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(71) Applicant: **THEMA 2 S.R.L.** [IT/IT]; Via F. Petrarca, 3, 46024 Moglia, Mantova (IT).

(72) Inventors: **MICHELINI, Claudio**; c/o Thema 2 S.r.l., Via F. Petrarca, 3, 46024 Moglia, Mantova (IT). **BARALDI, Stefano**; c/o Thema 2 S.r.l., Via F. Petrarca, 3, 46024 Moglia, Mantova (IT). **ROSSI, Alessandra**; c/o Thema

2 S.r.l., Via F. Petrarca, 3, 46024 Moglia, Mantova (IT). **GUERZONI, Giovanni**; c/o Thema 2 S.r.l., Via F. Petrarca, 3, 46024 Moglia, Mantova (IT). **SPOLLON, Luciano**; c/o Thema 2 S.r.l., Via F. Petrarca, 3, 46024 Moglia, Mantova (IT).

(74) Agent: **GUALENI, Nadia** et al.; c/o Jacobacci & Partners S.p.A., Piazza della Vittoria, 11, 25122 Brescia (IT).

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(54) Title: DEVICE AND RELATED METHOD FOR THE AUTOMATIC CONTROL OF THE COLOR TONE OF A REEL OF THREAD

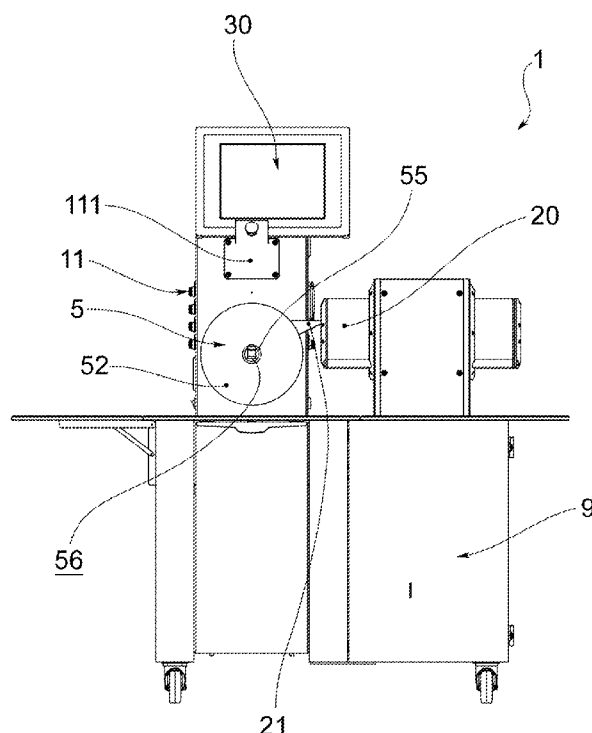


FIG. 1a

(57) Abstract: A device (1) for the automatic control of the color tone of a reel of thread, comprises: a frame (11) which supports an arm (10) on which a reel of thread (5) can be placed; a color measuring device (20) adapted to project a measuring beam (21) onto a cylindrical portion (53) of the reel of thread (5), said measuring device (20) comprising a camera (25) and an illuminator aligned with the camera (25), said illuminator being multispectral and adapted to illuminate the reel of thread (5) with different wavelengths; a computer provided with a screen (30) with graphic interface and connected to the meter (20), adapted to process the classification of the reel of thread (5) loaded on the arm (10) on the basis of the measurements made by the meter (20).



(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).

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- *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*
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DESCRIPTION**"Device and method for the automatic control of the color
tone of a reel of thread"**

[0001] It is the object of the present invention a device
5 for automatically reading the color tone of a reel of
textile thread (for example, for fabrics or ropes), and a
related classification method.

[0002] In the textile field, the responsibility for the
quality control of the thread produced rests with the
10 supplier, who in practice indicates a sample of thread as
the reference for the color tone of the whole subsequent
production. The mismatch between the actual tone of the
fabric produced and the sample tone translates into
penalties for the yarn supplier.

15 [0003] In fact, the non-uniformity of the color of the
reels of thread used, by way of explanation but not by
way of limitation, for the production of a fabric is
clearly visible in the final fabric, which has darker or
lighter linings with respect to the base color.

20 [0004] Currently, the control of the color tone of the
reels of thread is entrusted to the experience of
specialized operators, who carry it out in a completely
manual manner, i.e., the reel is placed in full daylight,
in a well-lit room, and compared with the naked eye
25 against a reference sample, or fabric samples are

produced alternatively woven with a few centimeters of sample thread alternating with a few centimeters of single numbered reels of thread to be compared with the sample reel itself, the comparison being always performed with the naked eye. It is clear that the assessment of the operator, although specialized, is still rather subjective and therefore a source of errors. It has been noted that statistically, following a shift and therefore an operator change, the verification of the color tone may give very different results.

[0005] It is the object of the present invention to solve the above issues.

[0006] Such an object is achieved by a device for the automatic control of the color tone of a reel of thread in accordance with claim 1, and by a related color tone classification method in accordance with claim 10. The dependent claims describe preferred embodiments of the invention.

[0007] The features and advantages of the device according to the present invention will be evident from the following description, given by way of explanation and not by way of limitation in accordance with the attached Figures, in which:

- Figures 1A and 1B respectively show a front view and an axonometric view of a device for the automatic control of

the color tone according to the present invention;

- Figure 2 shows a component of the device of Figure 1, in particular, it shows the color measuring device in an axonometric view;

5 - Figures 3A, 3B and 3C respectively show a front view, a sectional view, and an axonometric sectional view of the color measuring device of Figure 2.

[0008] With reference to the accompanying Figures, reference numeral 1 overall indicates a device for the
10 automatic control of the color tone of a reel of thread.

[0009] The device 1 comprises a frame 11 which supports an arm 10 on which it is possible to place a reel of thread 5 to be analyzed.

[0010] The reel of thread 5, visible for example in Figure
15 1, consists of thread wound on a reel 55. Looking at the reel of thread 5 from the front, it may be noticed that the wound thread forms a body 52 for which it is possible to define a cylindrical portion 53, interposed between two tapered portions 54. Looking at the reel from the
20 side, the reel 55, provided with a hole 56 for loading the reel of thread 5 on the arm 10 of the device 1 for the automatic control of the color tone, is visible.

[0011] The arm 10 is equipped with a rear shoulder 13, adapted to make an abutment for the reel 55 of the reel
25 of thread 5. The presence of the rear shoulder 13 allows

positioning the reel of thread 5 in the correct position for the measurement step.

[0012] The device 1 comprises at least one color measuring device 20, adapted to project a measuring beam 21 onto the reel of thread 5. In particular, the meter 20 projects a measuring beam 21 at the arm 10, so that, when the reel of thread 5 is loaded onto the arm 10, the measuring beam 21 intercepts the center line of the cylindrical portion 53 of the reel of thread.

10 [0013] Having defined as X the longitudinal axis of development of the arm 10, the meter 20 projects the measuring beam 21 orthogonally with respect to the axis (X).

[0014] Preferably, the meter 20 is positioned on a carriage 15 9 which is separable from the frame 11. The meter 20 is connected to a computer (not shown) provided with a screen 30 with a graphical user interface.

[0015] Preferably, the meter 20 is provided with vertical movement means 91, adapted to lift and lower the meter 20 with respect to the arm 10 along the vertical axis.

[0016] Preferably, the meter 20 is provided with horizontal movement means 92, adapted to move the meter closer and further away with respect to the arm 10 along a horizontal axis.

25 [0017] The meter 20 allows obtaining the difference in tone

of the reel under observation (target reel) with respect to a reference sample (sample reel). In particular, the meter 20 performs a multispectral analysis of the reel of thread 5, using a camera and an illuminator, suitably synchronized with the reading of the camera. It should be noted that the camera allows capturing images (up to eight) with the sample illuminated with eight types of light at various frequencies in the visible (UV light, BLUE light, GREEN light, REDDISH PURPLE light, RED light, INFRA RED light, FAR RED light, WHITE light).

[0018] The meter 20 therefore comprises a camera 25 and an illuminator, positioned aligned with the camera 25.

[0019] Preferably, the camera is high resolution monochrome.

15 [0020] Preferably, the illuminator is multispectral with eight built-in LEDs, each adapted to illuminate the target with a specific wavelength.

[0021] The meter 20, as a result of the measurement, provides a number which considers together the average intensity of the color of the target reel of thread 5, photographed for all the eight wavelengths emitted. If the eight results are all 0, it means that all the pixels with each light emitted are saturated with black. If the 8 results are all 255, it means that all the pixels with each light emitted are saturated with white.

[0022] An eight-dimensional space was thus defined (one dimension for each wavelength emitted) with the same properties as a Euclidean space. Two reference points are defined in such an eight-dimensional space:

- 5 - a midpoint, which has as coordinates the eight average saturations measured for the reference sample (sample reel);
- a black point, corresponding to the black saturation point.

10 [0023] The measurement on the reel under analysis (target reel) is calculated as the distance with respect to the midpoint and to the black point.

[0024] In detail, therefore, having obtained the eight average saturations as measurement, they are considered
15 as coordinates of a point.

$P \equiv (s1, s2, s3, s4, s5, s6, s7, s8)$

s1 = average saturation with UV light

s2 = average saturation with BLUE light

s3 = average saturation with GREEN light

20 s4 = average saturation with REDDISH PURPLE light

s5 = average saturation with RED light

s6 = average saturation with INFRA RED light

s7 = average saturation with FAR RED light

s8 = average saturation with WHITE light

25 [0025] From which the distance from the black point (i.e.,

from the point completely saturated to black) is obtained, calculated as the norm of the point:

5
$$\|P\| = \sqrt{\sum_{n=1}^8 (s_n^2)}$$

[0026] This result numerically expresses how intense the color observed by the meter is.

[0027] This is a number ranging from 0.0 to 721.25, and the unit of measurement is referred to as "are". By definition, therefore, the distance between a black color sample at all illuminations and a white color sample at all illuminations is 721.25 "ares".

[0028] It is also the object of the invention a method for the automatic control of the color tone of a reel of thread.

[0029] The method involves an initial step of setting the reference color, i.e., the acquisition of a color sample parameter (sample reel). Such a step involves loading a sample reel of thread onto the arm 10 of the device 1 and projecting the measuring beam 21 on a cylindrical portion 53 of the reel. The meter detects the eight average saturations of the reference sample (sample reel) and calculates the "midpoint" and "black point" reference points.

25 [0030] Once the setting has been completed, the method

involves a step of measuring the color of the reel, i.e., acquiring the color of the reel to be classified. Such a step involves loading the reel of thread to be classified onto the arm 10 of the device 1 and projecting the measuring beam 21 on a cylindrical portion 53 of the reel. The meter detects the eight average saturations of the target reel of thread.

[0031] At this point the eight average saturations of the target reel are classified by comparison with the "midpoint" and "black point" and the measurement on the reel is calculated as the distance with respect to the midpoint and the black point.

[0032] Thereby, it is possible to accurately establish the correspondence of the "reel color" with the "sample color", and, in case of mismatch, have an indication of how much lighter or darker the "reel color" is compared to the "sample color".

[0033] Therefore, the color acquisition step (both of the sample reel and of the reel to be classified) occurs on the basis of illumination with eight types of light at various frequencies in the visible (UV light, BLUE light, GREEN light, REDDISH PURPLE light, RED light, INFRA RED light, FAR RED light, WHITE light).

[0034] Preferably, the device 1 further allows the classification of the reels of thread 5 on the basis of

weight (gr), diameter (mm) and density (gr/cm³).

[0035] Preferably, the device 1 comprises, at the arm 10, a load cell for measuring the weight of the reel of thread 5 once the latter is positioned on the arm 10.

5 [0036] Preferably, the device 1 comprises a bridge 111, fastened to the frame 11, arranged above the arm 10. Preferably, the bridge 111 extends beyond the arm 10. The bridge 111 is provided with a longitudinal rail along which a detector slides. Such a detector is capable of
10 projecting a detection beam onto the reel of thread 5. In particular, the detector projects a detection beam at the arm 10, so that, when the reel of thread 5 is loaded onto the arm 10, the measuring beam 21 intercepts the body 52 of the reel of thread. Since the detector is slidable
15 along the rail, it is capable of projecting the detection beam along the whole body 52 of the reel of thread (i.e., both along the cylindrical portion 53 and along the tapered portions 54). Advantageously, therefore, the detector is capable of detecting the exact geometry of
20 the reel of thread loaded onto the arm 10.

[0037] The reel classification method, based on weight (gr), diameter (mm) and density (gr/cm³), comprises the steps of:

- loading the reel of thread 5 onto the arm 10, provided
25 with a load cell;

- measuring the weight: detection of the gross weight of the reel of thread loaded on the arm 10, calculation of the net weight of the thread by subtracting the weight of the reel 55;
- 5 - measuring the volume: activation of the detector, sliding along the rail, and recording of a plurality of geometry measurements of the reel, calculation of the total volume of the reel, calculation of the net volume of the thread by subtracting the volume of the reel 55:
- 10 - measuring the density: calculation of the density of the thread based on the weight and volume previously recorded.

[0038] At this point, the weight, volume, and density values are classified in comparison with previously set
15 reference values.

[0039] Advantageously, the measurement of the volume of the reel of thread 5, and in particular the measurement of the diameter, is used by the meter 20 to center the focus (autofocus) on the center line of the cylindrical portion
20 53 of the reel of thread.

[0040] It is therefore evident that the method for the automatic classification of the color tone of a reel of thread in accordance with the present invention, returns to the operator, in a convenient single number, the
25 result of an in-depth analysis of the color of the

target.

[0041] Furthermore, since the automatic classification of the color tone is based on the analysis of how the target color responds to all possible light sources, the
5 resulting measurement is extremely precise.

[0042] Innovatively, a device for the automatic control of the color tone of a reel of thread, and a related classification method in accordance with the present invention, allows the measurements taken on the reel to
10 be objective, and therefore to make the classification objective and error-free.

[0043] Advantageously, therefore, the device and method described herein allow the measurement and the classification of the reels of thread to be fully
15 automatic, with the dual purpose of ensuring absolute objectivity in the assessment and of reducing the cost of the labor used for the control itself and especially for all the possible, rather expensive, complaints resulting from subjective assessments of the quality of the reels
20 of thread. Such an aspect is very important, especially for high-end product categories.

[0044] Advantageously, therefore, the device and method described herein have the following technical advantages:
- they allow excluding the impact of external light
25 sources, which therefore do not affect the measurement;

- they allow excluding the effects due to the surface roughness of the reel of thread, which therefore do not affect the measurement;
- they allow excluding the effects due to the geometry of
5 the reel of thread, which therefore do not affect the measurement;
- they allow for an automatic positioning with Auto-Focus.

[0045] It is apparent that those skilled in the art may
10 modify the object described above, without departing from the scope of protection as defined by the following claims.

Claims

1. Device (1) for the automatic control of the color tone of a reel of thread, comprising:
- a frame (11) which supports an arm (10) on which a reel of thread (5) can be placed;
 - a color measuring device (20) adapted to project a measuring beam (21) onto a cylindrical portion (53) of the reel of thread (5), said measuring device (20) comprising a camera (25) and an illuminator aligned with the camera (25), said illuminator being multispectral and adapted to illuminate the reel of thread (5) with different wavelengths;
 - a computer provided with a screen (30) with graphic interface and connected to the meter (20), adapted to process the classification of the reel of thread (5) loaded on the arm (10) on the basis of the measurements made by the meter (20).
2. Device (1) according to claim 1, wherein the camera is high resolution monochrome.
3. Device (1) according to claim 1 or 2, wherein the multispectral illuminator comprises eight LEDs, and each of them projects a light at a precise frequency in the visible.
4. UV light, BLUE light, GREEN light, AMARANTO light, RED light, INFRA RED light, FAR RED light, WHITE light.

5. Device (1) according to any one of the preceding claims, wherein the meter (20) is provided with vertical movement means (91), adapted to lift and lower it with respect to the arm (10) along a vertical axis, and/or
5 horizontal movement means (92), adapted to move it closer and further away from the arm (10) along a horizontal axis.

6. Device (1) according to any one of the preceding claims, wherein the meter (20) is arranged on a carriage
10 (9) separable from the frame (11).

7. Device (1) according to any one of the preceding claims, wherein, having defined (X) the longitudinal axis of development of the arm (10), the measuring device (20) projects the measuring beam (21) orthogonally with
15 respect to the axis (X), so as to center the center line of the cylindrical portion (53) of the reel of thread.

8. Device (1) according to any one of the preceding claims, comprising, at the arm (10), a load cell (7) adapted to detect the weight of the reel of thread (5)
20 loaded on the arm (10).

9. Device (1) according to any one of the preceding claims, comprising a bridge (111), fixed to the frame (11) and above the arm (10), provided with a rail (112) on which a detector (40) slides, adapted to project a
25 detection beam on the body (52) of the reel of thread (5)

loaded on the arm (10), to detect the volume thereof.

10. Method for the automatic control of the color tone of a reel of thread, comprising the steps of:

- providing a device (1) for the automatic control of the color tone of a reel of thread, according to claim 1;
- setting the reference color:
- loading a sample reel of thread onto the arm (10) of the device (1) and projecting the measuring beam (21) on a cylindrical portion (53) of the reel;
- 10 - detecting through the meter (20) eight average saturations, one for each light frequency:
S1 = average saturation with UV light
S2 = average saturation with BLUE light
S3 = average saturation with GREEN light
15 S4 = average saturation with REDDISH PURPLE light
S5 = average saturation with RED light
S6 = average saturation with INFRA RED light
S7 = average saturation with FAR RED light
S8 = average saturation with WHITE light
- 20 - defining "sample color" the point having coordinates (S1, S2, S3, S4, S5, S6, S7, S8);
- measuring the color of the reel (5) to be analyzed:
- loading the reel of thread (5) to be analyzed onto the arm (10) of the device (1) and projecting the measuring
25 beam (21) on a cylindrical portion (53) of the reel;

- detecting through the meter (20) eight average saturations, one for each light frequency:
 - s1 = average saturation with UV light
 - s2 = average saturation with BLUE light
 - 5 s3 = average saturation with GREEN light
 - s4 = average saturation with REDDISH PURPLE light
 - s5 = average saturation with RED light
 - s6 = average saturation with INFRA RED light
 - s7 = average saturation with FAR RED light
 - 10 s8 = average saturation with WHITE light
 - defining "reel color" the point having coordinates (s1, s2, s3, s4, s5, s6, s7, s8);
 - classifying the color of the reel as the distance of the "reel color" point with respect to the "sample color" point.
- 15 point.
11. Method according to claim 10, further comprising the step of classifying the reel of thread (5) on the basis of weight, diameter and density, wherein this step provides for:
- 20 - providing a device (1) according to claims 8 and 9;
 - measuring the weight: measuring the weight of the reel of thread loaded on the arm (10) through the load cell (7), calculating the net weight of the thread by subtracting the weight of the reel (55);
 - 25 - measuring the volume: activating the detector (40),

sliding along the rail (112), and recording a plurality of geometry measurements of the reel, calculating the total volume of the reel, calculating the net volume of the thread by subtracting the volume of the reel (55);

- 5 - measuring the density: calculating the density of the thread based on the net weight and net volume previously recorded.

12. Method according to claim 11, wherein the geometry measurements detected during the volume measurement are
10 used to achieve the focusing of the meter (20) and/or the centering of the measuring beam (21) with respect to the axis center line of the cylindrical portion (53) of the reel of thread (5) loaded on the arm (10).

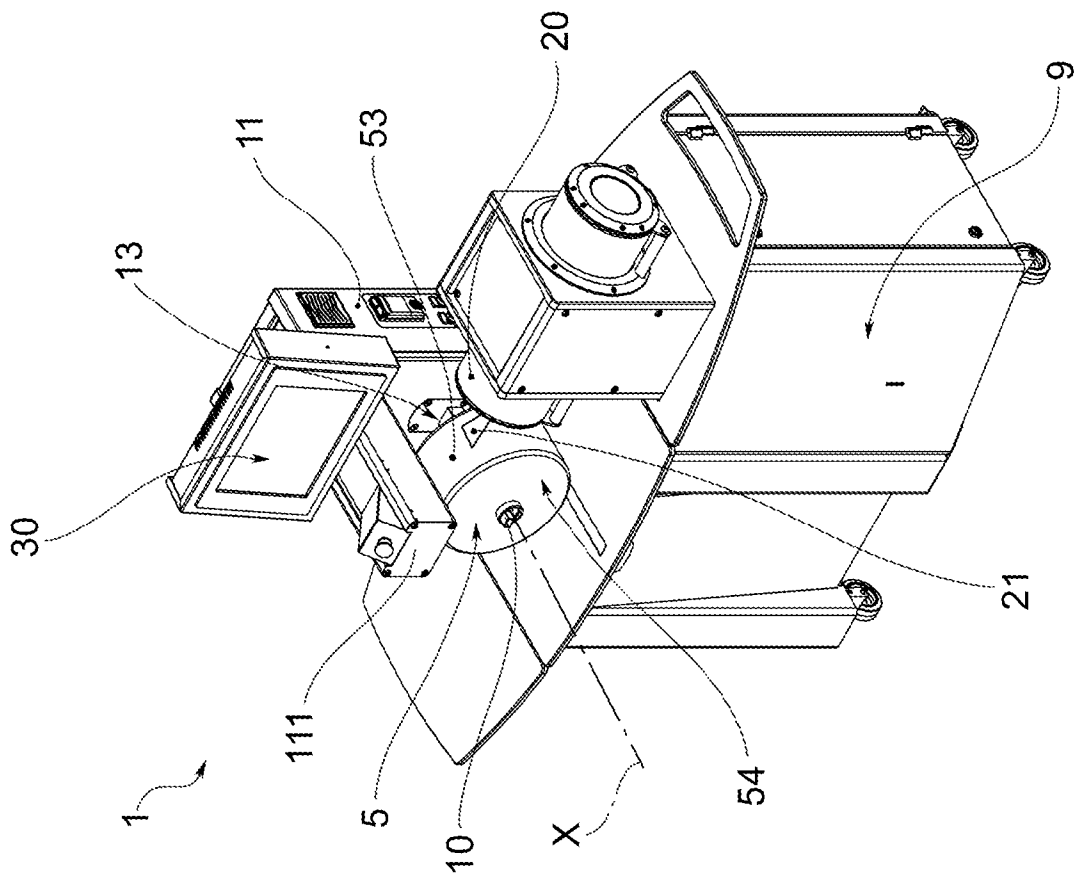


FIG.1b

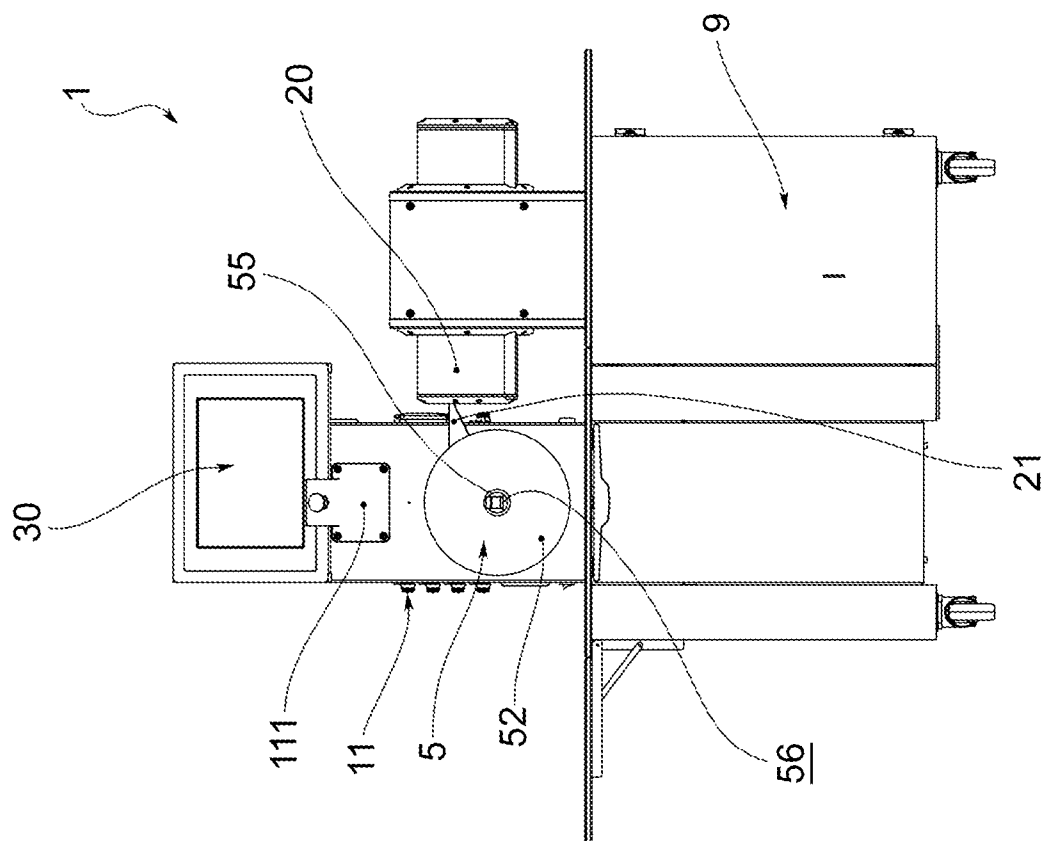


FIG.1a

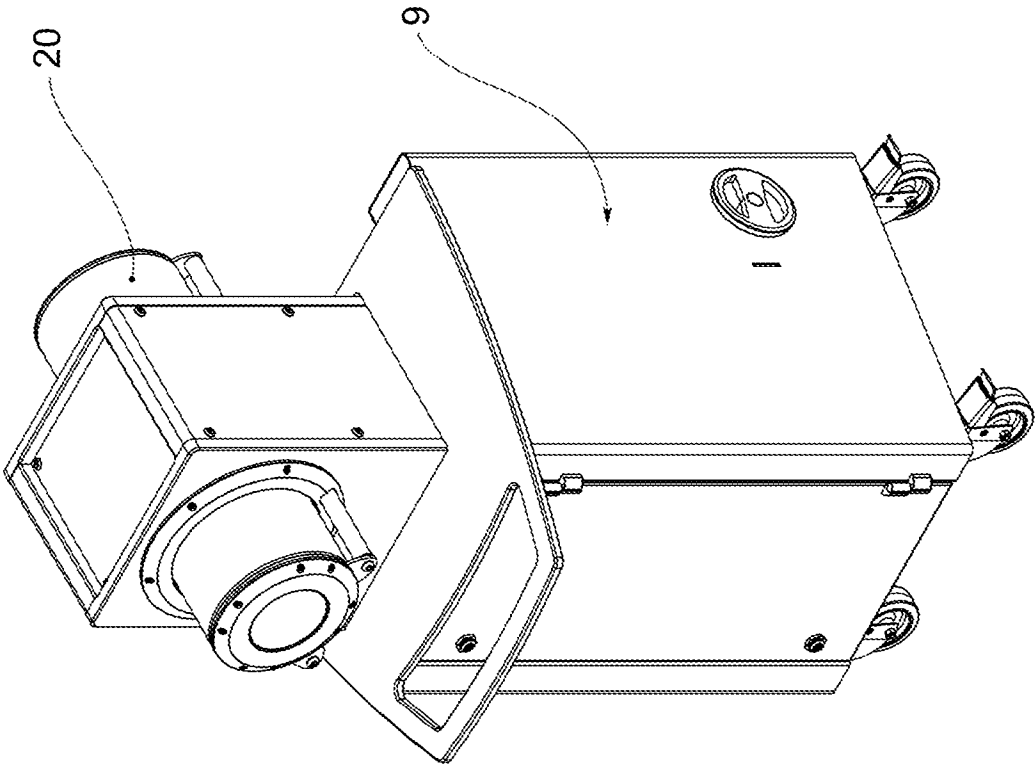


FIG.2

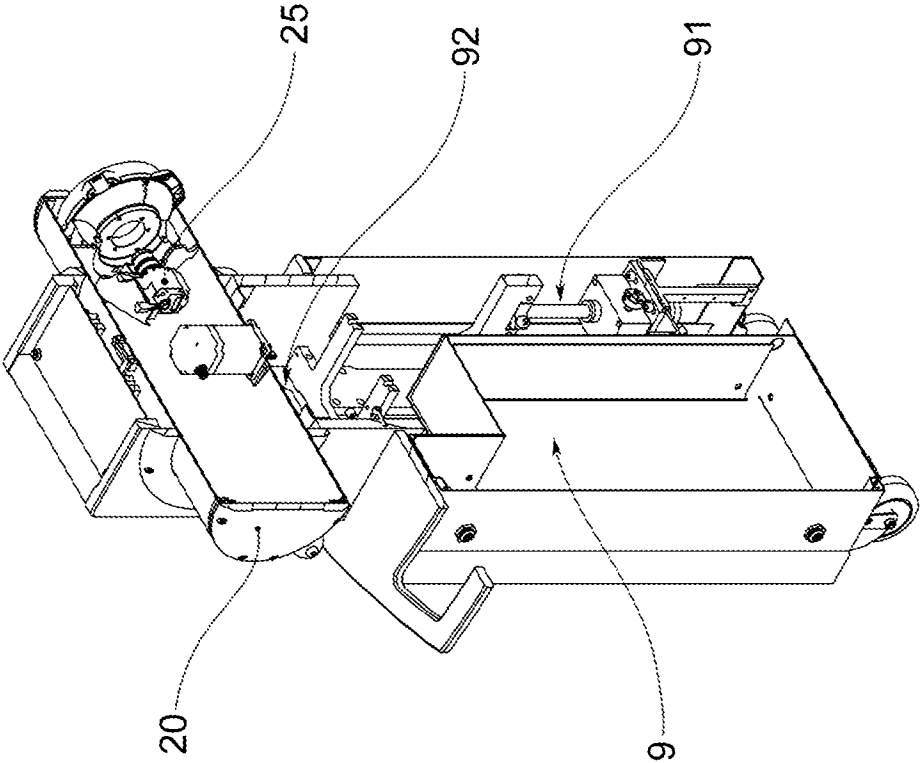


FIG.3C

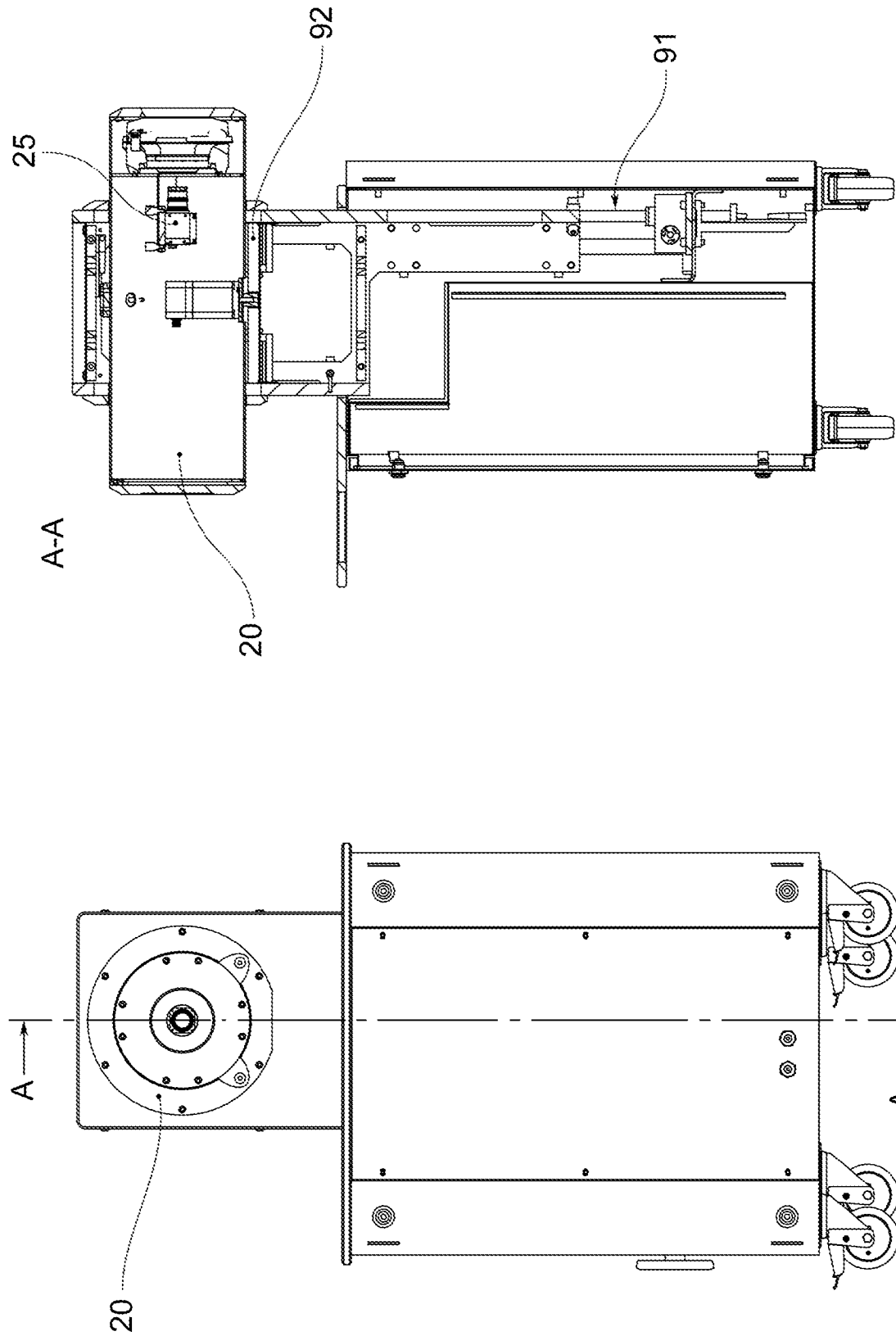


FIG.3b

FIG.3a

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2020/055679

A. CLASSIFICATION OF SUBJECT MATTER
INV. B65H63/00 G01N21/25
ADD.

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)
B65H G01N G01J

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

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

EP0-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Y	column 2, lines 58-65	2-4
A	column 3, line 60 - column 4, line 18; figures 1,2 column 4, lines 56-61 column 5, lines 28-30, 37-40 column 7, lines 52-63	10-12
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X	JP S64 1939 A (TEIJIN LTD) 6 January 1989 (1989-01-06) abstract; figure 1	1
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Further documents are listed in the continuation of Box C.



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Date of the actual completion of the international search

10 September 2020

Date of mailing of the international search report

18/09/2020

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040,
Fax: (+31-70) 340-3016

Authorized officer

Pussemier, Bart

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2020/055679

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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INTERNATIONAL SEARCH REPORT

Information on patent family members

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