware, or as software that runs on hardware, depends upon the particular application and design constraints imposed on the overall system. The described functionality can be implemented in varying ways for each particular application, but such implementation decisions should not be interpreted as causing a departure from the scope of the disclosure.

Moreover, the various illustrative logical blocks and modules described in connection with the embodiments disclosed herein can be implemented or performed by a machine, such as a computer system, a digital signal processor (DSP), an application specific integrated circuit (ASIC), a field programmable gate array (FPGA) or other programmable logic device, discrete gate or transistor logic, discrete hardware components, or any combination thereof designed to perform the functions described herein. A digital file system can be or include a microprocessor, but in the alternative, the digital file system can be or include a controller, microcontroller, or state machine, combinations of the same. A digital file system can include electrical circuitry configured to process computer-executable instructions. Although described herein primarily with respect to digital technology, a digital file system may also include

primarily analog components. For example, some or all of the prediction algorithms described herein may be implemented in analog circuitry or mixed analog and digital circuitry. A computing environment can include any type of computer system, including, but not limited to, a computer system based on a microprocessor, a mainframe computer, a digital signal processor, a portable computing device, a device controller, or a computational engine within an appliance, to name a few.

The elements of a method, process, routine, or algorithm described in connection with the embodiments disclosed herein can be embodied directly in hardware, in a software module executed by a digital file system, or in a combination of the two. A software module can reside in RAM memory, flash memory, ROM memory, EPROM memory, EEPROM memory, registers, hard disk, a removable disk, a CD-ROM, or any other form of a non-transitory computer-readable storage medium. An illustrative storage medium can be coupled to the digital file system such that the digital file system can read information from, and write information to, the storage medium. In the alternative, the storage medium can be integral to the digital file system. The digital file system and the storage medium can reside in an ASIC. The ASIC can reside in a user terminal. In the alternative, the digital file system and the storage medium can reside as discrete components in a user terminal.

Conditional language used herein, such as, among others, “can,” “could,” “might,” “may,” “e.g.,” and the like, unless specifically stated otherwise, or otherwise understood within the context as used, is generally intended to convey that certain embodiments include, while other embodiments do not include, certain features, elements and/or steps. Thus, such conditional language is not generally intended to imply that features, elements and/or steps are in any way required for one or more embodiments or that one or more embodiments necessarily include logic for deciding, with or without other input or prompting, whether these features, elements and/or steps are included or are to be performed in any particular embodiment. The terms “comprising,” “including,” “having,” and the like are synonymous and are used inclusively, in an open-ended fashion, and do not exclude additional elements, features, acts, operations, and so forth. Also, the term “or” is used in its inclusive sense (and not in its exclusive sense) so that when used, for example, to connect a list of elements, the term “or” means one, some, or all of the elements in the list.

Disjunctive language such as the phrase “at least one of X, Y, or Z,” unless specifically stated otherwise, is otherwise understood with the context as used in general to present that an item, term, etc., may be either X, Y, or Z, or any combination thereof (e.g., X, Y, and/or Z). Thus, such disjunctive language is not generally intended to, and should not, imply that certain embodiments require at least one of X, at least one of Y, or at least one of Z to each be present.

Unless otherwise explicitly stated, articles such as “a” or “an” should generally be interpreted to include one or more described items. Accordingly, phrases such as “a device configured to” are intended to include one or more recited devices. Such one or more recited devices can also be collectively configured to carry out the stated recitations. For example, “a processor configured to carry out recitations A, B and C” can include a first processor configured to carry out recitation A working in conjunction with a second processor configured to carry out recitations B and C.

While the above detailed description has shown, described, and pointed out novel features as applied to various embodiments, it can be understood that various

omissions, substitutions, and changes in the form and details of the devices or algorithms illustrated can be made without departing from the spirit of the disclosure. As can be recognized, certain embodiments described herein can be embodied within a form that does not provide all of the features and benefits set forth herein, as some features can be used or practiced separately from others. The scope of certain embodiments disclosed herein is indicated by the appended claims rather than by the foregoing description. All changes which come within the meaning and range of equivalency of the claims are to be embraced within their scope.

What is claimed is:

1. A system comprising:

a memory storing computer-executable instructions; and one or more hardware processors in communication with the memory and configured by the executable instructions to at least:

receive information associated with a garment, the information comprising a garment identifier and measurements associated with a first garment size;

generate a base digital file for the garment comprising: the garment identifier;

a version object identifying that the base digital file is associated with the garment in the first garment size;

an array of panel objects, wherein each panel object in the array of panel objects represents a portion of the garment, and wherein each panel object is associated with a panel identifier, a fabric identifier representing a fabric for the panel object, and one or more seam objects representing one or more seams which form the portion of the garment, wherein a first seam object is associated with (a) a first seam identifier that uniquely identifies a first seam represented by the first seam object and (b) panel identifiers that uniquely identify panel objects representing two or more panels to be attached to one another by the first seam when physically manufacturing the garment, wherein the base digital file further associates the first seam identifier with information defining how the first seam should join the two or more panels when physically manufacturing the garment; and an array of notions objects, wherein each notions object in the array of notions object is associated with a panel object in the array of panel objects and represents an accessory to be applied to the panel object;

wherein the base digital file for the garment is associated with a grading scale to transform the garment from the first garment size to a second garment size;

receive a request to transform the garment from the first garment size to the second garment size, wherein the request comprises a selection of the second garment size or a user input of one or more user body measurements;

generate a custom digital file for the garment based at least in part by modifying measurement information within the base digital file for the garment based on at least one of the user body measurements or the grading scale; and

transmit the custom digital file to a remote computing device for production of a garment corresponding to the custom digital file.

17

2. The system of claim 1, wherein each panel identifier associated with the array of panel objects is unique across a plurality of digital files.

3. The system of claim 1, wherein the received information associated with the garment comprises a digital exchange file or a scalable vector graphics file.

4. The system of claim 1, wherein the grading scale comprises a table of garment measurements in multiple sizes.

5. A system comprising:

a memory storing computer-executable instructions; and one or more hardware processors in communication with the memory and configured by the executable instructions to at least:

receive information associated with a garment, the information comprising a garment identifier and measurements associated with a first garment size;

generate a base digital file for the garment including or referencing each of:

the garment identifier;

a panel object, wherein the panel object represents a portion of the garment, and wherein the panel object is associated with a panel identifier; and

a seam object, wherein the seam object is associated with (a) a seam identifier that uniquely identifies a seam which forms a portion of the garment and (b) panel identifiers that uniquely identify panel objects representing two or more panels to be

attached to one another by the seam when physically manufacturing the garment, wherein the base digital file further associates the seam identifier with information defining how the seam should

join the two or more panels when physically manufacturing the garment;

receive a request to produce an instance of the garment in a second garment size, wherein the request comprises a selection of a standard garment size or a user input of one or more user body measurements;

generate a custom digital file for the garment based at least in part by modifying measurement information within the base digital file for the garment based on at least one of the user body measurements or a grading scale associated with the standard garment size; and

transmit the custom digital file to a remote computing device for production of a garment corresponding to the custom digital file.

6. The system of claim 5, wherein the base digital file and the custom digital file are each a JavaScript Object Notation file.

7. The system of claim 5, wherein the garment is associated with a plurality of base digital files.

8. The system of claim 5, wherein the base digital file further includes or references a notions object, wherein the notions object comprises a list of one or more buttons, patches, threads, or zippers to be included on at least one panel referenced in the panel objects.

9. The system of claim 5, wherein the panel object is further associated with a fabric identifier representing a fabric for the panel object.

18

10. The system of claim 5, wherein the panel object is further associated with one or more edge objects, wherein each edge object comprises an array of points and an edge type.

11. The system of claim 10, wherein the edge type comprises one of a straight line edge or a Bezier curve edge.

12. The system of claim 5, wherein the panel object is associated with panel metadata comprising one or more of a panel annotation, a mirror line, a fold line, or a grain line.

13. The system of claim 5, wherein the panel object is stored in a panel file and the panel object is referenced in the base digital file by the name of the panel file.

14. A method comprising:

generating a base digital file for a garment in a first size, the base digital file including or referencing each of:

a garment identifier;

a panel object, wherein the panel object represents a portion of the garment, and wherein the panel object is associated with a panel identifier; and

a seam object, wherein the seam object is associated with (a) a seam identifier that uniquely identifies a seam which forms a portion of the garment and (b) panel identifiers that uniquely identify panel objects representing two or more panels to be attached to one another by the seam when physically manufacturing the garment, wherein the base digital file further associates the seam identifier with information defining how the seam should join the two or more panels when physically manufacturing the garment;

wherein the base digital file for the garment is associated with a grading scale to transform the garment from the first size to one or more other sizes;

receiving a request to produce an instance of the garment in a second size, wherein the request comprises a selection of the second size or a user input of one or more user body measurements;

generating a custom digital file for the garment based at least in part by modifying measurement information within the base digital file for the garment based on at least one of the user body measurements or the grading scale; and

transmit the custom digital file to a remote computing device for production of a garment corresponding to the custom digital file.

15. The method of claim 14, wherein the panel object and the seam object are defined in one or more JavaScript Object Notation files.

16. The method of claim 14, wherein the base digital file and the custom digital file are stored in a data store.

17. The method of claim 14, further comprising transmitting the base digital file to the remote computing device.

18. The method of claim 14, wherein the garment is represented by a coordinate system and each panel object is associated with a unique set of coordinates in the coordinate system.

19. The method of claim 14, wherein the base digital file includes or references a plurality of panel objects and a plurality of seam objects.

20. The method of claim 14, wherein the information defining how the seam should join the two or more panels comprises a list of sewing operations to be performed relative to the two or more panels.

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