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(74) Agents: **AUYEUNG, Aloysius, T., C.** et al.; Columbia IP Law Group, PC, 4900 SW Meadows Road, Suite 109, Lake Oswego, OR 97035 (US).

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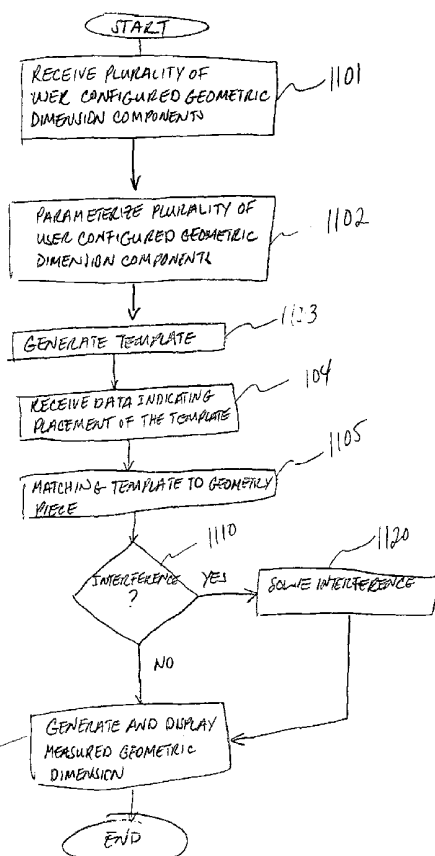
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(72) Inventors; and

(75) Inventors/Applicants (for US only): **SCOTT, Phillip, J.**(81) Designated States (*national*): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.(84) Designated States (*regional*): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE,

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(54) Title: METHOD AND APPARATUS FOR SIMPLIFIED DIMENSIONING OF A GEOMETRY PIECE OF A MECHANICAL DESIGN



(57) Abstract: The present invention includes computer instructions that receive a number of user configured geometric dimension components. Once the numbers of user configured geometric dimension components are received, the computer instructions operate to parameterize the user configured geometric dimension components. From the parameterized geometric dimension components, the computer instructions operate to generate a template. As a result, measured geometric dimensions may be generated and displayed with reduced number of operations, and therefore, reducing the, sometimes, tedious work of individually configuring every geometric component for a measured geometric dimension on multiple geometry pieces of mechanical designs. In one embodiment, the computer instructions are part of a mechanical design software application. In one embodiment, the mechanical software application, including the computer instructions, is embodied in a distribution storage medium.



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METHOD AND APPARATUS FOR SIMPLIFIED DIMENSIONING OF A GEOMETRY PIECE OF A MECHANICAL DESIGN

FIELD OF INVENTION

The present invention relates to the field of computer aided design (CAD). More specifically, the present invention relates to computer assistance to a designer working with dimensions of features of geometry of a mechanical design.

BACKGROUND OF THE INVENTION

Mechanical designs often include features such as holes, slots, pads, etc. An important factor in defining shapes and sizes of the features of mechanical designs is the generation of dimensions for the features. Examples of dimensions for the features are radius dimensions and linear dimensions. Dimensions define sizes and shapes of the features of the mechanical designs. Additionally, a designer may apply a combination of dimensions, forming a dimensioning scheme, to multiple similar features, where multiple similar features may be identically shaped with different sizes. Even though multiple similar features may be identically shaped, applying the dimensioning scheme to multiple similar features requires the designer to generate individual dimensions for each dimensioning scheme. For the purposes of this application, dimensions such as radius, linear, etc. will be generically referred to as dimensions. Additionally, for the purposes of this application, holes, slots, pads, etc. will be generically referred to as features.

Generally, only limited support is provided by conventional design software on dimensioning features, in particular, multiple similar features identically shaped with different sizes. Typically, even though several features can be shaped identically, the support is limited to a method involving manually creating dimensioning schemes for each feature, individually, due to variations in sizes (e.g., several identically shaped slots of varying sizes in a mechanical design). Thus, dimensioning a feature and multiple similar features identically shaped with different sizes will require the designer to tediously create each

dimensioning scheme, and the number of dimensioning schemes created will depend upon the number of similar features identically shaped with different sizes in a mechanical design. The number of features can be very numerous and creating each dimensioning scheme can take longer time for the designer.

Thus, a more user-friendly approach for dimensioning multiple similar features in a mechanical design, while maintaining dimensioning schemes for identically shaped features with different sizes is designed. As will be discussed in more detail below, the present invention achieves these and other desirable objectives, which will be apparent from the disclosure to follow.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention is illustrated by way of example and not by way of limitation in the figures of the accompanying drawings, in which the like references indicate similar elements and in which:

Figure 1 illustrates one embodiment of a mechanical design application incorporated with the teachings of the present invention;

Figure 2 illustrates a solid geometry piece of a mechanical design upon which an example of one embodiment of the present invention is illustrated;

Figure 3 illustrates setting up a dimensioning scheme to define a reference feature of the solid geometry piece **210** of the mechanical design under the present invention, in accordance with one embodiment;

Figure 4 and **5** illustrated an example of application of the reference dimensioning scheme to multiple features in accordance with the present invention;

Figure 6 illustrates a resulting solid geometry piece with slot features incorporated into the solid geometry piece creating slots;

Figure 7a-7b illustrate the relevant operational flows of one embodiment of dimensioning scheme manager;

Figure 8 illustrates user configured geometric dimension components in accordance with one embodiment of the present invention;

Figure 9 illustrates the user configured geometric dimension components for parameterizing the user configured geometric dimension components in accordance with one embodiment of the present invention;

Figure 10 illustrates utilizing the template with a geometry piece of a mechanical design in accordance with one embodiment of the present invention;

Figure 11 illustrates the relevant operational flows of one embodiment of dimensioning scheme manager **108** of **Fig. 1**; and

Figure 12 illustrates on embodiment of a computer system suitable to be programmed with the mechanical design application of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

In the following description, various aspects of the present invention will be described. However, it will be apparent to those skilled in the art that the present invention may be practiced with only some or all aspects of the present invention. For purposes of explanation, specific numbers, materials and configurations are set forth in order to provide a thorough understanding of the present invention.

However, it will also be apparent to one skilled in the art that the present invention may be practiced without the specific details. In other instances, well known features are omitted or simplified in order not to obscure the present invention.

Parts of the description will be presented in terms of operations performed by a computer system, using terms such as data, flags, bits, values, characters, strings, numbers and the like, consistent with the manner commonly employed by those skilled in the art to convey the substance of their work to others skilled in the art. As well understood by those skilled in the art, these quantities take the form of electrical, magnetic, or optical signals capable of being stored, transferred, combined, and otherwise manipulated through mechanical and electrical components of the computer system; and the term computer system include general purposes as well as special purpose data

processing machines, systems, and the like, that are standalone, adjunct or embedded.

Various operations will be described as multiple discrete steps in turn, in a manner that is most helpful in understanding the present invention, however, the order of description should not be construed as to imply that these operations are necessarily order dependent. In particular, these operations need not be performed in the order of presentation.

Figure 1 illustrates a block diagram of an embodiment of a mechanical design application for promoting user defined dimensions of multiple features of a mechanical design. In **Fig. 1**, mechanical design application **100** includes an end user interface **102**, a design engine, **104**, and a design database **106**. The design engine **104** includes, in particular, a dimensioning scheme manager **108** in accordance with the present invention. Together, the elements cooperate to promote user defined dimensions of multiple features of mechanical designs.

In **Fig. 1**, the end user interface **102** operates to graphically display and receive input, from a user, of dimensioning schemes for features of mechanical designs under the control of the design engine **104**. Also under the control of the design engine **104**, the design database **106** operates to store mechanical designs and dimensioning schemes created by the user. In particular, the dimensioning scheme manager **108** geometrically associates and promotes dimensioning schemes to one or more identical geometric features of different sizes. Except for the teachings of the present invention incorporated in the dimensioning scheme manager **108**, the mechanical design application **100** is intended to represent a broad range of computer aided design (CAD) drawing software known in the art, including but not limited to Mechanical Desktop® available from Autodesk, Inc. of San Rafael, CA.

Figure 2 illustrates an example of a solid geometry piece of a mechanical design upon which one embodiment of the present invention may be practiced in **Fig. 2**, a plane **215** of the solid geometry piece **210** is selected by a user using a cursor **220** for feature creation. The present invention will be described referencing the selected plane **215**. However, it should be noted that

the present invention may also be practiced on other surfaces as well as other geometry pieces.

Figure 3 illustrates setting up a dimensioning scheme to define a reference feature of the solid geometry piece **210** of the mechanical design in accordance with an embodiment of the present invention. In **Fig. 3**, a user has drawing a reference slot feature **310** on the plane **215** to incorporate into the solid geometry piece **210**. The user has selected to set up a dimensioning scheme **300** for the reference slot feature **310**.

The reference slot feature **310** comprises of two arc geometry pieces **311** and **312** and two line geometry pieces **313** and **314**. Additionally, in order to set up the dimensioning scheme **300**, the user has selected to generate a reference entity **320** denoting a center line and center points **321** and **322** for the arc geometry pieces **311** and **312**.

Setting up the dimensioning scheme to define the reference slot feature **310**, the user has selected to generate a radius dimension **330** defining the arc geometry piece **311**, a first linear dimension **331** defining a distance between the center point **321** and the reference entity **320**, and a second linear dimension **332** defining a distance between the two line geometry pieces **313** and **314**.

Illustrated in **Fig. 3**, the reference slot feature **310** is fully defined as to shape and size by the user selecting to generate the dimensioning scheme **300** for the reference slot feature **310**.

Once the dimensioning scheme **300** for the reference slot feature **310** is completed, the one embodiment of the present invention geometrically constrains the reference slot feature **310** with the dimensioning scheme **300** for promoting the dimensioning scheme **300** to other instances of the reference slot feature **310**. Therefore, changes in dimension values of the dimensioning scheme **300** results in "resizing" of various instances of the reference slot feature **310**.

Figure 4 illustrated an example of multiple features **410-413** upon which the dimensioning scheme **300** may be promoted. In **Fig. 4**, displayed upon the plane **215** of the solid geometry piece **210** (shown in **Fig. 2**) are multiple slot

features **410-413**. While the multiple slot features **410-413** are different sizes, the shapes are identical (i.e., the multiple slot features **410-413** comprise of line geometry pieces **420-427** and arc geometry pieces **430-437**) to the reference slot feature **310** (shown in **Fig. 3**).

Figure 5 illustrates promoting the dimensioning scheme **300** to multiple features in accordance with the present invention. In **Fig. 5**, the dimensioning scheme **300** is promoted to a first slot feature **410** by a single cursor selection **510** on the first slot feature **410**, a reference entity **520** and center points **525** and **526** of arc geometry pieces **430** and **431** are generated.

Illustrated in **Fig. 5**, once the reference entity **520** and the center points **525** and **526** are generated, the promoting continues by further generating a radius dimension **522** defining a distance between the center point **525** and the reference entity **520**, and a second linear dimension **523** defining a distance between the two line geometry pieces **420** and **421** of the first slot feature **410**. As shown in **Fig. 5**, promoting the dimensioning scheme **300** to the first slot feature **410** with a single cursor selection **510** defines the shape and size of the first slot feature **410** without requiring re-specification of the dimensioning scheme. Once promoted, the user may change the dimension values to “resize” the slot feature **410**, and the “resized” slot feature is updated in the solid geometry piece **210**. As a result, under the present invention, the effort required to dimension features of the like kind is significantly reduced. Those skilled in the art will appreciate that mechanical designs often involve many complex features, each requiring a complex dimensioning scheme.

Additionally, in **Fig. 5**, the dimensioning scheme **300** is promoted to a second slot feature **411** comprising of two line geometry pieces **422** and **423** and two arc geometry pieces **432** and **433**. As discussed above with respect to the first slot feature **410**, the dimensioning scheme **300** is promoted to the second slot feature **411** by a single cursor selection **510** on the second slot feature **411**. Again, in promoting the dimensioning scheme **300** to the second slot feature **411**, a reference entity **530** and center points **535** and **536** of arc geometry pieces **432** and **433** are generated.

As discussed above, once the reference entity **530** and the center points **535** and **536** are generated, the promoting continues by further generating a radius dimension **531** defining the arc geometry piece **432**, a first linear dimension **532** defining a distance between the center point **535** and the reference entity **530**, and a second linear dimension **533** defining a distance between the two line geometry pieces **422** and **423** of the second slot feature **411**.

Shown in **fig. 5**, while the shape of the second slot feature **411** is identical to the reference slot feature **310**, the size of the second slot feature **411** is different from the reference slot feature **310**. However, promoting the dimensioning scheme **300** to the second slot feature **411** with the single cursor selection **510** defines the shape and size of the second slot feature **411** without requiring re-specification of the dimensioning scheme. As discussed above, once promoted, the user may change the dimension values to “resize” the second slot feature **411**, and the “resized” slot feature is updated in the solid geometry piece **210**.

Again, as a result, under the present invention, the effort required to dimension features of like kind is significantly reduced. Similarly, those skilled in the art will appreciate that mechanical designs often involve many complex features, each requiring a complex dimensioning scheme.

Also shown in **Fig. 5**, the dimensioning scheme **300** is promoted to a third slot feature **412** comprising of tow line geometry pieces **424** and **425** and two arc geometry pieces **434** and **435**. As discussed above with respect to the first and second slot features **410** and **411**, the dimensioning scheme **300** is promoted to the third slot feature **412** by a single cursor selection **510** on the third slot feature **412**. Similar to the first and second slot features **410** and **411**, in promoting the dimensioning scheme **300** to the third slot feature **412**, a reference entity **540** and center points **545** and **546** of arc geometry pieces **434** and **435** are generated.

As discussed above with respect to the first and second slot features **410** and **411**, once the reference entity **540** and the center points **545** and **546** are generated, the promoting continues by further generating a radius

dimension **541** defining the arc geometry piece **434**, a first linear dimension **542** defining a distance between the center point **545** and the reference entity **540**, and a second linear dimension **543** defining a distance between the two line geometry pieces **424** and **425** of the third slot feature **412**.

Again, shown in **Fig. 5**, while the shape of the third slot feature **412** is identical to the reference slot feature **310**, the size of the third slot feature **412** is different from the reference slot feature **310**. However, promoting the dimensioning scheme **300** to the third slot feature **412** with the single cursor selection **510** defines the shape and size of the third slot feature **412** without requiring re-specification of the dimensioning scheme. As discussed above with respect to the first and second slot features **410** and **411**, once promoted, the user may change the dimension values to “resize” the third slot feature **412** and the “resized” slot feature is updated in the solid geometry piece **210**.

As discussed above, as a result, under the present invention, the effort required to dimension features of like kind is significantly reduced. Similarly, those skilled in the art will appreciate that mechanical designs often involve many complex features, each requiring a complex dimensioning scheme.

Furthermore, shown, in **Fig. 5**, the dimensioning scheme **300** is promoted to a fourth slot feature **412** comprising of two line geometry pieces **426** and **427** and two arc geometry pieces **436** and **437**. As discussed above with respect to the previous slot features, the dimensioning scheme **300** is promoted to the fourth slot feature **413** by a single cursor selection **510** on the fourth slot feature **413**. Similar to the other slot features shown in **Fig. 5**, in promoting the dimensioning scheme **300** to the fourth slot feature **413**, a reference entity **550** and center points **555** and **556** of arc geometry pieces **436** and **437** are generated.

As discussed above, once the reference entity **550** and center points **555** and **556** are generated, the promoting continues by further generating a radius dimension **551** defining the arc geometry piece **436**, a first linear dimension **552** defining a distance between the center point **555** and the reference entity **550**, and a second linear dimension **553** defining a distance

between the two line geometry pieces **426** and **427** of the fourth slot feature **413**.

Again, shown in **Fig. 5**, while the shape of the fourth slot feature **413** is identical to the reference slot feature **310**, the size of the fourth slot feature **413** is different from the reference slot feature **310**. However, promoting the dimensioning scheme **300** to the fourth slot feature **413** with a single cursor selection **510** defines the shape and size of the fourth slot feature **413** without requiring re-specification of the dimensioning scheme. As discussed above with respect to the slot features shown in **Fig. 5**, once promoted, the user may change the dimension values to “resize” the fourth slot feature **413**, and the “resized” slot feature is updated in the solid geometry piece **210**.

As discussed above, as a result, under the present invention, the effort required to dimension features of like kind is significantly reduced. Similarly, those skilled in the art of appreciate that mechanical designs often involve many complex features, each requiring a complex dimensioning scheme.

As discussed above, in **Fig. 5**, it should be appreciated by those skilled in the art that the dimensions **521-523**, **531-533**, **541-543**, and **551-553** differ in values due to the size differences between the slot features **410**, **411**, **412**, and **413**, however, as shown in **Fig. 5**, the shape of the slot features **410**, **411**, **412**, and **413** are identical to the reference slot feature **310**. Additionally, those skilled in the art will appreciate the fact that the dimensioning schemes **521-523**, **531-533**, **541-543**, and **551-553** are generated by the single cursor selection **510** on each slot feature **410**, **411**, **412**, and **413** without requiring re-specification of the dimensioning schemes **521-523**, **531-533**, **541-543**, and **551-553**.

Figure 6 illustrates a resulting solid geometry piece **600** with slot features **410**, **411**, **412**, and **413** incorporated into the solid geometry piece **600** creating slots **610-613**. It should be appreciated by those skilled in the art that extruding and subtracting the slot features **410**, **411**, **412**, and **413** for the creation of the slots **610-613** in the solid geometry piece **600** are well known in the art and need not be further described.

Figures 7a-7b illustrate the relevant operational flows of one embodiment of dimensioning scheme manager **108** of **Fig. 1**. For the illustrated embodiment, dimensioning scheme manager **108** is programmed in an event driven model, i.e., dimensioning scheme manager **108** is designed to be executed in a system environment where various event notification services are available from the operating system. One example of such an operating system suitable for practicing the present invention is the Windows® operating systems, available from Microsoft Corporation of Redmond, Washington. In alternate embodiments, dimensioning scheme manager **108** may be implemented in other programming approaches known in the art.

As shown in **Fig. 7a**, responsive to an event notification informing dimensioning scheme manager **108** of the fact that a plane is cursor selected, dimensioning scheme manager **108** determines if reference entities are detected (**705**). If the dimensioning scheme manager **108** determines that reference entities are not detected, dimensioning scheme manager **108** causes other functional blocks of design engine **104** to display a dimensioning scheme of a feature on the plane (**715**). If the dimensioning scheme manager **108** determines that reference entities are detected, dimensioning scheme manager **108** causes other functional blocks of design engine **104** to incorporate the reference entities into the dimensioning scheme (**710**) and display the dimensioning scheme of the feature with the incorporated reference entities on the plane (**715**). The manner in which the other functional blocks effectuate the incorporating and displaying of the dimensioning scheme for the feature may be implemented in any one of a number of manners known in the art.

As shown in **Fig. 7b**, responsive to an event notification informing dimensioning scheme manager **108** of the fact that a feature has been cursor selected, dimensioning scheme manager **108** determines if the cursor selected feature is similar (e.g., identical in shape) to a reference feature (**720**). If the dimensioning scheme manager **108** determines that the cursor selected feature is similar e.g., identical in shape) to a reference feature, dimensioning scheme manager **108** causes other functional blocks of design engine **104** to promote

the dimensioning scheme to the selected feature (735). However, if the dimensioning scheme manager 108 determines that the cursor selected feature is not similar (e.g., not identical in shape) to any reference features, dimensioning scheme manager 108 causes other functional blocks of design engine 104 to search the design database 106 for a dimensioning scheme for the cursor selected feature (725). Furthermore, dimensioning scheme manager 108 determines if a dimensioning scheme for the cursor selected feature is located (730). If the dimensioning scheme manager 108 determines that a dimensioning scheme for the cursor selected feature is located, dimensioning scheme manager 108 causes other functional blocks of design engine 104 to promote the dimensioning scheme to the selected feature (735). However, if the dimensioning scheme manager 108 determines that a dimensioning scheme for the cursor selected feature is not located, dimensioning scheme manager 108 causes other functional blocks of design engine 104 to search the design database 106 for a dimensioning scheme for the cursor selected feature.

The manner in which the other functional blocks of design engine 104 effectuate the searching of the design database may be implemented also in any one of a number of manners known in the art.

Figure 8 illustrates user configured geometric dimension components in accordance with one embodiment of the present invention. Shown in **Fig. 8**, the dimensioning scheme 300 (shown in **Fig. 3**) may have measured dimensions 801, 810, and 820 dimensioning reference geometry pieces defining the reference slot feature 310 (shown in **Fig. 3**). In **Fig. 8**, the user may configure the geometric dimension components 802-805, 811-814, and 821-825.

The geometric dimension components 802-805, 811-814, and 821-825 may include the position of arrowheads 804, 812, and 823, the position of the text 803, 811, and 822, and the position of anchor points 805, 814, 824, and 825. In **Fig. 8**, even though the geometric dimension components illustrated are position of arrowheads 804, 812, and 823, position of the text 803, 811, and 822, and position of anchor points 805, 814, 824, and 825, it should be

appreciated by one skilled in the art that the geometric dimension components may be any type of geometric dimension component known in the art such as, but not limited to, number of leader lines and dimensional tolerances.

Figure 9 illustrates the user configured geometric dimension components for parameterizing in accordance with one embodiment of the present invention. In **Fig. 9**, the measured dimension **801** has, for example, the user configured geometric dimension components **802-804**. The leader line geometric dimension component **802** is shown configured to have one leader line, i.e., the leader line for the right side need not exist because of the reference entity **320**.

Shown in **Fig. 9**, the position of the anchor point geometric dimension component **805** is configured to be the center point **321** of the radius **312**. The anchor point geometric dimension component opposite the anchor point geometric dimension component **805** is not shown because the measured dimension **801** is between the center point **321** and the reference entity **320**, where the anchor point may be any position along the reference entity **320**.

The position of the text geometric dimension component **803** is shown configured to center the text between the arrowheads of the measured dimension **801**. Additionally, shown in **Fig. 9**, the position of the arrowheads geometric dimension component **804** is configured to display at a distance **910** from the reference slot feature **310**.

The user configured geometric dimension components **802-805** are parameterized by forming relationships between the individual users configured geometric dimension components for the measured geometric dimension **801**. This is because the dimensioning scheme manager **108** interprets geometric dimension components as geometric entities similar to two-dimensional curves.

Once the user configured geometric dimension components **802-805** have been parameterized, a template of the parameterized geometric dimension components **802-805** is generated. The template maintains the relationship between parameterized geometric dimension components. By maintaining the parameterized geometric dimension components as a template, the parameterized user configured geometric dimension components

may be utilized on other geometry pieces than the reference slot feature **310** such as, for example, geometry pieces where linear dimensions defining a distance between a center point and a reference entity is desired. Once the template is generated, the template is stored in the design database **106** (shown in **Fig. 1**) for utilization with a geometry piece of a mechanical design.

The template generated utilizes the measured geometric dimension **801** between the center point **321** and the reference entity **320** dimensioning reference geometry pieces defining part of the reference slot feature **310**. However, the template may be more than one measured geometric dimension, and therefore, a single template may be generated comprising the three measured geometric dimensions **810**, **810**, and **820**. As a result, the single template may fully define geometry pieces of mechanical designs without generating several geometric dimension components.

Figure 10 illustrates utilizing the template with a geometry piece of a mechanical design in accordance with one embodiment of the present invention. Shown in **Fig. 10** is a geometry piece **1001** having two circular ends (one large **1010** and one small **1015**). As part of the geometry piece **1001**, a reference entity **1050** and two center points **1051** and **1052** are shown.

In **Fig. 10**, a cursor selection **1011** on the large circular end **1010** sends data indicating placement of a template stored in the design database **106**. The template is matched to the geometry piece by determining if the template generated from the measured dimension **810** is related to the type of geometry selected, the large circular end **1010**. However, if another cursor selection **1012** on the reference entity **1050** sends another data indicating another placement of the template stored in the design database **106**, the two cursor selections **1011** and **1012** of the geometry pieces will also be matched with a template generated from the measured geometric dimension **801** defining a distance from a center point to a reference entity.

Once the template is matched for the desired measurement, in one embodiment, interference between the cursor selection **1011** or selections **1011** and **1012** of the geometry piece with the parameterized dimension components **1014-1017** is solved for. If interference is determined not to be

present, the measured geometric dimension **1060** is generated and displayed, as shown in **Fig. 10**.

As shown in **Fig. 10**, because the user configured geometric dimension components have been parameterized, the relationships between the geometric dimension components such as leader line **1016**, position of the anchor point **1017**, position of the text **1015**, position of the arrowheads **1014** displayed at a distance **1018** from the geometry piece **1001** are maintained when displayed for the geometry piece **1001** with one to two cursor selections **1011** and **1012**.

As a result, measured geometric dimension **1060** may be generated and displayed with a reduced number of operations, and therefore, reducing the, sometimes, tedious work of individually configuring every geometric component for a measured geometric dimension on multiple geometry pieces of mechanical designs.

Interference between a cursor selection of a geometry piece with a parameterized dimension component may be illustrated by measured geometric dimension **1065** for one embodiment of the present invention. In **Fig. 10**, the measured geometric dimension **1065** is generated and displayed in a similar manner as discussed above with respect to generating and displaying the measured geometric dimension **1060**.

The template, which generated and displayed the measured geometric dimension **1060**, was also applied to the small circular end **1015**. As shown in **Fig. 10**, the parameterized geometric dimension components **1023-1027** comprising the template is similar to the measured geometric dimension **1060** because the same template was applied to the small circular end **1015**. However, as shown for the small circular end **1015**, once the template was matched to the small circular end **1015**, the dimensioning scheme manager determines that there is interference between the geometry piece (the small circular end **1015**) and the parameterized dimension components (the position of the text geometric dimension component **1025**).

In one embodiment shown in **Fig. 10**, once the cursor selections **1021** and **1022** are made, the template for generating and displaying the measured

geometric dimension **1025** between the center point **1052** and the reference entity **1050** is matched with the geometry pieces. However, the parameterized position of the text geometric dimension component **1025** would interfere with the geometry piece (either the small circular end **1015** or the reference entity **1050**) because the text would not fit in the centered position. Therefore, in one embodiment, the dimensioning scheme manager solves the interference by placing the text outside the arrowheads.

As a result, even though an interference between the parameterized dimension components and the geometry piece may arise, the measured geometric dimension **1065** may also be generated and displayed with limited number of operations, and therefore, reducing the, sometimes, tedious work of individually configuring every geometric component for solving an interference for a measured geometric dimension on multiple geometry pieces of mechanical designs.

Figure 11 illustrates the operational flows of one embodiment of dimensioning scheme manager **108** of **Fig. 1**. As previously discussed, for the illustrated embodiment, dimensioning scheme manager **108** is also programmed in an event driven model, i.e., dimensioning scheme manager **108** is designed to be executed in a system environment where various event notification services are available from the operating system. One example of such an operating system suitable for practicing the present invention is the Windows® operating systems, available from Microsoft Corporation of Redmond, Washington. In alternate embodiments, dimensioning scheme manager **108** may be implemented in other programming approaches known in the art.

In **Fig. 11**, dimensioning scheme manager **108** receives a number of user configured geometric dimension components defining a reference geometry piece of a mechanical design (**1101**). The number of user configured geometric dimension components may include such geometric dimension components as, but not limited to, position of arrowhead, position of text, and a position of anchor points.

As shown in **Fig.11**, responsive to an event notification informing dimensioning scheme manger **108** of the fact that the user defined geometric dimension components have been received, dimensioning scheme manager **108** parameterizes the number of user configured geometric dimension components by managing the geometric dimension components as geometry pieces such as, but not limited to, curves (**1102**). The parameterized geometric dimension components are then utilized to generate a template (**1103**). The template may comprise of a single parameterized geometric component or a number of parameterized geometric components.

In one embodiment, data, indicating placement of the template, is received by the dimensioning scheme manager **108** (**1104**). The data, indicating placement of the template, may be in the form of cursor selection on a geometry piece of a mechanical design for measured dimensioning. Once the data indicating placement of the template is received, the dimensioning scheme manager **108** matches the template to the geometry piece for the desired measured geometric dimension (**1105**).

As shown in **Fig. 11**, in one embodiment, the dimensioning scheme manager additionally determines if there is interference between the parameterized geometric dimension components and the geometry piece (**1110**).

If the dimensioning scheme manager **108** determines that there is no interference, dimensioning scheme manager **108** causes other functional blocks of design engine **104** to generate and display a measured geometric dimension (**1115**). If the dimensioning scheme manager **108** determines that there is interference, dimensioning scheme manager **108** solves the interference and proceeds to cause other functional blocks of design engine **104** to generate and display the solved measured geometric dimension (**1120**).

In one embodiment, the dimensioning scheme manager **108** detects and solves the interference by making an examining pass of the geometry piece after a binding operation, in which data in the parameterized geometric dimension components are matched with the geometry piece. For example, there may not be inputs representing geometry pieces corresponding to the

parameterized geometric dimension components, in which case, the dimensioning scheme manager **108** will generate and display measured geometric dimensions with each parameterized geometric dimension component based at least upon the template. The dimensioning scheme manager **108** may make several of these examining passes before generating and displaying measured geometric dimensions.

As a result, measured geometric dimensions may be generated and displayed with reduced number of operations, and therefore, reducing the, sometimes, tedious work of individually configuring every geometric component for a measured geometric dimension on multiple geometry pieces of mechanical designs.

Figure 12 illustrates one embodiment of a computer system suitable to be programmed with the mechanical design application of the present invention. As shown, for the illustrated embodiment, computer **1200** includes processor **1202**, processor bus **1206**, high performance I/O bus **1210** and standard I/O bus **1220**. Processor bus **1206**, and high performance I/O bus **1210** are bridged by host bridge **1208**, whereas I/O buses **1210** and **1212** are bridged by I/O bus bridge **1212**. Coupled to processor bus **1206** is cache **1204**. Coupled to high performance I/O bus **1210** are system memory **1214** and video memory **1216**, against which video display **1218** is coupled. Coupled to standard I/O bus **1220** are disk drive **1222**, keyboard and pointing device **1224**, and communication interface **1226**.

These elements perform their conventional functions known in the art. In particular, disk drive **1222** and system memory **1214** are used to store permanent and working copies of the mechanical design system. The permanent copy may be pre-loaded into disk drive **1222** in factory, loaded from distribution medium **1232**, or down loaded from a remote distribution source (not shown). Distribution medium **1232** may be a tape, a CD, and DVD or other storage medium of the like. The constitutions of these elements are known. Any one of a number implementations of these elements known in the art may be used to form computer system **1200**.

In general, those skilled in the art will recognize that the present invention is not limited by the details described, instead, the present invention can be practiced with modifications and alterations within the spirit and scope of the appended claims. The description is thus to be regarded as illustrative instead of restrictive on the present invention.

Thus, a mechanical design application with improved facility for simplified dimensioning a geometry piece of a mechanical design has been described.

CLAIMS

What is claimed is:

1. A method comprising:
receiving a plurality of user configured geometric dimension components
defining a reference geometry piece of a mechanical design;
parameterizing said plurality of user configured geometric dimension
components to provide parameterized geometric dimension components; and
generating a template from said parameterized geometric dimension
components.
2. The method of claim 1 further comprising receiving data indicating a
placement of said template, wherein placement comprises data indicating a
cursor selection of a geometry piece.
3. The method of claim 2, wherein said placement of said template further
comprises matching said template to said geometry piece of said mechanical
design.
4. The method of claim 3 further comprising:
detecting an interference between said parameterized geometric
dimension components and said geometry piece; and
solving said interference upon so detecting.
5. The method of claim 1, wherein said receiving comprises receiving at
least one of a position of one or more, arrowheads, text, and anchor points.
6. The method of claim 1, wherein said parameterizing comprises forming
relationships between said plurality of user configured geometric dimension
components.

7. The method of claim 1, wherein said generating comprises maintaining relationships between said parameterized geometric dimension components.
8. A storage medium having stored therein a plurality of instructions that are machine executable, wherein when executed, said executing instructions operate to receive a plurality of user configured geometric dimension components defining a reference geometry piece of a mechanical design, parameterize said plurality of user configured geometric dimension components to provide parameterized geometric dimension components, and generate a template from said parameterized geometric dimension components.
9. The storage medium of claim 8, wherein said executing instructions further operate to receive data indicating a placement of said template, wherein placement comprises data indicating a cursor selection of a geometry piece.
10. The storage medium of claim 9, wherein said executing instructions further operate to match said template to said geometry piece of said mechanical design.
11. The storage medium of claim 10, wherein said executing instructions further operate to detect an interference between said parameterized geometric dimension components and said geometry piece and solve said interference upon so detecting.
12. The storage medium of claim 8, wherein said executing instructions operate to receive at least one of a position of one or more, arrowheads, text, and anchor points.
13. The storage medium of claim 8, wherein said executing instructions operate to form relationships between said plurality of user configured geometric dimension components.

14. The storage medium of claim 8, wherein said executing instructions operate to maintain relationships between said parameterized geometric dimension components.
15. An apparatus comprising:
a storage medium having stored therein a plurality of instructions that are machine executable, wherein when executed, said executing instructions operate to receive a plurality of user configured geometric dimension components defining a reference geometry piece of a mechanical design, parameterize said plurality of user configured geometric dimension components to provide parameterized geometric dimension components, and generate a template from said parameterized geometric dimension components; and
a processor coupled to said storage medium to execute said instructions.
16. The apparatus of claim 15, wherein said executing instructions further operate to receive data indicating a placement of said template, wherein placement comprises data indicating a cursor selection of a geometry piece.
17. The apparatus of claim 16, wherein said executing instructions further operate to match said template to said geometry piece of said mechanical design.
18. The apparatus of claim 17, wherein said executing instructions further operate to detect an interference between said parameterized geometric dimension components and said geometric piece and solve said interference upon so detecting.
19. The apparatus of claim 15, wherein said executing instructions operate to receive at least one of a position of one or more, arrowheads, text, and anchor points.

20. The apparatus of claim 15, wherein said executing instructions operate to form relationships between said plurality of user configured geometric dimension components.
21. The apparatus of claim 15, wherein said executing instructions operate to maintain relationships between said parameterized geometric dimension components.
22. A method comprising:
setting up a dimensioning scheme for a reference feature;
receiving a selection of a feature of a mechanical design;
determining if said selected feature is similarly shaped to said reference feature with said dimensioning scheme; and
promoting said dimensioning scheme to said selected feature upon determining that said selected feature is similarly shaped to said reference feature with said dimensioning scheme of said mechanical design.
23. The method of claim 22, wherein said setting up comprises geometrically constraining said reference feature with said dimensioning scheme.
24. The method of claim 22, wherein said receiving comprises receiving a cursor selection of said selected feature of said mechanical design.
25. The method of claim 22, wherein said determining further comprises searching for a stored dimensioning scheme for said selected feature upon determining that said selected feature is not similarly shaped to said reference feature of said mechanical design.
26. The method of claim 22, wherein said promoting comprises promoting said dimensioning scheme to a plurality of additional selected features.

27. The method of claim 22, wherein said promoting further comprises promoting said dimensioning scheme to said plurality of additional selected features by a single cursor selection of each of said plurality of additional selected features.
28. A storage medium having stored therein a plurality of instructions that are machine executable, wherein when executed, said executing instructions operate to set up a dimensioning scheme for a reference feature, receive a selection of a feature of a mechanical design, determine if said selected feature is similarly shaped to said reference feature with said dimensioning scheme, and promote said dimensioning scheme to said selected feature upon determining that said selected feature is similarly shaped to said reference feature with said dimensioning scheme of said mechanical design.
29. The storage medium of claim 28, wherein said executing instructions operate to geometrically constrain said reference feature with said dimensioning scheme.
30. The storage medium of claim 28, wherein said executing instructions operate to receive a cursor selection of said selected feature of said mechanical design.
31. The storage medium of claim 28, wherein said executing instructions further operate to search for a stored dimensioning scheme for said selected feature upon determining that said selected feature is not similarly shaped to said reference feature of said mechanical design.
32. The storage medium of claim 28, wherein said executing instructions operate to promote said dimensioning scheme to a plurality of additional selected features.

33. The storage medium of claim 28, wherein said executing instructions operate to promote said dimensioning scheme to said plurality of additional selected features by a single cursor selection of each of said plurality of additional selected features.

34. An apparatus comprising:

a storage medium having stored therein a plurality of instructions that are machine executable, wherein when executed, said executing instructions operate to set up a dimensioning scheme for a reference feature, receive a selection of a feature of a mechanical design, determine if said selected feature is similarly shaped to said reference feature with said dimensioning scheme, and promote said dimensioning scheme to said selected feature upon determining that said selected feature is similarly shaped to said reference feature with said dimensioning scheme of said mechanical design; and
a processor coupled to said storage medium to execute said instructions.

35. The apparatus of claim 34, wherein said executing instructions operate to geometrically constrain said reference feature with said dimensioning scheme.

36. The apparatus of claim 34, wherein said executing instructions operate to receive a cursor selection of said selected feature of said mechanical design.

37. The apparatus of claim 34, wherein said executing instructions further operate to search for a stored dimensioning scheme for said selected feature upon determining that said selected feature is not similarly shaped to said reference feature of said mechanical design.

38. The apparatus of claim 34, wherein said executing instructions operate to promote said dimensioning scheme to a plurality of additional selected features.

39. The apparatus of claim 34, wherein said executing instructions operate to promote said dimensioning scheme to said plurality of additional selected features by a single cursor selection of each of said plurality of additional selected features.

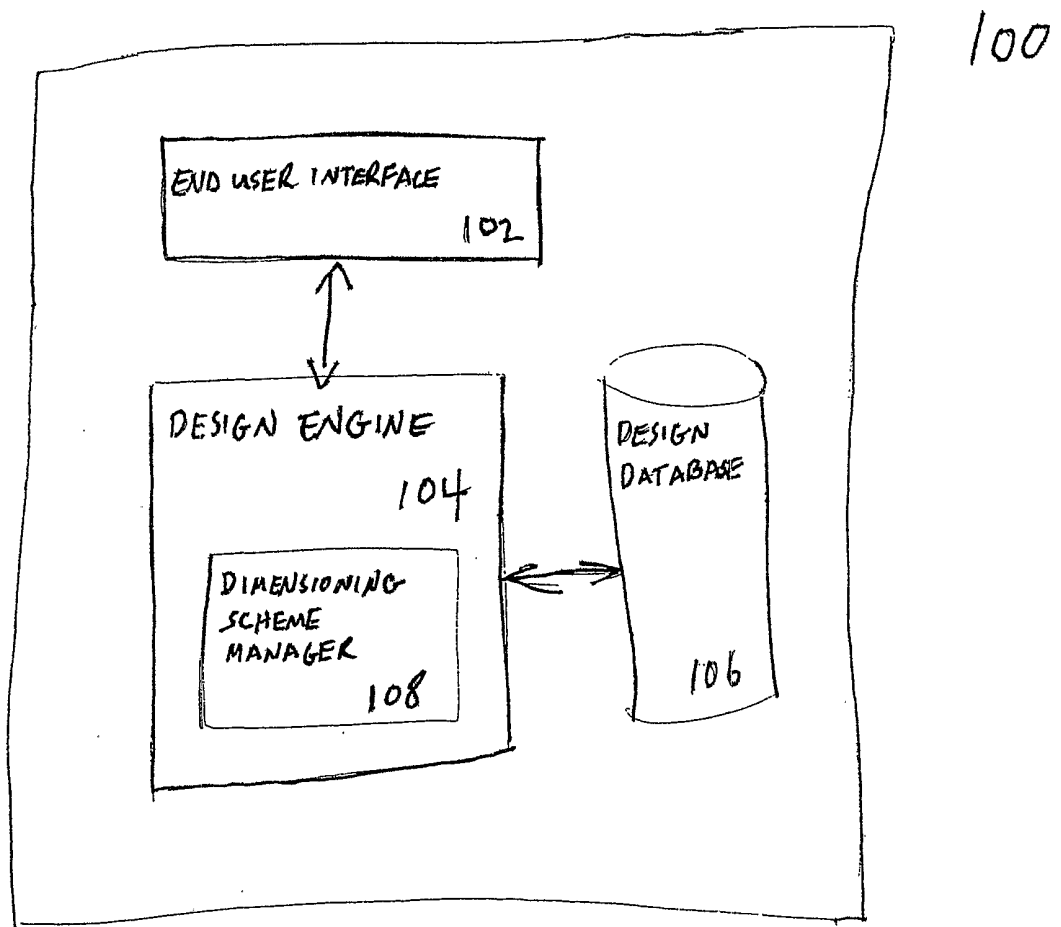


FIG. 1

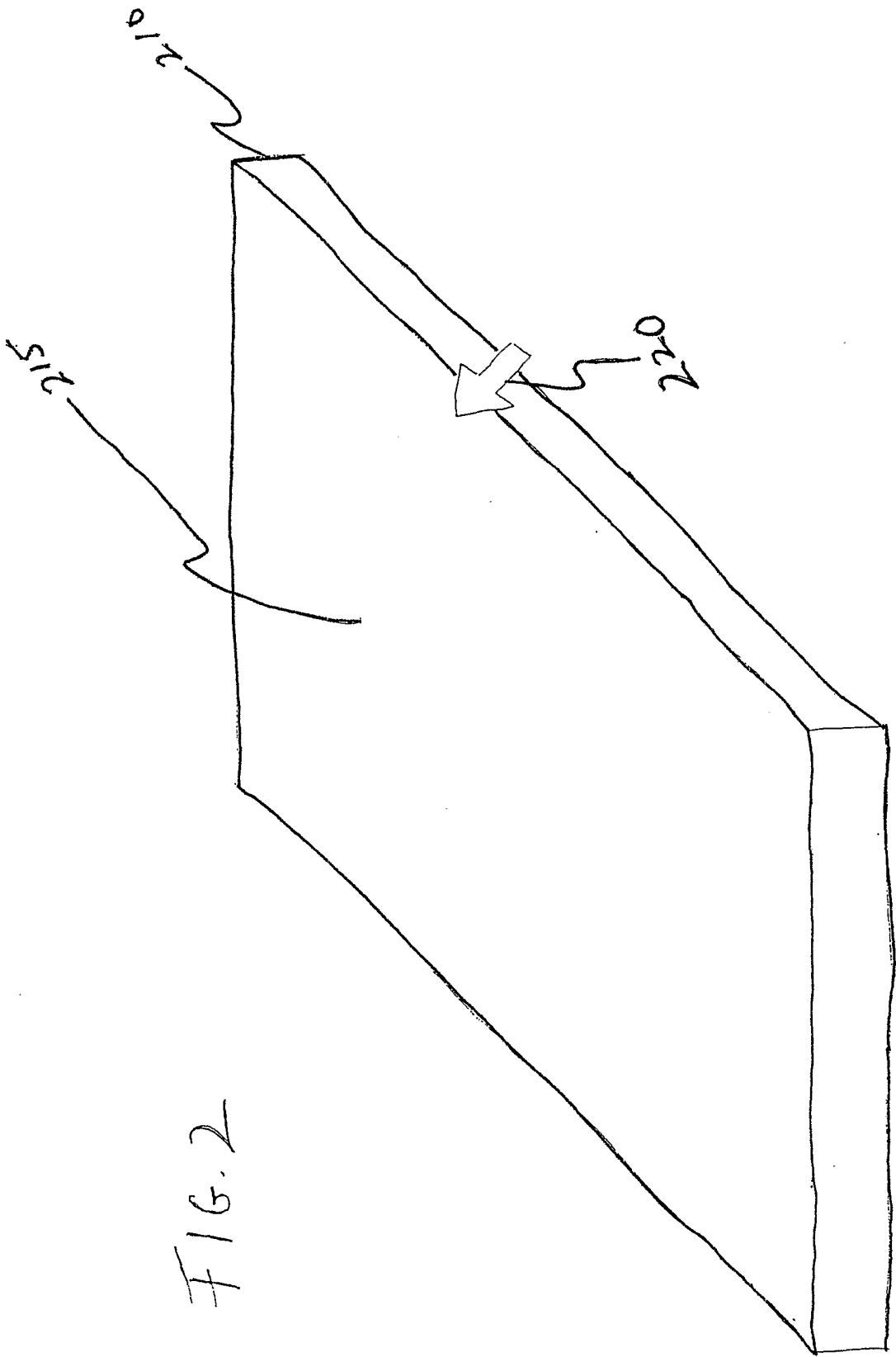


FIG. 2

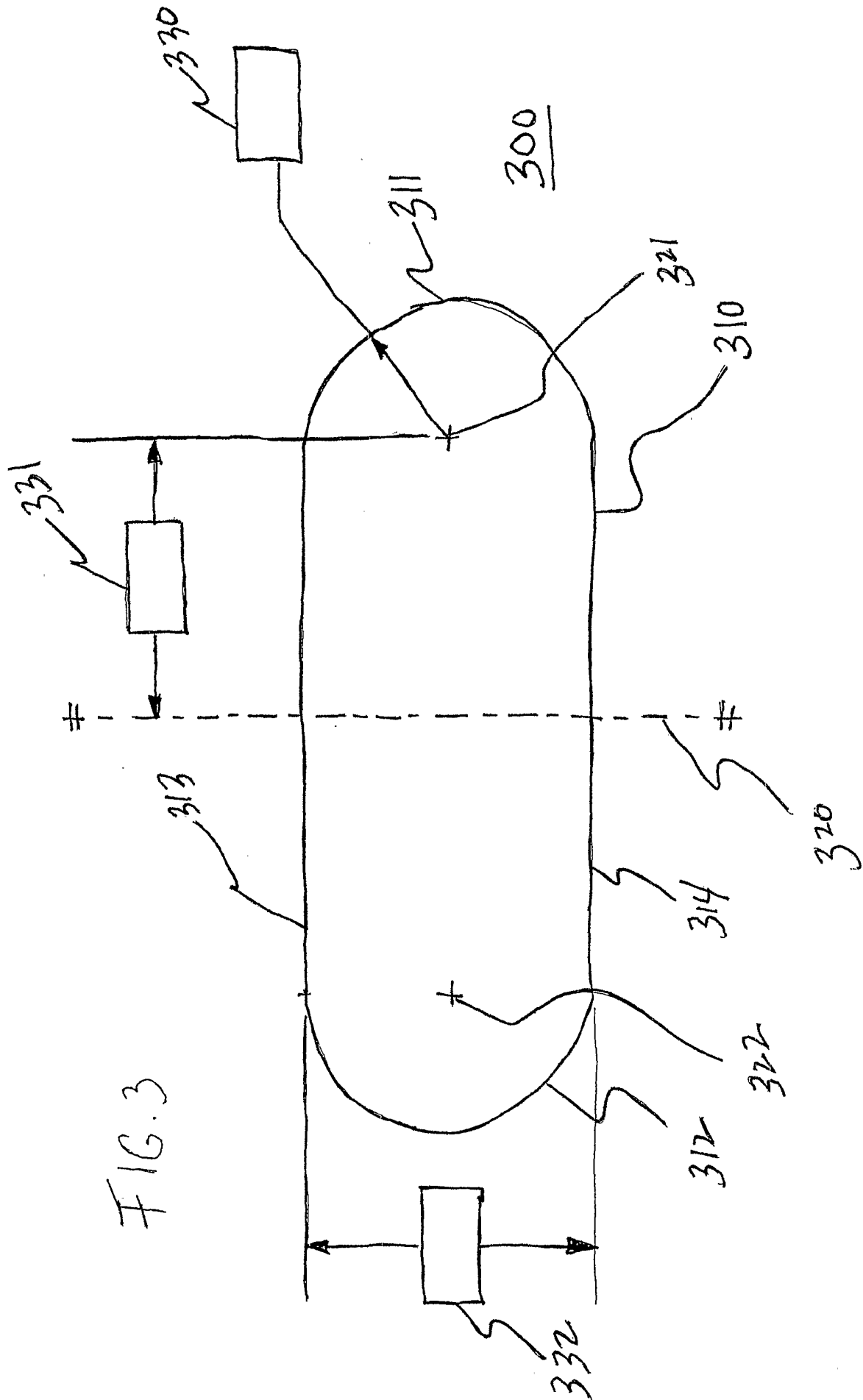


FIG. 4

215

210

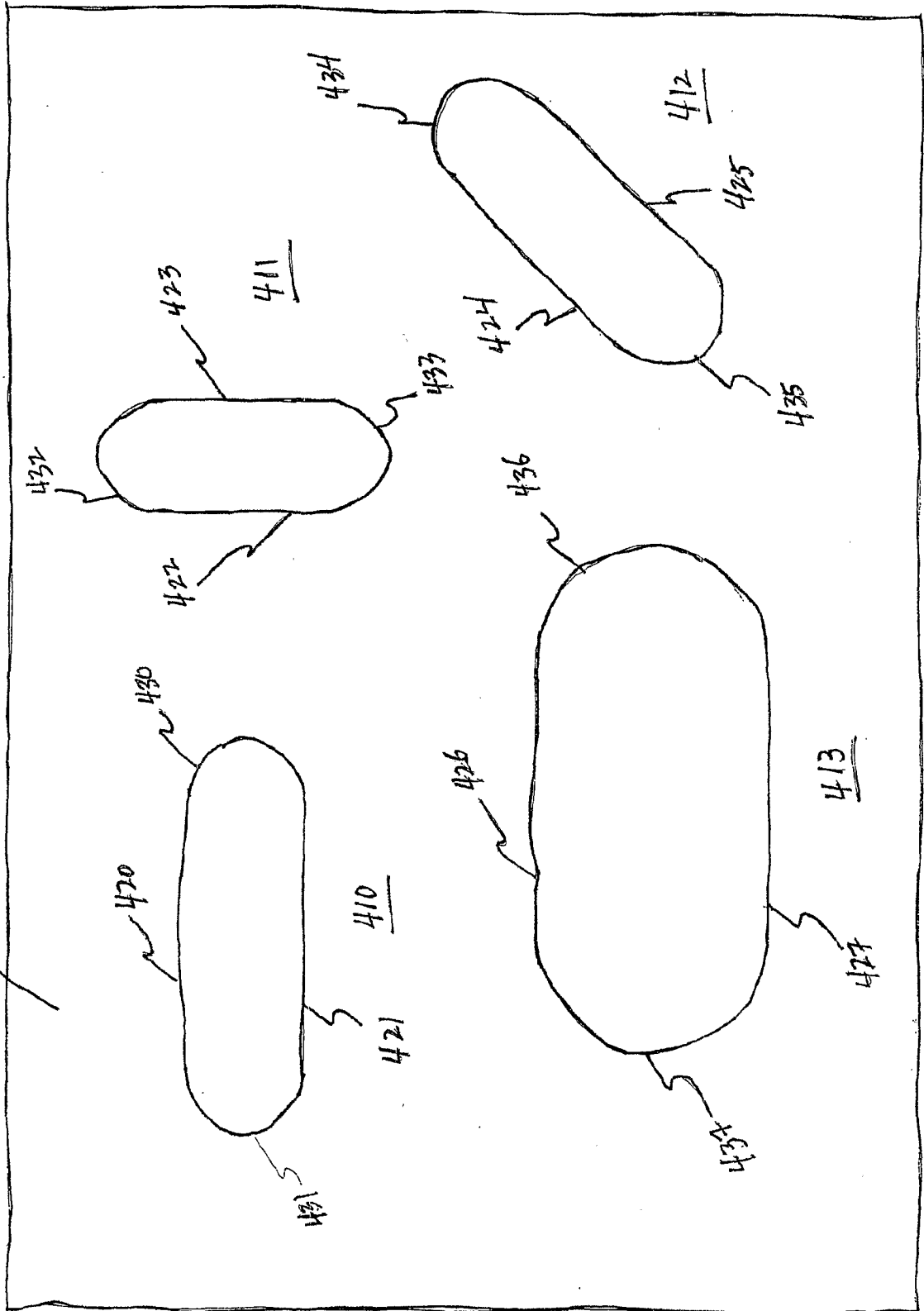
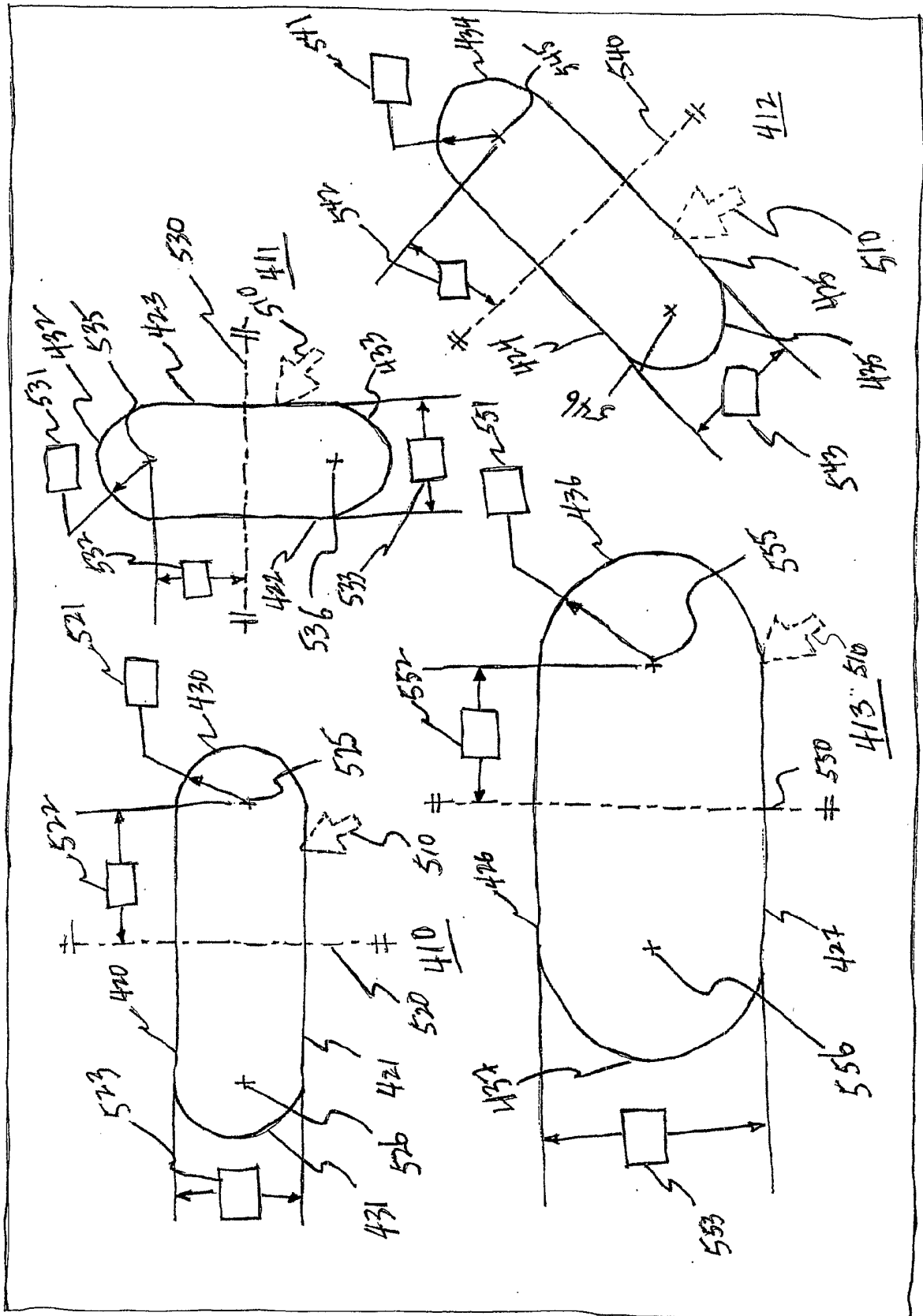


FIG. 5



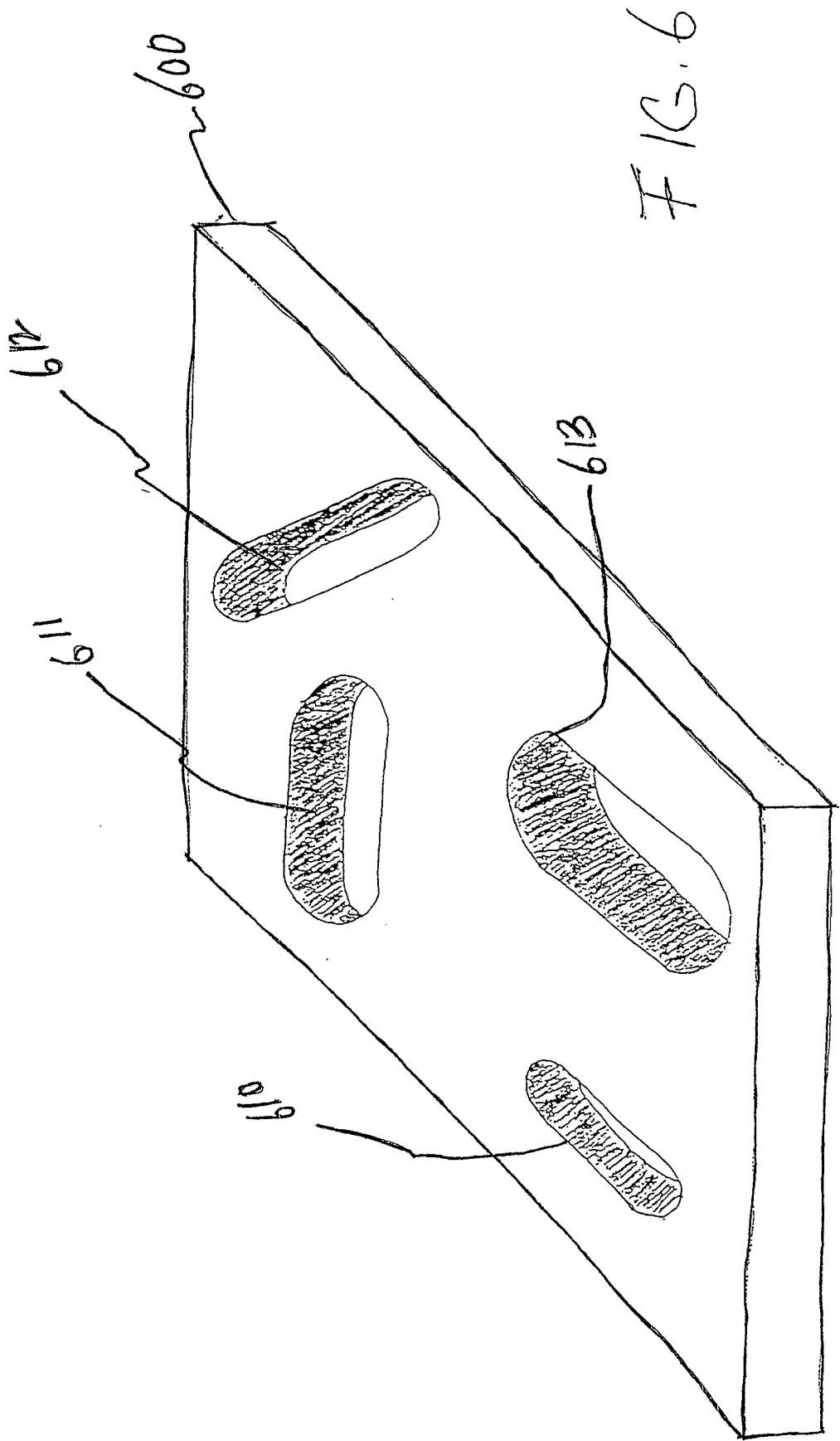


FIG. 6

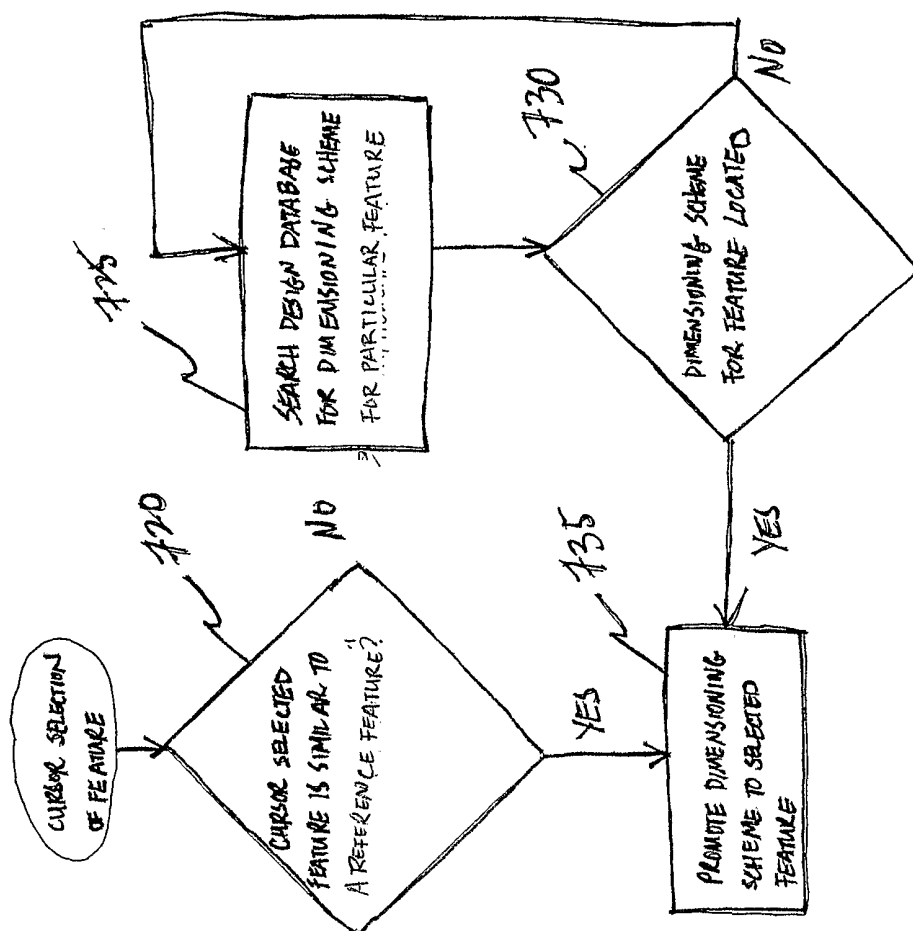


FIG. 7b

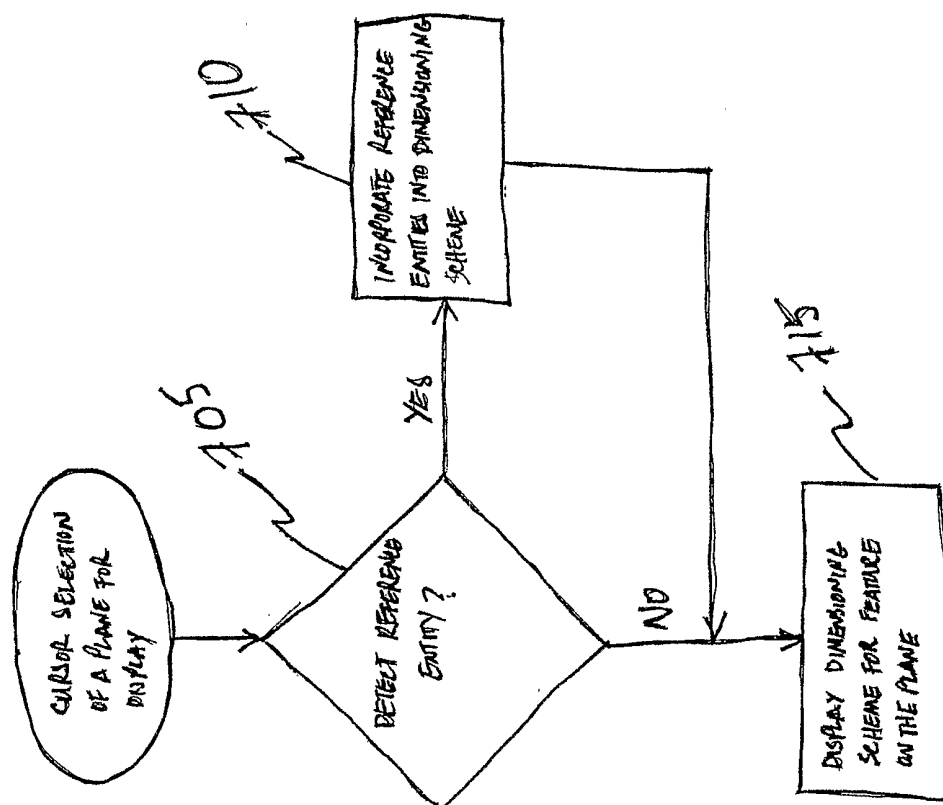


FIG. 7a

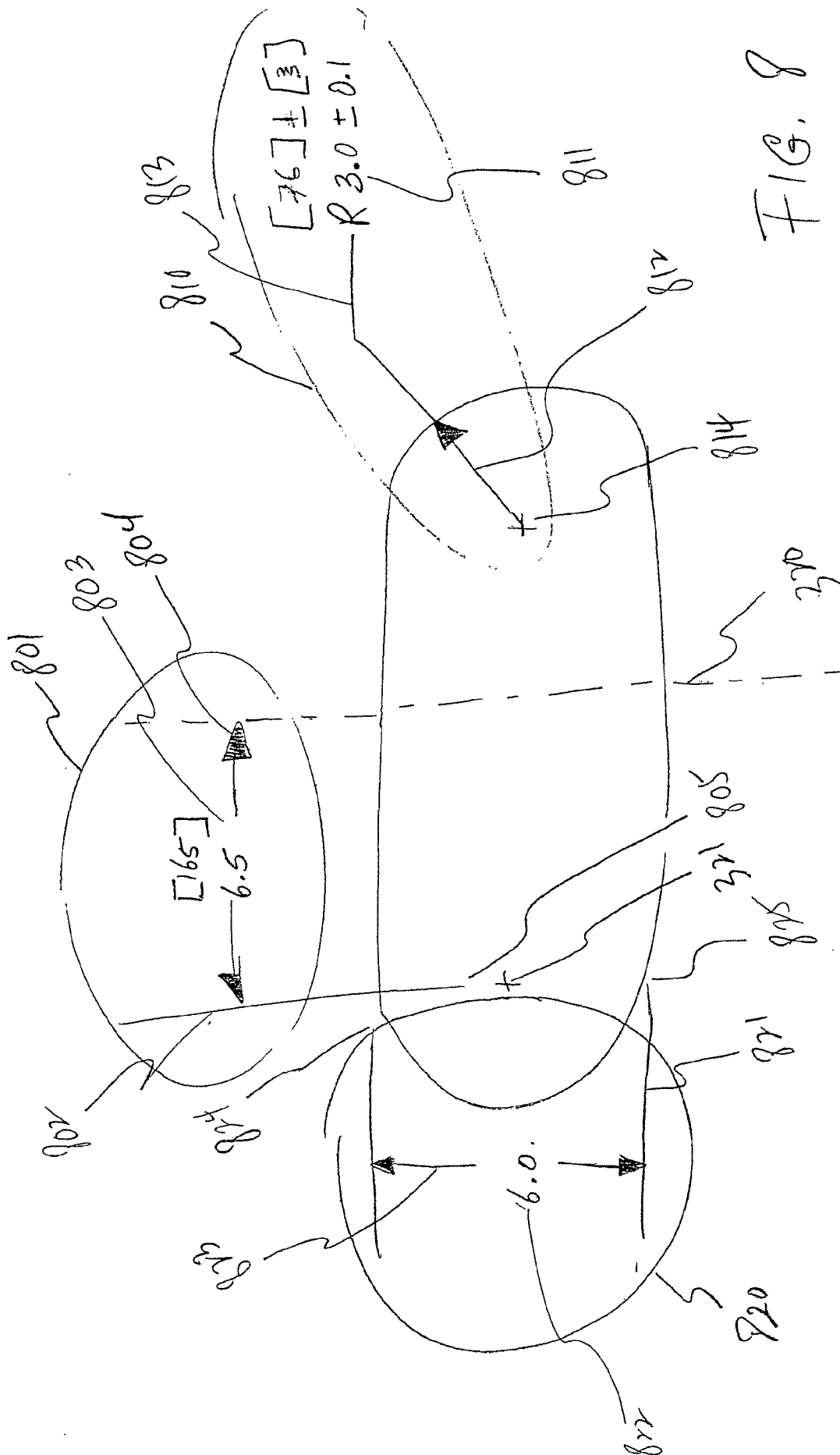
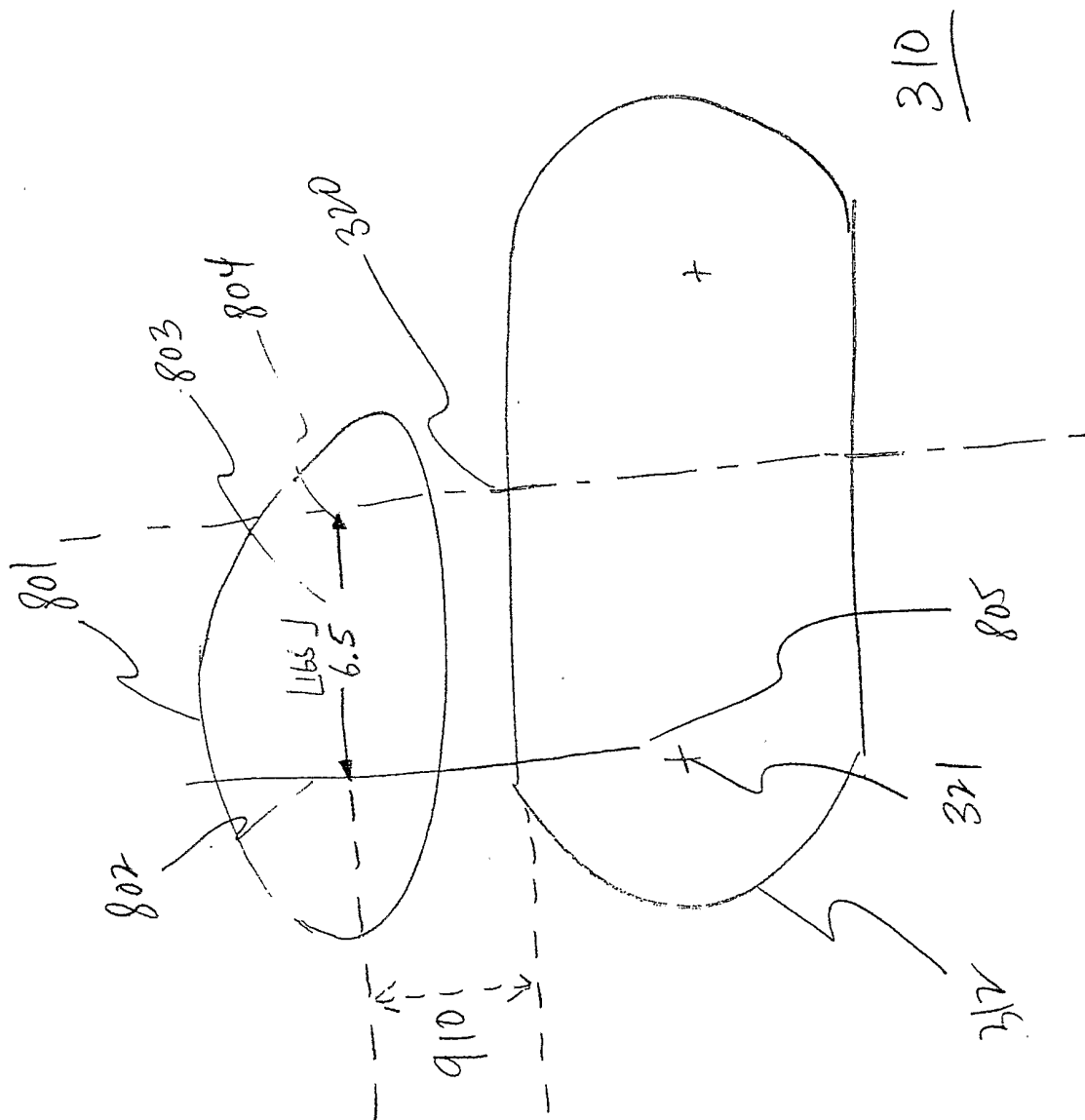
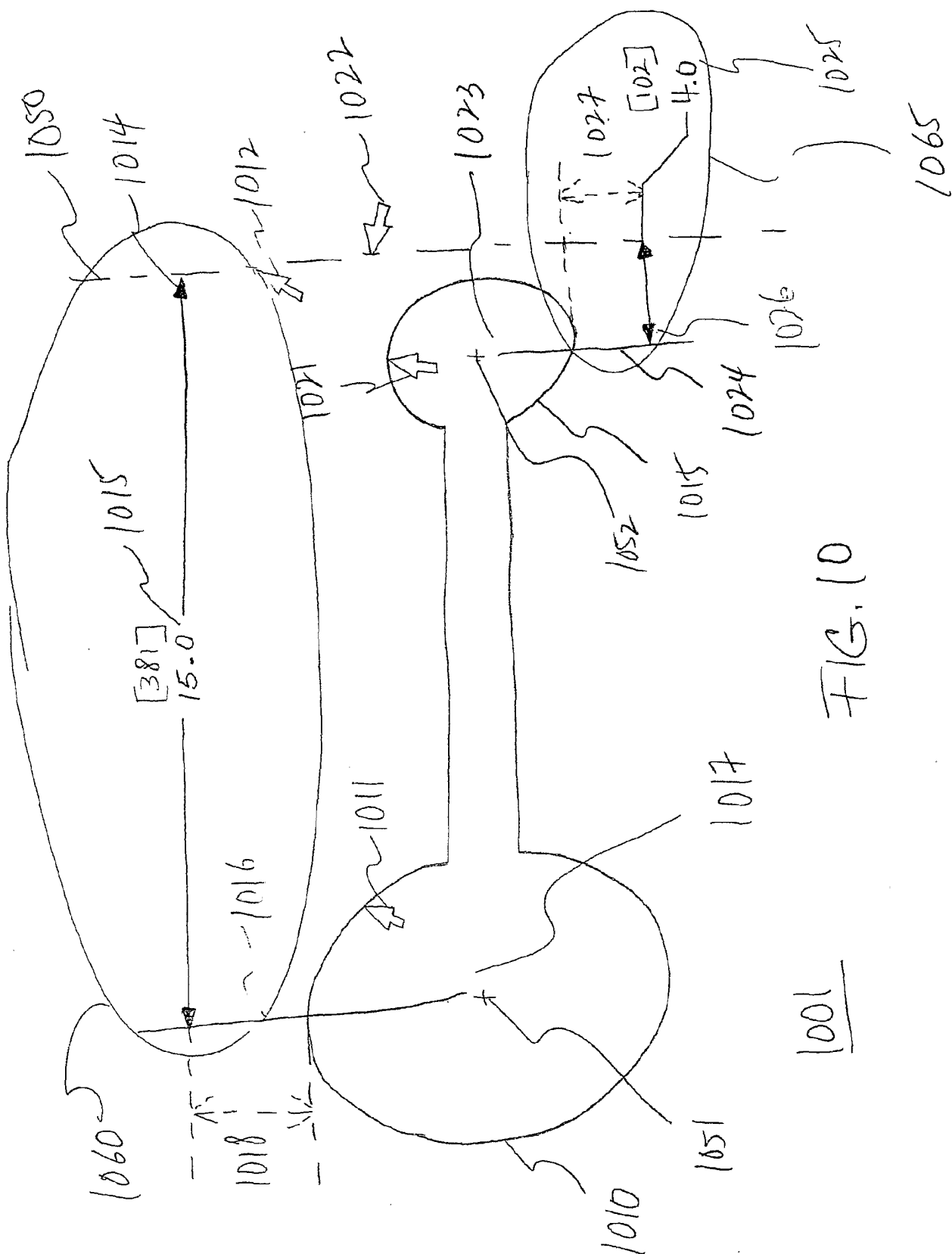


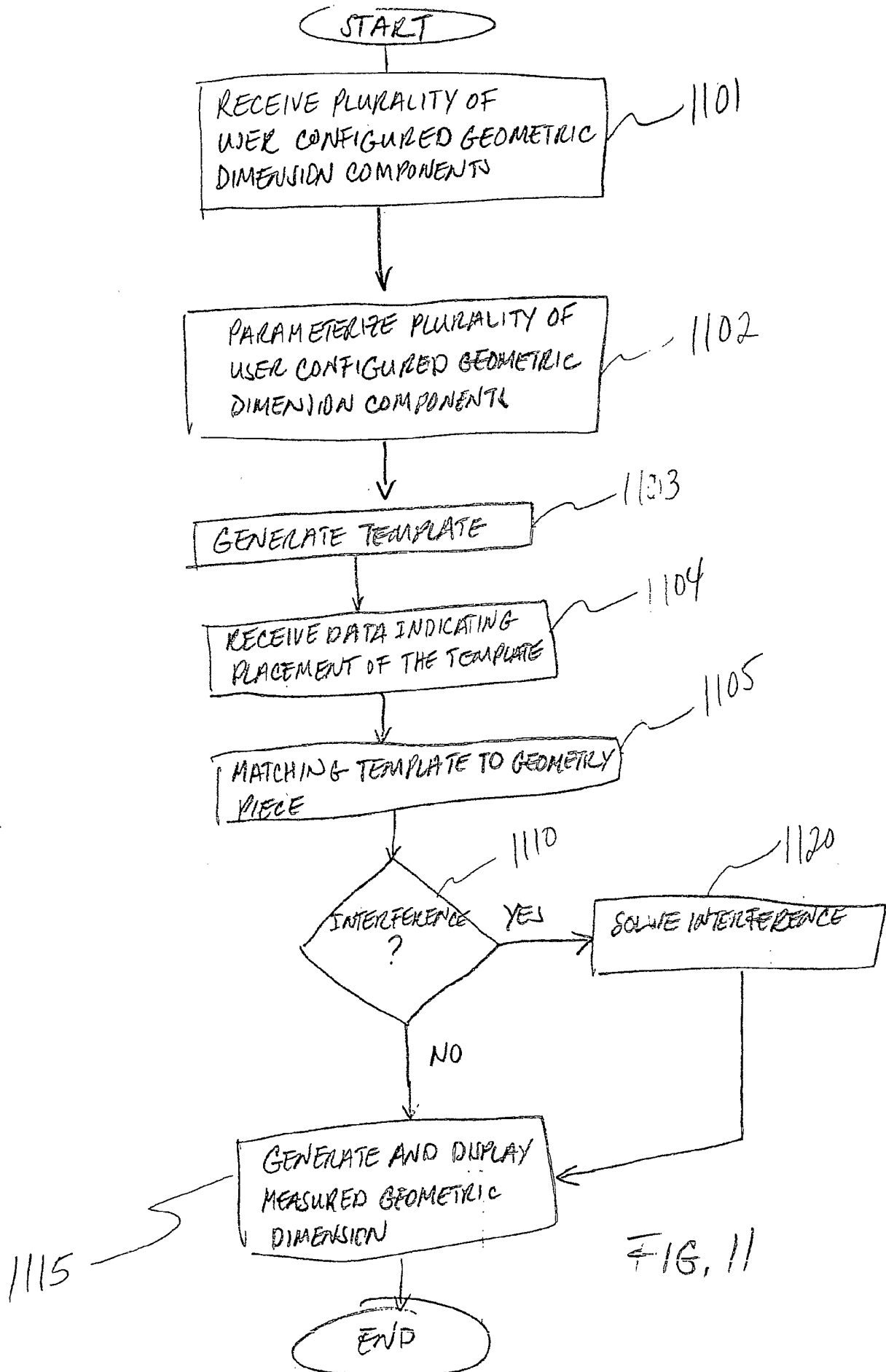
FIG. 8



1911



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1200

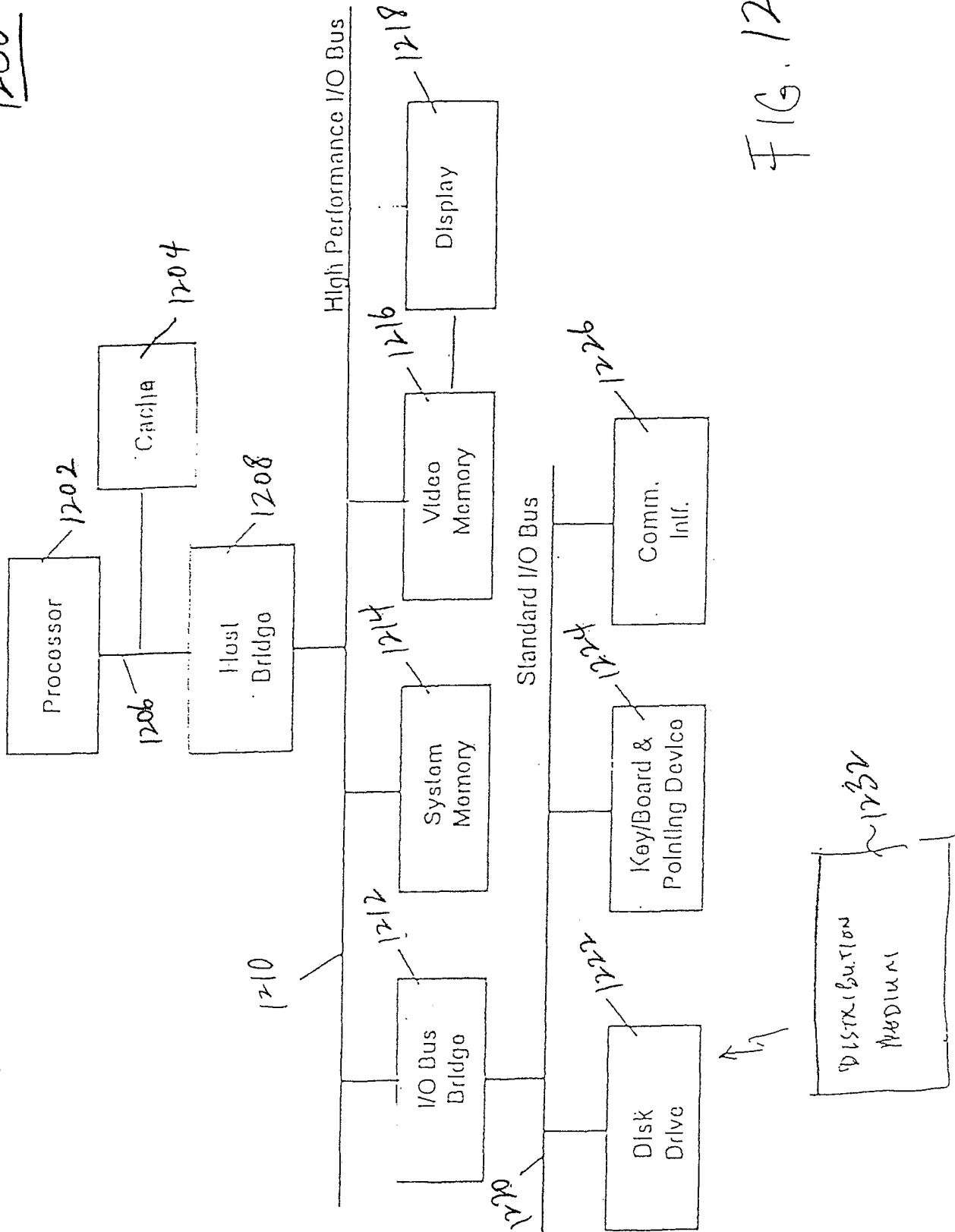


FIG. 12