



(51) International Patent Classification:
B41J 3/32 (2006.01)

(21) International Application Number:

PCT/US2011/026427

(22) International Filing Date:

28 February 2011 (28.02.2011)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

61/308,518 26 February 2010 (26.02.2010) US

(71) Applicant (for all designated States except US):
NORTHEASTERN UNIVERSITY [US/US]; 360 Huntington Avenue, Boston, MA 02115 (US).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **SIPAHI, Rifat** [TR/US]; 1155 Tremont Street, Boston, MA 02102 (US).
ULUSOY, Melda [TR/US]; 471 Commonwealth Avenue, Apt. 3F, Boston, MA 02115 (US).

(74) Agents: **HARTNELL, George, W., III** et al.; Weingarten, Schurgin, Gagnebin & Lebovici, LLP, Ten Post Office Square, Boston, MA 02109 (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, 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, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, 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,

[Continued on next page]

(54) Title: LOW-COST, PORTABLE, MECHATRONICS-BASED-BRAILLE EMBOSsing APPARATUS AND WRITING SYSTEM FOR THE BLIND

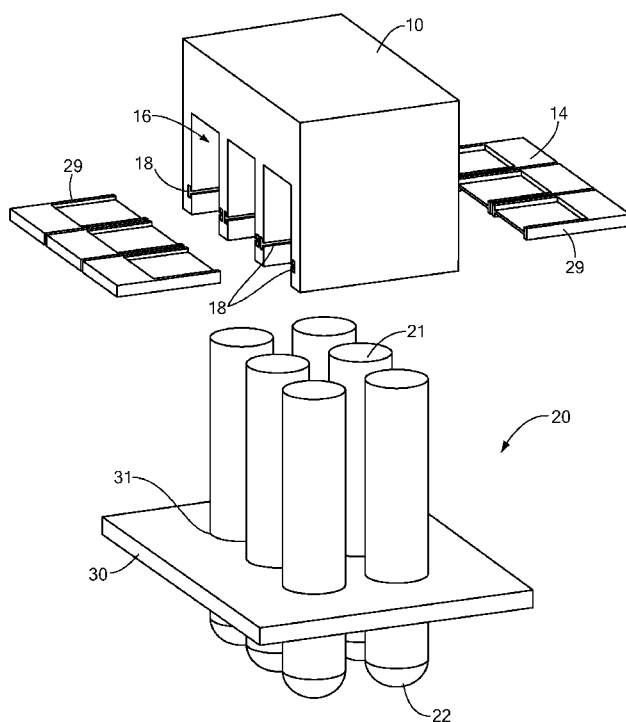


FIG. 3

(57) Abstract: An apparatus for embossing a Braille character on a tangible medium. The embossing apparatus includes embossing pins, each of which corresponds to a discrete one of the typing keys; drawers, each of which corresponds to a discrete one of the embossing pins; an embossing unit having housings, each of which includes a housing for a corresponding drawer; and an embossing unit driving apparatus that is structured and arranged to drive the embossing unit into the embossing pins to emboss a raised dot Braille character on the tangible medium. The apparatus is structured and arranged so that for each depressed key, the corresponding drawer covers the corresponding housing and forces the corresponding embossing pin into the tangible medium.



SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ,
GW, ML, MR, NE, SN, TD, TG).

— *of inventorship (Rule 4.17(iv))*

Declarations under Rule 4.17:

Published:

— *as to applicant's entitlement to apply for and be granted
a patent (Rule 4.17(ii))*

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

— *as to the applicant's entitlement to claim the priority of
the earlier application (Rule 4.17(iii))*

TITLE OF THE INVENTION

LOW-COST, PORTABLE, MECHATRONICS-BASED BRAILLE
EMBOSSING APPARATUS AND WRITING SYSTEM FOR THE BLIND

5

CROSS REFERENCE TO RELATED APPLICATIONS

This application claims priority under 35 U.S.C. §119(e) to
Provisional Patent Application Number 61/308,518, which was
10 filed on February 26, 2010.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR
DEVELOPMENT

15 The U.S. Government has a paid-up license in this invention
and the right, in limited circumstances, to require the patent
owner to license others on reasonable terms as provided for by
the terms of Contract Number CBET 0921360 awarded by the
National Science Foundation.

20

BACKGROUND OF THE INVENTION

There are about 180 million blind and vision-impaired
persons (hereinafter, collectively the "vision-impaired" or
25 "vision-impaired persons") throughout the world. Approximately
10 million vision-impaired persons live in North America.
Approximately 1.3 million of those are legally blind. Under the
umbrella of the American Federation of the Blind, about 100,000
vision-impaired students are currently being educated,
30 recognizing that educated students have a better opportunity to
be integrated into society than those who are not educated.

In the United States, the cornerstone to furthering literacy among the vision-impaired and preparing the vision-impaired to enter the work force is familiarity of and fluency in the Braille system, which was named for Louis Braille.

5 Referring to FIG. 1, the Braille system (for the Latin alphabet) represents each Latin letter with a cell or character having up to six raised dots arranged in a 3 (rows) by 2 (columns) configuration. When arranged one after the other, the cells facilitate reading for the vision-impaired and form the
10 backbone of literacy, instruction, and learning how to spell words in a language.

Studies on emergent literacy indicate that reading and writing are complementary processes, which is to say that each supports and reinforces the learning of the other. Hence,
15 writing Braille is as much a key to success to the vision-impaired as reading Braille. Counterintuitively, the independent progression of commercially-available products for writing and for reading for the vision-impaired, however, has been working against this natural coupling between reading and writing. More
20 specifically, although there are impressive technological enhancements for reading-assistive devices, the availability of writing-assistive devices is limited.

Accordingly, a practical writing utility for the vision-impaired is desirable to assist the vision-impaired, to retain,
25 organize, and retrieve information efficiently, and, moreover, in a classroom environment, to take class notes during periods of instructions. These are the most critical ingredients for successful education from elementary school to life-long learning.

30 Charles Barbier and Louis Braille devised a slate and stylus as the tool for "writing" Braille. The Barbier-Braille apparatus allows for an easy, inexpensive, and convenient method of making embossed printing for Braille characters, i.e., raised

dots. Writing is accomplished, first, by placing a piece of very heavy paper between a front portion and a back portion of the slate; aligning the paper correctly; and closing the front and back portions of the slate.

5 The front portion of the slate includes a plurality of cell openings that are uniformly spaced. An awl or a stylus is positioned in each cell and pressed to form a depression on the working side of the paper, which translates into a raised dot on the reading side of the paper. The writer positions the awl at
10 each desired dot location in each cell, going from cell to cell. The paper is repositioned within the slate as needed to continue writing on the paper. When the writer has completed his/her writing, the paper can be removed from the slate.

Disadvantageously, the slate and stylus writing method
15 requires the writer to make a mirror image of the document to be read. Indeed, the side of the paper on which the awl or stylus is pressed is not the side that is read, but rather the opposing side of the paper read by the vision-impaired. Consequently, each combination of dots in a cell has to be completed backward
20 and the order of writing travels from right to left. In short, the writer must prepare a mirror image of what is to be read. For example, a writer must enter the following on the working side of the writing paper:

○ ○ ○
 ○ ○ ○
 ○

5

to spell the word "BAT", so that it can be read on the opposite side of the paper as

○ ○ ○
 ○ ○ ○
 ○

10

This means that, with a slate and stylus, the vision-impaired must learn one alphabet for reading, i.e., the Braille characters, and a second alphabet for writing, i.e., the mirror image of Braille characters.

In cooperation with the National Federation of the Blind (NFB), students at Johns Hopkins University developed a portable, mechanical Braille writing apparatus in 2006. The Johns Hopkins device operates in a purely mechanical fashion. Six depressible buttons are arranged in the 2 x 3 array corresponding to the Braille characters and disposed in device that can be held in one hand. The arrangement of the buttons in the array; however, is not ergonomic and precludes the use of the thumb. Moreover, four fingers have to push up to six buttons, which means that all of the buttons may not be depressible simultaneously.

Furthermore, the device is used in combination with a traditional Braille slate; hence, it merely replaces the stylus. As a result, it encounters similar difficulties as the slate and stylus, viz., writing in a reverse direction; the necessity of a special, heavy paper; and the requirement that the writer's index finger guides the apparatus from one cell to another.

The "Jot A Dot" brailler is a lightweight, portable embossing device that allows writers to write from right to left. The "Jot A Dot" device also includes six buttons. Each button corresponds to a discrete one of the raised dots in the

Braille character. Vision-impaired users complain that the device is not reliable, that maintenance on the device is difficult, and it is not easy to use. Furthermore, the device is purely mechanical, requiring a multi-stage dot formation that
5 lends itself to mechanical failures and problems. It also must be placed on a surface to use.

Accordingly, it would be desirable to provide an inexpensive, lightweight, durable, portable embossing apparatus for Braille writing and a system using the apparatus.

10

BRIEF SUMMARY OF THE INVENTION

An apparatus for embossing a Braille character on a tangible medium and a writing system using the same are
15 disclosed. The embossing apparatus includes six embossing pins, each of which corresponds to a discrete one of six typing keys; an embossing unit having a housing for each of the six embossing pins; six drawers for engaging or masking a corresponding housing; and an embossing unit driving apparatus that is
20 structured and arranged to drive the embossing unit into the embossing pins to emboss a raised dot Braille character on the tangible medium. The apparatus is structured and arranged so that for each depressed key, the corresponding drawer covers or masks the corresponding housing so that the corresponding
25 embossing pin cannot enter the housing when the embossing unit translates, forcing the corresponding embossing pin into the tangible medium. Advantageously, the embossing apparatus does not require the writer to enter the mirror image of the Braille character desired.

30 The writing system includes at least one embossing apparatus, a keyboard, and a controller. Preferably, the at least one embossing apparatus is a plurality of embossing apparatuses that are structured and arranged in a linear array.

The system permits writing from left-to-right as well as from right-to-left and is hence usable with languages that are read from right-to-left, e.g., Semitic languages.

5 BRIEF DESCRIPTION OF THE DRAWINGS

Other features and advantages of the invention will be apparent from the following description of the preferred
10 embodiments thereof and from the claims, taken in conjunction with the accompanying drawings, in which:

FIG. 1 shows the Braille raised-dot equivalents for the Latin alphabet;

15 FIG. 2 shows a diagrammatic view of the working principles of the invention as claimed;

FIG. 3 shows an isometric view of an embodiment of the embossing unit, pins, and drawers of the embossing apparatus;

FIG. 4 shows an isometric view of the embossing apparatus
20 shown in FIG. 3 that has an engaged embossing pin ready to emboss a tangible medium;

FIG. 5 shows a block diagram of a writing system in accordance with the present invention;

FIG. 6 shows an embodiment of a writing system in
25 accordance with the present invention;

FIG. 7 shows the orientation of the tangible medium "into" the writing system for left-to-right writing; and

FIG. 8 shows the orientation of the tangible medium "out of" the writing system for right-to-left writing.

30 DETAILED DESCRIPTION OF THE INVENTION AND ITS PREFERRED EMBODIMENTS

An embossing apparatus and writing system for writing documents in Braille characters on a tangible medium are

disclosed. Referring to FIGs. 2-5, the working principles and structure of the present invention from which a Braille writing or Braille embossing process will be described. The embossing system 100 (FIG. 5) includes a keyboard 90, a controller 40, and
5 at least one embossing device 80. In its simplest embodiment, the keyboard 90 is structured and arranged to include six keys 12, each key 12 corresponding to one of the six discrete dots configured in a 3 x 2 array that comprise a Braille character. Although the invention will be described assuming that the
10 keyboard 90 includes only six keys 12 for embossing Braille characters to constrain the size, weight, and cost, those skilled in the art can appreciate that a larger keyboard could also include any number of a plurality of special keys to save time. Special keys can correspond to Braille characters that
15 are used for, for example, numerals, punctuations, accented letters, frequently-used abbreviations, frequently-used words, and other special Braille signs.

The embossing device 80 includes a motor 19 and an embossing apparatus 50. The embossing apparatus 50 includes an
20 embossing unit 10, six insertable/removable drawers 14, and six embossing pins 20. The embossing unit 10 includes six housings 16 that are each adapted for receiving a corresponding embossing pin 20. Each of the drawers 14 corresponds to a discrete housing 16 and discrete embossing pin 20. Each housing 16 is
25 provided for and disposed to be in registration with a corresponding embossing pin 20. A selectively movable drawer 14 is adapted to cover ("engage") or to expose ("unengage") each housing 16.

Each embossing pin 20 is adapted to correspond to a
30 discrete key 12 on the keyboard 90 and, accordingly, to one of the six discrete dots that comprise a Braille character. Embossing pins 20 can be cylindrical or substantially cylindrical in shape with a diameter of about 1 mm to about 2

mm. The overall length of an embossing pin can be about 1 to 10 mm. A proximal end 21 of the embossing pins 20 is planar or substantially planar and a distal, embossing end 22 is dome-shaped.

5 As shown in FIG. 2 (but not FIG. 3), an annular ring 17 is fixedly attached to each embossing pin 20 between its proximal 21 and distal 22 ends. As shown in FIG. 2 and FIG. 3, each of the embossing pins 20 is disposed in an opening 31 through a planar substrate 30. At least one biasing device 13, e.g., a
10 spring, dash pot, damper, and the like, is operatively disposed between the annular ring 17 and the planar substrate 30. Each biasing device 13 biases a corresponding embossing pin 20 to remain in an at-rest, "unengaged" position with respect to the substrate 30 unless an "engaged" drawer 14 covers a
15 corresponding housing 16. When a discrete drawer 14 is engaged so as to cover a corresponding housing 16, the drawer 14 is adapted to transfer load from the motor 19 to the corresponding embossing pin 20. After the load on the proximal end 21 of an engaged embossing pin 20a is removed, i.e., when the motor 19
20 and/or platform 26 return to an at-rest position, the biasing device 13 returns each previously engaged embossing pin 20a to its unengaged position.

Although the invention has been described as having drawers 14 that are physically pushed into the slots/grooves 18, this
25 was done for illustrative purposes only. Alternatively, drawers 14 can be structured and arranged to be retained within and to move freely in a vertical (y-) direction inside the housing 16. Electromagnetism can be used to engage a drawer 14 corresponding to a depressed key 12. The magnetic field should
30 be strong enough to retain the drawer 14 corresponding to a depressed key 12 within the slots/grooves 18 but without affecting drawers 14 in adjacent housings 16. Moreover, the magnetic field should be strong enough to transfer the driving

force of the embossing unit 10 to the engaged embossing pin 20a to generate an acceptable raised dot on the tangible medium. Drawers 14 retained within housings 16 that are not electromagnetically engaged are adapted so as not to transfer
5 any load from the embossing unit 10 to the unengaged embossing pins 20b and to ride on the proximal ends 21 of the unengaged embossing pins 20b during the embossing event.

Referring to FIGs. 2-4, application of vertical pressure on any of the keys 12 causes two things to occur before the
10 embossing apparatus 50 embosses a raised-dot Braille character on a tangible medium. Depressing one or more of the keys 12 causes the unique drawer 14 corresponding to the depressed key(s) 12 to enter a corresponding housing 16 in the embossing unit 10, and, more specifically, to enter corresponding
15 slots/grooves 18 contained within the housing 16. Drawers 14 associated with undepressed keys 12 remain in an unengaged position outside of the housing 16. For mechanical devices 80 (FIG. 5), vertical pressure on a key 12 can be translated into a horizontal force on the corresponding drawer 14, e.g., using a
20 horizontal slider 15, to urge docking portions 29 of the drawer 14 into the slots/grooves 18 in the housing 18 of the embossing unit 10. A drawer locking unit 27 is provided to ensure that engaged drawers 14 do not pop-out of the slots/grooves 18 once the embossing unit 10 begins to translate in the y-direction
25 towards the pins 20.

A biasing device 11, such as a spring, dashpot, and the like, can be provided within the slots/grooves 18. The biasing device 11 is adapted to return the drawer 14 to the unengaged position outside of the housing 16 after the embossing step is
30 completed and the motor 19 is at-rest. The biasing device 11 can be as long as the length of the slots/grooves 18 or shorter, as necessary, as long as the spring constant is capable of

forcing the drawer 14 completely out of the slots/grooves 18 when not locked in position.

A sensing apparatus 70 (FIG. 5) is also provided within each housing 16 and/or within one of the slots/grooves 18 in each housing 16. Each of the sensing devices 70 is electrically coupled to the controller 40 and each is, further, adapted to generate and transmit a data signal to the controller 40. The data signals designate that a drawer 14 has been properly installed in a housing 16, i.e., "engaged" (LOGIC 1), or is "unengaged" (LOGIC 0).

Although FIGs. 3 and 4 show T-shaped slots/grooves 18 and a corresponding I-shaped docking portions 29 on the drawers 14, this is done for illustrative purposes only. The slots/grooves 18 of the embossing unit 10 and docking portion 29 of the drawer 14 can assume any convenient, economical shape as long as the mating shapes enable and facilitate insertion and removal of a drawer 14 into or from the housing 16 of the embossing unit 10.

Pressing one or more of the keys 12 also activates a motor 19, e.g., a stepper motor, a linear actuator, and the like, and, further, transmits a signal(s) to the controller 40 as to which of the six keys 12 have been depressed. The controller 40 is adapted to compare the signals transmitted by the keys 12 with the data signals from the sensing devices 70. Advantageously, the controller 40 prevents the motor 19 from driving the embossing unit 10 until the controller 40 has determined that data signals from the sensing device as to the drawers 14 engaged corresponds to the signals from the depressed keys 12. Once this has been verified, the motor 19 energizes to drive the embossing unit 10 towards the embossing pins 20.

Although FIG. 2 shows a platform 26 mechanically coupled to the shaft 25 of the (linear actuator-type) motor 19 for driving the embossing unit 10, this is done for illustrative purposes only. Indeed, rotational motion of a stepper motor can be

converted to linear motion, e.g., using a simple gear mechanism, in order to push the embossing unit 10 towards the embossing pins 20.

When urged by the action of the motor 19, the embossing unit 10 translates or displaces in the y-direction, which is to say towards the embossing pins 20. The stroke of the embossing unit can be about 1 mm. Recall, however, that the embossing unit 10 includes six housings 16 that are in registration with a corresponding embossing pin 20. Accordingly, as the embossing unit 10 is lowered, the proximal ends 21 of those embossing pins 20b for which a corresponding drawer 14 is in an unengaged position will enter its corresponding housing 16 and each drawer 14 in an engaged position will prevent its corresponding embossing pin 20a from entering the housing 16. Moreover, engaged drawers 14 transfer the force of the translating embossing unit 10 onto the proximal end(s) 21 of their corresponding embossing pin 20a.

As shown in FIG. 4, the transferred force onto the embossing pin 20a is of sufficient magnitude to overcome the bias of the biasing device 13 to cause the distal end(s) 22 of the engaged embossing pin(s) 20a to extend beyond the distal ends 22 of the other, unengaged embossing pins 20b. The magnitude of the distance between the engaged embossing pin(s) 20a and the unengaged embossing pin(s) 20b can be on the order of 0.5 mm in order to provide sufficient depth of embossing pin(s) 20a into the tangible medium to produce a raised dot that can be "read".

Once the embossing unit 10 engages the embossing pins 20, the motor 19 continues to apply a force until the engaged embossing pin(s) 20a emboss the desired combination of Braille raised dots onto the tangible medium, e.g., a sheet of paper, a sheet of plastic, a sheet of metal, a piece of tape, and so forth.

The relationship between the amount of delivered force to generate raised dots on the tangible medium and the size of the actuator present one of the main challenges of designing a portable, hand-held embossing device 80. However, a fulcrum
5 mechanism using mechanical advantage can be included in the design for force amplification purposes. For example, the platform 26 can be a beam that can be used as a lever with the shaft 25 of the motor 19 (or the linear actuator) disposed on some portion of the beam 26 that is farther from the fulcrum and
10 the embossing unit 10 disposed on a portion of the beam 26 that is closer to the fulcrum. Ratios of about 10:1 are possible without jeopardizing the size and power requirements.

Writing System

15 Having described a device 80 and an apparatus 50 for embossing a single Braille character on a tangible medium, a writing system using the one or more of the same will now be described. Referring to FIG. 6, the writing system 100 includes at least one and, more preferably, a linear array 60 of
20 embossing apparatuses 50 and/or embossing devices 80.

Although the writing system 100 will be described as having a linear array 60 of embossing devices 80/embossing apparatuses 50, those of ordinary skill in the art can appreciate that a system 100 could employ but a single embossing device
25 80/embossing apparatus 50. Such a system, however, would also require means for advancing the embossing device 80/embossing apparatus 50 from one side of the tangible medium 85, e.g., a sheet of paper, to the other or, alternatively, for advancing the tangible medium 85 past a stationary embossing apparatus
30 80/embossing apparatus 50 after each Braille character is embossed. For example, a simple guide (not shown) on the keyboard 90 can advance the tangible medium 85 or the embossing apparatus 80/embossing apparatus 50 to a subsequent embossing

area for the next Braille character or small mechanical engaging units, such as spherical balls loaded with springs, can be structured and arranged to engage and to disengage with the application of a small force. Alternatively, this advancing can
5 be done manually.

Preferably, the use of plural devices 80/apparatuses 50 in a linear array 60 on a single writing system 100 would include a sufficient number of the apparatuses 80 to emboss a complete line on the tangible medium 85 simultaneously. Each apparatus
10 80 in the array 60 would be adjacent and coupled to at least one other apparatus 80. For ease of description, henceforth, we assume that the array 60 includes ten (10) embossing apparatuses 50, requiring sixty embossing pins 20 and sixty housings 16. Those skilled in the art can appreciate that the actual number
15 of embossing apparatuses 50 can be more or less than ten.

Preferably, the planar substrate 30 for holding the embossing pins 20 and the embossing unit 10 of each discrete embossing apparatus 50 (shown in FIG. 3 and FIG. 4) for each of the embossing apparatuses 50 in the array 60 can instead be
20 replaced with, respectively, a single, continuous, elongate substrate that holds all 60 of the embossing pins for all ten of the embossing apparatuses 50 and a single, continuous, elongate embossing unit that includes sixty housings 16 that are in registration with all sixty of the embossing pins 20. The
25 elongate substrate (not shown) and elongate embossing unit can be attached to the system 100 and supported slightly above the plane of an embossing area 82. Alternatively, a combination of ten discrete embossing apparatuses 80 can be coupled in a side by side arrangement.

30 Similar to the traditional stylus and slate concept, the actual embossing area 82 is adapted to support the tangible medium 85; to hold it in place; and to keep it from moving during the embossing step, but is also elastic enough to

facilitate each embossing pins 20 impressing a raised dot in the tangible medium 85 without puncturing the tangible medium 85. In this way, the writing system 100 does not require special, heavy paper. Advantageously, the keys 12, drawers 14, and
5 embossing pins 20 are adapted so that the Braille character does not have to be input as a reverse mirror image.

Unlike the stylus and slate concept, the writing system 100 can be adapted to selectively write from left-to-right or from right-to-left. As previously mentioned, writing from right-to-
10 left may be desirable when writing Semitic languages, such as Hebrew and Arabic, which read from right-to-left, in Braille characters. In either case, the system platen 81 -- a typewriter-like roller -- is bi-directional to allow loading the tangible medium to in either direction.

More particularly, this feature permits the tangible medium
15 85 to be advanced into the system 100 (FIG. 7) or out of the system 100 (FIG. 8). For the purpose of this disclosure, when the tangible medium 85 advances "out of" the system 100, the direction of the embossing Braille characters for the Latin
20 alphabet is from right-to-left. When the tangible medium 85 advances "into" the system 100, the direction of the embossing Braille characters for the Latin alphabet is from left-to-right. Preferably, each system 100 is capable of embossing in either a left-to-right or a right-to-left format and to receive paper
25 into or out of the system 100.

The embossing area 82 can be included on a rotatable, cylindrical platen 81 having an axis of rotation 83. The platen 81 can be structured and arranged similar in shape and function to the platen of a conventional typewriter. More particularly,
30 the manual or automatic rotation of the platen 81 about the axis of rotation 83 can selectively advance the tangible medium 85 (FIG. 7 and FIG. 8) any desired line spacing distance, e.g., single space, double space, and so forth. A platen knob 84 for

manually rotating the platen 81 can be attached to one or both ends of the platen 81.

Optionally, in addition to the six, primary keys 12, the keyboard 90 of the system 100 can also include a horizontal
5 space key or bar 92, a return key or bar 94, and an emboss key or bar 96. The space key 92 is structured and arranged to generate horizontal space in same the horizontal printing line, to separate words. The return key 94 is structured and arranged to generate a vertical space between horizontal printing lines.
10 The emboss key 96 activates the motor 19 to emboss a complete horizontal printing line of Braille characters and horizontal spaces at one time.

The embossing step involves creation of raised dots for an entire horizontal printing line. Preferably, a single motor 19
15 is adapted to force the elongate embossing unit of the entire array 60 at once. Alternatively, the motor 19 can drive the embossing units individually in succession, e.g., from left-to-right or from right-to-left. For example, the latter could include a wheel-like platform that successive rolls over each
20 embossing unit from one direction to the other.

After the embossing step of a full line is completed, the system 100 automatically executes a "return" function in which the platen 81 automatically advances the tangible medium 85 vertically to the next horizontal printing line and key entry
25 re-sets to the next Braille character at the extreme left or extreme right, depending on whether the tangible medium 85 is rotating into the system 100 or out of the system 100, respectively. The "return" function can also be performed manually.

30 Optionally, the system 100 can include a audible speaker 95 that is adapted to read back the Braille characters that have been input and that are to be embossed in the pending horizontal printing line. The speaker 95 can provide an audible readback

after each Braille character is entered and/or after an entire horizontal printing line of Braille characters has been entered but before the motor 19 drives the elongate embossing unit 10 into the array of embossing pins 20. The purpose of the audible
5 speaker 95 is to allow the writer to correct mistakes before embossing and can also be used to train/teach children the Braille alphabet and how to use the writing system.

Although preferred embodiments of the invention have been described above, it will be recognized and understood that
10 various modifications may be made in the invention and that the appended claims are intended to cover all such modifications which fall within the spirit and scope of the invention.

CLAIMS

What we claim are:

- 5 1. A device for embossing a Braille character on a tangible medium, each raised dot of the Braille character corresponding to a key, the apparatus comprising:
- a plurality of embossing pins, each embossing pin corresponding to a discrete one of the plurality of keys;
- 10 a plurality of drawers, each drawer corresponding to a discrete one of the plurality of embossing pins;
- an embossing unit having a plurality of housings, each housing including a housing for a corresponding drawer, each housing structured and arranged to be in registration with a
- 15 corresponding embossing pin; and
- an embossing unit driving apparatus that is structured and arranged to drive the embossing unit into the plurality of embossing pins to emboss a raised dot Braille character on the tangible medium,
- 20 wherein the apparatus is structured and arranged so that for each depressed key, the corresponding drawer covers the corresponding housing and forces the corresponding embossing pin into the tangible medium.
- 25 2. The device as recited in claim 1, wherein each embossing pin is cylindrical or substantially cylindrical in shape and includes an annular ring at a proximal end thereof, each embossing pin is capable of displacing through a hole in a planar substrate.
- 30 3. The device as recited in claim 2, wherein at least one of a compressible spring, a dash pot, and a biasing device is disposed about or adjacent to a corresponding embossing pin,

each spring, dash pot, and biasing device adapted to bias the corresponding embossing pin by exerting a force against the corresponding annular ring.

5 4. The device as recited in claim 1 further comprising a plurality of sliding units, each sliding unit of said plurality of sliding unit mechanically coupled to a corresponding key, each sliding unit structured and arranged to force a corresponding drawer into the corresponding housing of the
10 embossing unit after the corresponding key is depressed.

5. The device as recited in claim 1 further comprising a drawer lock unit that is adapted to retain an engaged drawer in a corresponding housing after the engaged drawer is properly
15 inserted in the corresponding housing.

6. The device as recited in claim 1 further comprising a sensing apparatus for sensing that a drawer is properly engaged in a corresponding housing and for generating a data signal when
20 the drawer is properly engaged.

7. The device as recited in claim 1 further comprising a controller that is structured and arranged to:

- receive first data signals from each depressed key;
- 25 receive second data signals generated by a sensing apparatus that is adapted to detect when a drawer is properly engaged in a corresponding housing;
- compare the second data signals to the first data signals;
- and
- 30 activate the embossing unit driving apparatus to drive the embossing unit when the second data signals corresponds to the first data signals.

8. The device as recited in claim 1 further comprising at least one lever and a fulcrum, one end of the at least one lever closest to the fulcrum mechanically coupled to the embossing unit and another end of said at least one lever farthest from said fulcrum mechanically coupled to the embossing unit driving
5 apparatus.

9. The device as recited in claim 1, the embossing unit driving apparatus selected from the group comprising: a motor,
10 a linear actuator, a stepper motor, a beam mechanically connected to a motor, a beam mechanically connected to a linear actuator or a beam mechanically connected to a stepper motor.

10. The device as recited in claim 1, wherein electromagnetism
15 is used to cause the corresponding drawer to cover the corresponding housing.

11. An apparatus device for embossing a Braille character on a tangible medium, each raised dot of the Braille character
20 corresponding to a key, the apparatus comprising:

a plurality of embossing pins, each embossing pin corresponding to a discrete one of the plurality of keys;

a plurality of drawers, each drawer corresponding to a discrete one of the plurality of embossing pins;

25 an embossing unit having a plurality of housings, each housing including a housing for a corresponding drawer, each housing structured and arranged to be in registration with a corresponding embossing pin,

wherein the apparatus is structured and arranged so that
30 for each depressed key, the corresponding drawer covers the corresponding housing and forces the corresponding embossing pin into the tangible medium.

12. The apparatus as recited in claim 11, wherein each embossing pin is cylindrical or substantially cylindrical in shape and includes an annular ring at a proximal end thereof, each embossing pin is capable of displacing through a hole in a planar substrate.

13. The apparatus as recited in claim 12, wherein at least one of a compressible spring, a dash pot, and a biasing device is disposed about or adjacent to a corresponding embossing pin, each spring, dash pot, and biasing device adapted to bias the corresponding embossing pin by exerting a force against the corresponding annular ring.

14. The apparatus as recited in claim 11 further comprising a sensing apparatus for sensing that a drawer is properly engaged in a corresponding housing and for generating a data signal when the drawer is properly engaged.

15. The apparatus as recited in claim 11 further comprising a controller that is structured and arranged to:

receive first data signals from each depressed key;

receive second data signals generated by a sensing apparatus that is adapted to detect when a drawer is properly engaged in a corresponding housing;

compare the second data signals to the first data signals; and

activate the embossing unit driving apparatus to drive the embossing unit when the second data signals corresponds to the first data signals.

16. A system for embossing a Braille character on a tangible medium, the system comprising:

a keyboard having a plurality of keys, each key corresponding to a discrete raised dot in a Braille character;

at least one embossing apparatus including:

a plurality of embossing pins, each embossing pin corresponding to a discrete one of the plurality of keys;

a plurality of drawers, each drawer corresponding to a discrete one of the plurality of embossing pins;

an embossing unit having a plurality of housings, each housing including a housing for a corresponding drawer, each housing structured and arranged to be in registration with a corresponding embossing pin; and

an embossing unit driving apparatus that is structured and arranged to drive the embossing unit into the plurality of embossing pins to emboss a raised dot Braille character on the tangible medium

17. The system as recited in claim 16 further comprising a controller that is structured and arranged to:

receive first data signals from each depressed key;

receive second data signals generated by a sensing apparatus that is adapted to detect when a drawer is properly engaged in a corresponding housing;

compare the second data signals to the first data signals; and

activate the embossing unit driving apparatus to drive the embossing unit when the second data signals corresponds to the first data signals.

18. The system as recited in claim 16 further comprising an audio device that is adapted to sound out an equivalent of each entered Braille character.

19. The system as recited in claim 16, wherein the embossing apparatus is structured and arranged to emboss the tangible medium from both a right-to-left direction and a left-to-right direction.

5

20. The system as recited in claim 16, wherein the at least one embossing apparatus is a plurality of embossing apparatuses that is disposed in a linear array.

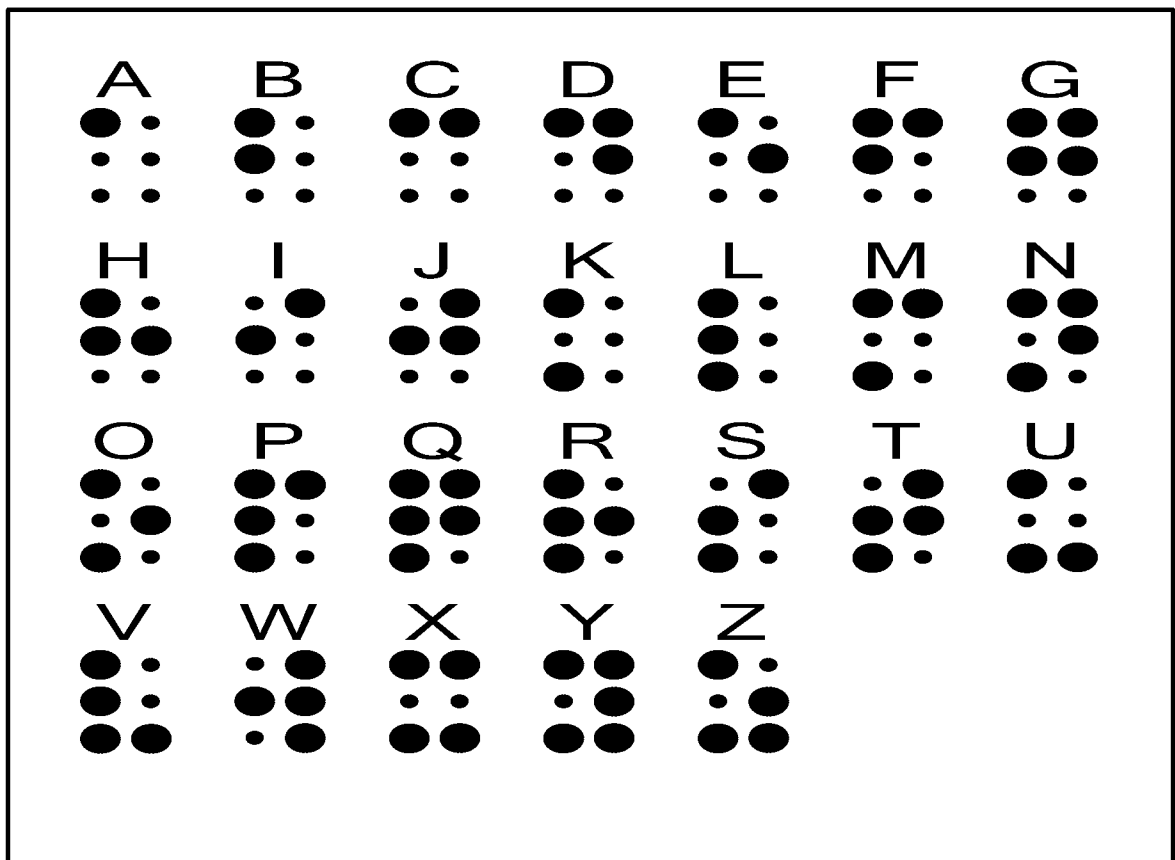
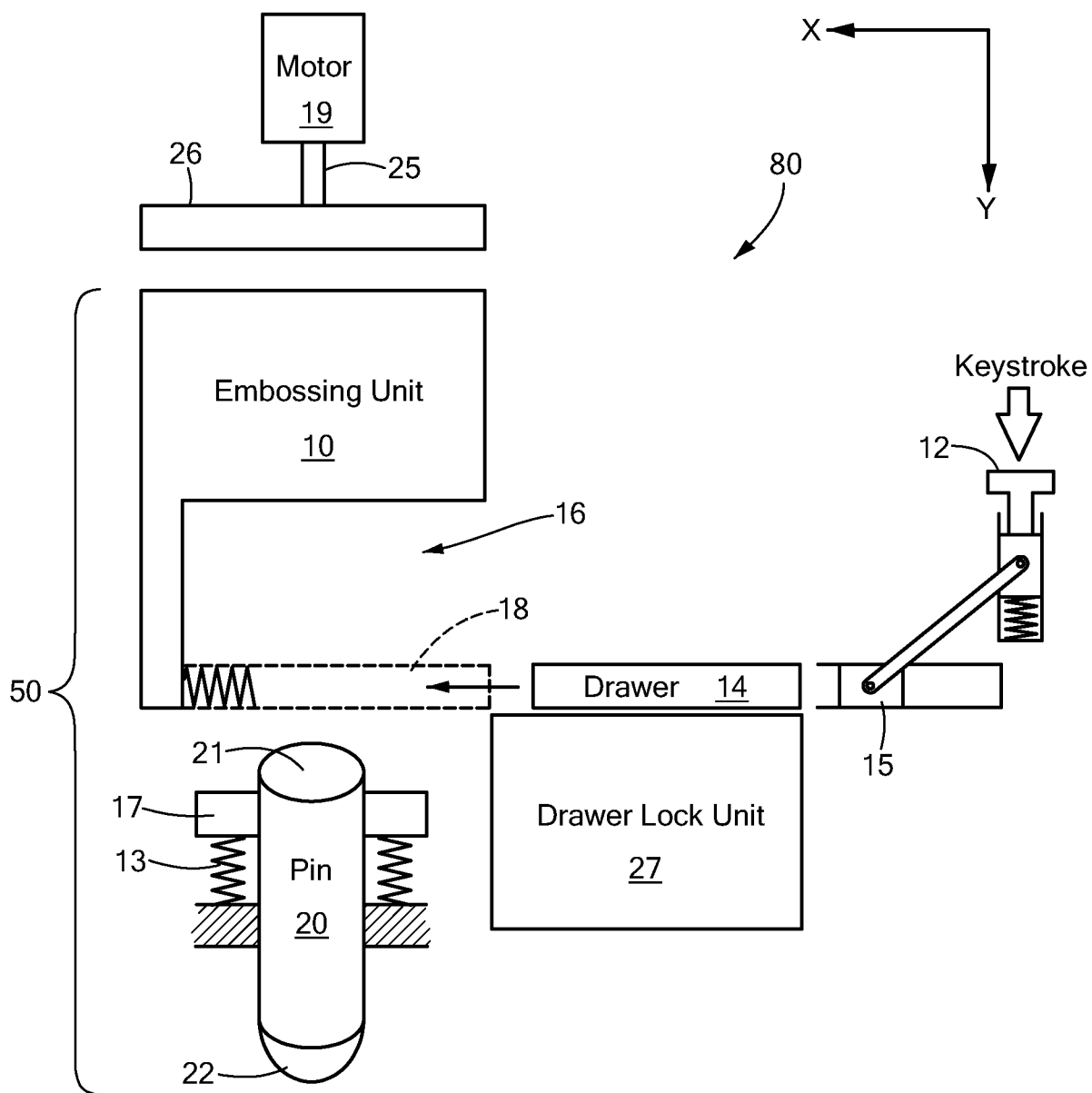
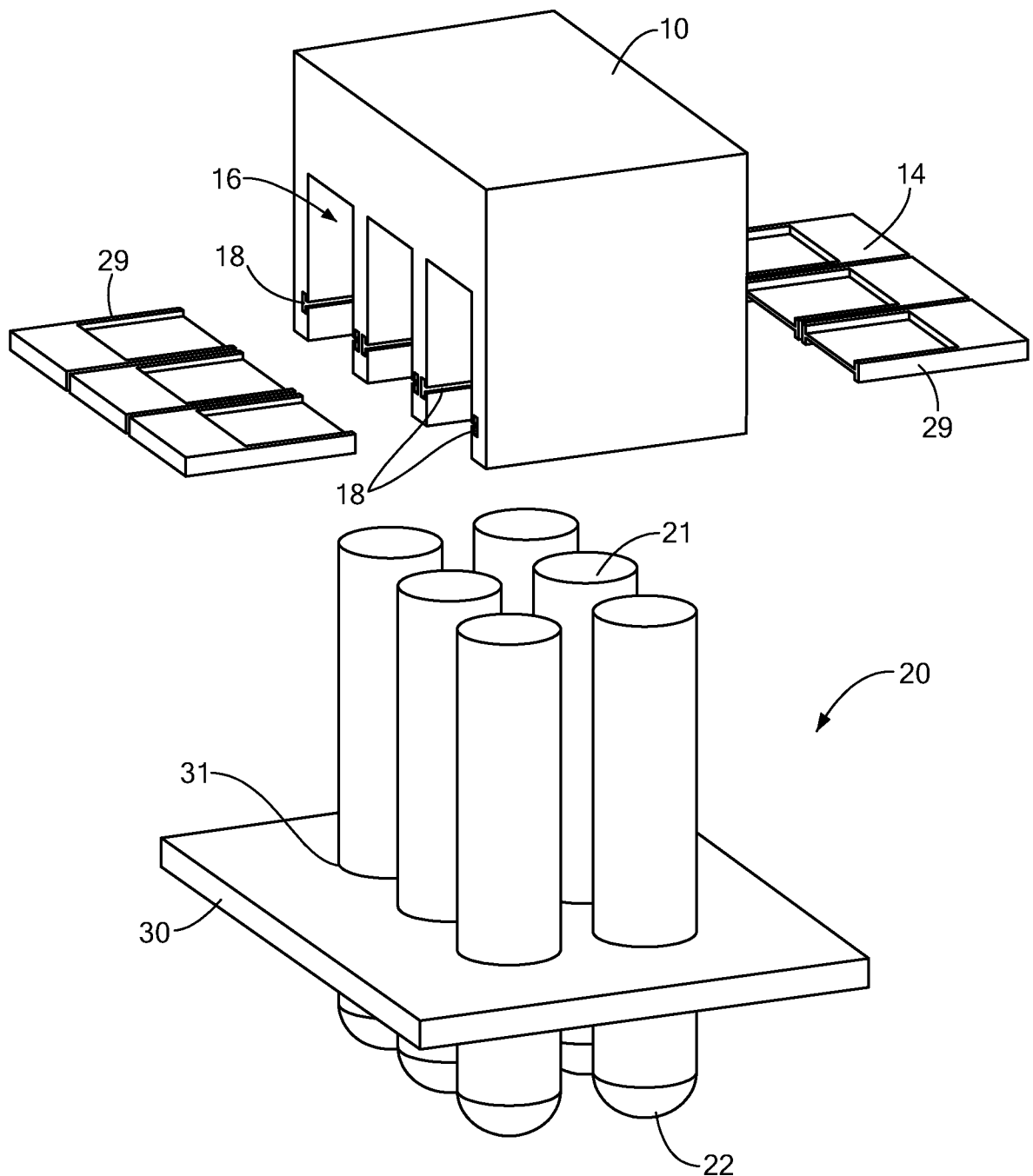
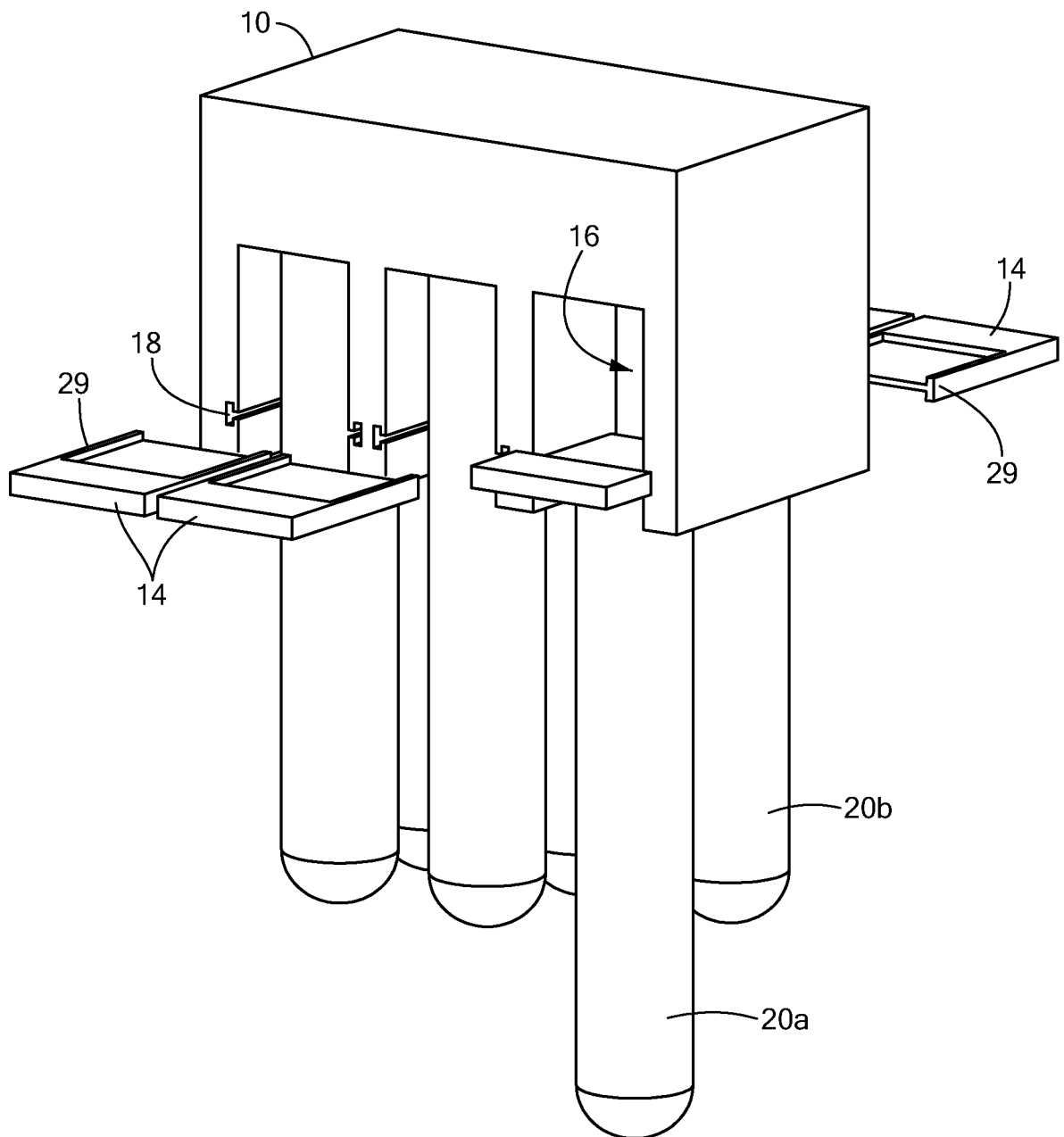


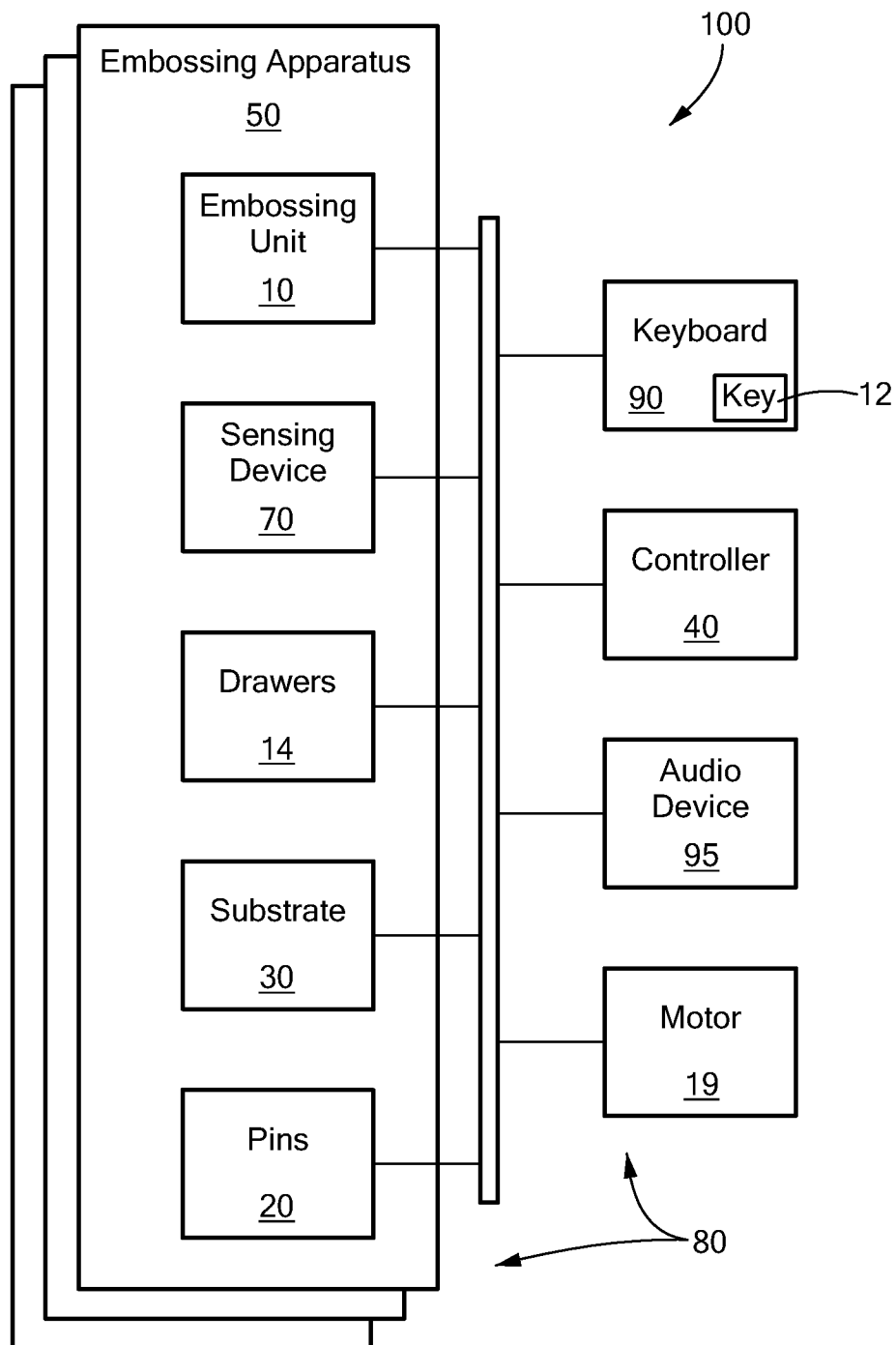
FIG. 1

PRIOR ART

**FIG. 2**

**FIG. 3**

**FIG. 4**

**FIG. 5**

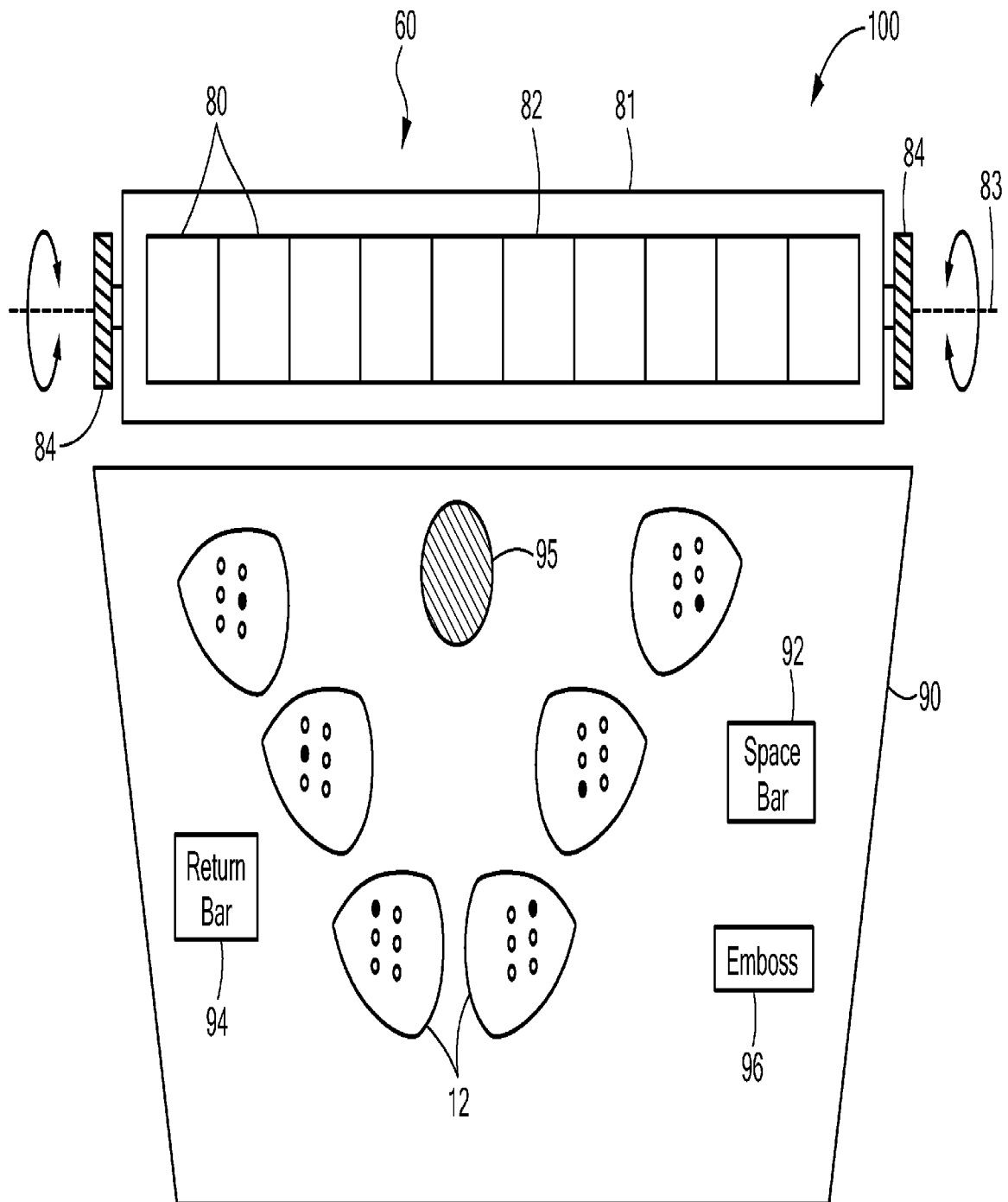


FIG. 6

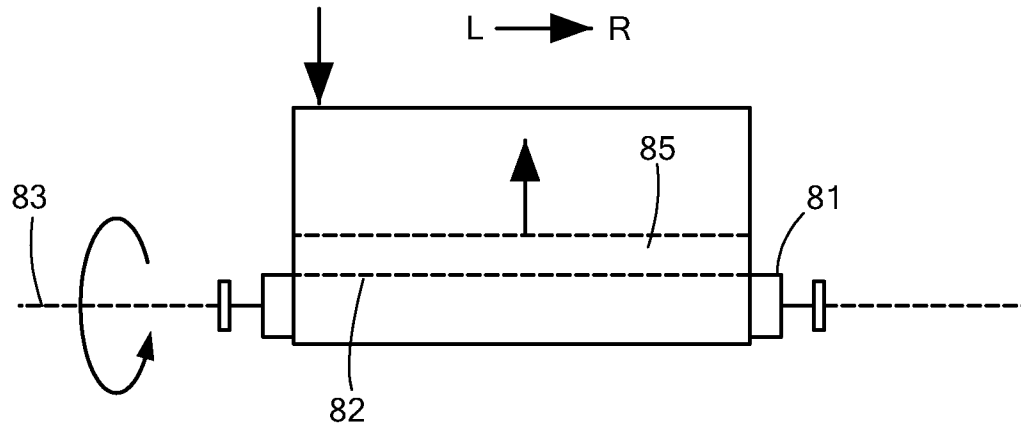


FIG. 7

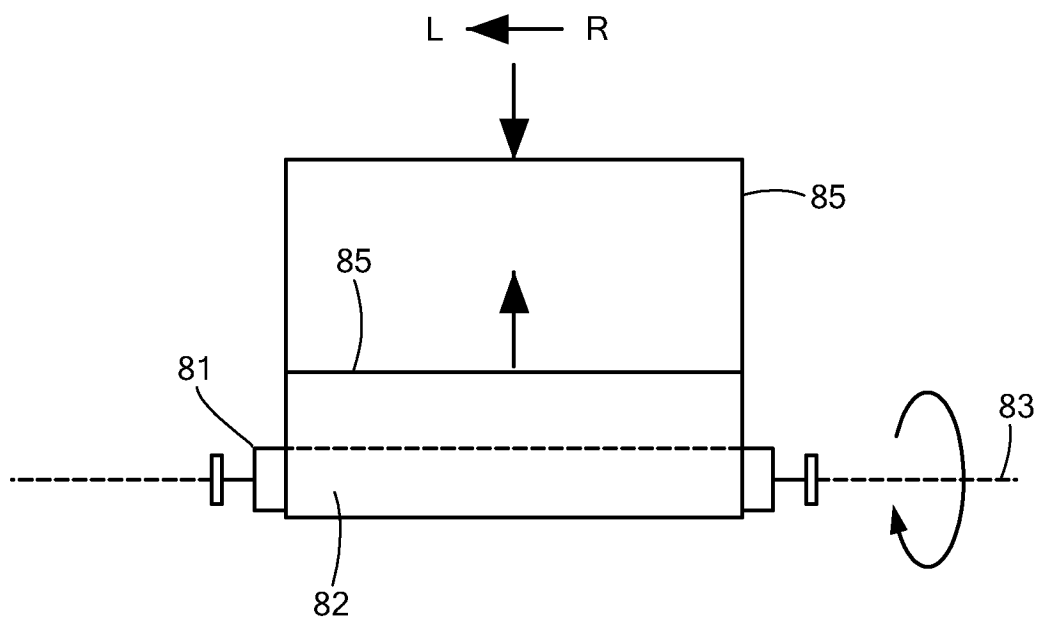


FIG. 8

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2011/026427

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - B41J 3/32 (2011.01)

USPC - 400/109.1

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)

IPC(8) - B41J 3/32 (2011.01)

USPC - 101/18; 340/407.1, 407.2; 400/87, 88, 109, 109.1, 112, 127, 279; 407/116; 434/112, 114, 115

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)

MicroPatent, Google Patents

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 4,488,828 A (OHTSUKI) 18 December 1984 (18.12.1984) entire document	1-3, 5-7, 9-20
Y	US 5,209,584 A (GALARNEAU) 11 May 1993 (11.05.1993) entire document	1-3, 5-7, 9-20
Y	US 4,183,683 A (HIRATSUKA et al) 15 January 1980 (15.01.1980) entire document	2, 3, 12, 13
Y	US 2005/0000337 A1 (AHNE et al) 06 January 2005 (06.01.2005) entire document	6-7, 14-15, 17
Y	US 5,527,117 A (ROY) 18 June 1996 (18.06.1996) entire document	10
Y	US 4,507,088 A (WILSON) 26 March 1985 (26.03.1985) entire document	18
A	US 7,029,190 B1 (DAVIS et al) 18 April 2006 (18.04.2006) entire document	1-20

☐ Further documents are listed in the continuation of Box C.

* 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

25 April 2011

Date of mailing of the international search report

12 MAY 2011

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. 571-273-3201

Authorized officer:

Blaine R. Copenheaver

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