

(51) International Patent Classification:
A41H 1/02 (2006.01)

(21) International Application Number:
PCT/US2018/047306

(22) International Filing Date:
21 August 2018 (21.08.2018)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
62/550,214 25 August 2017 (25.08.2017) US

(71) Applicant: **MAYO FOUNDATION FOR MEDICAL
EDUCATION AND RESEARCH** [US/US]; 200 First
Street S.W., Rochester, Minnesota 55905 (US).

(72) Inventors: **JENSEN, Michael D.**; 3850 Hidden Way N.E.,
Rochester, Minnesota 55906 (US). **JENSEN, Teresa B.**;
3850 Hidden Way NE, Rochester, Minnesota 55906 (US).

(74) Agent: **KNIGHT, Erin B.** et al.; Fish & Richardson P.C.,
PO Box 1022, Minneapolis, Minnesota 55440-1022 (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, BN, BR, BW, BY, BZ,
CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO,
DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN,

HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP,
KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME,
MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ,
OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA,
SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, 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, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ,
UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ,
TM), European (AL, 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, RS, SE, SI, SK, SM,
TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW,
KM, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

- *as to applicant's entitlement to apply for and be granted a
patent (Rule 4.17(ii))*
- *as to the applicant's entitlement to claim the priority of the
earlier application (Rule 4.17(iii))*

Published:

- *with international search report (Art. 21(3))*

(54) Title: ABDOMINAL MEASUREMENT APPARATUSES AND RELATED METHODS

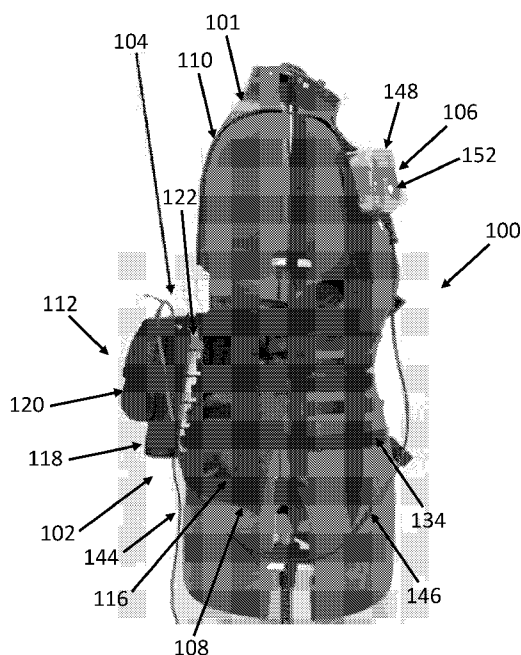


FIG. 3

(57) Abstract: An abdominal measurement apparatus includes multiple belts configured to be lengthened and shortened around respective portions of an abdomen, multiple tensioning mechanisms respectively coupled to the multiple belts and configured to maintain substantially constant tensions in the multiple belts around the respective portions of the abdomen, and multiple measurement devices respectively coupled to the multiple belts and configured to provide indications of lengths of the multiple belts while the multiple belts are maintained in tension around the respective portions of the abdomen.

**ABDOMINAL MEASUREMENT APPARATUSES AND RELATED
METHODS**

CROSS-REFERENCE TO RELATED APPLICATIONS

5 This application claims priority to U.S. Provisional Patent Application No. 62/550,214, filed on August 25, 2017, the entire contents of which are incorporated herein by reference.

TECHNICAL FIELD

10 This disclosure relates to abdominal measurement apparatuses, and more particularly to automated abdominal measurement apparatuses that can determine an abdominal volume.

BACKGROUND

15 Waist circumference measurement has been established as a better predictor of disease risk (e.g., diabetes risk, obesity risk, etc.) than body mass index (BMI). However, a number of challenges limit the use, accuracy, and reliability of waist circumference measurements. These include improper technique due to inadequate training (resulting in incorrect values), patient unease at having someone measure the
20 patient's waist during a health care visit, and the additional office time associated with acquiring such measurements, as is recommended by national guidelines. Thus, user error and the manual nature of measuring waist circumference account for significant drawbacks to using abdominal measurements to predict disease risk in the medical office or other settings. Given that internal volumes of organs (e.g., liver, kidneys,
25 spleen, intestines, etc.) is similar across patients, whereas abdominal fat can vary widely across patients, abdominal volume may turn out to be an even better predictor of disease risk than an accurately measured waist circumference.

SUMMARY

30 The present disclosure provides an automated, portable, and lightweight abdominal measurement apparatus that includes a small backpack, a measurement assembly, and a user interface terminal. The abdominal measurement apparatus

provides an accurate, reliable measurement of abdominal circumference and/or volume that removes the variability associated with conventional manual measuring tapes used to measure waist circumference. Owing to the small footprint and light weight of the abdominal measurement apparatus, the abdominal measurement
5 apparatus may be transported easily and made readily available in a variety of settings, such as at a home, an office, a medical facility, or a fitness center.

In one aspect, an abdominal measurement apparatus includes multiple belts configured to be lengthened and shortened around respective portions of an abdomen, multiple tensioning mechanisms respectively coupled to the multiple belts and
10 configured to maintain substantially constant tensions in the multiple belts around the respective portions of the abdomen, and multiple measurement devices respectively coupled to the multiple belts and configured to provide indications of lengths of the multiple belts while the multiple belts are maintained in tension around the respective portions of the abdomen.

15 Embodiments may include one or more of the following features.

In some embodiments, each belt of the multiple belts includes two portions.

In certain embodiments, each tensioning mechanism of the multiple tensioning mechanisms includes two spring-loaded rollers.

In some embodiments, the abdominal measurement apparatus further includes
20 a backpack to which the multiple belts are mounted, the backpack being adjustable to accommodate various sizes of subject torsos.

In certain embodiments, each measurement device of the multiple measurement devices is configured to acquire measurements at a predetermined frequency.

25 In some embodiments, the abdominal measurement apparatus further includes a processor in communication with the multiple measurement devices.

In certain embodiments, the processor is configured to receive measurements from the multiple measurement devices and to output the measurements to a computing device.

30 In some embodiments, the processor is configured to wirelessly communicate with the computing device.

In certain embodiments, the abdominal measurement apparatus further includes a user interface terminal by which the abdominal measurement apparatus can be controlled.

In another aspect, a method of measuring an abdomen includes receiving, by a
5 processor, multiple signals that respectively indicate peripheral measurements of an abdomen and determining, by the processor, an index associated with the abdomen based on the multiple signals indicating peripheral measurements of the abdomen. The multiple signals are generated by an abdominal measurement apparatus in contact with the abdomen. The abdominal measurement apparatus includes multiple belts
10 configured to be lengthened and shortened around respective portions of an abdomen, multiple tensioning mechanisms respectively coupled to the multiple belts and configured to maintain substantially constant tensions in the multiple belts around the respective portions of the abdomen, and multiple measurement devices respectively coupled to the multiple belts and configured to provide indications of lengths of the
15 multiple belts while the multiple belts are maintained in tension around the respective portions of the abdomen.

In some embodiments, each belt of the multiple belts includes two portions.

In certain embodiments, the method further includes adjusting a length of one or more of the multiple belts.

20 In some embodiments, each tensioning mechanism of the multiple tensioning mechanisms includes two spring-loaded rollers.

In certain embodiments, the method further includes receiving, by the processor, the multiple signals at a predetermined frequency.

In some embodiments, the index is an abdominal volume.

25 In certain embodiments, the index is an abdominal circumference.

DESCRIPTION OF DRAWINGS

FIG. 1 is a front view of an abdominal measurement apparatus.

FIG. 2 is a rear view of the abdominal measurement apparatus of FIG. 1.

FIG. 3 is a side view of the abdominal measurement apparatus of FIG. 1.

30 FIG. 4 is a perspective view of a portion of multiple measurement devices of the abdominal measurement apparatus of FIG. 1.

FIG. 5 is a perspective view of a portion of a measurement assembly including the multiple measurement devices of FIG. 4.

FIG. 6 is a perspective view of an internal portion of one of the multiple measurement devices of FIG. 4.

5 FIG. 7 is an exploded perspective view of a portion of one of the multiple measurement devices of FIG. 4.

FIG. 8 is a screenshot of a viewing window displaying data output from the abdominal measurement apparatus of FIG. 1.

10 FIG. 9 is a graph of a coefficient of variation (CV) for replicate waist circumference measurements.

Like reference symbols in the various figures indicate like elements. In some examples, illustrations shown in the drawings may not be drawn to scale.

DETAILED DESCRIPTION

15 FIGS. 1-3 are front, rear, and side images, respectively, of an abdominal measurement apparatus 100 that determines an abdominal volume of a subject 101. The abdominal measurement apparatus 100 includes a backpack 102, a measurement assembly 104, and a user interface terminal 106. The abdominal measurement apparatus 100 is portable and has a light weight of about 3 lbs to about 4 lbs.

20 The backpack 102 is typically made of fabric (e.g., nylon or another material) and includes a support band 108, two shoulder straps 110, a centrally located pouch 112 that houses electronics, two anchoring straps 114 that secure a position of the pouch 112, and two guide straps 116 that locate components of the measurement assembly 104, as will be discussed in more detail below. The support band 108 is
25 sized to span an abdomen of the subject 101 and typically has a length of about 48 cm to about 52 cm and a width of about 13 cm to about 15 cm. The length and width of the support band 108 may vary and may be selected in dependence on a size of the subject 101. The shoulder straps 110 are adjustable to accommodate various torso sizes. The pouch 112 includes inner portion 118 and an outer portion 120. The inner
30 portion 118 has a height of about 18 cm to about 22 cm, a width of about 9 cm to about 11 cm, and a depth of about 5 cm to about 6 cm. The outer portion 120 has a height of about 14 cm to about 15 cm, a width of about 7 cm to about 9 cm, and a

depth of about 4 cm to about 5 cm. The guide straps 116 are attached to the support band 108 at upper ends, lower ends, and multiple (e.g., four) intermediate points to define multiple (e.g., five) spaces that locate components of the measurement assembly 104.

5 FIGS. 4-7 are various illustrations of portions of the measurement assembly 104. Referring to FIGS. 1-7, the measurement assembly 104 includes multiple (e.g., five) measurement devices 122, a zipper 124 attached to the measurement devices 122, two clips 154 located at opposing ends of the zipper 124, and a processing module 126 that processes data from the measurement devices 122. Referring
10 particularly to FIGS. 4-7, each measurement device 122 includes two rollers 128 (e.g., spring-loaded rollers) that rotate about respective magnetic encoders 132, two belts 134 that are respectively attached to the rollers 128, a circuit board 136 providing electronics, two encoder readers 138 attached to the circuit board 136 that respectively determine a number of revolutions taken by the rollers 128 and a
15 direction of the revolutions, a cable 140 extending from the circuit board 136 to the processing module 126, and a multi-part enclosure 142 that surrounds the various components of the measurement device 122. The enclosures 142 of the measurement devices 122 are covered by the inner portion 118 of the pouch 112.

 The two belts 134 of each measurement device 122 together form a measuring
20 tape that can be lengthened and shortened to accommodate a size the subject 101 according to rotation of the respective rollers 128. The belts 134 are typically made of fabric (e.g., nylon or another material) and extend from the enclosure 142 to the zipper 124 through the spaces formed by the guide straps 116. The fabric from which the belts 134 are made is flexible, but not subject to stretching or shortening such that
25 the belts 134 do not change in length with use. In this manner, the spaces formed by the guide straps 116 serve to maintain a vertical position of the belts 134 around the support band 108 and between the enclosure 142 and the zipper 124. Each belt 134 (i.e., forming half of a measurement tape) has a total extended length of about 35 cm to about 70 cm and a width of about 1 cm to about 3 cm. The belts 134 are typically
30 spaced vertically from each other (e.g., as measured from centerlines of the belts 134) by about 2 cm to about 4 cm (e.g., about 2 cm) over a total height of about 25 cm to about 30 cm.

The processing module 126 is secured to the measurement devices 122 and houses processing electronics (not shown) to which the cables 140 of the measurements devices 122 are connected. A cable 144 extends from the processing electronics to a computer (not shown), and a cable 146 extends from the processing electronics to the user interface terminal 106. The processing module 126 is covered by the outer portion 120 of the pouch 112.

The user interface terminal 106 is releasably securable to the shoulder straps 110 via a snap button. The user interface terminal 106 includes an enclosure 148, a viewing window 150 on which messages are displayed, and a control button 152 for operating the abdominal measurement apparatus 100.

In operation, a user positions the abdominal measurement apparatus 100 in an open, flat configuration on a generally flat surface. In some implementations, the abdominal measurement apparatus 100 may hang on a wall or be otherwise stored in a position that makes it easy for the user to slip on the abdominal measurement apparatus. The user connects the cable 144 of the processing module 126 to a computer and then opens an application of the processing module 126 to establish communication between the computer and the user interface terminal 106. In some implementations, the cable 144 may already be connected to the computer such that the user interface terminal 106 is ready for use. In some alternative embodiments, the user interface terminal 106 may have an independent power supply and be connected to the computer via a Bluetooth connection. The application starts up the processing module 126, and the measurement devices 122 determine initial, home positions of the rollers 128 and the associated belts 134. The subject 101 puts the abdominal measurement apparatus 100 on by sliding his or her arms through the shoulder straps 108 and then closing the backpack 102 against his or her abdomen by clasping the clips 144 together. Next, the subject 101 adjusts the shoulder straps 110 to snugly position the shoulder straps 110 in contact with the torso of the subject 101.

The subject 101 then adjusts his or her clothes to ensure that the clothes are generally flat (e.g., smooth and un-bunched) underneath the backpack 102. In order to obtain accurate readings, it will be suggested that the subject 101 wears a single layer of light clothes. The subject 101 also adjusts the belts 134 to ensure that the belts 134 are flat against the abdomen along an entire frontal surface of the abdomen

and positions the zipper 124 horizontally at an approximate centerline of the abdomen and vertically approximately at a waistline of the subject 101. The subject 101 zips up the zipper 124, and as the zipper 124 is being zipped, the rollers 128 of the measurement devices 122 adjust (e.g., rotate to lengthen or shorten the belts 134) to
5 produce a constant tension of about 4 pounds to about 7 pounds in the belts 134 such that the belts 134 snugly contact the abdomen without squeezing the abdomen.

The subject 101 grasps the user interface terminal 106 and presses the control button 152 to activate the processing module 126. The viewing window 150 indicates a type of round occurring (e.g., a measurement round or a relaxation round), an
10 amount of time (in seconds) remaining in the round, and a count of the total number of rounds. The normal breathing motion of the subject 101 often causes the abdomen to expand and contract throughout the round.

During measurement rounds, the belts 134 are lengthened (e.g., unwound) around the abdomen or shortened (e.g., wound) within the respective measurement
15 device 122 by rotation of the spring-loaded rollers 128 such that the constant tension is maintained in the belts 134 as the abdomen expands and contracts. Both belts 134 in a same measurement device 122 are adjusted by an equal amount in opposite roller directions such that both belts 134 are simultaneously lengthened by the same amount or such that both belts 134 are simultaneously shortened by the same amount. The
20 encoder readers 138 of the measurement devices 122 can register 128 counts to 512 counts (e.g., 256 counts) per revolution of the respective rollers 128 and directions of revolutions to determine a length of the belts 134 extended from a respective measurement device 122.

The processing module 126 determines an abdominal circumference
25 associated with the length measurements of the two belts 134 acquired for each measurement device 122. A value of the abdominal circumference may have an error of about 0.08 cm to about 1.00 cm. Each measurement round lasts about 60 seconds and is divided into four, 15 second intervals that are displayed on the user terminal viewing 150 as alternating indications of “measuring” and “relax”. The data
30 generated includes about 60 abdominal circumference values (one per second) for each set of belts 134. The tension in the belts 134 remains constant throughout each 60 second measurement round. The indications of “measuring” and “relax” are

intended to discourage the subject 101 from holding in his or her abdomen during the measurements.

Referring to FIG. 8, an abdominal circumference, a type of the round, and an associated time stamp are outputted in a row to a viewing window 170 displayed on a monitor of the computer for each set of length measurements produced for each measurement device 122. Measuring the abdominal circumference at five locations allows determination of an optimal circumference that is associated with health risk for entry into an electronic medical record (EMR). In addition, an abdominal volume of the subject 101 can be calculated from this data. In some embodiments, the processing module 126 may be programmed to compute an abdominal volume of the subject 101 according to an algorithm. The outputted data can be stored in various types of files, such as a spreadsheet or a text file. In some implementations, the optimal circumference and/or computed abdominal volume can be stored in the EMR in association with a date, an identity of the subject 101, or other parameters.

In some implementations, the abdominal measurement apparatus 100 may be used to determine the abdominal circumference of a subject every 3 months to every 12 months, depending on a health state and a health objective of the subject. The abdominal measurement apparatus 100 provides an accurate, precise (e.g., repeatable) abdominal measurement that removes the variability associated with conventional manual measurement tapes used by subjects and clinicians to measure abdomens (e.g., waist circumference) of the subjects. Owing to the small footprint and light weight of the abdominal measurement apparatus 100, the abdominal measurement apparatus 100 may be transported easily and made readily available in a variety of settings, such as at a home, an office, a medical facility, or a fitness center.

Testing of the abdominal measurement apparatus 100 has shown that, even an adult who is inexperienced in putting on and operating the abdominal measurement apparatus 100 can measure his or her waist circumference (e.g., for 5 days in a row) more reproducibly than can a highly trained operator using a standard measuring tape, as shown in FIG. 9.

A number of embodiments have been described. Nevertheless, it will be understood that various modifications may be made without departing from the spirit and scope of the present disclosure. For example, while the abdominal measurement

apparatus 100 has been described as having certain dimensions, operational parameters, and material constituencies, in some embodiments, abdominal measurement apparatuses that are generally similar in construction and function to the abdominal measurement apparatus 100 may include different dimensions, operational
5 parameters, and material constituencies.

While the abdominal measurement apparatus 100 has been described and illustrated as a wired apparatus, in some embodiments, an abdominal measurement apparatus that is similar in function and construction to the abdominal measurement apparatus 100 may include one or both of a wireless processing module and wireless
10 user terminal and associated Bluetooth technologies.

While the abdominal measurement apparatus 100 has been described as being used to determine an optimally predictive abdominal circumference, in some embodiments, an abdominal measurement apparatus that is similar in function and construction to the abdominal measurement apparatus 100 may be designed to
15 determine other indices or parameters associated with the abdomen, such as abdominal volume.

In certain embodiments, an abdominal measurement apparatus that is otherwise similar in function and construction to the abdominal measurement apparatus 100 may additionally include a distance sensor system for measuring
20 anterior-posterior diameter, thereby improving volume measurements. For example, one or more distance sensors can be located at the front and/or back of the abdominal measurement apparatus to measure anterior-posterior distance. In one example, one distance sensor can be located at or close to the zipper 124 along a front portion of the abdominal measurement apparatus, and another distance sensor can be located at or
25 close to the measurement device 122 along a rear portion of the abdominal measurement apparatus. In another example, two or more distance sensors can be mounted on different belts 134 close to the zipper 124 along a front portion of the abdominal measurement apparatus, and two or more distance sensors can be mounted
30 on different belts 134 close to the measurement device 122 along a rear portion of the abdominal measurement apparatus.

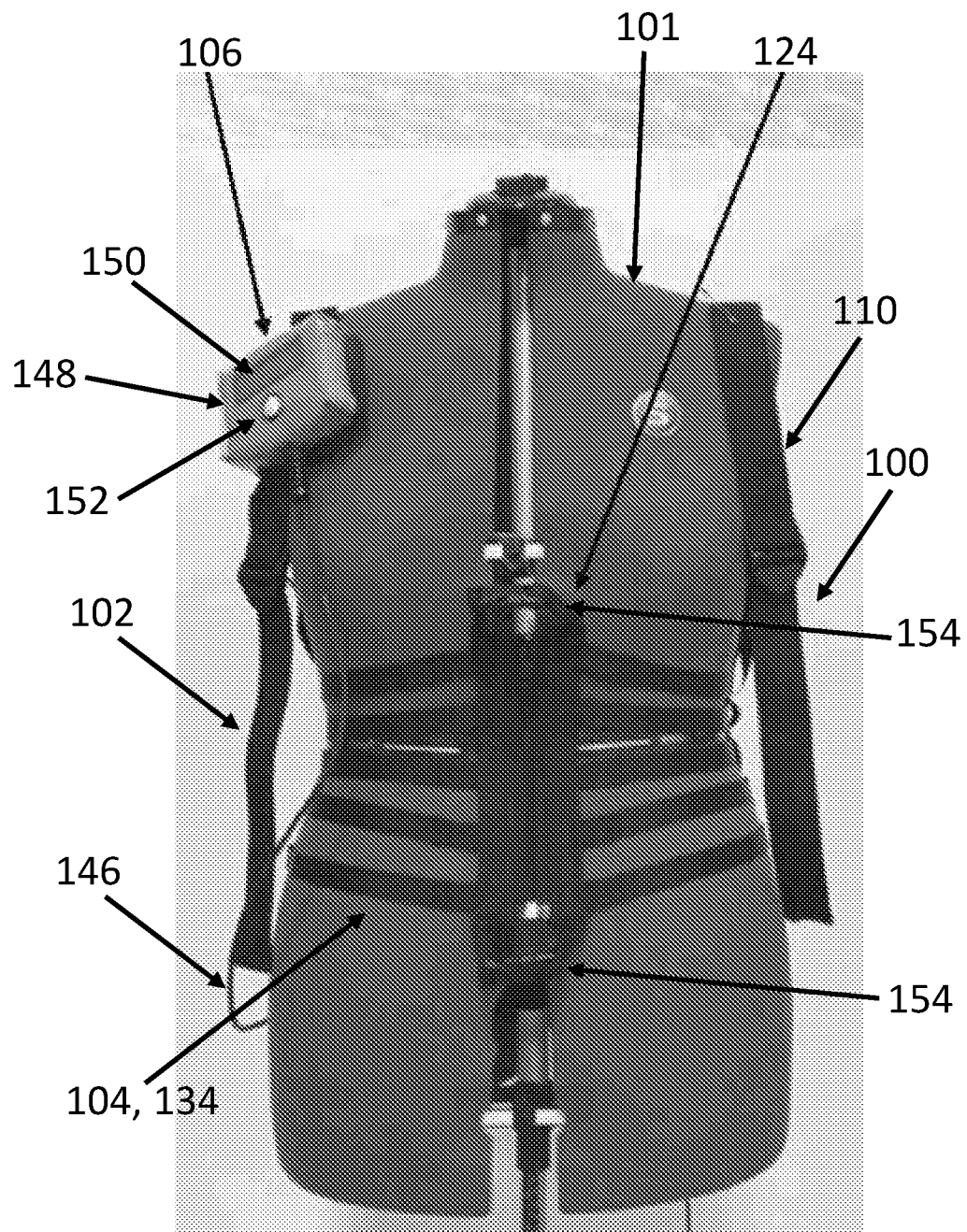
Other embodiments are within the scope of the following claims.

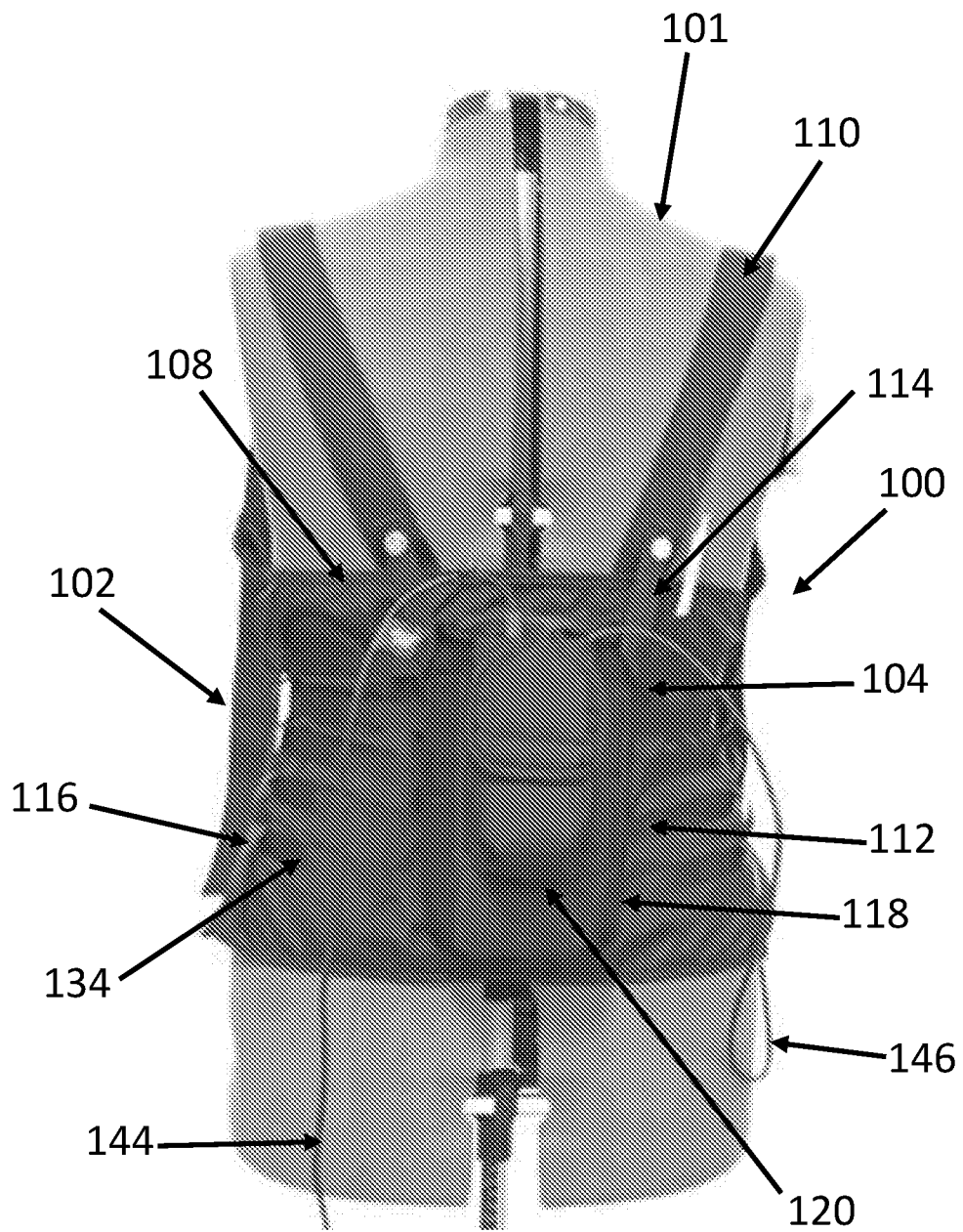
WHAT IS CLAIMED IS:

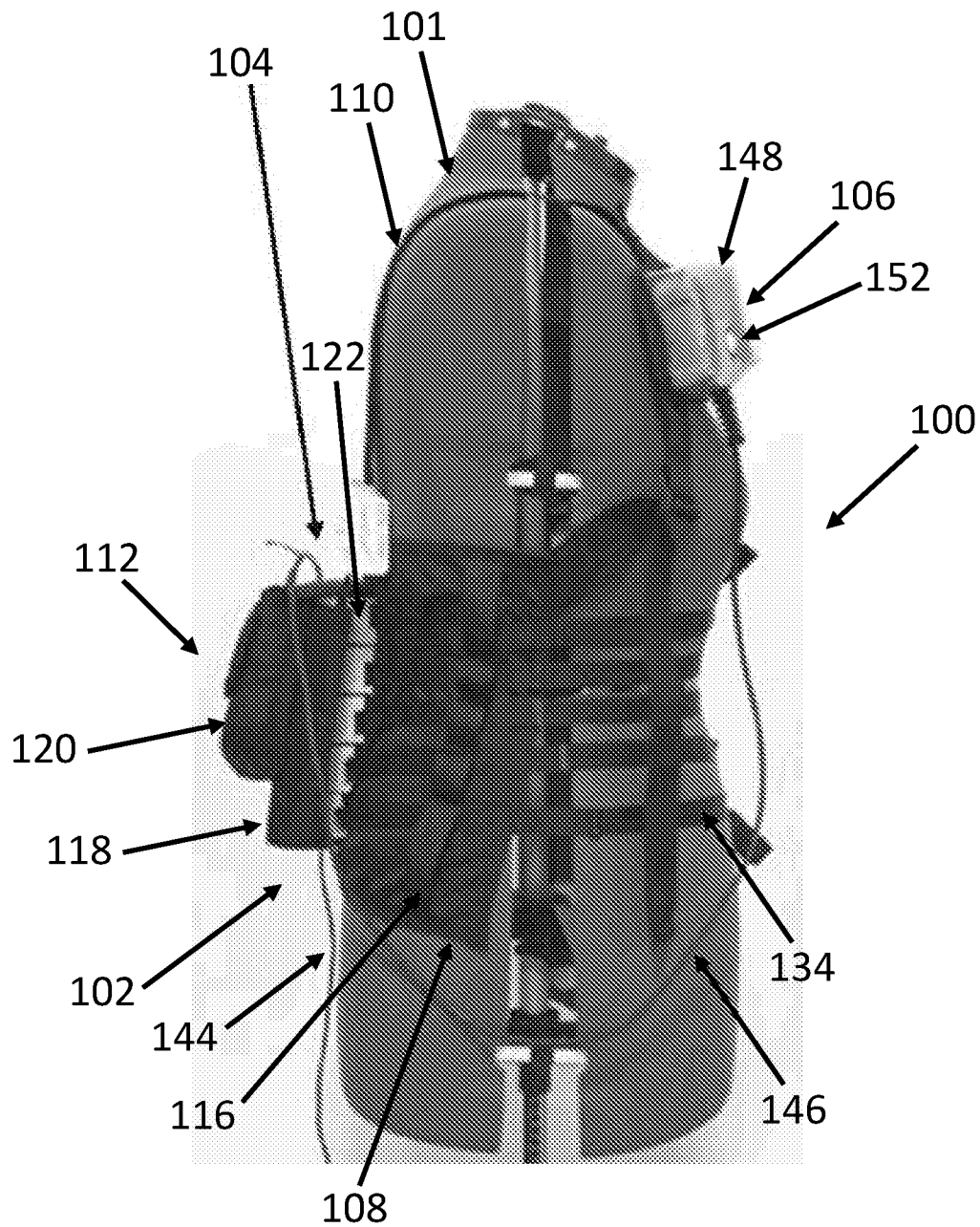
1. An abdominal measurement apparatus, comprising:
a plurality of belts configured to be lengthened and shortened around respective portions of an abdomen;
a plurality of tensioning mechanisms respectively coupled to the plurality of belts and configured to maintain substantially constant tensions in the plurality of belts around the respective portions of the abdomen; and
a plurality of measurement devices respectively coupled to the plurality of belts and configured to provide indications of lengths of the plurality of belts while the plurality of belts is maintained in tension around the respective portions of the abdomen.
2. The abdominal measurement apparatus of claim 1, wherein each belt of the plurality of belts comprises two portions.
3. The abdominal measurement apparatus of any of the preceding claims, wherein each tensioning mechanism of the plurality of tensioning mechanisms comprises two spring-loaded rollers.
4. The abdominal measurement apparatus of any of the preceding claims, further comprising a backpack to which the plurality of belts is mounted, the backpack being adjustable to accommodate various sizes of subject torsos.
5. The abdominal measurement apparatus of any of the preceding claims, wherein each measurement device of the plurality of measurement devices is configured to acquire measurements at a predetermined frequency.
6. The abdominal measurement apparatus of any of the preceding claims, further comprising a processor in communication with the plurality of measurement devices.

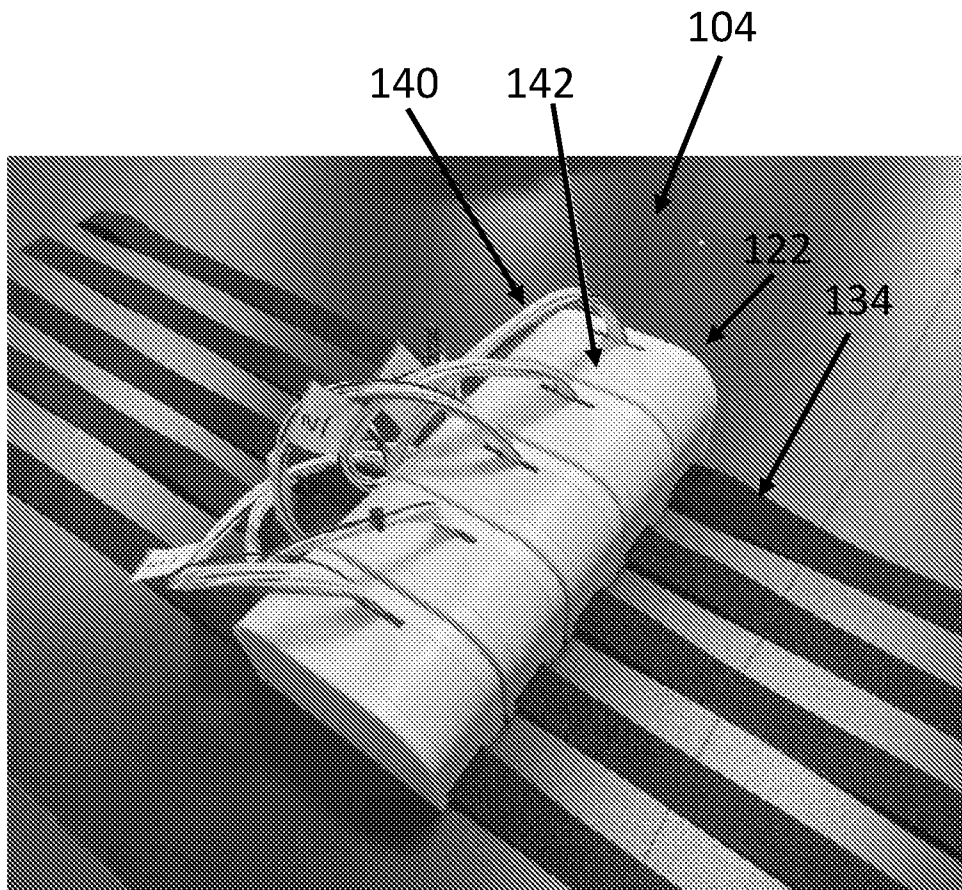
7. The abdominal measurement apparatus of any of the preceding claims, wherein the processor is configured to receive measurements from the plurality of measurement devices and to output the measurements to a computing device.
8. The abdominal measurement apparatus of any of the preceding claims, wherein the processor is configured to wirelessly communicate with the computing device.
9. The abdominal measurement apparatus of any of the preceding claims, further comprising a user interface terminal by which the abdominal measurement apparatus can be controlled.
10. A method of measuring an abdomen, the method comprising:
 - receiving, by a processor, a plurality of signals that respectively indicate peripheral measurements of an abdomen, the plurality of signals generated by an abdominal measurement apparatus in contact with the abdomen, the abdominal measurement apparatus comprising:
 - a plurality of belts configured to be lengthened and shortened around respective portions of an abdomen,
 - a plurality of tensioning mechanisms respectively coupled to the plurality of belts and configured to maintain substantially constant tensions in the plurality of belts around the respective portions of the abdomen, and
 - a plurality of measurement devices respectively coupled to the plurality of belts and configured to provide indications of lengths of the plurality of belts while the plurality of belts is maintained in tension around the respective portions of the abdomen; and
 - determining, by the processor, an index associated with the abdomen based on the plurality of signals indicating peripheral measurements of the abdomen.
11. The method of claim 10, wherein each belt of the plurality of belts comprises two portions.

12. The method of any of claims 10 and 11, further comprising adjusting a length of one or more of the plurality of belts.
13. The method of any of claims 10-12, wherein each tensioning mechanism of the plurality of tensioning mechanisms comprises two spring-loaded rollers.
14. The method of any of claims 10-13, further comprising receiving, by the processor, the plurality of signals at a predetermined frequency.
15. The method of any of claims 10-14, wherein the index comprises an abdominal volume.
16. The method of any of claims 10-15, wherein the index comprises an abdominal circumference.

**FIG. 1**

**FIG. 2**

**FIG. 3**

**FIG. 4**

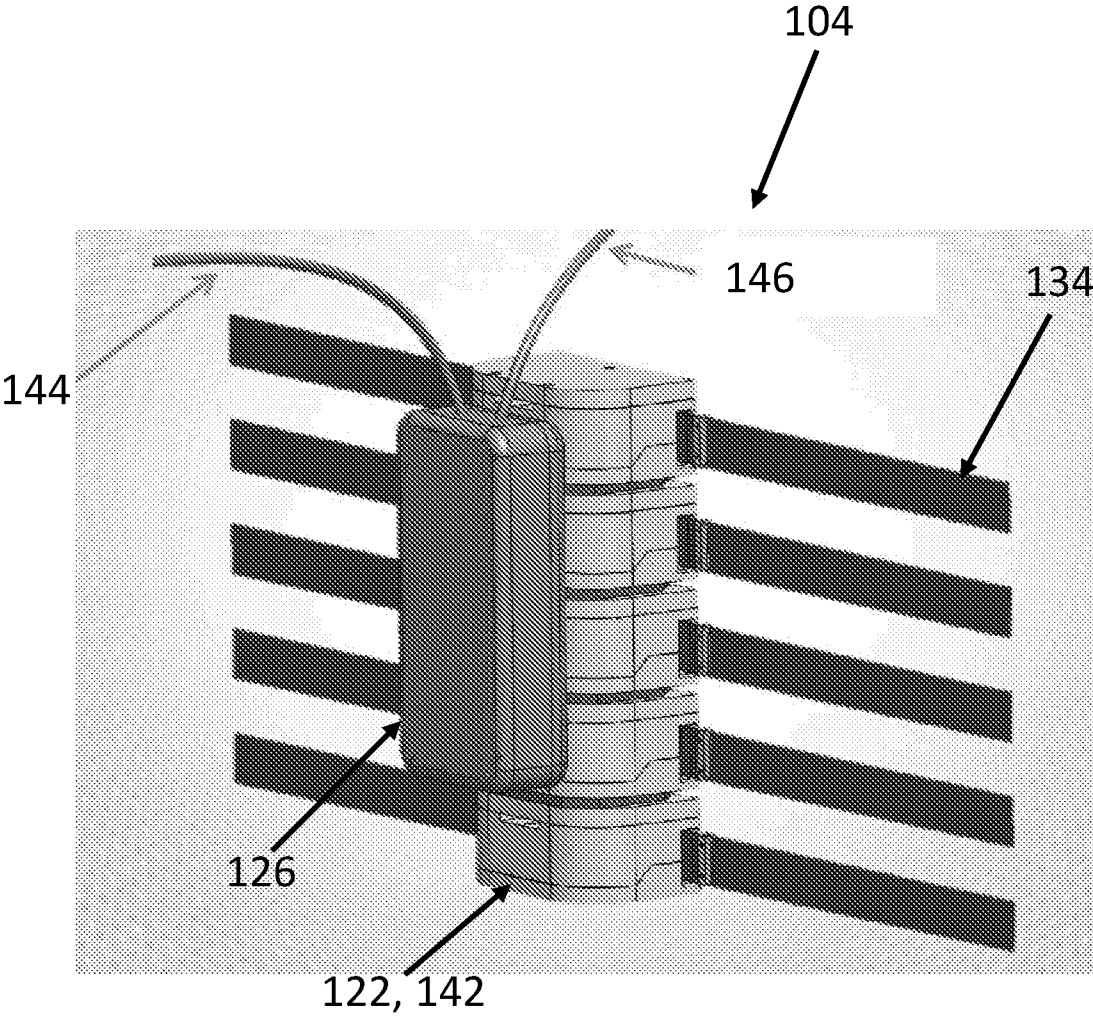
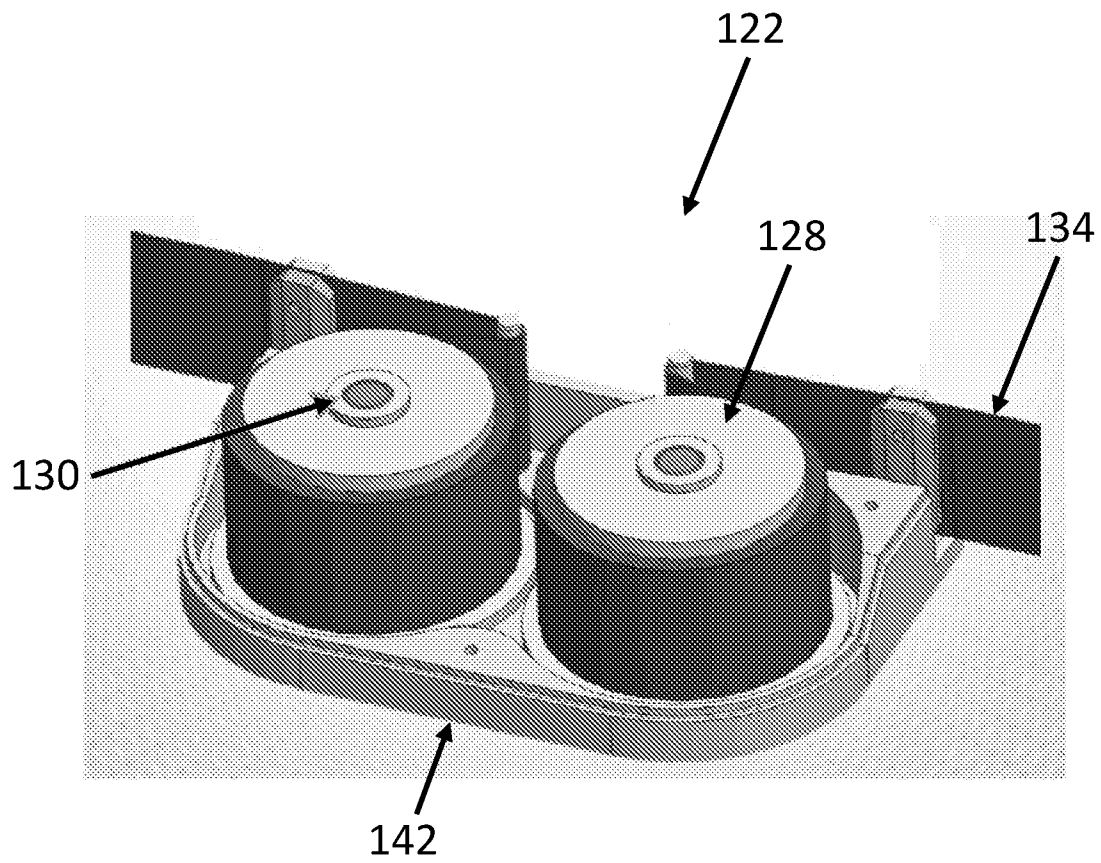
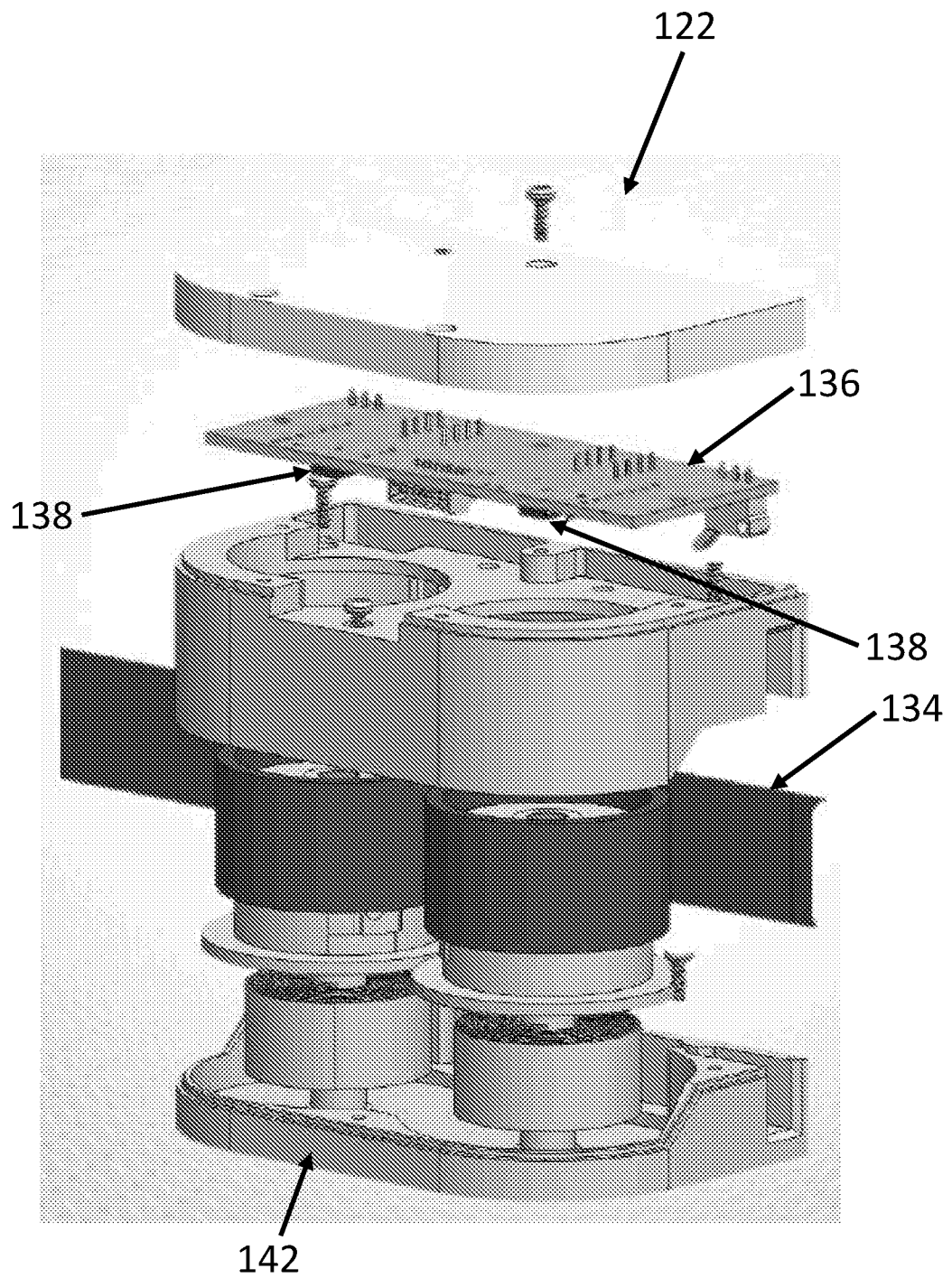


FIG. 5

**FIG. 6**

**FIG. 7**

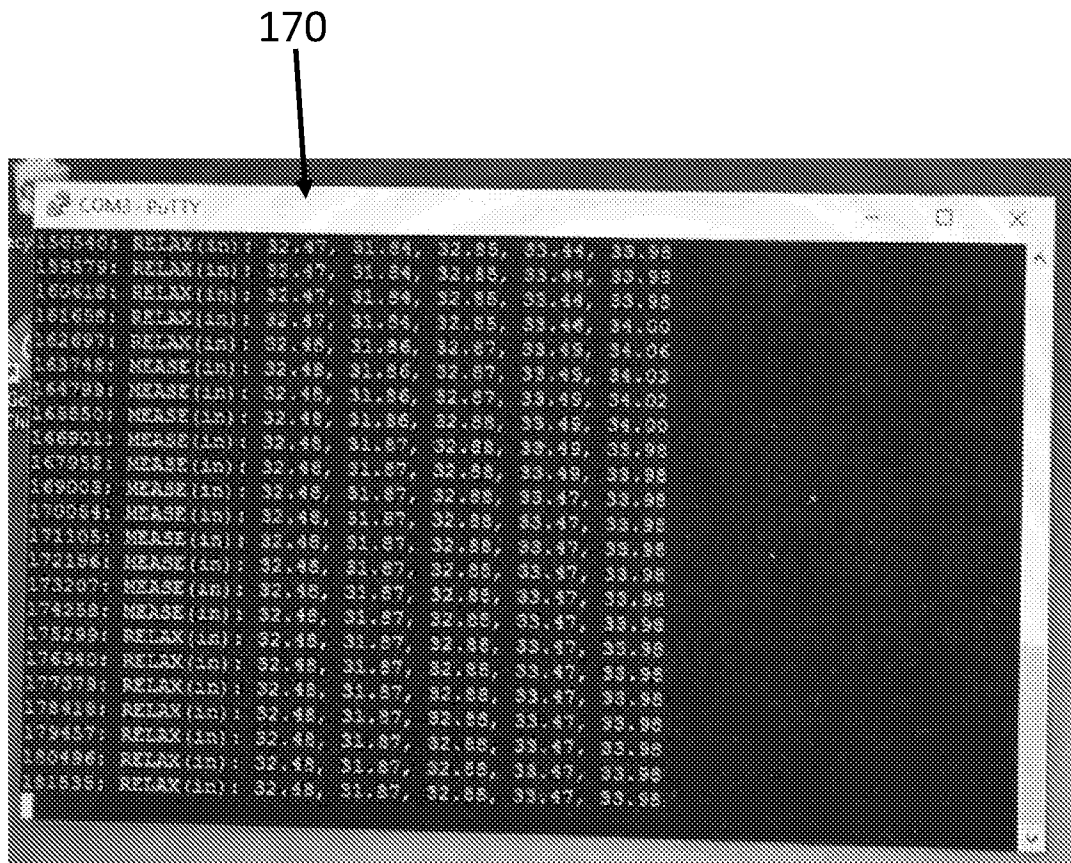


FIG. 8

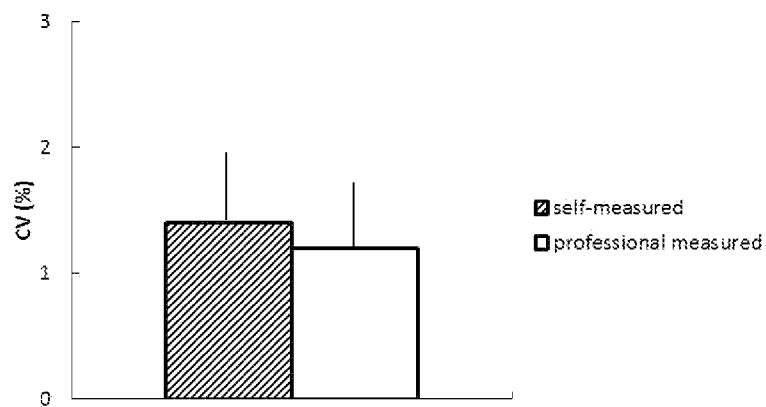


FIG. 9: Coefficient of variation (CV) of replicate waist circumference measurements taken by inexperienced adult (self-measured) using the abdominal measurement apparatus 100 and by experienced, professionally trained individual using a measuring tape.

FIG. 9

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 18/47306

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - A41H 1/02 (2018.01)

CPC - A61B 5/6823

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

See Search History Document

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

See Search History Document

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

See Search History Document

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X - Y	CN 103416884 A (HUANG et al.); 04 December 2013 (04.12.2013); entire document, especially Fig. 3, Abstract, para. [0016]-[0018], [0021].	1, 10, 12/10 2-3, 11, 12/11
X	US 2016/0165988 A1 (eBay, Inc); 16 JUNE 2016 (16.06.2016); entire document, especially Fig. 11, para. [0075], [0080]-[0086].	1
Y	GB 160,441 A (JUNGSMANN); 07 July 1921 (07.07.1921); entire document, especially Fig. 1-2, Abstract; pg. 1, ln 48-54; pg. 2, ln 17-40.	2-3, 11, 12/11
A	US 2016/0302724 A1 (COULM et al.); 20 October 2016 (20.10.2016); entire document.	1-3, 10-12
A	US 4,473,949 A (SCHECHTMAN); 02 October 1984 (02.10.1984); entire document.	1-3, 10-12
A	US 2011/0295144 A1 (MURAKAWA et al.); 01 December 2011 (01.12.2011); entire document.	1-3, 10-12
A	US 2016/0153853 A1 (eBay, Inc); 02 June 2016 (02.06.2016); entire document.	1-3, 10-12

☐ Further documents are listed in the continuation of Box C.☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

09 October 2018

Date of mailing of the international search report

15 NOV 2018

Name and mailing address of the ISA/US

Mail Stop PCT, Attn: ISA/US, Commissioner for Patents
P.O. Box 1450, Alexandria, Virginia 22313-1450
Facsimile No. 571-273-8300

Authorized officer:

Lee W. Young

PCT Helpdesk: 571-272-4300
PCT OSP: 571-272-7774

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 18/47306

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☒ Claims Nos.: 4-9, and 13-16
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.