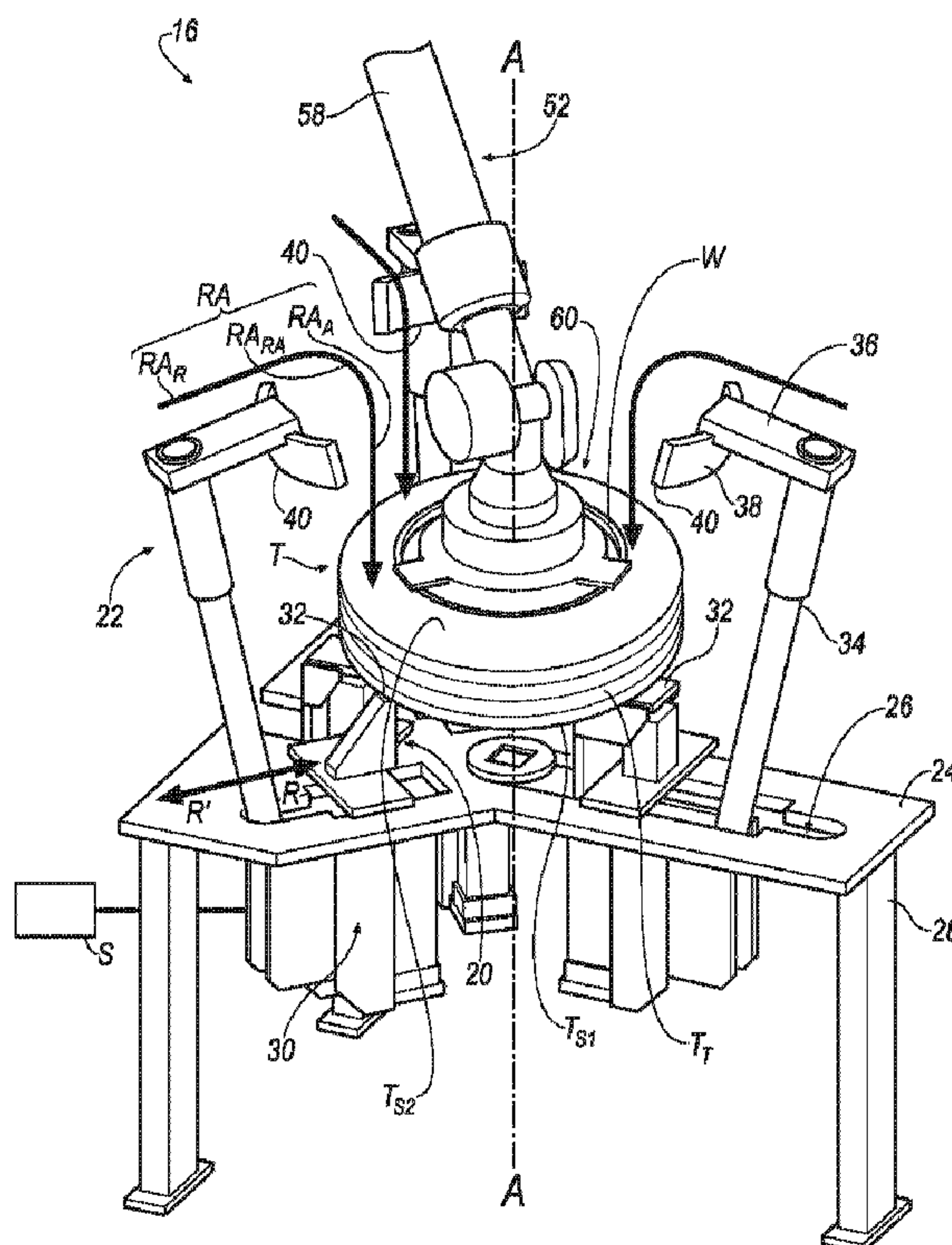




(86) Date de dépôt PCT/PCT Filing Date: 2009/09/04
(87) Date publication PCT/PCT Publication Date: 2010/03/11
(45) Date de délivrance/Issue Date: 2014/07/08
(85) Entrée phase nationale/National Entry: 2011/02/28
(86) N° demande PCT/PCT Application No.: US 2009/056021
(87) N° publication PCT/PCT Publication No.: 2010/028233
(30) Priorité/Priority: 2008/09/04 (US61/094,097)

(51) Cl.Int./Int.Cl. *B60C 25/132* (2006.01),
B60C 25/00 (2006.01)
(72) Inventeur/Inventor:
LAWSON, LAWRENCE J., US
(73) Propriétaire/Owner:
ANDROID INDUSTRIES LLC, US
(74) Agent: RIDOUT & MAYBEE LLP

(54) Titre : STATION D'INDEXATION ROBOTISEE
(54) Title: ROBOTIC INDEXING STATION



(57) Abrégé/Abstract:

A single-cell workstation (10) for processing a tire-wheel assembly (TW) including a tire (T) and a wheel (W) is disclosed. The single-cell workstation (10) includes a mounting and indexing sub-station (16, 106) including a first plurality of tire engaging portions (20) including one or more first tire-engaging surfaces (32), and a second plurality of tire engaging portions (22) including one or more second tire-engaging surfaces (40).



(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
11 March 2010 (11.03.2010)

PCT

(10) International Publication Number
WO 2010/028233 A3

(51) International Patent Classification:

B60C 25/132 (2006.01) *B60C 25/00* (2006.01)

(21) International Application Number:

PCT/US2009/056021

(22) International Filing Date:

4 September 2009 (04.09.2009)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

61/094,097 4 September 2008 (04.09.2008) US

(71) Applicant (for all designated States except US): **ANDROID INDUSTRIES LLC** [—/US]; 2155 Executive Hills Dr., Auburn Hills, MI 48326-2943 (US).

(72) Inventor; and

(75) Inventor/Applicant (for US only): **LAWSON, Lawrence, J.** [US/US]; 2691 Pearl Drive, Troy, MI 48085 (US).

(74) Agent: **COPPOLA, Joseph, V.**; Honigman Miller Schwartz and Cohn LLP, 38500 Woodward Avenue, Suite 100, Bloomfield Hills, MI 48304-5048 (US).

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ,

CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

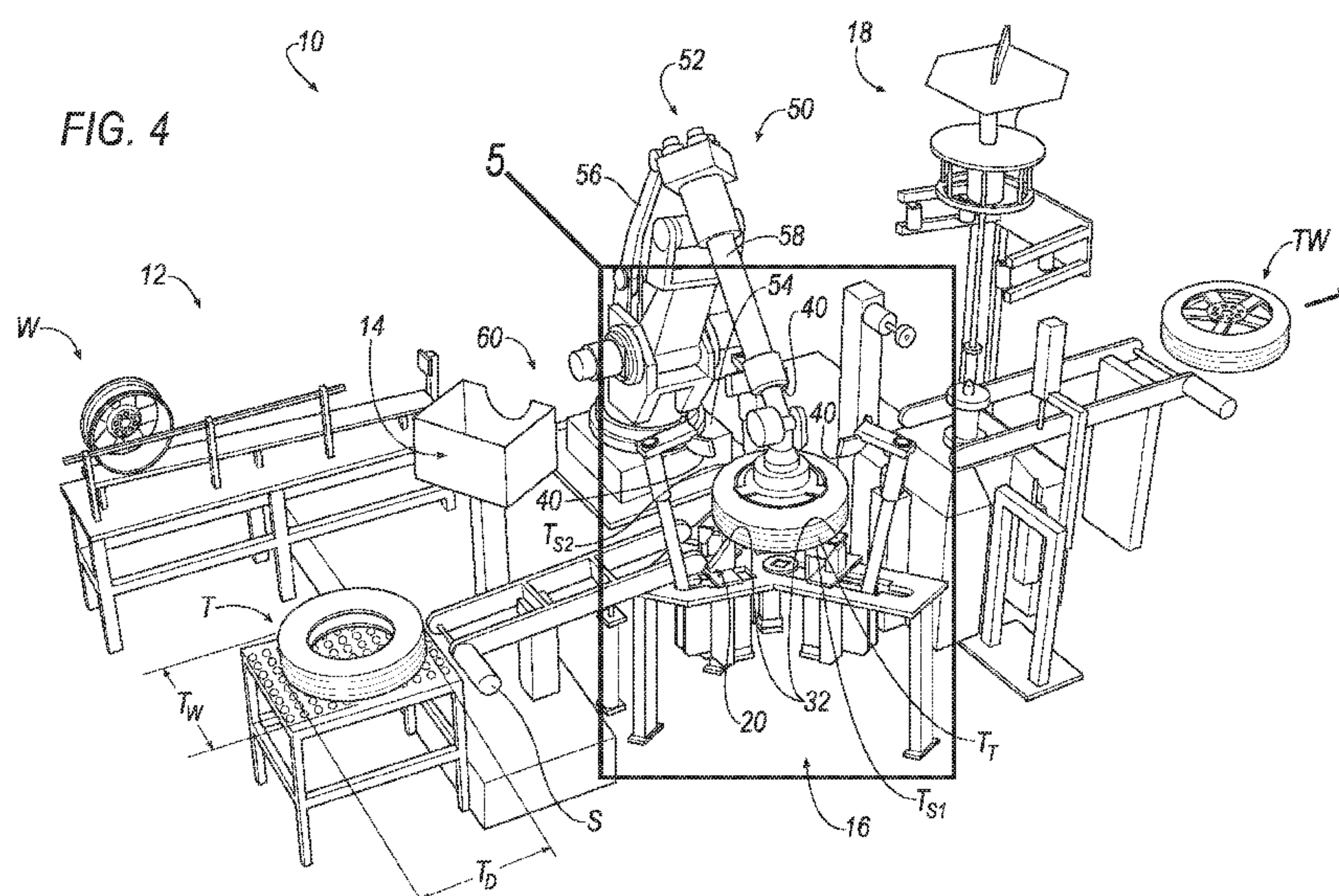
— with international search report (Art. 21(3))

— before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))

(88) Date of publication of the international search report:

10 June 2010

(54) Title: ROBOTIC INDEXING STATION



(57) Abstract: A single-cell workstation (10) for processing a tire-wheel assembly (TW) including a tire (T) and a wheel (W) is disclosed. The single-cell workstation (10) includes a mounting and indexing sub-station (16, 106) including a first plurality of tire engaging portions (20) including one or more first tire-engaging surfaces (32), and a second plurality of tire engaging portions (40) including one or more second tire-engaging surfaces (40).

ROBOTIC INDEXING STATION

FIELD OF THE INVENTION

[0001] The disclosure relates to tire-wheel assemblies and to a method and apparatus for processing a tire-wheel assembly.

DESCRIPTION OF THE RELATED ART

[0002] It is known in the art that a tire-wheel assembly is processed in several steps. Usually, conventional methodologies that conduct such steps require a significant capital investment and human oversight. The present invention overcomes drawbacks associated with the prior art by setting forth a device utilized for processing a tire-wheel assembly.

BRIEF DESCRIPTION OF THE DRAWINGS

[0003] The disclosure will now be described, by way of example, with reference to the accompanying drawings, in which:

[0004] Figures 1-4 illustrate perspective views of an apparatus and method for processing a tire-wheel assembly in accordance with an exemplary embodiment of the invention.

[0005] Figures 5-7 illustrate a sub-station of the apparatus method according to line 5 of Figure 4 in accordance with an exemplary embodiment of the invention;

[0006] Figures 8 and 9 illustrate a top view of a tire and wheel as well as a partial overhead view of the sub-station of Figures 1-7 in accordance with an exemplary embodiment of the invention;

[0007] Figure 10 illustrates the sub-station of the apparatus method according to Figures 1-9 in accordance with an exemplary embodiment of the invention;

[0008] Figure 11 illustrates a view of a mounting and indexing substation and a robotic arm in accordance with an exemplary embodiment of the invention;

[0009] Figures 12A-12C illustrate embodiments of a dimple of the mounting and indexing substation of Figure 11 in accordance with an exemplary embodiment of the invention;

[0010] Figure 13 illustrates another view of a mounting and indexing substation and a robotic arm in accordance with an exemplary embodiment of the invention;

[0011] Figure 14 illustrates a partial cross-sectional view of the mounting and indexing substation and a tire attached to the robotic arm in accordance with an exemplary embodiment of the invention;

[0012] Figure 15 illustrates another partial cross-sectional view of the mounting and indexing substation and a tire attached to the robotic arm in accordance with an exemplary embodiment of the invention;

[0013] Figure 16 illustrates a cross-sectional view of a portion of the robotic arm and a top view of the tire and a wheel in accordance with an exemplary embodiment of the invention;

[0014] Figure 17 illustrates another partial cross-sectional view of the mounting and indexing substation and a tire attached to the robotic arm in accordance with an exemplary embodiment of the invention;

[0015] Figure 18 illustrates another cross-sectional view of a portion of the robotic arm and a top view of the tire and a wheel in accordance with an exemplary embodiment of the invention;

[0016] Figure 19 illustrates another partial cross-sectional view of the mounting and indexing substation and a tire attached to the robotic arm in accordance with an exemplary embodiment of the invention; and

[0017] Figure 20 illustrates another cross-sectional view of a portion of the robotic arm and a top view of the tire and a wheel in accordance with an exemplary embodiment of the invention.

DETAILED DESCRIPTION OF THE INVENTION

[0018] The Figures illustrate an exemplary embodiment of an apparatus and method for processing a tire-wheel assembly in accordance with an embodiment of the invention. Based on the foregoing, it is to be generally understood that the nomenclature used herein is simply for convenience and the terms used to describe the invention should be given the broadest meaning by one of ordinary skill in the art.

[0019] In an embodiment, an apparatus shown generally at 10 in the Figures 1-4 may be referred to as a “single-cell” workstation. In the foregoing disclosure, it will be appreciated that term “single-cell” indicates that the workstation 10 provides a tire-wheel assembly, TW, without requiring a plurality of successive, discrete workstations that may otherwise be arranged in a conventional assembly line. Rather, the single cell workstation 10 provides one

workstation having a plurality of subs-stations 12-18, each performing a specific task in the processing of a tire-wheel assembly, TW. As such, the novel single-cell workstation 10 significantly reduces the cost, investment and maintenance associated with a conventional tire-wheel assembly line located on a relatively large real estate footprint. Thus, capital investment and human oversight is significantly reduced when a single cell workstation 10 is employed in the processing of tire-wheel assemblies, TW.

[0020] In an embodiment, the single-cell workstation 10 includes a device 50. In operation, the device 50 interfaces with a wheel, W, in order to prepare a tire-wheel assembly, TW. The ability of the device 50 to interface with the wheel, W, eliminates the need to “hand-off” one or more of a wheel, W, and tire, T, to a subsequent workstation of a plurality of workstations in a conventional assembly line.

[0021] In an embodiment, the device 50 associated with the single-cell workstation 10 may include a robotic arm 52 that may be located in a substantially central position relative a plurality of sub-stations. In an embodiment, a plurality of sub-stations is shown generally at 12-18.

[0022] In operation, a wheel, W, is removably-attached to the robotic arm 52. In an embodiment, the robotic arm 52 interfaces with the wheel, W, throughout some or all of the steps associated with the preparation of the tire-wheel assembly, TW. In an embodiment, the robotic arm 52 may include, for example, a base portion 54, a body portion 56 connected to the base portion 54, an arm portion 58 connected to the body portion 56, and a claw portion 60 connected to the arm portion 58.

[0023] In an embodiment, the body portion 56 is rotatably-connected to the base portion 54 such that the body portion 56 may be pivoted 360° relative the base portion 54. Further, in an embodiment, the body portion 56 may be generally hinged to the base portion 54 having, for example, hinged, scissor-style arms such that the body portion 56 may be articulated vertically upward or downward relative the base portion 54.

[0024] In an embodiment, the arm portion 58 may be connected to the body portion 56 such that the arm portion 58 may be articulated in any desirable upward or downward position relative the body portion 56. Similar to the rotatable connection of the base portion 54 and body portion 56, the claw portion 60 may be rotatably-connected to the arm portion 58 such that the claw portion 60 may be rotated, pivoted or otherwise spun more or less than 360° relative the arm portion 58. In an embodiment, movement of the portions 54-60 may be

controlled manually with a joystick (not shown), or, alternatively, automatically by way of logic stored on a controller having a processor (not shown).

[0025] In the following description, it will be appreciated that prescribed movements of the body portion 56 relative the base portion 54 may have occurred before, during or after movement of the arm portion 58 and/or claw portion 60. For example, the body portion 56 may have been rotated, articulated or the like in order to locate the arm and claw portions 58, 60 to a desired position at or proximate a particular sub-station.

[0026] Regarding the general movement of the device 50 relative the sub-stations 12-18, in an embodiment, as seen in Figure 2, the robotic arm 52 is manipulated such that it obtains a wheel, W, at a wheel repository sub-station 12. Then, in an embodiment, as seen in Figure 3, the robotic arm 52 is articulated such that it lubricates / “soaps” the wheel, W, at a soaping sub-station 14. Then, in an embodiment, as seen in Figures 4-9, the robotic arm 52 is articulated such that it mounts the soaped wheel, W, to a tire, T, at a mounting and indexing sub-station 16 to define a non-inflated tire-wheel assembly. Subsequent to the mounting and indexing of the tire, T, and wheel, W, the robotic arm 52 locates the non-inflated tire-wheel assembly at an inflating sub-station 18 for inflating the non-inflated tire-wheel assembly; once inflated, an inflated tire-wheel assembly, TW, may be said to be formed. The inflated tire-wheel assembly, TW, may be discharged from the single-cell workstation 10 for further processing by a balancing sub-station or the like.

[0027] Referring now to Figure 5, the mounting and indexing sub-station 16 is shown according to an embodiment. In general, the mounting and indexing substation 16 includes a first and second plurality of adjustable tire engaging portions, which are shown generally at 20 and 22. In an embodiment, the first plurality of tire engaging portions 20 may axially engage a first sidewall surface, T_{S1} , of the tire, T. In an embodiment, the second plurality of tire engaging portions 22 may axially engage a second sidewall surface, T_{S2} , of the tire, T, that is opposite the first sidewall surface, T_{S1} .

[0028] Although the first and second plurality of tire engaging portions 20, 22 are described to respectively engage the first and second sidewall surfaces, T_{S1} , T_{S2} , of the tire, T, it will be appreciated however, that the invention is not limited to the configuration/orientation of the first and second plurality of tire engaging portions shown at 20, 22 and that any desirable configuration/orientation of a tire engaging portion may be utilized, as desired. For example, in an embodiment, one or more of the first and second plurality of tire engaging portions 20, 22 may radially engage a circumferential / tread

surface, T_T , of the tire, T , or, alternatively, in an embodiment, one or more of the first and second plurality of tire engaging portions 20, 22 may radially and axially engage the circumferential / tread surface, T_T , and one or more of the first and second sidewall surfaces, T_{S1} , T_{S2} , of the tire, T .

[0029] As seen in Figure 5, in an embodiment, the first and second plurality of tire engaging portions 20, 22 are adjustable relative an axis, A-A. In an embodiment, the first plurality of tire-engaging portions 20 are radially adjustable relative the axis, A-A, according to the direction of arrows, R / R' . In an embodiment, the first plurality of tire-engaging portions 20 are radially adjustable prior to locating a tire, T , at the mounting and indexing sub-station 16 (see, e.g., Figures 1-2). Radial adjustment of the first plurality of tire engaging portions 20 in the direction of the arrows, R / R' , may be conducted to accommodate any type of tire, T , defined by any diameter, which is shown generally at T_D (see, e.g., Figure 1) according to an embodiment.

[0030] In an embodiment, the mounting and indexing sub-station 16 may include or be interfaced with one or more sensors that detects the diameter, T_D , of the tire, T , such that the first plurality of tire engaging portions 20 may be automatically adjusted responsive to the detected diameter, T_D , of the tire, T . In an embodiment, a sensor is shown generally at S in Figures 1-7. However, in an alternative embodiment, the radial adjustment of the first plurality of tire engaging portions 20 may be conducted manually by an operator without utilizing a sensor, S .

[0031] In an embodiment, as seen in Figure 5, the second plurality of tire-engaging portions 22 are adjustably-disposed relative the axis, A-A, in one or more directions according to the arrow, RA . In an embodiment, the arrow, RA , may include a radial segment, RA_R , an axial segment, RA_A , and a compounded, arcuate segment having a radial and axial component, which is shown generally at RA_{RA} .

[0032] Similar to the movement of the first plurality of tire engaging portions 20, adjustment of the second plurality of tire engaging portions 22 in the direction of the arrows, RA , may be conducted to accommodate any type of tire, T , defined by any diameter, T_D . In an embodiment, the sensor, S , that detects the diameter, T_D , of the tire, T , may also cause the second plurality of tire engaging portions 22 to be automatically adjusted responsive to the detected diameter, T_D , of the tire, T . In an embodiment, the adjustment of the second plurality of tire engaging portions 22 may be conducted manually by an operator without utilizing a sensor, S .

[0033] As seen in Figures 5-7, in an embodiment, the first and second plurality of tire engaging portions 20, 22 are movably-adjustable relative a platform 24. In an embodiment, the platform 24 may define a plurality of radially elongated openings 26. Further, in an embodiment, the platform 24 may be supported by a plurality of legs, which are shown generally at 28, such that one or more actuators 30 may be disposed underneath the platform 24.

[0034] In an embodiment, each of the first and second plurality of tire engaging portions 20, 22 are connected to the one or more actuators 30. In an embodiment, each of the tire engaging portions 20, 22 are connected to the one or more actuators 30 and extend through the plurality of elongated openings 26. In an embodiment, the one or more actuators 30 may be connected to the one or more sensors, S, such that the one or more sensors, S, provide instructions to the one or more actuators 30 for automatically controlling the adjustable movement of the first and second plurality of tire engaging portions 20, 22.

[0035] In an embodiment, the first plurality of tire engaging portions 20 are adjustably-disposed substantially adjacent the platform 24. In an embodiment, the second plurality of tire engaging portions 22 are adjustably disposed at a distance spaced away from the platform 24.

[0036] In an embodiment each engaging portion of the first plurality of tire engaging portions 20 generally defines a first engaging surface, which is shown generally 32 (see, e.g., Figures 1-2). In an embodiment, the first engaging surfaces 32 are disposed adjacent the first sidewall surface, T_{S1} , of the tire, T, when the tire, T, is moved to a processing position (see, e.g., Figure 3) from a stowed position (see, e.g., Figure 1).

[0037] In an embodiment, each engaging portion of the second plurality of engaging portions 22 includes an arm portion 34 extending from the one or more actuators 30, a head portion 36 connected to the arm portion 34 and an arcuate engaging portion 38 connected to the head portion 36. The arcuate engaging portion 38 generally defines a second engaging surface, which is shown generally at 40.

[0038] In an embodiment, the second engaging surfaces 40 are disposed adjacent the second sidewall surface, T_{S2} , of the tire, T, upon moving the tire, T, to the processing position. Further, in an embodiment, the first and second engaging surfaces 32, 40 are arranged in a substantially opposing relationship when the first and second engaging surfaces 32, 40 respectively engage the first and second sidewall surfaces, T_{S1} , T_{S2} , of the tire, T (see, e.g., Figure 6).

[0039] Referring to Figures 5-9 a method for operating the mounting and indexing sub-station 16 is described. In an embodiment, as seen in Figures 1-3, the robotic arm 52 may obtain and subsequently lubricate / soap a wheel, W, at the soaping sub-station 14. Before, during or after the lubricating / soaping of the wheel, W, one or more characteristics relating to the shape/size of a tire, T, is determined, in an embodiment, by the one or more sensors, S.

[0040] In an embodiment, upon the sensor, S, determining the one or more characteristics of the tire, T, the sensor, S, may send data related to the one or more characteristics of the tire, T, to a processor associated with the one or more actuators 30 such that the one or more actuators 30 may be permitted to adjustably-manipulate the positioning of one or more of the first and second plurality of tire engaging portions 20, 22 for accommodating the determined size/shape of the tire, T.

[0041] Alternatively, in an embodiment, rather than utilizing a sensor, S, an operator (e.g., a person) may manually determine the one or more characteristics of the tire, T, by, for example, visually inspecting the tire, T. In an embodiment, the operator may determine the size/shape of the tire, T, and provide data pertaining to the size/shape of the tire, T, to the processor associated with the one or more actuators 30 by way of a data entry keypad terminal (not shown). As similarly explained above, data that is manually provided to the processor permits the one or more actuators 30 to adjustably-manipulate the positioning of one or more of the first and second plurality of tire engaging portions 20, 22 for accommodating the determined size/shape of the tire, T.

[0042] In an embodiment, a characteristic of the tire, T, that may be determined at the determining step is a diameter, T_D , of the tire, T. Further, in an embodiment, another characteristic of the tire, T, that may be determined at the determining step is a width/thickness, T_W (see, e.g., Figures 1-4), of the tire, T; in an embodiment, the width/thickness, T_W , of the tire, T, may be utilized by the one or more actuators 30 for adjusting the second plurality of tire engaging portions 22.

[0043] Subsequent to the determining the diameter, T_D , of the tire, T, the first plurality of tire engaging portions 20 are moved according to the direction of the arrow, R, such that the first engaging surfaces 32 may be positioned for supportingly-engaging the first sidewall surface, T_{S1} , of the tire, T. Then, the tire, T, may be moved to the processing position (see, e.g., Figure 3) such that the first sidewall surface, T_{S1} , of the tire, T, may be disposed adjacent the first engaging surfaces 32.

[0044] Then, as seen in Figures 4-5, the robotic arm 52 disposed the wheel, W, within a central opening defined by the tire, T, such that the tire, T, is circumferentially disposed about the wheel, W. Then, as seen in Figures 5 and 6, the second plurality of tire engaging portions 22 are moved according to the direction of the arrow, RA, such that the second tire engaging surfaces 40 are disposed adjacent the second sidewall surface, T_{S2} , of the tire, T.

[0045] Referring to Figure 6, upon disposing the second tire engaging surfaces 40 adjacent the second sidewall surface, T_{S2} , of the tire, T, the first and second plurality of tire engaging portions 20, 22 functionally clamp the tire, T. Upon clamping the tire, T, between the first and second tire engaging portions 20, 22, rotational movement of the tire, T, about the axis, A-A, is substantially prevented.

[0046] Referring to Figure 7, the claw portion 60 of the robotic arm 52 may rotate the wheel, W, relative the fixed, clamped positioning of the tire, T, according to the direction of the arrow, R_W . Rotation of the wheel, W, relative the tire, T, may be conducted to minimize an amount of weight added to the tire-wheel assembly in order to balance the tire-wheel assembly.

[0047] Referring to Figures 8 and 9, in an embodiment, a tire, T, may be marked with a heavy balance point, which is shown generally at THP, and the wheel, W, may be marked with a heavy balance point, which is shown generally at WHP. Accordingly, in an embodiment, the claw portion 60 may include, for example, an optical sensor that determines / detects both of the heavy balance points THP, WHP. Then, upon determining the location of the heavy balance points THP, WHP, the claw portion 60 may rotate the wheel, W, according to the direction of the arrow, R_W (that is also shown in Figure 7), such that the heavy balance points THP, WHP are offset from one another by approximately 180^0 , as seen, for example, in Figure 9.

[0048] As seen in Figure 10, upon offsetting the heavy balance points THP, WHP approximately 180^0 , the second plurality of tire engaging portions 22 may be moved in a direction substantially opposite the direction of arrow, RA, which is shown generally at RA', such that the tire, T, is no longer clamped by the first and second plurality of tire engaging portions 20, 22. With the claw portion 60 still affixed to the wheel, W, the robotic arm 52 may move the non-inflated tire-wheel assembly to the inflating sub-station 18 for inflating the non-inflated tire-wheel assembly.

[0049] Although it has been described above that the tire, T, is prevented from rotating about the axis, A-A, as the wheel, W, is permitted to rotate about the axis, A-A, it will be

appreciated that the invention is not limited to the above described methodology. For example, it will be appreciated that, in an alternative embodiment, one or more of the first and second plurality of tire engaging portions 20, 22 may clamp and rotate the tire, T, about the axis, A-A, as the robotic arm 52 retains the wheel, W, in a fixed position such that the wheel, W, is prevented from rotating about the axis, A-A. In order to permit the first and second plurality of tire engaging portions 20, 22 to rotate the tire, T, one or more components of the mounting and indexing sub-station 16 may be rotated about the axis, A-A, as the wheel, W, is held in an axially-fixed position by the robotic arm 52. Further, in an embodiment, it will be appreciated that both the tire, T, and wheel, W, may be rotated, in opposite directions, about the axis, A-A, such that the heavy balance points THP, WHP may be offset approximately 180° . Thus, it will be appreciated that either one of the tire, T, and wheel, W, may be fixed about the axis, A-A, while the other is rotatably-adjusted, or, alternatively, both of the tire, T, and wheel, W, may be rotatably-adjusted in opposite directions in order to offset the heavy balance points THP, WHP by approximately 180° .

[0050] Referring to Figures 11-19, a mounting and indexing substation 106 of a single-cell workstation for processing a tire-wheel assembly, TW, including a tire, T, and a wheel, W, is shown according to an embodiment. In an embodiment, a robotic arm is shown generally at 152 and includes, for example, an arm portion 158 and a claw portion 160. The robotic arm 152 is substantially similar to the robotic arm 58 described above, and, as such, the specific operation of the robotic arm 152 is not described in further detail. In an embodiment, the substation 106 also includes a platform 124 having a surface 126. In an embodiment, the platform 124 may be supported by legs 128.

[0051] In an embodiment, a plurality of dimples 130 extends axially away from the surface 126. In an embodiment, each dimple 130 is defined by a top surface, which is shown at 132. In an embodiment, one or more of the plurality of dimples 130 is defined to have a friction coefficient, k , that is greater than zero (i.e., $k > 0$).

[0052] In an embodiment, the friction coefficient, k , that is greater than zero may be provided by forming the dimples 130 from a material that includes a friction coefficient greater than zero. Accordingly, in an embodiment, one or more of the plurality of dimples 130 may be formed from, for example, rubber, plastic, metal, wood, or the like.

[0053] In addition to, or, alternatively, instead of a material defining the friction coefficient, k , in an embodiment, the friction coefficient, k , greater than zero may be provided by the structure of the plurality of dimples 130. Referring to Figures 12A-12C, an

enlarged sectional view of the dimples 130 is shown according to an embodiment. As seen in Figure 12A, in an embodiment, the top surface 132 may include a substantially flat surface 134. As seen in Figure 12B, in an embodiment, the top surface 132 may include a coating of frictional, tacky material that is shown generally at 136. As seen in Figure 12C, in an embodiment, the top surface 132 may include a non-flat surface 138, such as, for example, a jagged, saw-tooth surface.

[0054] In an embodiment the substation 106 may be operated as follows. Referring to Figure 11, in an embodiment, the claw portion 160 retains the wheel, W, and the wheel, W, loosely-secures an un-inflated tire, T. Referring to Figures 13-14, the robotic arm 152 then locates the wheel, W, and tire, T, proximate the platform 124 by moving the wheel, W, and tire, T, according to the direction of the arrow, X, until the first sidewall surface, T_{S1} , of the tire, T, comes into contact with the top surface 132 of each of the plurality of dimples 130.

[0055] As seen at Figure 15, upon bringing the first sidewall surface, T_{S1} , of the tire, T, into contact with the top surface 132 of each of the plurality of dimples 130, a first sidewall surface, W_{S1} , of the wheel, W, is spaced from the surface 126 of the platform 124 at a distance, d. Further, as seen at Figure 17, as the robotic arm 152 moves further according to the direction of the arrow, X, the distance, d, is further reduced.

[0056] Further, as seen at Figures 15-18, as the robotic arm 152 continues to move the wheel, W, and tire, T, according to the direction of the arrow, X, the robotic arm 152 rotates both of the wheel, W, and tire, T, according to the direction of arrows, R_W , R_T . As illustrated, the claw portion 160 is removably-affixed to the wheel, W, and a bead, T_B , of the tire, T, engages a circumference, W_C , of the wheel, W, such that rotation of the robotic arm 152 imparts rotation to the wheel, W, according to the direction of the arrow, R_W , which then imparts rotation to the tire, T, according to the direction of the arrow, R_T .

[0057] Referring to Figures 19 and 20, upon further moving the robotic arm 152 according to the direction of the arrow, X, the distance, d, is further reduced until the first sidewall surface, W_{S1} , of the wheel, W, is located substantially adjacent, but at the distance, d, spaced from the surface 126 of the platform 124; accordingly, when positioned as shown at Figures 19 and 20, the bead, T_B , of the tire, T, no longer engages the circumference, W_C , of the wheel, W, such that rotation of the robotic arm 152 still imparts rotation to the wheel, W, according to the direction of the arrow, R_W , while no longer imparting rotation to the tire, T, according to the direction of the arrow, R_T . Thus, the tire, T, is no longer engaged with the wheel, W, but rather, is supported upon the top surface 132 of the plurality of dimples 130 in

rotationally-fixed position while the wheel, W, may be rotatably-retrained by the robotic arm 152. It will be appreciated, however, in an embodiment, that the frictional constant, k , assists in preventing or substantially reducing rotation of the tire, T, when the wheel, W, is positioned according to that as shown in Figures 15-20.

[0058] Once positioned as described above in Figures 19-20, an imaging system 175 (see, e.g., Figures 11 and 13) of the substation 106 may be utilized to identify the tire's marked heavy balance point, which is shown generally at THP, and the wheel's marked heavy balance point, which is shown generally at WHP. Because the tire, T, is no longer rotatable, the imaging system 175 may monitor the relationship of the marked points, THP, WHP, in order to identify when the marked points, THP, WHP, are offset from one another by approximately 180^0 .

[0059] Accordingly, when the robotic arm 152 has rotated the wheel, W, about the tire, T, to a position when the marked points, THP, WHP, are offset from one another by approximately 180^0 (see, e.g., Figure 20), the imaging system 175 may send a signal to the robotic arm 152 in order to instruct the robotic arm 152 to cease the rotation of the wheel, W. Once the rotation of the wheel, W, has ceased, the robotic arm 152 may be moved according to the direction of the arrow, X' (see, e.g., Figure 19), that is substantially opposite the direction of the arrow, X, such that the wheel, W, and tire, T, are removed from the platform 124 with heavy balance points, THP, WHP, of the tire, T, and wheel, W, offset from each other by approximately 180^0 .

[0060] In order to permit the above-described function of the substation 106, it will be appreciated that the arrangement of the plurality of dimples 130 be spaced from the axis, A-A, in a desired manner. As illustrated, for example, in Figure 19, the location where a sidewall surface 140 of the plurality of dimples 130 extend from the surface 126 of the platform should be radially spaced from the axis, A-A, at a distance greater than that of the radius of the wheel, W; as illustrated, in order to permit the wheel, W, to be positioned at the distance, d , that is substantially adjacent the surface 126 of the platform 124, the wheel, W, should not engage the plurality of dimples 130. Thus, the dimples may not interfere with the axial movement of the wheel, W, such that the dimples 130 function by axially offsetting the location of the tire, T, with respect to the wheel, W, in order to terminate the rotation of the tire, T, with that of the wheel, W.

[0061] The present invention has been described with reference to certain exemplary embodiments thereof. However, it will be readily apparent to those skilled in the art that it is

possible to embody the invention in specific forms other than those of exemplary embodiments described above. The scope of the claims should not be limited by the preferred embodiments set forth in the examples, but should be given the broadest interpretation consistent with the description as a whole.

CLAIMS

What is claimed is:

1. A single-cell workstation for processing a tire-wheel assembly including a tire and a wheel, comprising:

a mounting and indexing sub-station that spatially fixes an orientation of the tire as a result of a clamping force imparted by the mounting and indexing sub-station, wherein the mounting and indexing sub-station includes:

a platform that defines a plurality of elongated slots that project radially away from a central axis,

a first plurality of tire engaging portions including one or more lower tire sidewall-engaging surfaces that are movably-arranged within the plurality of elongated slots in:

a radial segment direction, and

a second plurality of tire engaging portions including one or more upper tire sidewall-engaging surfaces that are movably-arranged within the plurality of elongated slots in:

a radial segment direction,

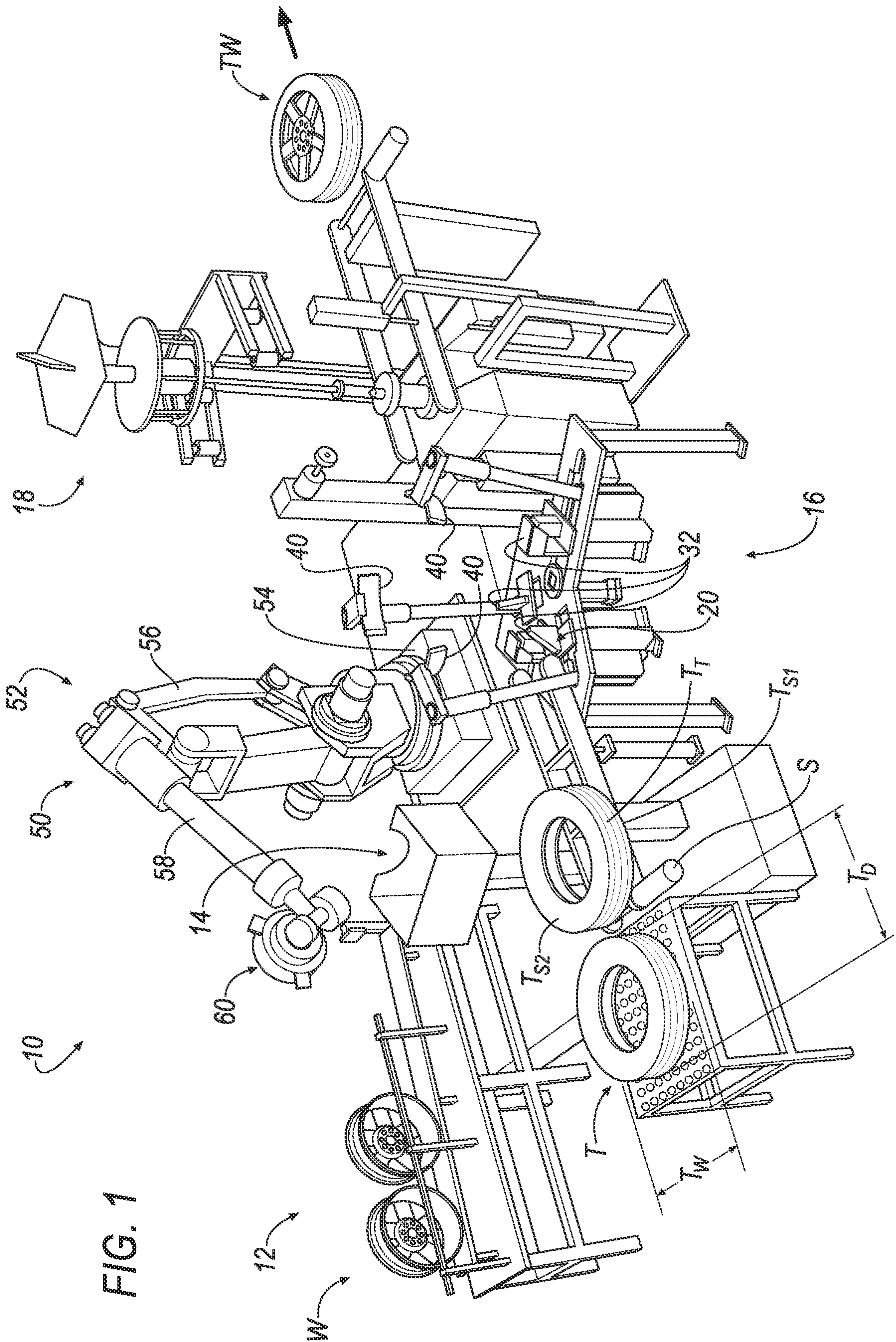
a compounded arcuate segment direction having a radial component and an axial component, and

an axial segment direction.

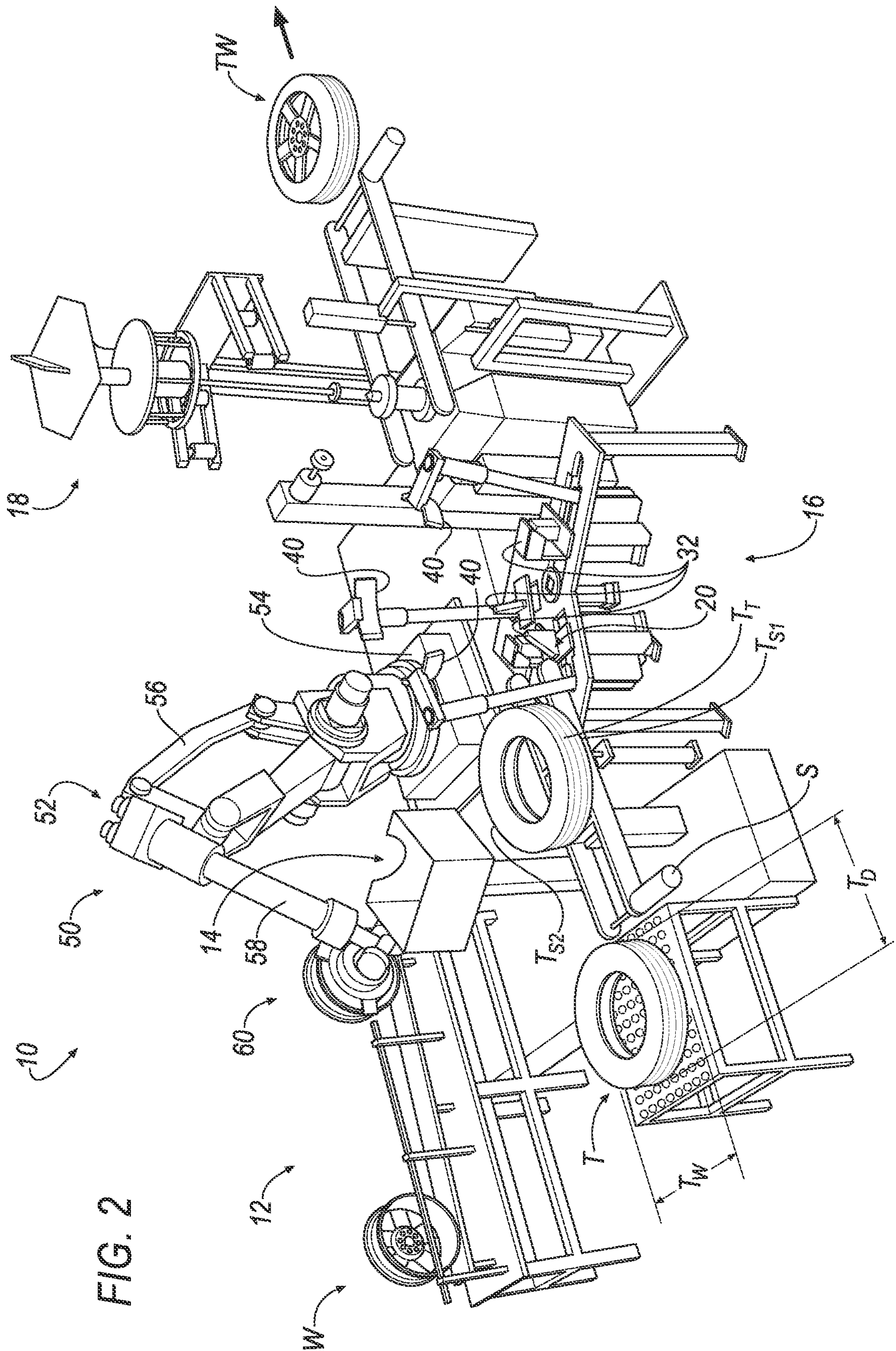
2. The single-cell workstation according to claim 1, wherein the first plurality of tire engaging portions are adjustably-disposed substantially adjacent the platform proximate the one or more radially-elongated slots, wherein the second plurality of tire engaging portions are adjustably-disposed at a distance away from the platform.

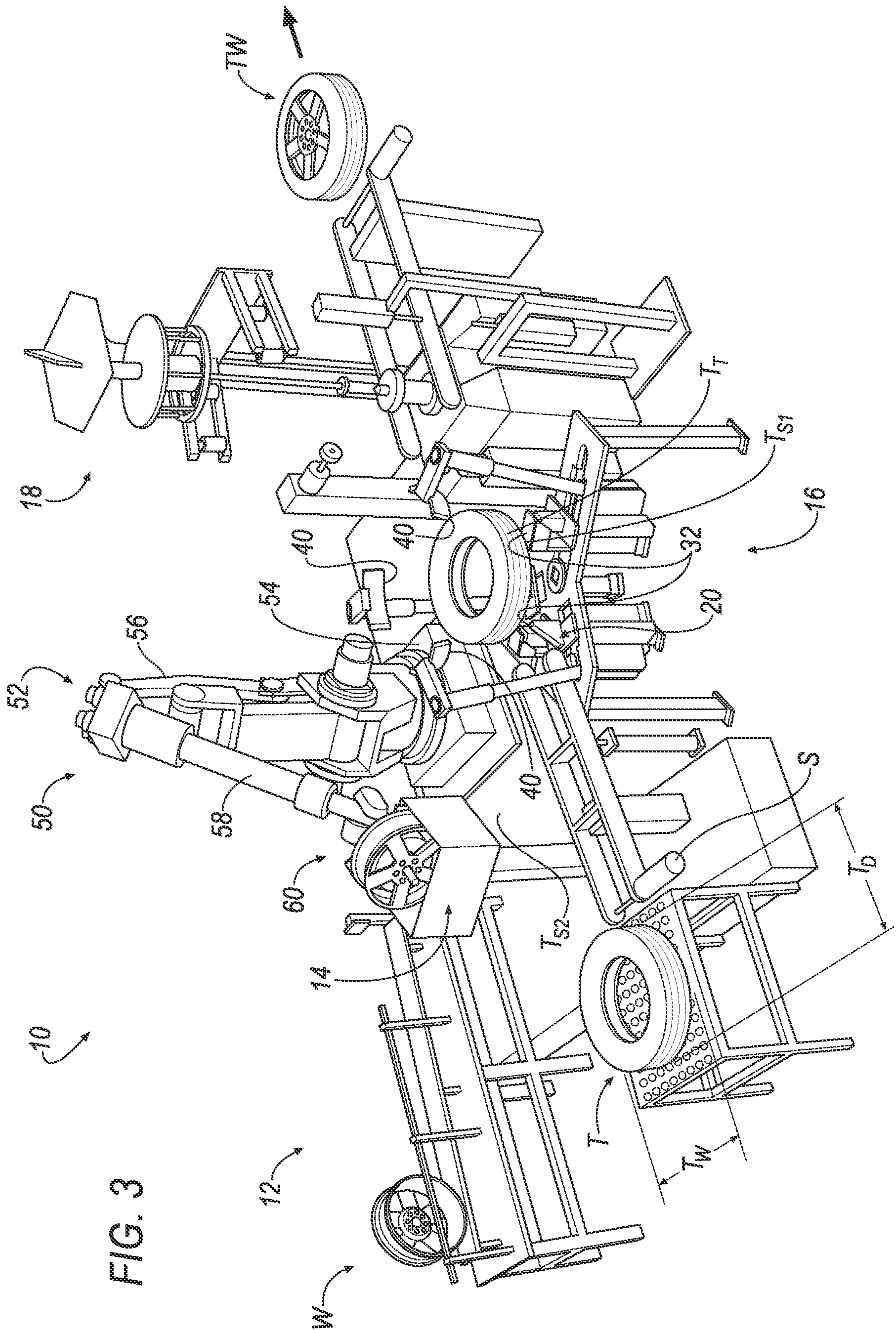
3. The single-cell workstation according to claim 1, wherein each of the second plurality of tire engaging portions include:
 - an arm portion, and
 - a head portion connected to the arm portion, wherein each head portion defines one of said one or more upper tire sidewall-engaging surfaces.
4. The single-cell workstation according to claim 1, further comprising:
 - means for adjusting the first plurality of tire engaging portions in the radial segment direction; and
 - means for adjusting the second plurality of tire engaging portions in the radial segment direction, the axial segment direction , and the compounded arcuate segment direction .
5. The single-cell workstation according to claim 4, wherein the means for adjusting the first and second plurality of tire engaging portions includes:
 - one or more actuators connected to the first and second plurality of tire engaging portions.
6. The single-cell workstation according to claim 5, further comprising:
 - means for determining one or more characteristics of the tire, wherein the means for determining includes
 - one or more tire characteristic sensors connected to the one or more actuators, wherein the one or more tire characteristic sensors provides tire characteristic data to a processor connected to the one or more actuators, wherein the data includes one or more characteristics of the tire, wherein the one or more characteristics includes a diameter of the tire and a width of the tire, wherein the means for adjusting the first plurality of tire engaging portions in the radial direction and the means for adjusting the second plurality of tire engaging portions in the more than one direction is responsive to the tire characteristic data received at the processor.

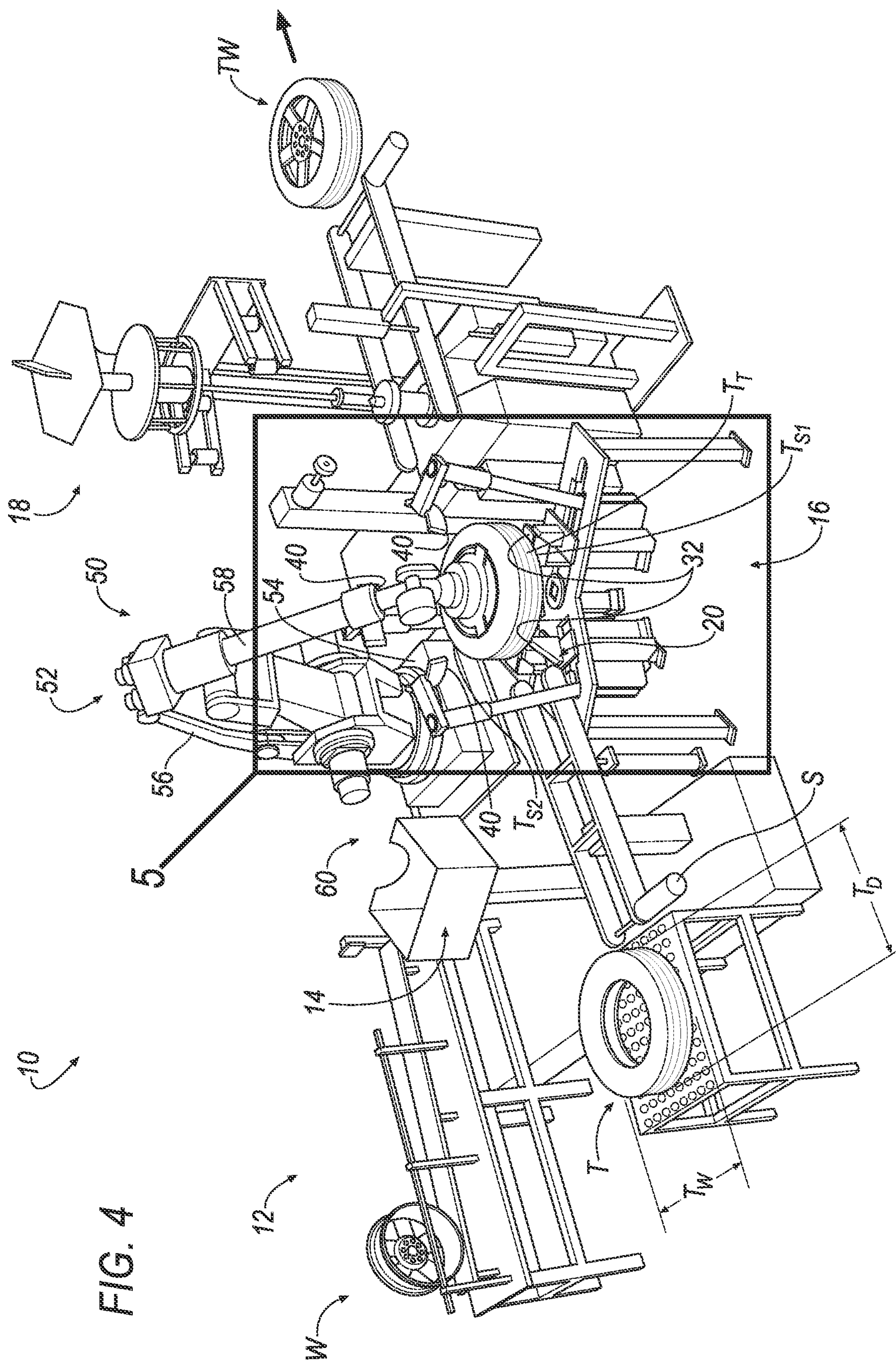
7. The single-cell workstation according to claim 1 further comprising:
means for identifying a spatial relationship of a heavy balance point of the tire and a heavy balance point of the wheel in order to identify when the heavy balance point of the tire and the heavy balance point of the wheel are offset from one another by approximately 180°.
8. The single-cell workstation according to claim 7, wherein the first plurality of tire engaging portions and the second plurality of tire engaging portions clamp the tire for spatially-fixing the tire, wherein the wheel is directly connected to and spatially manipulatable by a robotic arm for offsetting the heavy balance point of the tire and the heavy balance point of the wheel from one another by approximately 180°.



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GL







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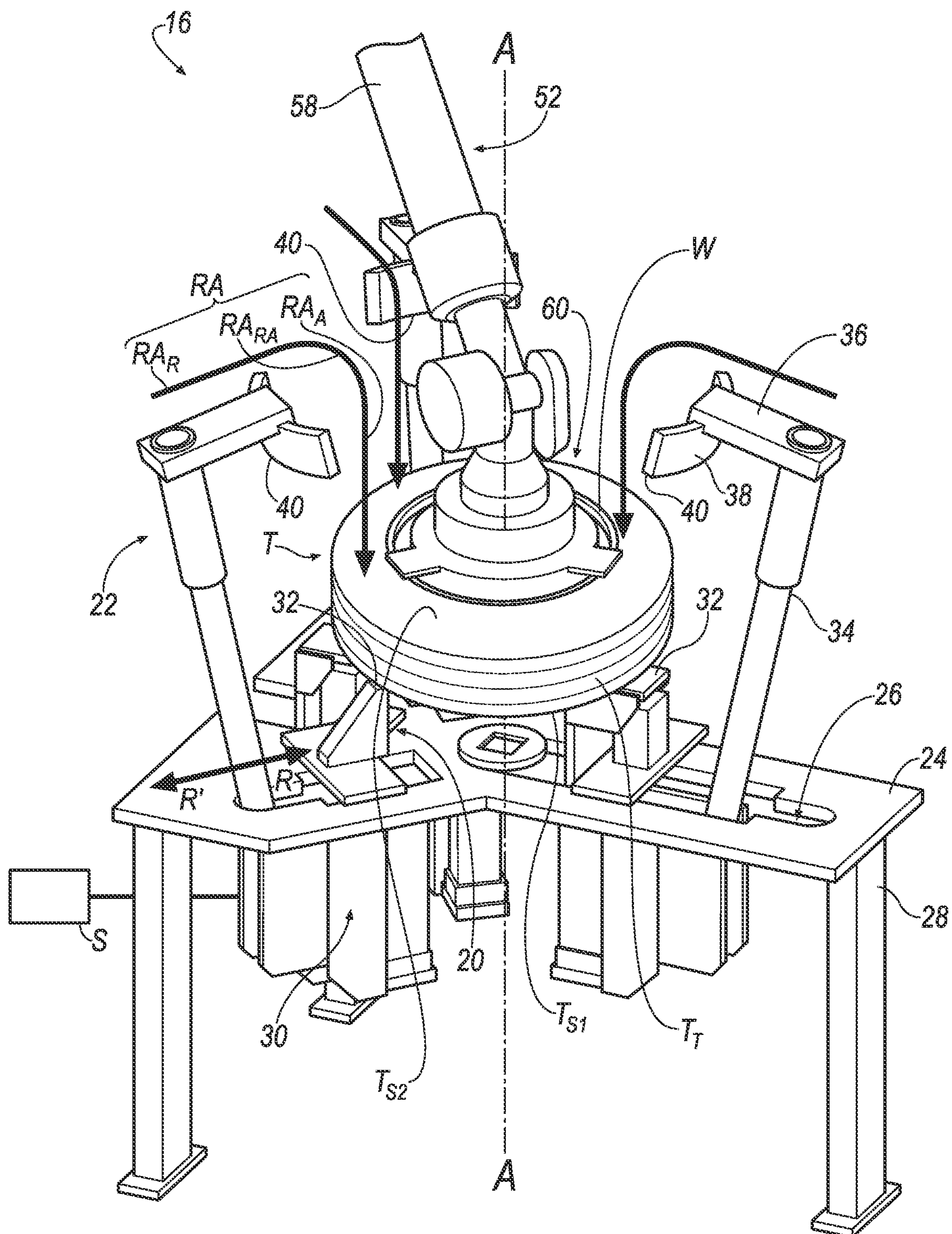


FIG. 5

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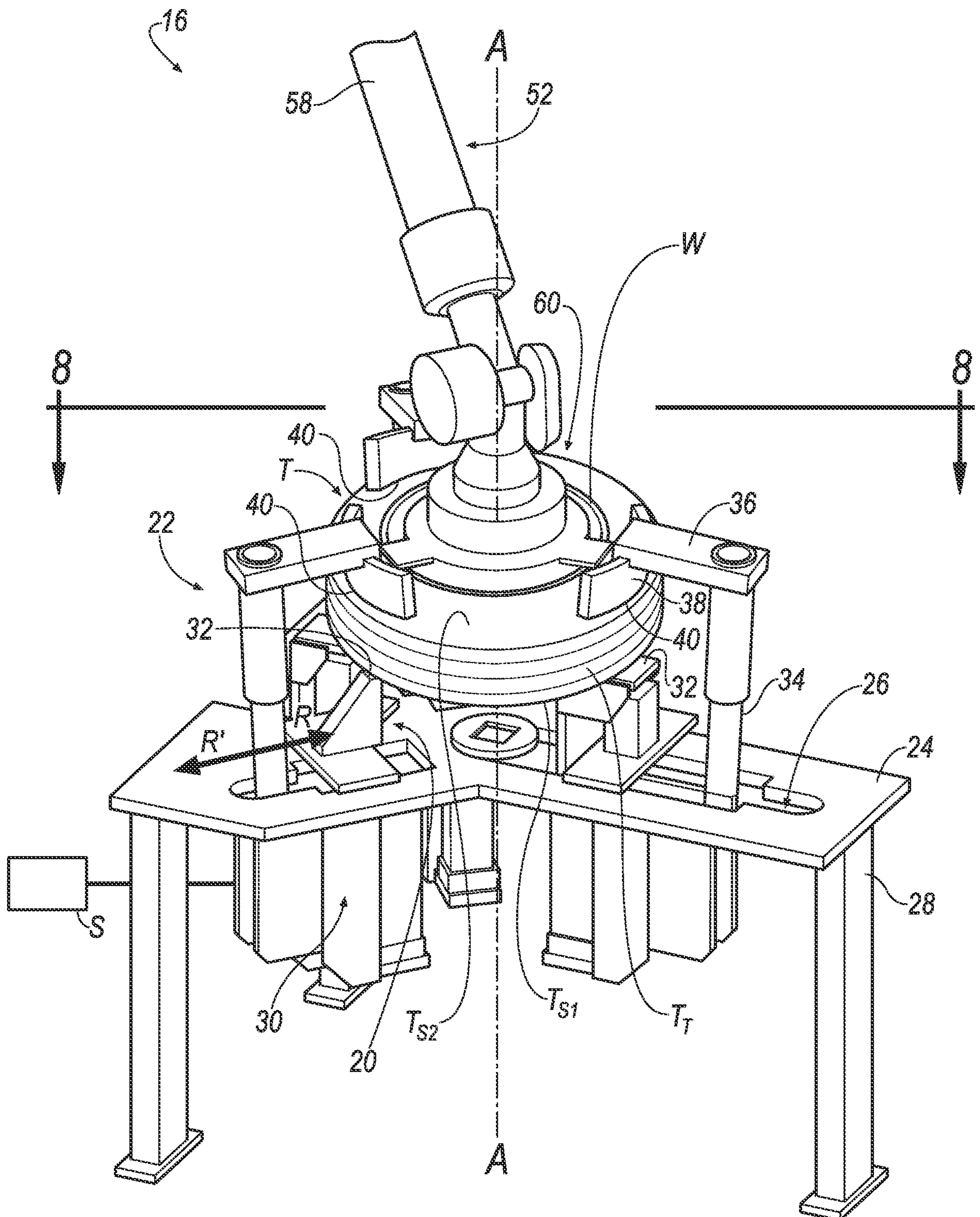


FIG. 6

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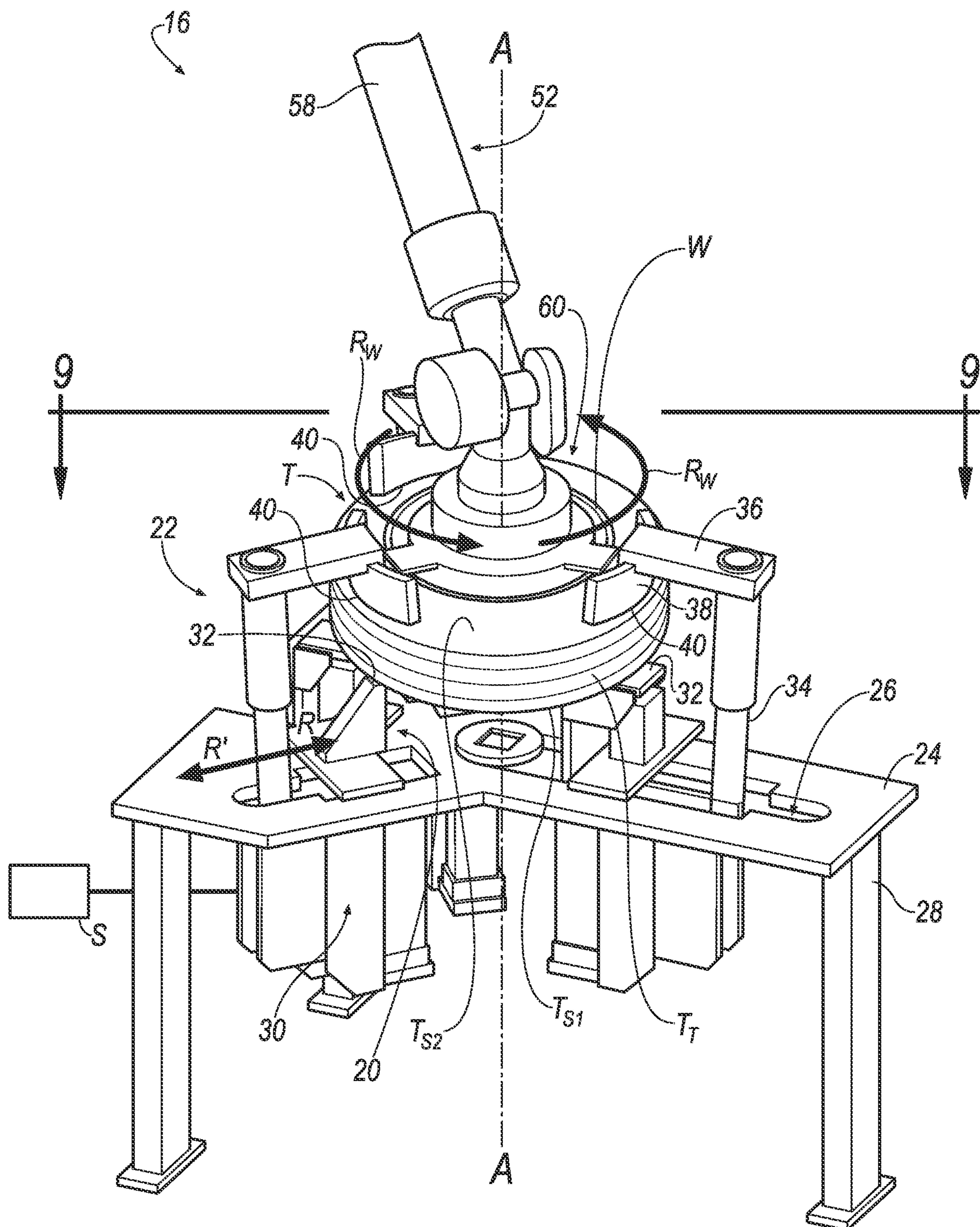


FIG. 7

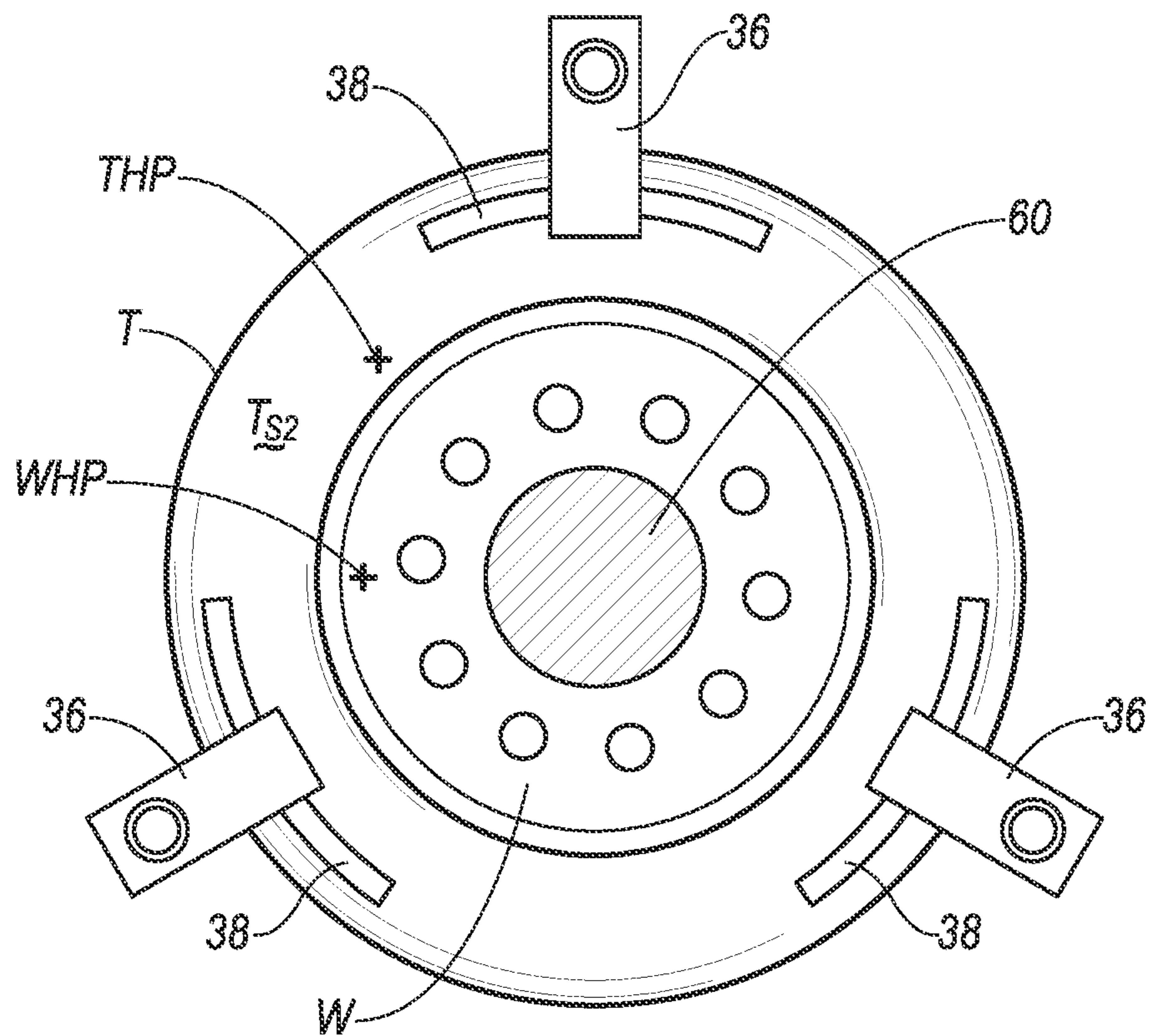


FIG. 8

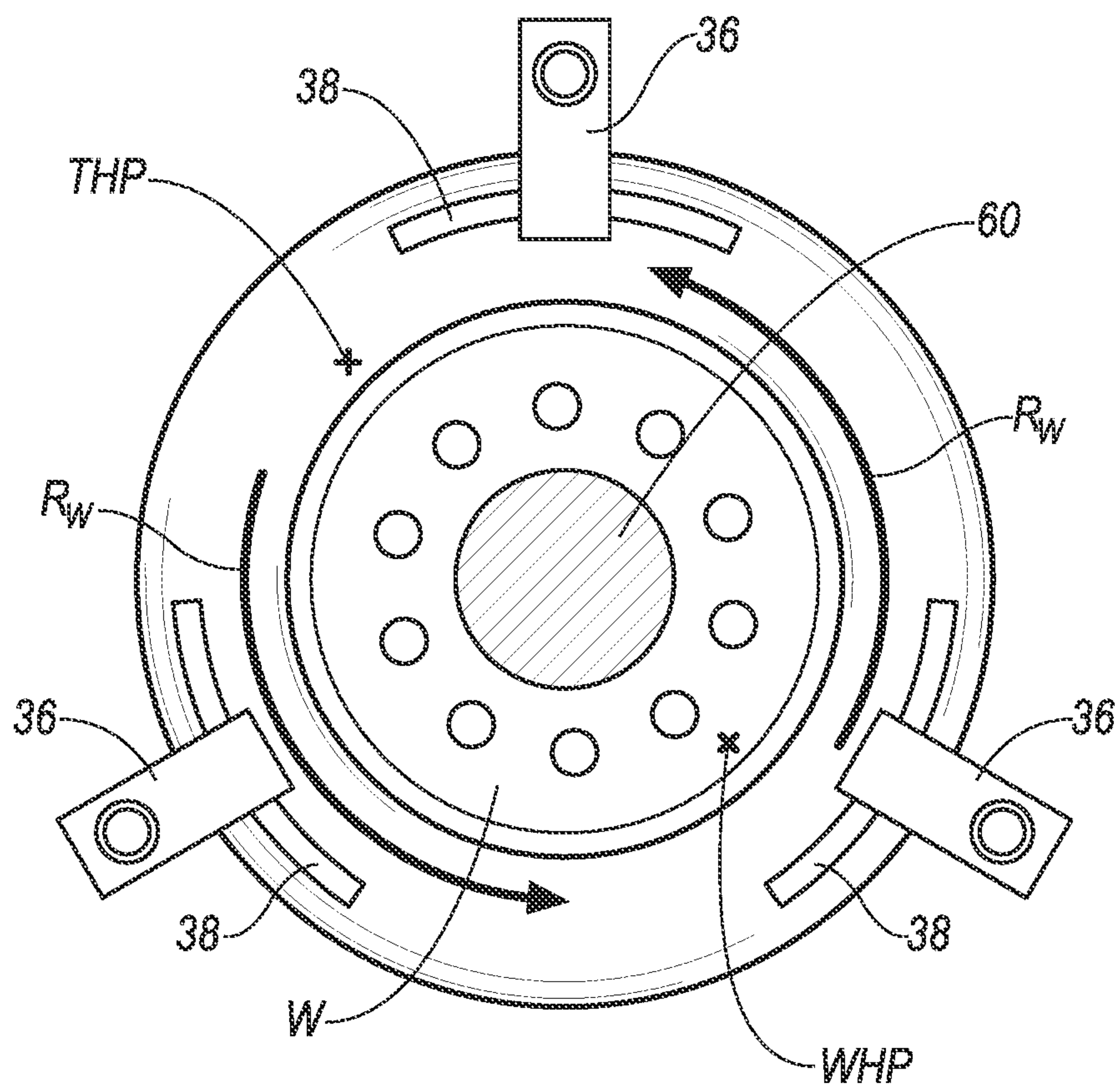


FIG. 9

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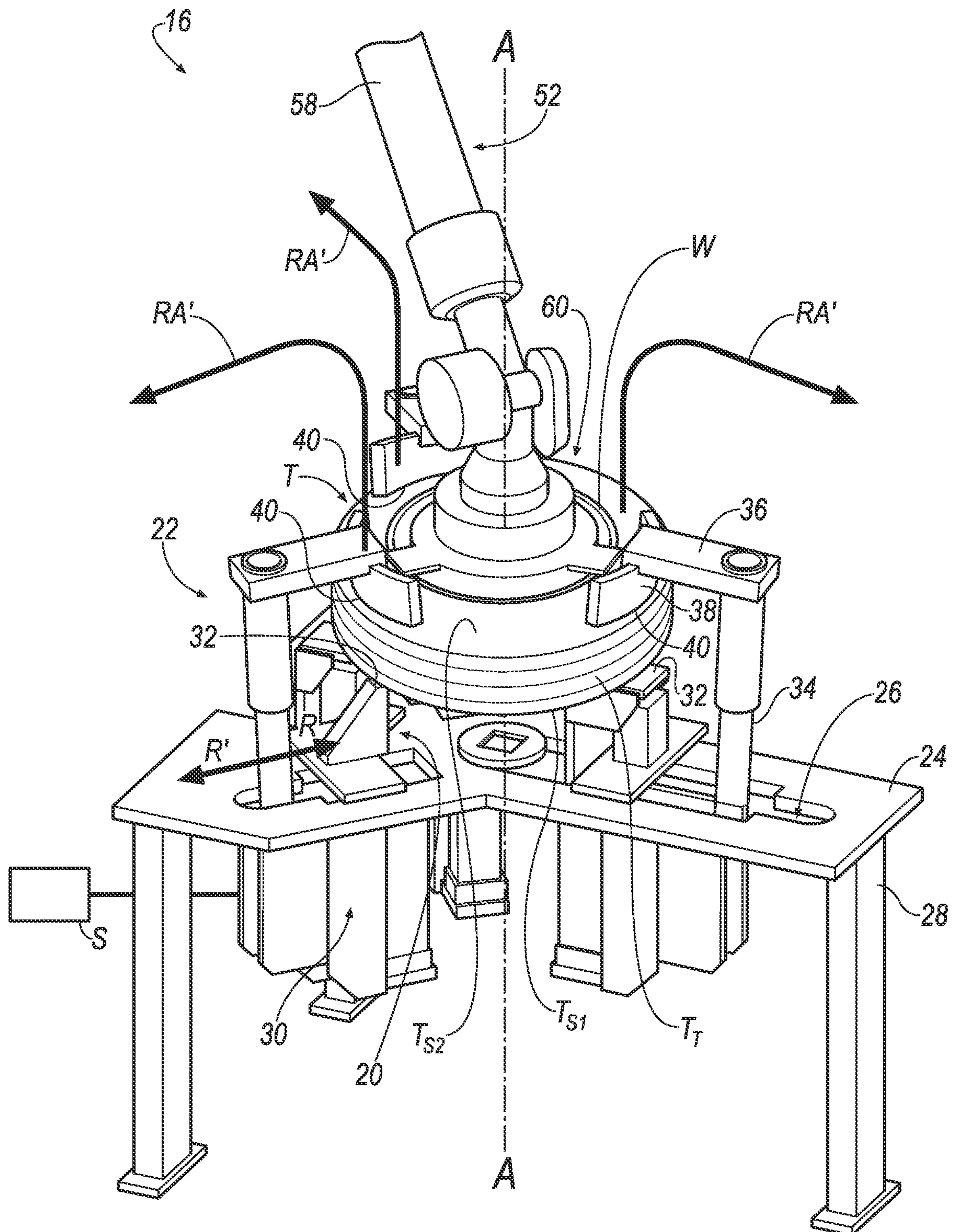


FIG. 10

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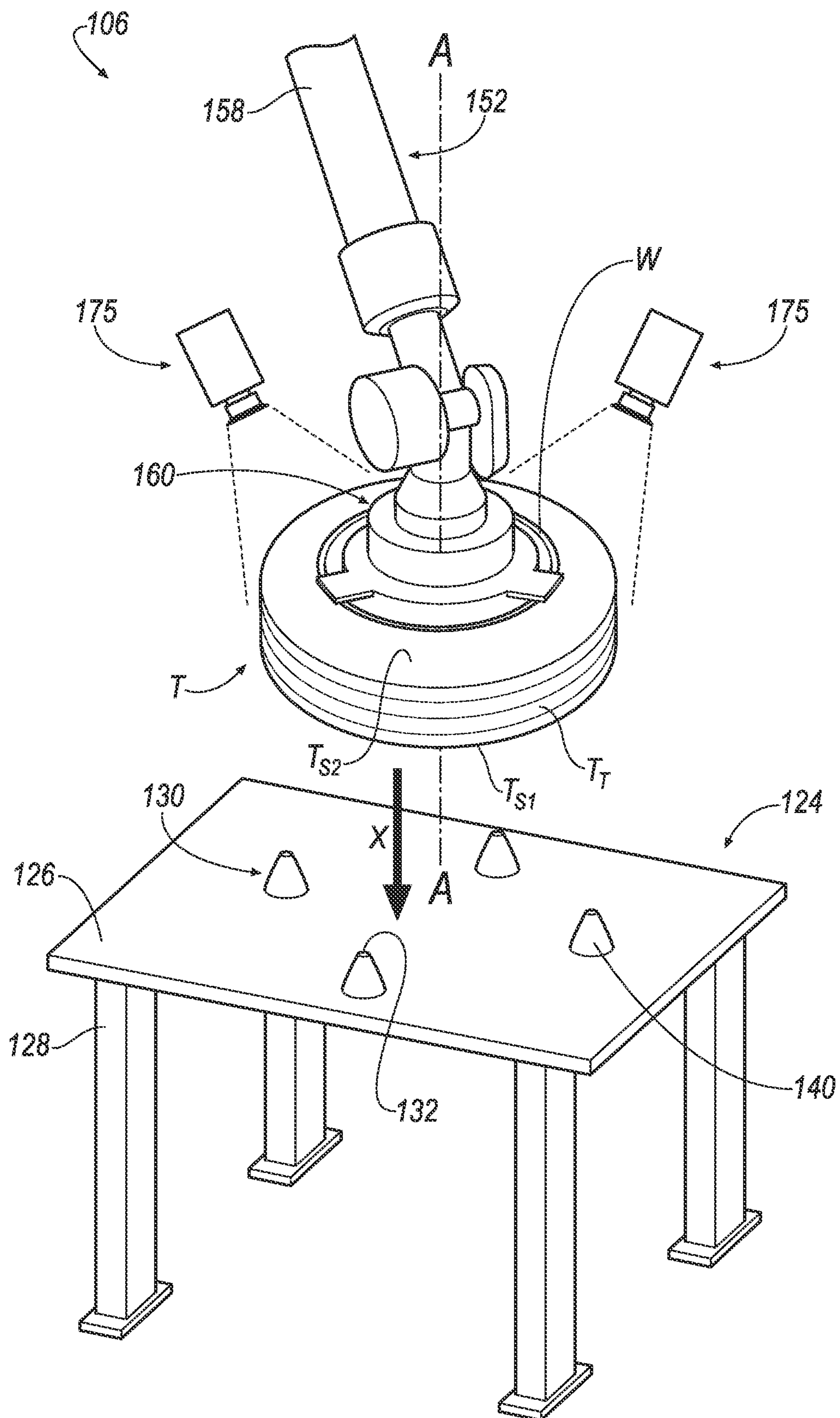


FIG. 11

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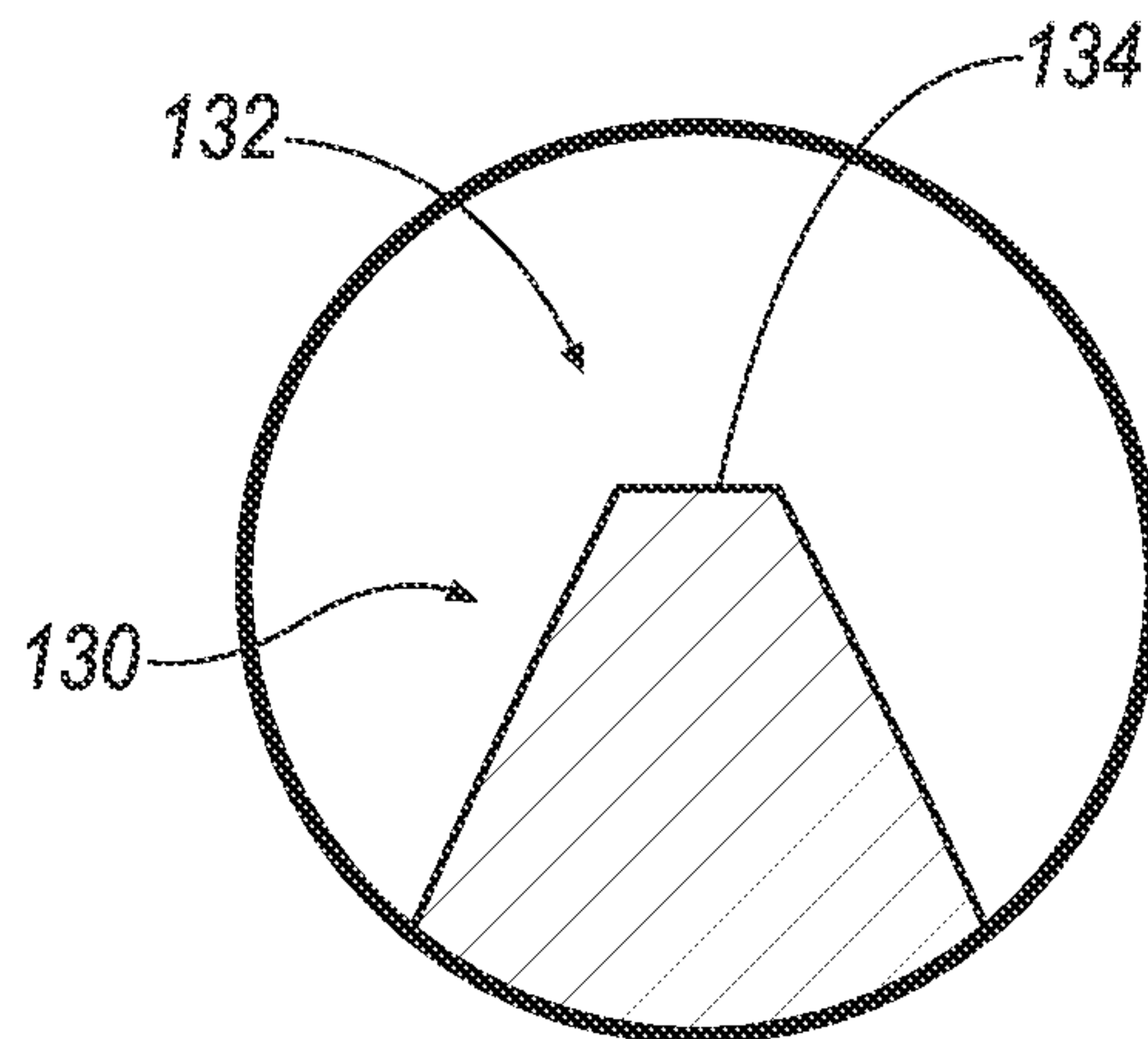


FIG. 12A

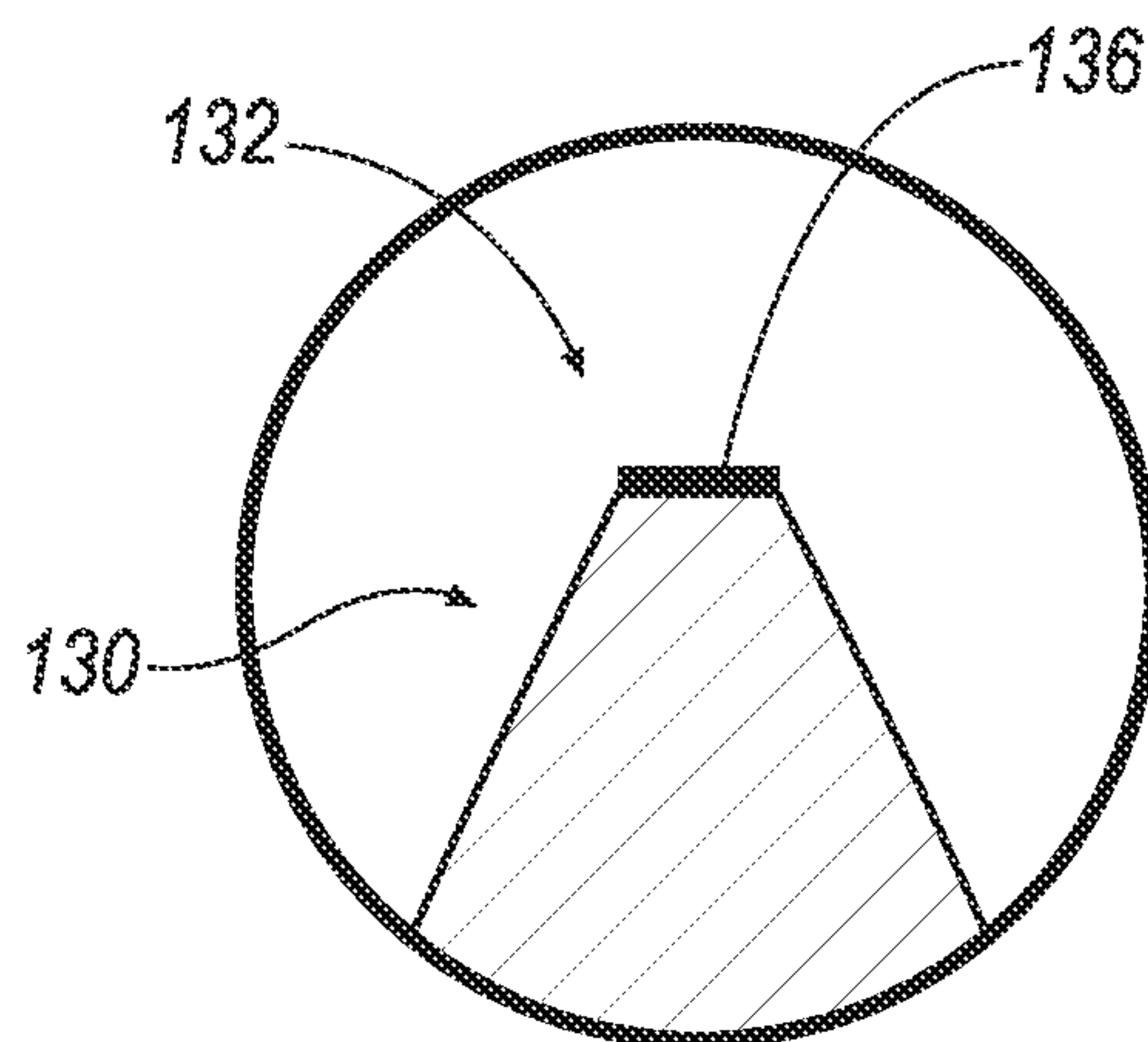


FIG. 12B

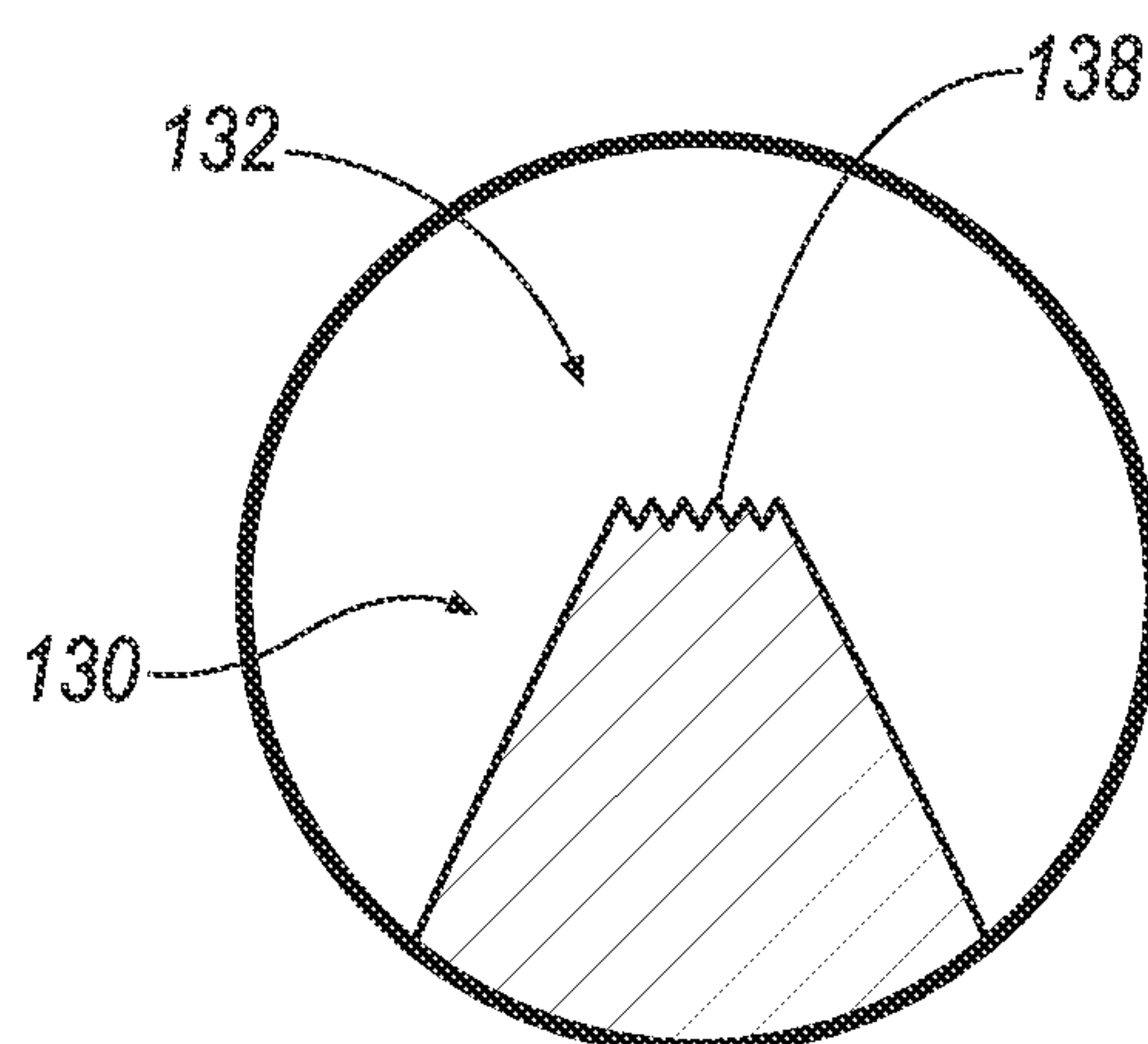


FIG. 12C

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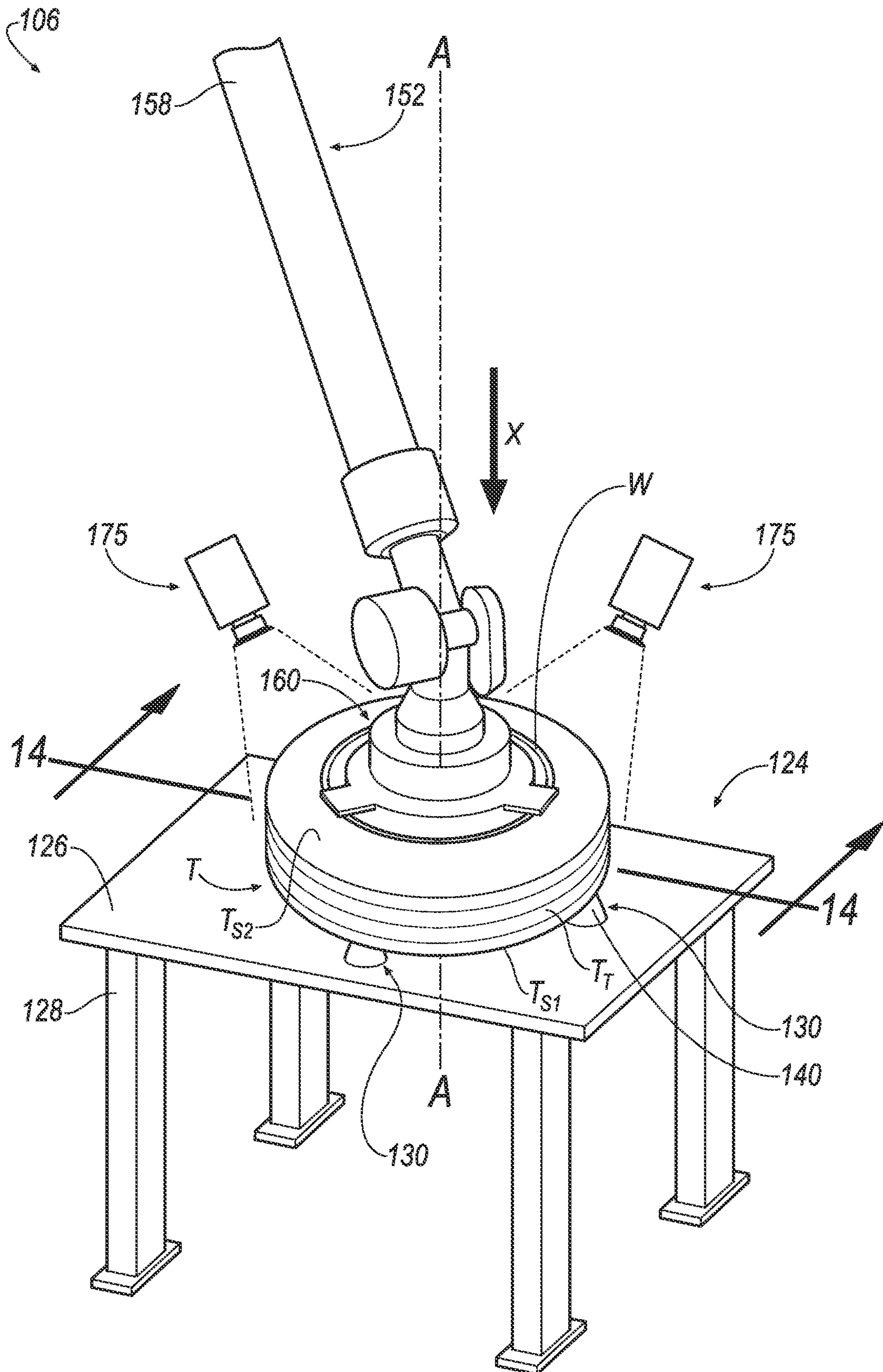


FIG. 13

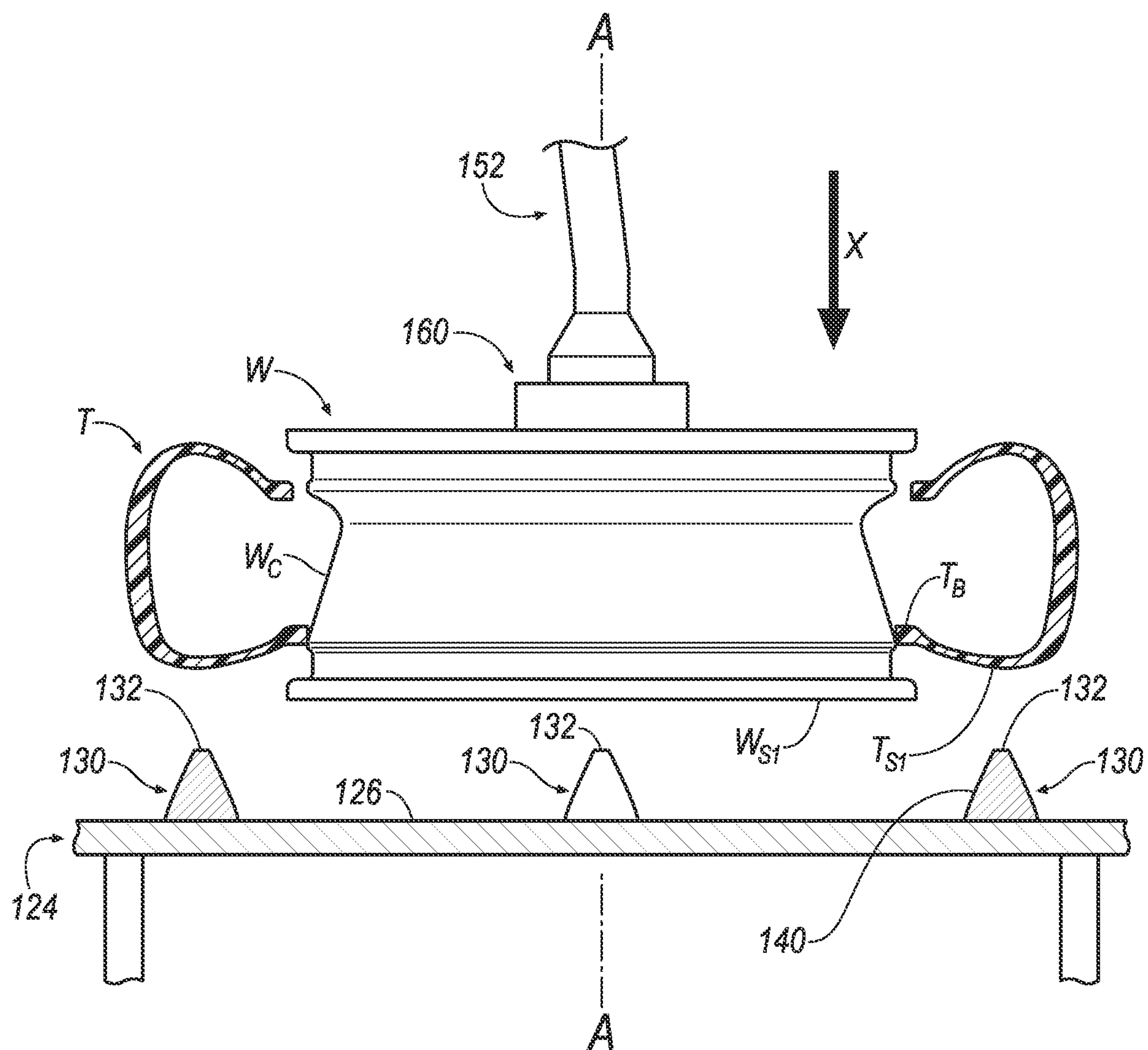


FIG. 14

