



(86) Date de dépôt PCT/PCT Filing Date: 2012/05/02
(87) Date publication PCT/PCT Publication Date: 2012/11/15
(85) Entrée phase nationale/National Entry: 2013/11/01
(86) N° demande PCT/PCT Application No.: CA 2012/050281
(87) N° publication PCT/PCT Publication No.: 2012/151691
(30) Priorité/Priority: 2011/05/06 (US61/483,433)

(51) Cl.Int./Int.Cl. *A01G 31/04* (2006.01),
A01G 9/20 (2006.01), *B65G 17/30* (2006.01)
(71) Demandeur/Applicant:
NON-INDUSTRIAL MANUFACTURE, INC., CA
(72) Inventeurs/Inventors:
BENNE, JACOB, CA;
MEIKLEHAM, DANIEL, CA
(74) Agent: GOODWIN MCKAY

(54) Titre : PROCÉDE ET APPAREIL POUR LA CULTURE DE PLANTES LE LONG D'UN PARCOURS ONDULE
(54) Title: METHOD AND APPARATUS FOR GROWING PLANTS ALONG AN UNDULATING PATH

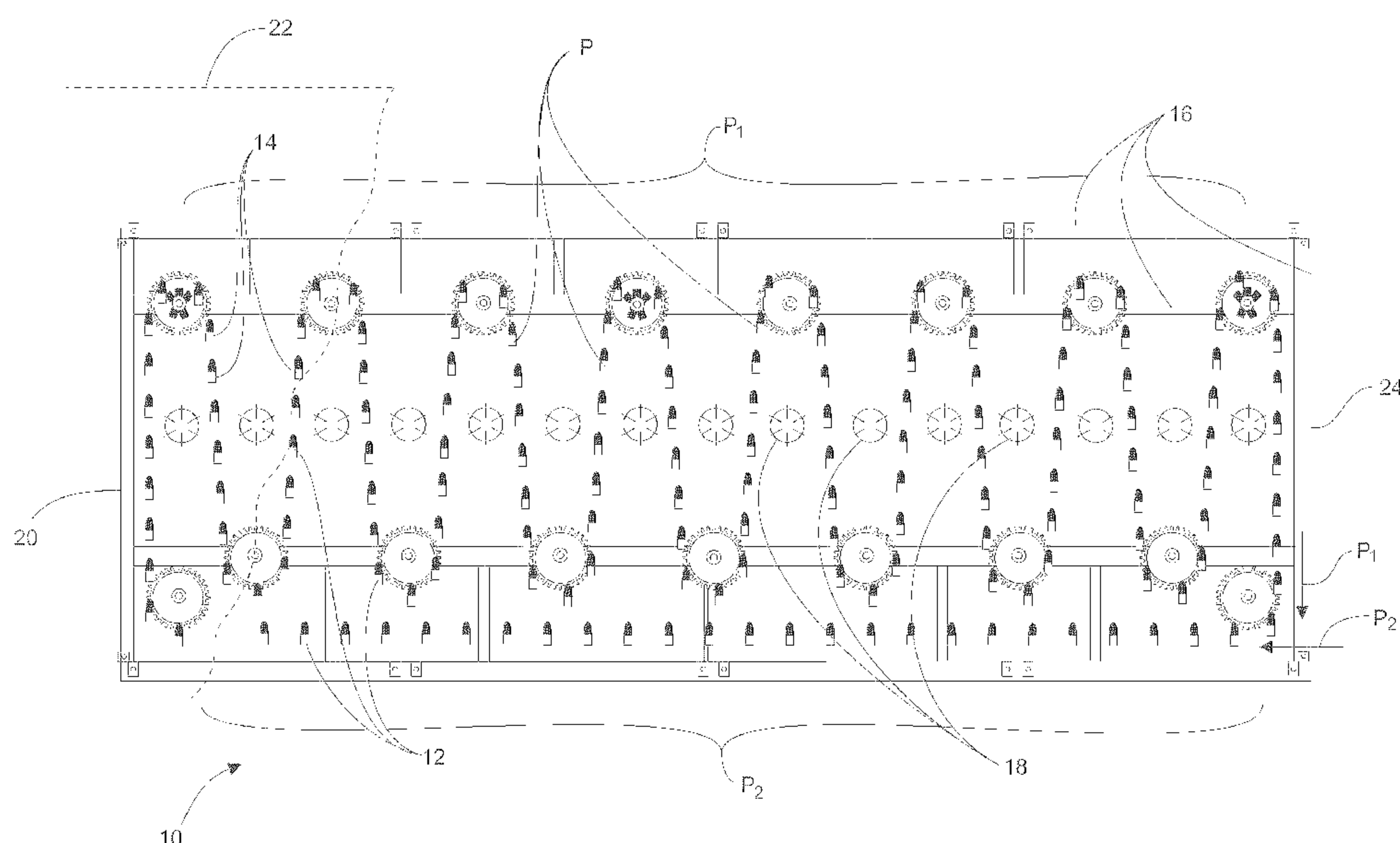


Fig. 1

(57) **Abrégé/Abstract:**

Plants are grown in a growing machine by advancing a plurality of plant cradles on an endless conveyor along a growing path, at least a portion of the path being an undulating path having alternating upward and downward portions and having a return portion for looping back to the undulating portion. Using a pair of parallel endless conveyors, the cradles are removably supported between the conveyors. The cradles are supplied with growth-sustaining liquid and growth-promoting light. The cradles are advanced along the path until the one or more plants have reached a target growth after which they can be harvested or transferred to one or more subsequent machines until mature for harvest. The machine can be in a controlled environment, including located in modules arranged in series, parallel or combinations thereof.

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

(19) World Intellectual Property
Organization
International Bureau



WIPO | PCT



(10) International Publication Number

WO 2012/151691 A1

(43) International Publication Date
15 November 2012 (15.11.2012)

(51) International Patent Classification:

A01G 31/04 (2006.01) *B65G 17/30* (2006.01)
A01G 9/20 (2006.01)

(21) International Application Number:

PCT/CA2012/050281

(22) International Filing Date:

2 May 2012 (02.05.2012)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

61/483,433 6 May 2011 (06.05.2011) US

(71) Applicant (for all designated States except US): **NON-INDUSTRIAL MANUFACTURE, INC.** [CA/CA]; 12936 Elbow Drive SW, Calgary, Alberta T2W 6G6 (CA).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **BENNE, Jacob** [CA/CA]; 7170 Glover Road, Milner, British Columbia V0X 1T0 (CA). **MEIKLEHAM, Daniel** [GB/CA]; 12936 Elbow Drive, Calgary, Alberta T2W 6G6 (CA).

(74) Agent: **GOODWIN MCKAY**; Suite 222, Parkside Place, 602-12th Avenue SW, Calgary, Alberta T2R 1J3 (CA).

(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, QA, RO, RS, RU, RW, 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, 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, ML, MR, NE, SN, TD, TG).

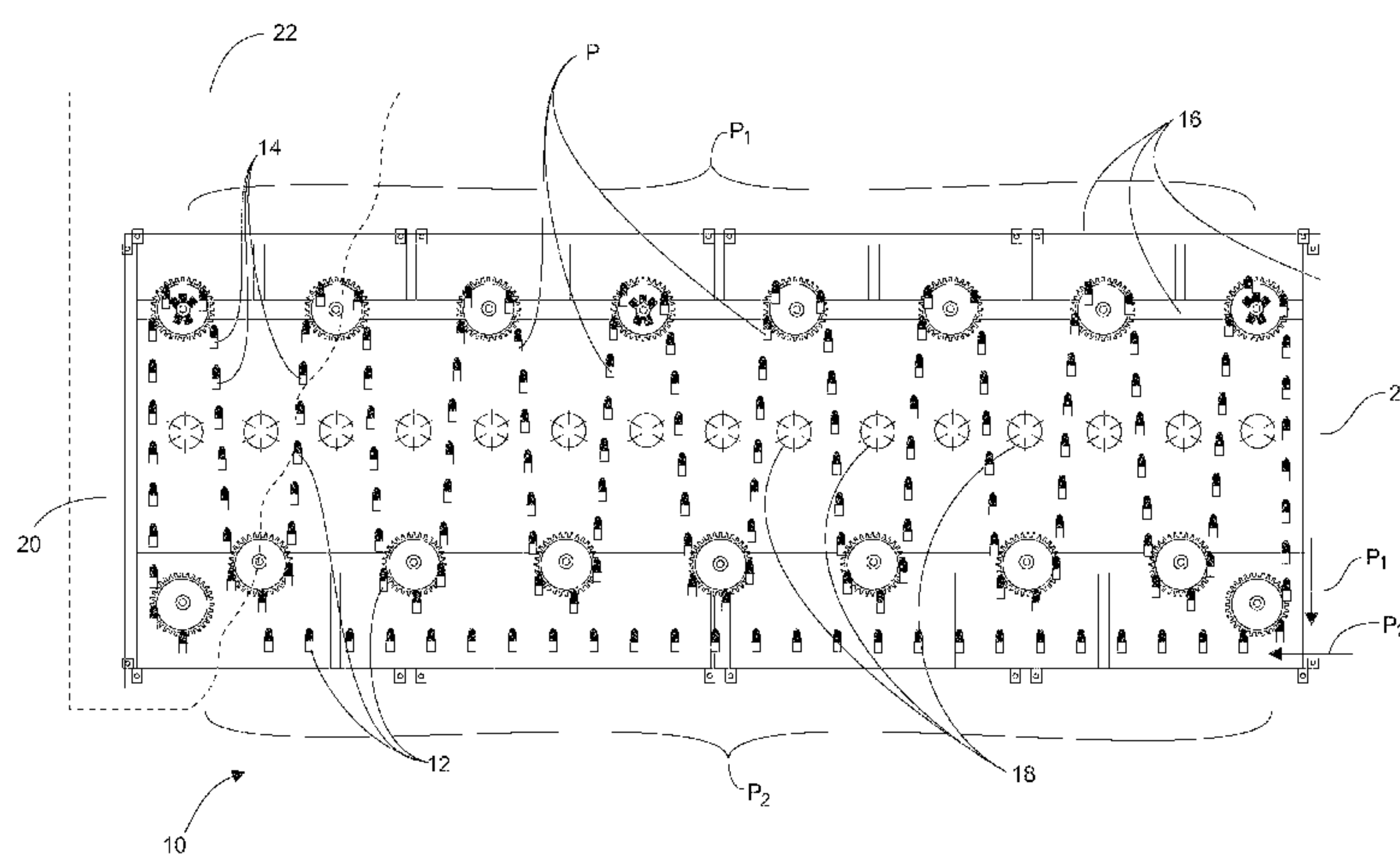
Declarations under Rule 4.17:

— of inventorship (Rule 4.17(iv))

Published:

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

(54) Title: METHOD AND APPARATUS FOR GROWING PLANTS ALONG AN UNDULATING PATH

**Fig. 1**

(57) **Abstract:** Plants are grown in a growing machine by advancing a plurality of plant cradles on an endless conveyor along a growing path, at least a portion of the path being an undulating path having alternating upward and downward portions and having a return portion for looping back to the undulating portion. Using a pair of parallel endless conveyors, the cradles are removably supported between the conveyors. The cradles are supplied with growth-sustaining liquid and growth-promoting light. The cradles are advanced along the path until the one or more plants have reached a target growth after which they can be harvested or transferred to one or more subsequent machines until mature for harvest. The machine can be in a controlled environment, including located in modules arranged in series, parallel or combinations thereof.

METHOD AND APPARATUS FOR GROWING PLANTS ALONG AN UNDULATING PATH

1

2

3

CROSS REFERENCE OF RELATED APPLICATIONS

4

5

6

This application claims the benefits under 35 U.S.C 119(e) of US Provisional Application Serial No. 61/483,433, filed May 6, 2011, which is incorporated fully herein by reference.

7

8

FIELD

9

10

11

12

13

Embodiments disclosed herein relate to a system and method for growing plants in a controlled environment. More specifically, the embodiments relate to a system and method using an endless conveyor in a controlled environment for maximizing production while minimizing a footprint.

14

BACKGROUND

15

16

17

18

19

20

21

22

Traditional commercial farming techniques are typically labor intensive, and require vast amounts of viable land to harvest a crop. At the beginning of each growing cycle or season, an operator or farmer must first prepare the field before planting either seeds or seedlings of a crop of interest. Preparation of a field typically involves plowing a field by pulling a plow behind a tractor back and forth across the entire field. Depending on the size of the field to be plowed, plowing is typically labor and time intensive and costs associated with the fuel used in the tractor can be substantial.

1 After plowing the field, the farmer, using commercially available seeds
2 or seedlings, can then plant the crop by pulling a seeding machine or seeder back
3 and forth across the field. Again, seeding or planting the field can be labor and time
4 intensive and can have substantial costs associated with it.

5 A typical farm usually employs a system for irrigating the field. Further,
6 to encourage rapid and healthy growth of the crop, the farmer may also decide to
7 apply fertilizers (chemical or otherwise) which can be done by either traveling back
8 and forth across the field pulling a fertilizer applicator with the tractor, or by spraying
9 a chemical fertilizer from the air using aircraft, such as a small airplane or helicopter.

10 During the growing cycle of the planted crop, the farmer can also
11 ensure that the crop is not damaged by pests or invasive weeds by spraying
12 chemical pesticides and/or herbicides. The spraying of the chemical pesticides
13 and/or herbicides is typically done by either travelling back and forth across the field
14 with a chemical applicator, or can be sprayed aurally from an aircraft.

15 After the crop matures, harvesting is typically done by traveling back
16 and forth across the field in harvesting equipment, such as a combine or a harvester
17 being pulled by the tractor.

18 The harvested crop can then transported from the farm to processing
19 centers to be packaged and distributed to local warehouses where they will be
20 shipped to local supermarkets or other groceries. The transfer from the farm to
21 local groceries or supermarkets can take upwards of 7 days or longer, depending
22 on the geographical location of the final destination of the crop.

1 Typically, harvesting a crop occurs when about 10% of the crop is
2 over mature and when about 10% is under mature. Further, about another 20% of
3 the remaining crop spoils as a result from long distance transportation and related
4 warehousing which reduces shelf life due to the time from harvest to retail shelf.

5 Traditional farming techniques require large expanses of viable farm
6 land, large capital investments for farm machinery, large capital expenses for fuel,
7 and large expenses for shipping. Traditional farming techniques are also at the
8 mercy of unpredictable weather patterns, such as floods, extreme temperatures,
9 extraordinary storms, etc., which can cause substantial damage to a potential crop.

10 Traditional farming techniques further require large storage or
11 warehouse space to receive harvested crop and to re-distribute the crop to their
12 final destinations. Up to 70% of the retail costs for vegetables at the local market
13 can be attributed to transportation costs. Further, due to the transportation times,
14 much of the vegetables that are sold at the local markets are not fresh and do not
15 have their full nutritional content.

16 For example, lettuce farmed using traditional farming techniques
17 produces about 200,000 heads of lettuce per acre per year. A head of lettuce
18 produced in California, USA, requires 6 days to travel from the farm to a local
19 market in Calgary, Alberta, Canada. It is known that just 2 days after harvest, the
20 lettuce will lose about 50% of its nutritional value. Thus, the lettuce sold to
21 consumers in Calgary, Alberta, Canada, will not be fresh, already being at least 6
22 days old and having less than about 50% of its nutritional value.

1 International Published Patent Application WO 2010/097562 to
2 Bradford et. al., assigned to Valcent Product (EU) Limited, teaches a growing room,
3 such as a greenhouse, for growing plants in a controlled environment. The growing
4 room houses a vertical growing system for growing plants in the controlled
5 environment. The system comprises a horizontal overhead conveyor system
6 supporting a plurality of support assemblies therefrom and moveable therealong.
7 Each support assembly further comprises a plurality of removable receptacles for
8 planting crops therein. The receptacles can be stacked vertically, one above
9 another, along each support assembly. The overhead conveyor system moves the
10 receptacles along a horizontal path and through a single watering station for
11 providing water and nutrients to the plants as they pass through. The system has a
12 significant areal footprint

13 There is a need for a system and method of farming which reduces
14 the overall costs associated with farming to reduce the price paid by consumers for
15 vegetables and that increases the freshness and nutritional value of crops sold to
16 consumers at local markets.

17 There is a need for a system and method of farming that increases the
18 overall crop output with a minimum footprint as compared to the crop output from
19 traditional methods of farming.

20

1

A system and method for producing fruits, vegetables and other commercially grown plants in commercial quantities using a small footprint in any location and in any climate is disclosed. The volume of produce or crop output that can be grown in a given footprint is increased dramatically in a controlled agricultural environment compared to traditional industrial commercial farming methods.

8 Embodiments disclosed herein include a high output growing machine
9 that is suitable for local food production in indoor urban settings leading to
0 improvements in the economic factors of long distance transportation from remote
1 food production areas or farms.

Embodiments can be used to control environmental conditions to use significantly less water than traditional industrial outdoor farming methods and provide greater access to light. Further, as the plants are in controlled indoor environments, the plants are less susceptible to pests and weeds negating the need for pesticides and/or herbicides. Accordingly, embodiments herein have a reduced environmental impact associated the wide scale use of herbicides and pesticides. Safety, sustainability, traceability, and reduced carbon footprint are factors which embodiments take into consideration.

20 In operation, a growing system is populated with seeds or seedlings in
21 a plurality of growing cradles that are conveyed along an endless conveyor. The
22 endless conveyor can be arranged with a vertically up and down undulating

1 arrangement to maximizes travel in a minimum plan area or footprint. Further, an
2 undulating arrangement enables maximizing of plant exposure to grow lights. The
3 growing system can include means for nutrient application, pollination, and pest
4 control. Each stage of growth can be handled in a module. Further, during the
5 growing cycle, as the plants grow larger and encroach on the growing space of an
6 adjacent plant, the plants can be spaced further apart. To provide sufficient growing
7 space for each plant, cradles can be spaced farther apart from one another to
8 permit plant growth. One embodiment is to move incrementally larger plants to a
9 module having incrementally greater spacing between cradles.

10 In one aspect, a growing machine for growing plants comprises an
11 endless conveyor forming a growing path having at least a portion of which is an
12 undulating path having alternating upward and downward portions and a return path.
13 A plurality of cradles are spaced along and supported by the conveyor for
14 movement along the growing path, each cradle supporting one or plants therein in a
15 plant and growth-sustaining liquid orientation. One also provides a source of the
16 growth-sustaining liquid and a source of growth-sustaining light.

17 In another aspect, a method for growing plants comprises: providing a
18 growing machine having an endless conveyor having a plurality of growing cradles
19 spaced apart therealong, each cradle supporting one or more plants therein. The
20 method proceeds with advancing the plurality of cradles along a path, at least a
21 portion of which is an undulating path having alternating upward and downward
22 portions while supplying the cradles with growth-sustaining liquid and exposing the

1 one or more one plants to growth-promoting light. As long as the one or more
2 plants have not yet reached a target growth, one continues repeating the advancing
3 the plurality of cradles along the path until the one or more plants have reached the
4 target growth for that machine. Once target growth is reached, and the plants are
5 not yet mature for harvest, the plants can be moved to a further machine, having
6 spaced the plants suitable to make appropriate growing room to achieve the next
7 target growth, and so on until harvest.

8 As a result, crops can be grown in a minimal footprint, and mature
9 crops can be harvested as just-in-time inventory, grown locally and available to local
10 food retail chains eliminating the substantial wastage typically experience due to
11 delays between industrial agriculture harvesting and ultimate sale to the consumer.

12 13 BRIEF DESCRIPTION OF THE DRAWINGS

14 Figure 1 is a side view of an embodiment of an embodiment
15 illustrating an endless conveyor supporting a plurality of growing cradles moving
16 along a first path in a first direction and returning along a return path in a second
17 direction opposite the first direction, the conveyor hidden for clarity of the other
18 elements;

19 Figure 2 is a partial, side perspective view of an embodiment
20 illustrating a frame supporting a pair of spaced endless conveyors operatively
21 connected to one another by a gear motor and a common drive shaft, for
22 synchronized movement of the two endless conveyors, only some cradles shown at

1 the transition between the first and second paths, most cradles and the conveyor
2 hidden for clarity of the other elements;

3 Figure 3 is a representative drawing of a portion of an endless drive
4 chain conveyor being driven by a sprocket;

5 Figure 4 is side perspective view of an embodiment of a cradle,
6 illustrating hooks on opposing end of the cradle and a backsplash forming a liquid-
7 receiving portion;

8 Figure 5A is a plan view of a nozzle directing growth-sustaining liquid
9 to a liquid receiving portion of a cradle;

10 Figure 5B is a side cross-sectional view of the embodiment along line
11 B-B of Fig. 5A;

12 Figure 6 is a side cross-sectional view of the cradle of Fig. 4,
13 illustrating a drain port in a bottom of the cradle and the liquid receiving portion;

14 Figure 7 is a plan view of the cradle of Fig. 4 illustrating the drain port;

15 Figure 8A is a side cross-sectional view of an embodiment illustrating
16 the cradle of Fig. 4 having a drain port in its closed sealed position and approaching
17 a drainage trough as the cradle transitions from a first path to a second return path;

18 Figure 8B is a side cross-sectional view of the embodiment of Fig. 8A,
19 illustrating the cradle on its second return path and its plug engaging the drainage
20 trough manipulating and maintaining the plug its open drain position;

1 Figure 8C is a partial schematic view of the steps of the drain port
2 transitioning from the sealed position to the drain position of the embodiments of
3 Figs. 8A and 8B;

4 Figure 9 is an end view of an embodiment illustrating cradle extending
5 horizontally between two synchronous conveyors supported within a frame, each
6 cradle being suspended constantly and substantially parallel to the ground floor;

7 Figure 10A is an end view of an embodiment illustrating cradles
8 travelling along one of the upward or downward portion of the undulating path and
9 having one end of the cradle indexed ahead of the other end for imparting a slope to
10 the cradle;

11 Figure 10B is an end view of the embodiment of Fig. 10A illustrating
12 the shifting or reversal of the slope of each cradle as the cradle travelled along the
13 along the other of downward or upward portion of the undulating path;

14 Figure 10C is a fanciful perspective view of opposing sprockets of a
15 pair of conveyors and one illustrating cradle, the cradle having a first orientation or
16 slope formed by the differential height created by one end being advanced over the
17 other end;

18 Figure 10D is a fanciful perspective view according to Fig. 10C
19 illustrating each cradle having a reversed, second orientation or slope as it crests an
20 apex of the undulating path;

1 Figure 11 is a representative drawing of an embodiment, illustrating
2 rotational indexing of opposing drive sprockets, chain and support pins used for
3 shifting a slope of each cradle during travel along a first path;

4 Figure 12A illustrates the growing sequence not the apparatus, of a
5 first growing machine having a plants that have grown sufficiently enough to
6 encroach on an available growing space of an adjacent plant;

7 Figure 12B illustrating the transfer of the grown plants of Fig. 12A onto
8 a second growing machine, again the growing sequence not the apparatus, of the
9 embodiment of Fig. 12A, the transferred plants being spaced farther apart from one
10 another to increase the available growing space therebetween;

11 Figures 13A through 13D illustrate the implementation of transfer
12 between machines wherein

13 Fig. 13A illustrates an end of a first growing machine having a
14 growing cradle with growing plants, the plants being ready to be transferred
15 to a second growing machine,

16 Fig. 13B illustrates the transfer of the growing plants from the
17 first machine of Fig. 13A to the second or subsequent growing machine,

18 Fig 13C illustrates the transfer of several of the growing plants
19 from the second machine to a third subsequent growing machine, the
20 growing plants on the third machine being spaced farther apart from one
21 another for increasing an available growing space between the plants, and

1 Fig. 13D illustrates the transfer of several of the plants from the
2 third growing machine to the fourth growing machine, the plants on the fourth
3 growing machine being spaced apart from one another for increasing the
4 growing space between the plants, and the plants being ready for harvesting
5 after full maturation;

6 Figure 14 is a representative drawing of three separate modules each
7 having a growing machine housed therein, the modules being stacked one on top of
8 another for forming a stack;

9 Figure 15A is a representative drawing of a possible layout of a
10 plurality of modules or stacks of modules within a warehouse environment
11 illustrating the overall movement of plants during its growth cycle; and

12 Figure 15B is a representative drawing of another possible layout of a
13 plurality of modules of stacks of modules within a warehouse environment
14 illustrating the overall movement of plants during its growth cycle.

15 16 DETAILED DESCRIPTION

17 With reference to Figs. 1 and 2, a system for growing plants in a
18 controlled indoor environment comprises a growing machine 10 for moving cradles
19 of plants along an undulating path P for minimizing the areal footprint of the
20 machine 10. At least one endless conveyor 12 supports one or more horizontally
21 extending growing cradles 14 for progression along the path P, the path lying
22 generally in a plane. The endless conveyor 12 is supported within a frame 16. The

1 path P may lie in a vertical plane. In an embodiment, a multiplicity of cradles 14, 14
2 ... are distributed along the conveyor 12 and are supported generally horizontal and
3 thus generally perpendicular to the conveyor path P. The cradles 14 are spaced
4 apart and arranged along the undulating path P like a plurality of gondolas. Each
5 cradle 14 supports one or more plants therealong, the term plants including all
6 stages of growth including such as seeds, seedlings and ultimately plants of a crop
7 of plants.

8 The cradles 14 travel along an endless path within the frame 16. The
9 cradles 14 travel along a first path P1 in a first direction and a second return path
10 P2 in a second direction, opposite to the first direction, to return to a first end 20.
11 The growing machine 10 can be housed in a module 22 for individual management
12 and environment control. Two or more machines 10, 10 ... or two or more modules
13 22, 22 ... can be arranged in parallel, in series or combinations thereof. A sea or
14 shipping container is an example of a suitable module being robust and having a
15 closable, contained environment. In one embodiment, a module houses a single
16 growing machine 10 having a plurality of cradles 14, 14 ... each cradle 14 is
17 removably supported upon the conveyor for enabling loading onto the conveyor and
18 removing from the conveyor. Conveniently, for a machine 10, loading occurs at the
19 first end 20 and unloading or removal from the opposing end 24. With reference to
20 Fig. 3, each cradle 14 is pivotally supported upon the endless conveyor 12 so that
21 the cradles hang under the gravity with the plants upright, regardless of the location
22 of the cradle 14 on the conveyor 12 along paths P1, P2. As each growing cradle 14

1 travels along the first and second paths P1,P2, the plants therein are exposed to
2 growth-sustaining liquid L including water, nutrients and other additives useful for
3 sustaining growth. Various formulations for sustaining liquids L are known in the art
4 of hydroponics and other agricultural processes to encourage and promote plant
5 growth. Each cradle forms a growing environment suitable for one of many types of
6 approaches including hydroponic, such as floating raft, nutrient film and flood and
7 drain systems. Growing media can be provided such as rockwool, coir, peat, or
8 compost.

9 The conveyor 12 has a rate of travel that can be manipulated to
10 control the length of time the plants remain thereon before reaching a target growth
11 such as being ready for harvest or being of a size suitable for transfer to a
12 subsequent growing machine. Target growth may also be reached when the plant
13 outgrows the space constraints of the machine 10, namely spacing between plants
14 in a cradle or spacing between cradles.

15 Environmental factors, including sustaining liquid L, CO₂ levels,
16 humidity and lights 18 are manipulated including controlling the amounts and
17 exposure provided to the plants while traveling first and second paths P1,P2.

18 As shown in Fig. 2, in an embodiment, the machine 10 has a width for
19 accommodating the length of the cradles 14 and, as shown in Fig.1, a longitudinal
20 extent or length, forming a generally rectangular footprint. First path P1 moves from
21 a first end 20 of the machine 10 to a second end 24 of the machine, the second
22 path P2 returning to the first end 20. Path P1 is undulating, having at least a first

1 generally upward path 26 and at least a first generally downward path 27 while also
2 having an incremental longitudinal advance 28 generally therealong as path P1
3 moves towards the second end. The upward and downward portions 26,27 of the
4 paths can repeat in an undulating manner, repeatedly and alternately traveling up
5 26 and down 27 and incrementally advancing 28 along an entire length of the
6 longitudinal extent of the machine 10. The first path P1 alternates upwards 26 and
7 downwards 27 between a trough 30 and a peak or apex 32. The apex 32 is within a
8 permissible ceiling height of the frame 16 and the trough 30 is within a lower portion
9 of the frame 16, spaced from the second return path P2. The first path P1 can
10 transition, at an opposing removal end 24 of the frame 16, to the second return path
11 P2 for travel back to the beginning of the first path P1. The return path P2 can be
12 generally horizontal and below the one or more troughs 30,30... of the first path P1,
13 thus creating a continuous loop.

14 The undulating path increases the effective length of the machine 10,
15 maximizing exposure of the plants conveyed therealong to the environmental
16 factors while minimizing the overall length of the growing machine 10. The
17 undulating first path P1 increases the capacity of the endless conveyor 12,
18 supporting a greater number of growing cradles thereon and providing greater
19 exposure to the environmental factors as opposed to a typical conveyor having just
20 a linear path.

21 In embodiments described herein, the first path P1 begins at the first
22 loading end 20 of the frame 16. Upward travel at the loading end 20 can include

1 traversing an access or loading position, suitable to allow an operator or apparatus
2 to comfortably and safely position each cradle 14 onto the conveyor 12. The
3 loading position is at some height sufficiently spaced above a work floor or work
4 platform. The rate of travel may be such as to permit loading on-the-fly, or the
5 conveyor may be started and stopped as necessary to permit hanging of each
6 cradle 14 in turn on the conveyor 12. Thus, as each cradle 14 is positioned on the
7 conveyor 12, it advances along the first path P1, leaving sufficient space on the
8 conveyor 12 at the point of access for placement of a subsequent growing cradle 14.

9 As shown, the second return path P2 can be a linear, generally
10 horizontal path P2. However, in alternate embodiments, the second return path P2
11 can also be an undulating path for further increasing the production capacity of the
12 growing machine 10, while minimizing its footprint.

13 With reference to Figs. 2 and 9, and in an embodiment, a pair of
14 endless conveyors 12,12 can be supported, parallel to each other, for supporting
15 cradles therebetween. Each conveyor is in a plane and the respective planes are
16 parallel. Conveniently for a rectangular frame 16, the planes of the conveyors are
17 generally vertical and the conveyors 12,12 are spaced apart to the periphery or side
18 walls of the frame. The plurality cradles 14,14 ... are suspended between the
19 spaced apart conveyors 12,12. The pair of conveyors are operated for
20 synchronized movement with one another for moving the cradles along the first and
21 second paths P1,P2. As shown, each of the two endless conveyors 12,12 can be a
22 drive chain 40, driven and guided by one or more sprockets. The pair of conveyors

1 12,12 can be driven by a common drive shaft 42, having a common gear motor 44
2 and extending across the width of frame 16 for synchronously driving both endless
3 conveyors 12,12 via respective drive sprockets 46,46. The gear motor 44 can be
4 any suitable gear motor for small industrial applications, such as a helical gear
5 motor (Model R37/A R17) available from SEW-Eurodrive GmbH & Co KG of
6 Bruchsal, Germany.

7 With reference to Fig. 3, each of the conveyors 12 comprises cradle
8 support means 50 for removably and pivotally suspending and supporting the
9 growing cradles 14 extending horizontally therebetween. Thus, as the pair of
10 conveyors 12,12 travel synchronously along the first path P1, the cradles 14 travel
11 up and down while maintaining an upright and liquid friendly orientation.

12 With reference to Figs. 3 and 4, and in an embodiment, each cradle
13 14 has ends fit with hangers 52 for removable support from the conveyor. The
14 cradle support means comprise a pair of corresponding horizontally pivots, such as
15 a plurality pins 54,54, distributed extending horizontally from each conveyor 12
16 towards the opposing conveyor 12. Each pin 54 pivotally supports the hanger 52 of
17 a respective end of the cradle 14.

18 With reference also to Fig. 4, each cradle 14 is a liquid-holding trough
19 56 for containing and distributing both the plants and growth-sustaining liquid L
20 therealong. Each cradle 14 comprises an open-top, generally rectangular trough 56
21 having opposing end walls 58,58 and side walls 60,60 and a bottom 62 extending
22 therebetween. The cradle is open at a top 64. Adjacent each end wall 58

1 comprises the cradle hanger 52, more particularly comprising a hook extending
2 upwardly from the cradle 14 for engaging and hanging from one of the pins 54
3 distributed along each of conveyors 12 12. The hanger 52 can be integral with the
4 end wall 58, the bottom 62 and side walls 60,60 being fastened to the opposing
5 ends walls 58,58 by fastening means, such as bolts 65. The bottom 62 and side
6 walls 60,60 can be formed of a U-shaped channel material, minimizing seams.

7 With reference to Figs. 5A, 5B, embodiments of the growing machine
8 10 further comprise an irrigation system to supply sustaining liquids L to the plants.
9 The liquids L can be applied directly to each plant in each of the growing cradles 14
10 or can be applied to each of the cradles. The supply of the liquid can be from
11 directly above, such as at the crest or apex 32 of one or more of the undulations of
12 the first path P1, and spaced clear of the path to avoid contact with the cradles.
13 Liquid can also be provided from a point spaced longitudinally from the path P of the
14 cradles.

15 The sustaining liquid L can be delivered, such as from a common
16 storage tank, to the plants by any suitable irrigation means while each cradle 14
17 travels along the paths P1, P2. As shown, one irrigation means can comprise a
18 nozzle 70, fluidly connected to the common storage tank, for directing water and/or
19 nutrients pumped from the storage tank to a liquid-receiving portion 72 of each
20 cradle 14.

21 With reference to Figs. 5A, 5B, 6 and 7, for maximizing optional
22 arrangements for supplying liquid input to the cradles and minimizing liquid losses

1 through spray and splash, each cradle 14 comprises a backsplash 74 as necessary
2 to intercept the liquid L and directing the liquid into liquid-receiving portion 72. As
3 shown, the backsplash 74 is positioned at one end of the cradle 14 extends above
4 the top 64 of the cradle 14 for maximal interception of the liquids L. The backsplash
5 74 has a lower edge 76 spaced from the cradle bottom so as to provide a passage
6 78 (Fig.6) thereunder to permit liquid to flow out to the remainder of the cradle. The
7 supply nozzle 70 can provide the liquid L from the side of the cradle 14, remaining
8 clear of cradle movement along the path P. The supply of liquid can be timed for
9 providing liquid L only when a cradle is adjacent the nozzle. In one embodiment,
10 the liquid L is provided at an apex 32 of the path P1, or in another embodiment at a
11 transition from path P2 to path P1 or vice versa. Further, the liquid L can be added
12 during the downward movement 27 of the cradle of the first path P1 for assisting
13 with the machine's efficiency of moving the endless conveyors 12/12.

14 Fig. 6 & 7, liquid is distributed along the bottom 62 of the cradle 14 for
15 access to the plants spaced therealong. A drainage port 80 is provided as
16 commensurate with the growing technique for draining or complete removal of spent
17 liquid in the cradle 14. The drainage port 80 is located adjacent a cradle end 58
18 opposite the water receiving portion 72.

19 With reference to Figs. 8A to 8C, the frame 16 can further comprise a
20 drainage trough 82 for receiving liquid drained from each of the cradles 14. The
21 drainage trough 82 is positioned below return, second path P2 to intercept the
22 cradles 14 as they travel along the second return path P2. The drainage trough 82

1 can extend along at least a portion of a length of the second path P2. As shown,
2 each cradle port 80 is fit with a drainage plunger or plug 84. As shown in Fig. 8B,
3 the plug 84 has a sealing element 86 and a shaft 88. In Fig. 8A, the shaft 88 is
4 freely received through the drainage port 80 and rests under its own weight with the
5 sealing element 86 engaging the bottom 62 of the cradle about port 80. The plug is
6 operable between a closed position (Fig. 8A) to retain liquid L in the cradle and an
7 open position (Fig. 8B) for draining the liquid L.

8 As shown also in Fig. 8C, the plug 84 can be freely manipulated
9 upwardly into its open position for interfering with the sealing element's 86 seal with
10 the cradle 14. The plug 84 is maintained in its open position for draining a portion
11 or all of the liquid from each cradle 14. The shaft 88 of each drain plug 84 is sized
12 sufficiently to have a height that is greater than a spacing between the bottom wall
13 62 of each cradle 14 and the drainage trough 82 underneath each conveyor 12.
14 Accordingly, as each cradle 14 reaches the second return path P2, the shaft 88 of
15 its drain plug 84 engages the drainage trough 82 (Fig. 8B) and lifts the sealing
16 element 86 off the bottom wall 62 to the open position. The plug 84 is dragged
17 along the length of the drainage trough 82. As second path P2 transitions to first
18 path P1, each cradle 14 moves upwardly (Fig. 8A), releasing the plug 84 and re-
19 engaging the sealing element 86 with the bottom 62 of the cradle 14.

20 Drained liquid can travel along the drainage trough 82 for recovery,
21 recycling or disposal.

1 In an embodiment, and as shown in Fig.9, liquids L are distributed
2 through hydraulic head, being received into the cradle 14 and distributing
3 therealong. In other embodiments, shown in Figs. 10A through 10D, the cradles 14
4 are arranged at a slope to more vigorously move incoming liquid from one end to
5 the other.

6 In Fig. 9, each cradle 14 extends horizontally between the two
7 conveyors 12,12 and is substantially parallel to the ground G upon which the frame
8 16 is oriented. Liquid L supplied to each cradle will level out, evenly distributing
9 itself within each cradle.

10 However, in the embodiments of Figs. 10A and 10B, the growing
11 machine 10 is further provided with means for introducing extra impetus to the
12 distribution of the liquid within each cradle 14. Simply, the cradles are alternately
13 rocked end-to-end so as to urge the liquid one direction and back again. The
14 orientation of each cradle 14 is arranged such that each cradle 14 rocks back and
15 forth while travelling along the first path P1.

16 As shown in Fig. 10A, during upward travel towards the apex 32 along
17 the first path P1, a first end wall 58a of each cradle 14 can be arranged to be higher
18 than an opposing, second end wall 58b. On a pair of synchronous, continuous
19 endless conveyors 12,12, the first end wall 58a is supported upon its conveyor 12
20 indexed slightly ahead of or behind that of the other conveyor 12. On the upward
21 movement 26, this indexing creates the slope of each cradle 14, providing the extra
22 impetus for liquid to travel from the higher end wall 58a to the lower end wall 58b

1 and driving downward travel 27, as shown in Fig. 10B, the cradle is sloped from
2 end 58b to end 58a.

3 As shown in Fig. 10C, the first end wall 58a is indexed ahead of the
4 second end wall 58b and the cradle slopes from the first end wall 58a to the second
5 end wall 58b on the upward movement. On the upward movement 26, the cradle
6 assumed a first horizontal orientation or first slope 91. As the cradle 14 approaches
7 and crests the apex 32, the cradle becomes generally level during transition to
8 moving downward. After cresting, as shown in Fig. 10D, the slope of the cradle
9 reverses, assuming an opposing, second slope 92 which persists on the downward
10 movement 27. As a result, the liquid in the cradle travels from the now higher
11 second end wall 58b to the now lower first end wall 58a. The shifting of the slope
12 91,92, by rocking of each cradle 14, causes liquid to travel back and forth therein.

13 In one embodiment, drive sprocket 46a of one conveyor can be
14 rotationally indexed relative to the opposing sprocket 46b, namely by advancing a
15 reference tooth slightly ahead of a reference tooth of the other. Fine control of the
16 indexing can be achieved. In the embodiment, where reference teeth of the drive
17 sprockets 46a,46b are rotationally aligned, such as having identical sprockets, and
18 identically keyed to the drive shaft, an operator can intentionally suspend one
19 conveyor 12 end of a cradle in advance or retarded on the conveyor 12 from the
20 opposing end creating the slope. Depending on the nature of connection between
21 the end wall 58 and the conveyor 12, control over the slope may be coarser. For
22 example, pivot pin 54 for the first end wall 58a can be advanced or index one or

1 more links along the drive chain 40 compared to the synchronously-driven drive
2 chain 40 of the other conveyor, the change in slope being related to the link
3 dimensions and the length of the cradle 14.

4 Returning to Fig. 1, growing machine 10 further comprises grow lights
5 18 throughout the frame 16. In an embodiment, a plurality of light sources 18 can
6 be spaced and positioned along the length of the first path P1 to maximize the
7 amount of light exposed to each plant. In the undulating path embodiment, the
8 lights can be provided in each trough between an upwardly moving portion 26 and a
9 downwardly moving portion 27. Accordingly, a light source or array of light sources
10 18,18...simultaneously reach plants conveyed both on an upward travel and plants
11 conveyed on a downward travel. The lights 18 can be controlled to manage
12 exposure including whether they are on or off or the intensity emitted thereby. The
13 lights 18 can be manually or automatically turned on or off or adjusted to control the
14 exposure, including providing illumination on a light cycle.

15 In an embodiment, the plurality of light sources 18 can be light
16 emitting diodes (LED's) which permits operator control of the spectrum of light
17 exposed to the planted crops to accommodate and control specific stages of plant
18 growth and development. Furthermore, as LED's draw approximately 25% less
19 power than typical fluorescent lamps, the use of LED's permits the use of solar
20 power feasible which is especially beneficial in remote regions.

21 With reference to Figs. 2 and 14, in an embodiment, a growing
22 machine 10 can be within or can be supported as part of a module 22. An example

1 of a module 22 is a shipping container having access at an end for loading and
2 removal of cradles or plants. The module can have reflective interior walls to
3 maximize the light available and maximize the exposure of the plants to the light
4 available.

5 In another embodiment, each module 22 can further comprise means
6 for controlling humidity and temperature therein for providing optimum growth
7 conditions tailored for the plant being grown therein.

8

9 IN OPERATION

10 In one embodiment, a method for growing plants comprises providing
11 at least one growing machine 10 having plurality of generally horizontally extending
12 growing cradles 14 spaced along a continuous or endless conveyor 12 for
13 movement along path P, at least a portion of which is undulating, each cradle
14 bearing one or more plants. One suspends the at least one growing cradle 14 on
15 the growing machine 10 at a first loading position 20 and advances the at least one
16 growing cradle 14 from the loading position upwardly and downwardly, and
17 incrementally longitudinally 28 along a first undulating path P1. Throughout, one
18 exposes the at least one plant to growth promoting light 18 and provides at least
19 growth-sustaining liquid L to the at least one plant. The at least one growing cradle
20 14 is returned to the loading position along a second return path P2. If mature, the
21 plants can be harvested at convenient access points including the first end 20 or the
22 second end 24. If not ready for harvest, one repeats until the at least one plant is

1 ready for harvest or has reached some other target growth, including having
2 outgrown the cradle or cradle to cradle spacing.

3 In an embodiment, the rate of advancing of the growing cradles can
4 be controlled for controlling the amounts and rates of the simultaneous delivery of
5 light and sustaining liquids for optimizing plant growth.

6 In an embodiment, plants are removed from the conveyor after one
7 pass, either for harvest or subsequent handling. In another embodiment, plants are
8 removed from the conveyor after a threshold growth stage such as after reaching a
9 certain maturity or size. In another embodiment, plants are loaded and removed
10 from the same end 20,20 of the conveyor. In another embodiment, plants are
11 loaded from a loading end 20 of the growing machine and removed from a second
12 removal end 24 of the growing machine.

13 An operator can plant seeds or seedlings within an inert growing
14 medium, such as bricks or cubes of rockwool, readily and commercially available
15 from various horticultural suppliers, such as from Cultilene (of Saint-Gobain
16 Cultilène B.V., Tilburg, The Netherlands) and position the planted seeds or
17 seedlings within a growing cradle. Each loaded or planted growing cradle 14 can
18 be removably and pivotally suspended on the growing machine at the loading
19 position at the loading end 20 of the growing machine 10. The cradles will remain
20 oriented for proper plant growth, regardless of the tortuous path of the conveyor
21 machinery itself. The cradles travel along the first and second path P1,P2 being
22 exposed to light and provided with at least growth-sustaining liquid for growth.

1 Turning to Figs. 12A through 13D, after a period of growth, the plants
2 will reach a target growth for that machine. For example, the plants may be ready
3 for harvest or, although too immature for harvesting, may likely have grown
4 sufficiently enough to encroach on an available growing space of an adjacent plant
5 or cradle and may require an increase in growing space. Thus, the plants of
6 increased size are further spaced apart from one another.

7 As shown in Figs. 12A and 12B, in an embodiment merely reflecting
8 demonstration of growth and transport, not necessarily the machine 10, the plants
9 are conveyed from the loading position 20 to a removal point 24. If the plants have
10 reached a suitable growth stage of a growth cycle, the plants can be harvested by
11 removing the growing cradles from the growing machine 10 at the removal point 24
12 for that machine 10.

13 In cases where the plants have yet to mature, the plants are conveyed
14 along the first path P1 from the loading position to the removal point 24, and
15 returned along the second path P2 to the loading position 20 to continue the
16 growing process. This endless first to second path P1,P2 circuit or loop can be
17 repeated as long as necessary to reach the target growth stage and/or complete a
18 growth cycle. The target growth stage could include a specified maturity or plant
19 size.

20 With reference to Figs. 13A through 13D, a series of growing
21 machines are provided, in series, each managing a stage of the plant's growth cycle.
22 In Fig. 13A, in an embodiment, a first growing machine 10a can be used to grow

1 seedlings from seed. As shown, after a period of growth, the six seeds per cradle
2 germinate and grow into to seedlings. The six seedlings, having increased in size
3 sufficiently to be removed, are removed for transfer to a subsequent or second
4 growing machine 10b.

5 With reference to Fig. 13B, a received at the loading end of the
6 second growing machine 10b, the six seedlings could be grown to harvest as
7 mature plants. Alternatively, and being plant dependent, the six seedlings could be
8 grown until the immature plants start to encroach on the available growing space of
9 an adjacent cradle. The cradles can be re-distributed to be spaced longitudinally
10 farther apart on the conveyor to increase the available growth space between each
11 cradle or moved to another subsequent growing machine 10c.

12 As shown, and now with reference to Fig. 13C, a fewer number of
13 plants and a fewer number of cradles, four cradles shown, are transferred and
14 loaded into a subsequent or third growing machine or machines 10c. Similarly, the
15 plants can be harvested or, with reference to Fig. 13D the cradles, bearing larger
16 immature plants, can be moved to one or more subsequent and final machines 10d,
17 as shown in Fig. 13D.

18 The spacing and stages of growing machines can be pre-determined
19 for particular plant characteristics including growth rates and sizes.

20

1 Example

2 Embodiments disclosed herein can comprise one or more stackable
3 modules 22, each housing a frame 16 of a growing machine 10. In an embodiment,
4 and as shown in Fig. 14, a stackable module 22 can be 8 foot by 8 foot by 40 foot,
5 and three modules 22,22,22 can be stacked one on top of another to form a single
6 stack. Thus, a typical 10,000 ft² warehouse can house in the order of thirteen side-
7 by-side or end-to-end stacks of three growing machines for a total of about 39
8 growing machines.

9 Depending upon the design of the warehouse footprint, the placement
10 of the stacks of growing machines can be varied. As shown in Fig. 15A, and for
11 about 10,000 ft², in one embodiment, thirteen stacks can be aligned into a single
12 column. In another embodiment, and as shown in Fig. 15B, the thirteen stacks can
13 be aligned into four columns of three rows, with one column having a fourth row.

14 In an embodiment, growing machines are placed into “pods or a
15 defined space” within the warehouse or barn. A pod is a form of module having
16 three, solid wall area, floor to ceiling walls with the forth wall being a door for ease
17 of access. Pod’s can contain one or more growing machines appropriate for the
18 barn. For example, for a barn that needed 100 growing machines there could be 20
19 pods with five growing machines in each. A pod ensures control over the climate
20 environment for the particular crops being grown.

21 Control of the growing environment at, and within, the growing
22 machine can include water, nutrients, Carbon Dioxide (CO₂), humidity and other

1 growth factors. Herein, the growing machine provides all three major functions that
2 are basic to plant growth and development including photosynthesis, respiration and
3 transpiration. As discussed growth sustaining liquid and light is provided. In the
4 case of CO₂ management, consumption of CO₂ by growing plants can be replaced
5 to avoid impairment of photosynthesis and can supplemented based on type of crop
6 and conditions. CO₂ increases productivity through improved plant growth and
7 vigour.

8 Embodiments described herein are useful in providing a local source
9 of fresh vegetables and fruits with low capital investment, regardless of
10 geographical location. As embodiments can further comprise a means for providing
11 light, water and nutrients to the plants, each module can be located and placed in
12 remote locations or placed in locations close to local markets. Thus, shipping costs
13 are minimized as use of the growing machines is not restricted by region or growing
14 season as any location with a supply of water and power is suitable.

15 Furthermore, as embodiments can further comprise growing machine
16 within a controlled environment, there is a reduced necessity for an operator to tend
17 to each of the plants, thereby reducing the labour that is associated with typical
18 industrial commercial farming.

19 Plants can be grown in accelerated growing cycles to meet everyday
20 food needs as well as specialized requirements for specific needs such as by
21 nutraceutical companies. World hunger needs can be addressed locally.

1 Embodiments can offer environmental advantages such as reduced
2 fossil fuel use in transporting product to market, energy efficiency, reduced and/or
3 negligible nutrient pollution, elimination of the use of toxic pesticides and fertilizers,
4 controlled and reduced water usage and the reuse of abandoned or idle facilities.

5 In one aspect, a system for growing plants housed in a controlled
6 enclosed environment space is provided comprising: a high density growing
7 machine comprising a series of horizontal, laterally extending growing cradles
8 carrying plants, the cradles being connected to and suspended between
9 synchronized and parallel endless conveyors moving in a undulating path in an
10 upward and downward motion and incrementally longitudinally between a first
11 position and a second position and returning to the first position, a plurality of
12 growth-promoting light sources, means for providing water and plant growth
13 nutrients to the growing cradles. The endless conveyor can be supported in a
14 frame wherein the first position is a loading end and the second position is a
15 removal end of the frame. The frame can be part of or housed within a module.

16 In an embodiment, said plants are carried on a plurality of growing
17 cradles and as the plants grow the cradles are spaced further apart. One approach
18 is to remove the cradles and place them and space them further apart on a
19 subsequent machine. Another approach is to remove some cradles, leaving the
20 remaining cradles with greater spacing and place the removed cradles on a
21 subsequent machine. The spacing is chosen to maximize the concentration of
22 plants per area of the growing machine.

1 In an embodiment, said growing cradles are irrigated with water and/or
2 plant nutrients at the peak vertical height on the conveyor chain so that gravity
3 acting on the downward travel assists in lifting the somewhat lighter cradles on the
4 upward travel.

5 In an embodiment, a plurality of plant growth promoting light sources
6 can be strategically spaced in troughs along the undulating path, can be distributed
7 along the width of the frame, and can be manipulated during periods of plant growth.

8 In an embodiment, said conveyor chain temporary exits a controlled
9 space or environment, such as to separate the employees from high levels of CO₂,
10 or other hazards existing in the controlled growing environment, for loading and
11 unloading the growing cradles.

12 In another aspect, the system can further comprise apparatus or
13 means for inserting the liquid, such as water and plant nutrients. into growing
14 cradles containing a growth medium.

15 In another aspect, the system can comprise an apparatus or means
16 for providing liquid comprising water and plant nutrients to the growing cradles to
17 grow hydroponically.

18 In an embodiment, the system can further comprise an apparatus or
19 means for controlling a concentration of gases present in the controlled environment.

20

1 THE EMBODIMENTS OF THE INVENTION IN WHICH AN
2 EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS
3 FOLLOWS:
4

5 1. A method for growing plants in a controlled environment
6 comprising:

7 providing growing machine having an endless conveyor having a
8 plurality of growing cradles spaced apart therealong, each cradle supporting one or
9 more plants therein;

10 advancing the plurality of cradles along a path, at least a portion of
11 which is an undulating path having alternating upward and downward portions;

12 supplying the cradles with growth-sustaining liquid;

13 exposing the one or more one plants to growth-promoting light; and

14 repeating the advancing the plurality of cradles along the path until the
15 one or more plants have reached a target growth for the machine.

16
17 2. The method of claim 1 wherein the advancing of the plurality of
18 cradles along the path until the one or more plants have reached a target growth
19 further comprises:

20 advancing the plurality of cradles until the one or more plants
21 encroach on an available growing space of another of the plants.

22
23 3. The method of claim 1 or 2 wherein, after the plants have
24 reached the target growth, transferring the cradles to a subsequent growing

1 machine for repeating the advancing the plurality of cradles along the path of the
2 subsequent growing machine until the one or more plants have reached the target
3 growth for the subsequent machine.

4
5 4. The method of claim 3 further comprising repeating transferring
6 the cradles, having plants at their target growth for the subsequent machine, to a
7 subsequent growing machine until the one or more plants are ready for harvest.

8
9 5. The method of any one of claims 1 to 4 wherein for any
10 machine or subsequent machine, after the plants have reached the target growth for
11 the machine or subsequent machine, spacing the growing cradles further apart on
12 the conveyor.

13
14 6. The method of any one of claims 1 to 5 wherein, supporting the
15 one or more plants in each growing cradle further comprises planting one or more
16 seeds in an inert growing medium.

17
18 7. The method of any one of claims 1 to 6, wherein supplying
19 growth-sustaining liquid to each cradle further comprises orienting the cradle on a
20 slope; supplying the liquid to the cradle; and flowing the liquid along the sloped
21 cradle.

1 8. The method of any one of claim 7, further comprising reversing
2 the slope of the cradle as the cradle alternates between the upward and downward
3 portions of the undulating path.

4

5 9. The method of any one of claims 1 to 8, further comprising
6 draining at least a portion of the fluid in the cradles along the path.

7

8 10. The method of any one of claims 1 to 9, wherein the exposing
9 of the one or more one plants to growth-promoting light comprises illuminating the
10 plants from a light source located between alternating upward and downward
11 portions.

12

13 11. The method of any one of claims 1 to 9, wherein the supplying
14 of growth-sustaining liquid to the cradles comprises introducing the liquid to at least
15 one of the downward portions of the path.

16

1 12. A growing machine for growing plants in a controlled
2 environment comprising:

3 an endless conveyor forming a growing path having at least a portion
4 of which is an undulating path having alternating upward and downward portions
5 and a return path;

6 a plurality of cradles spaced along and supported by the conveyor for
7 movement along the growing path, each cradle supporting one or plants therein in a
8 plant and growth-sustaining liquid orientation;

9 a source of the growth-sustaining liquid; and

10 a source of growth-sustaining light.

11
12 13. The growing machine of claim 12, wherein

13 the endless conveyor is a pair of endless conveyors and the cradles
14 are supported therebetween, further comprising:

15 each cradle has opposing ends supported between the pair of
16 conveyors for conveying the cradle in a generally horizontal orientation.

17
18 14. The growing machine of claim 13, wherein each of the endless
19 conveyors of the pair of endless conveyors is in a plane and the planes are parallel
20 to one another.

1 15. The growing machine of claim 13 or 14 wherein the growing
2 path further comprises: a first path including the undulating upward and downward
3 portions and the return path is a second path for looping back to the first path.

4

5 16. The growing machine of claim 15 wherein the second path is a
6 liner, generally horizontal path.

7

8 17. The growing machine of any one of claims 12-13 wherein the
9 cradles are removable from the conveyor.

10

11 18. The growing machine of any one of claims 13 to 16 wherein:
12 a pair of first hanging supports, each first hanging support extending
13 laterally from each conveyor at each cradle location; and

14 each cradle has second hanging supports compatible with the first
15 hanging supports for pivotally hanging the cradles from the conveyors for
16 maintaining the plant and growth-sustaining liquid orientation.

17

18 19. The growing machine of claim 18, wherein the pair of first
19 hanging supports are pins and the second handing supports are hooks extending
20 upwardly from the cradles.

21

1 20. The growing machine of any one of claims 12 to 19 wherein
2 each cradle further comprises a bottom having a drainage port for periodically
3 draining the growth-sustaining liquid therefrom.

4

5 21. The growing machine of claim 20, wherein the drainage port
6 further comprises a drain plug freely fit within the drainage port and operable
7 between a drain position and a sealing position.

8

9 22. The growing machine of claim 21 further comprising a drainage
10 trough positioned underneath the return path of at least one of the two conveyors
11 for actuating the drain plug to the drain position.

12

13 23. The growing machine of any one of claims 12 to 22 further
14 comprises a nozzle for directing the growth-sustaining liquid into cradles advanced
15 thereby.

16

17 24. The growing machine of any one of claims 13 to 23 wherein
18 each conveyor further comprises an endless drive chain, a drive sprocket and a
19 plurality of guide sprockets.

20

21

1 25. The growing machine of claim 24 wherein each conveyor
2 further comprises a gear motor and a common drive shaft operatively connected to
3 each of the pair of endless conveyors for synchronously driving the pair of endless
4 conveyors.

5
6 26. The growing machine of claims 18 or 19 wherein each
7 conveyor further comprises an endless drive chain, a drive sprocket a plurality of
8 guide sprockets, a gear motor and a common drive shaft operatively connected to
9 each of the pair of endless conveyors for synchronously driving the pair of endless
10 conveyors, the first hanging supports extending from one of the pair of conveyors
11 being indexed ahead of the other first hanging support of the other conveyor for
12 imparting a slope to each cradle and for reversing the slope as cradle moves
13 upwardly and then downwardly along the undulating path.

14
15 27. The growing machine of claim 26 wherein for each cradle,
16 indexing of the first hanging support extending from one of the pair of conveyors
17 ahead of the other first hanging support of the other conveyor further comprises
18 rotationally indexing the drive sprockets of one of the pair of conveyors relative to
19 the other.

1 28. The growing machine of claim 26 wherein for each cradle,
2 indexing of the first hanging support extending from one of the pair of conveyors
3 ahead of the other first hanging support of the other conveyor further comprises
4 positioning the first hanging support from one of the pair of conveyors in advance or
5 retarded on the growing path relative to the other first hanging support of the other
6 conveyor.

7
8

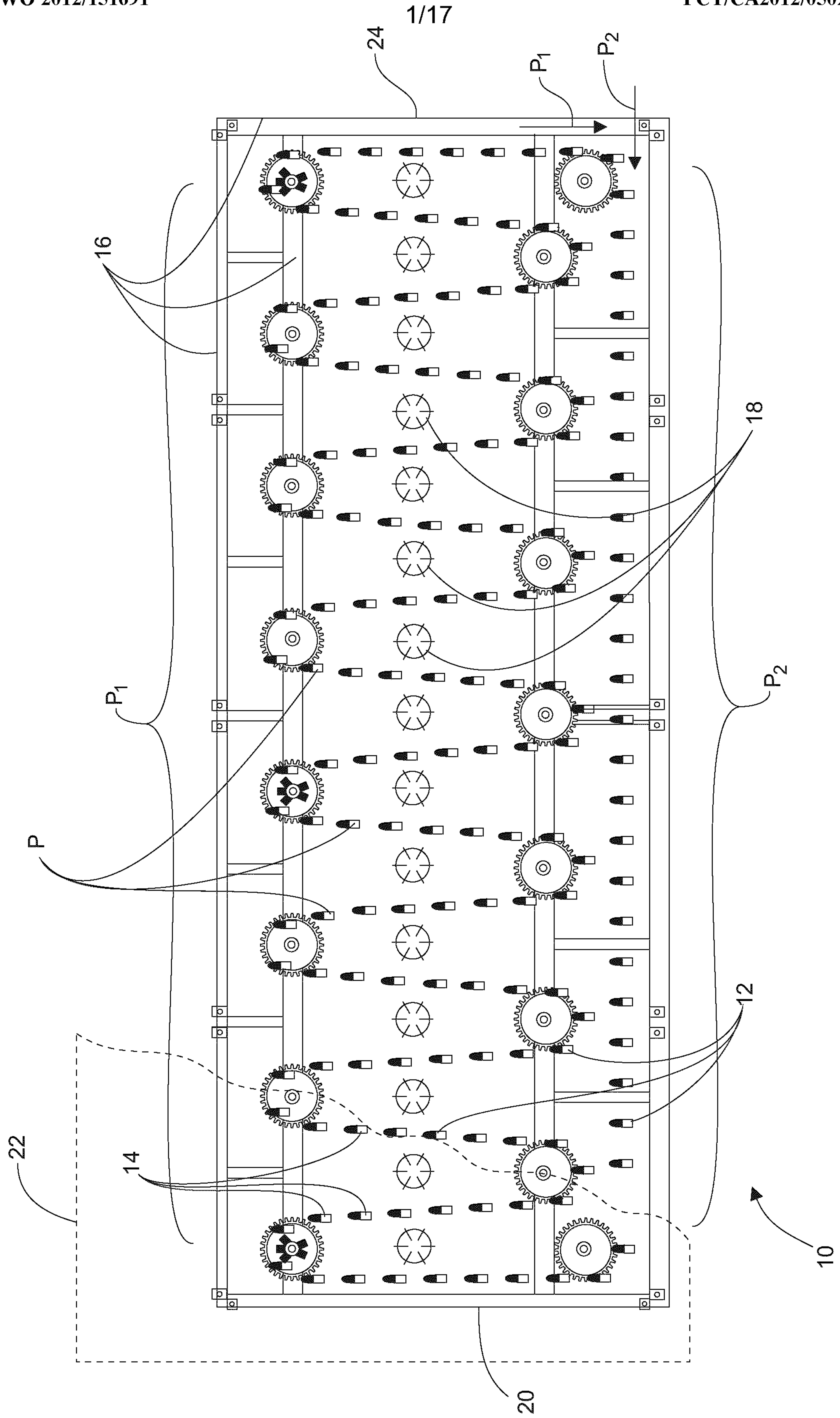
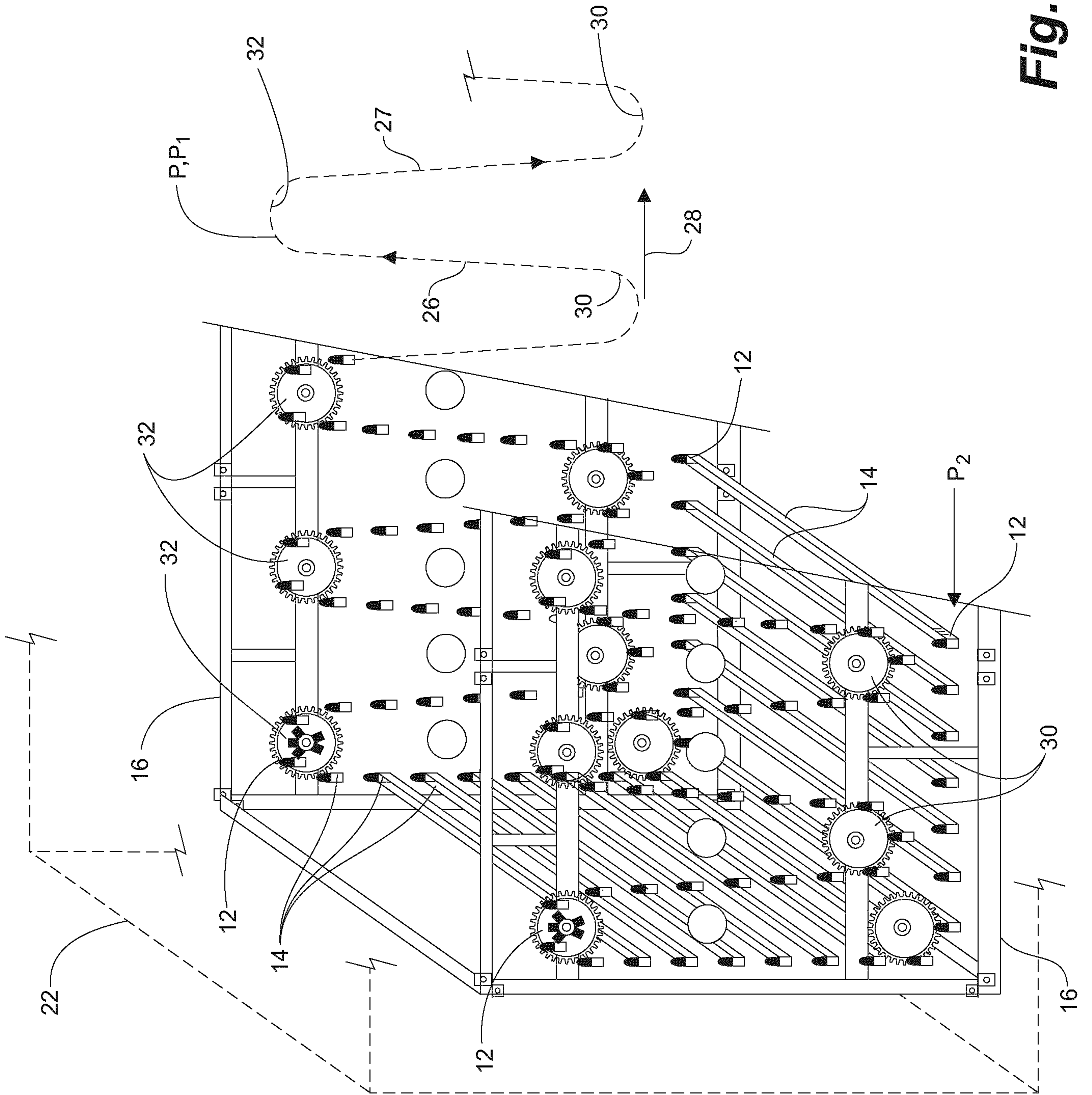
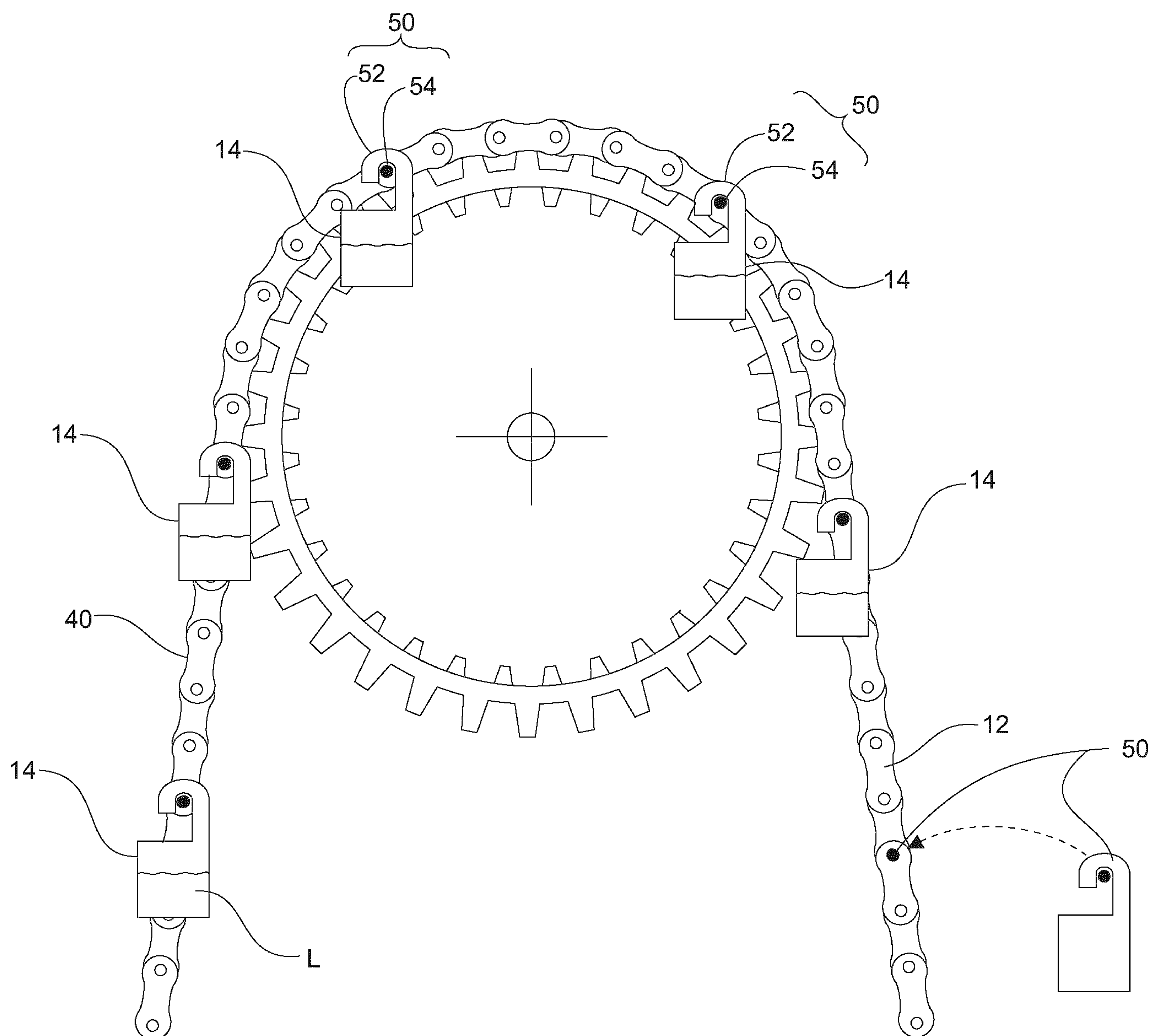
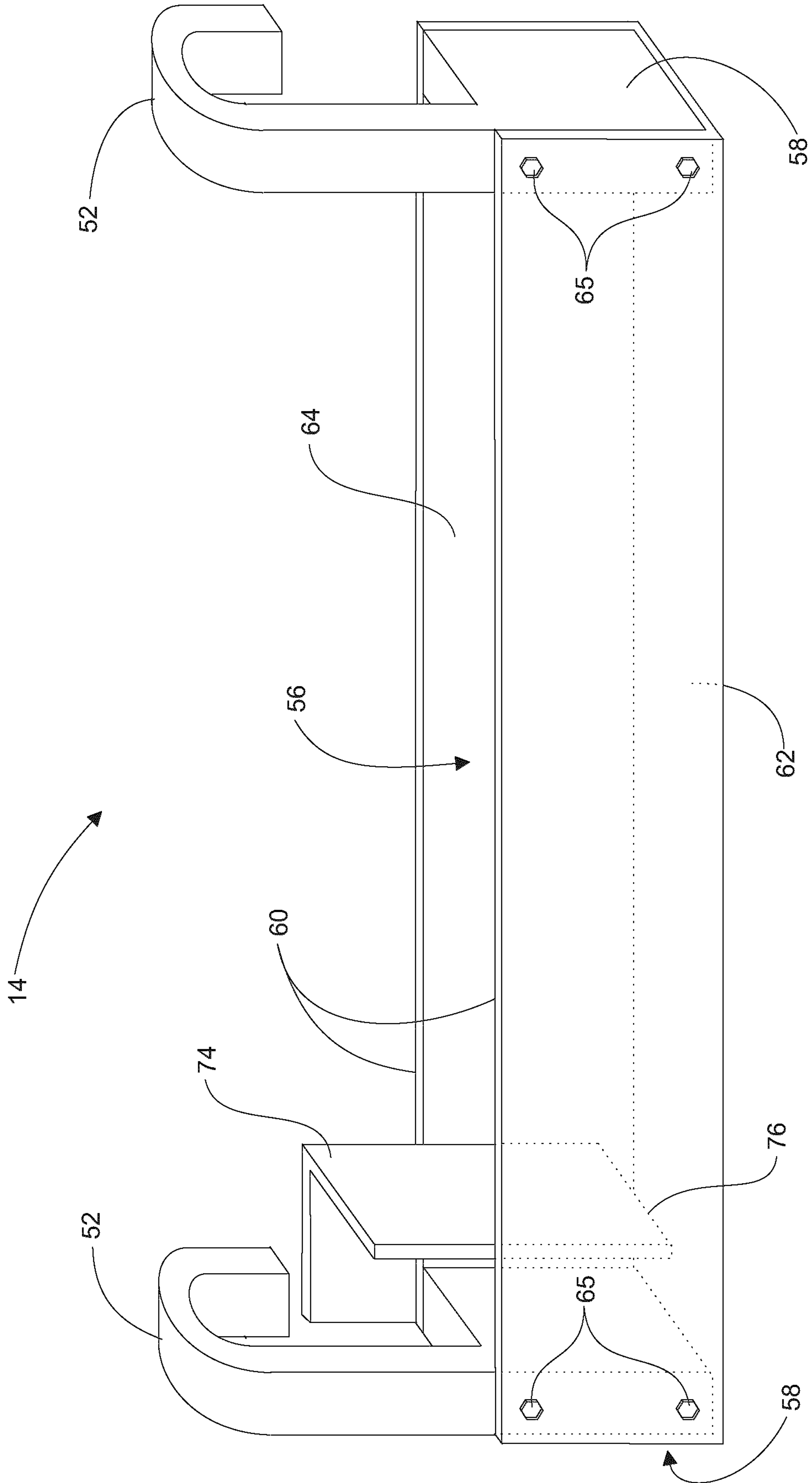
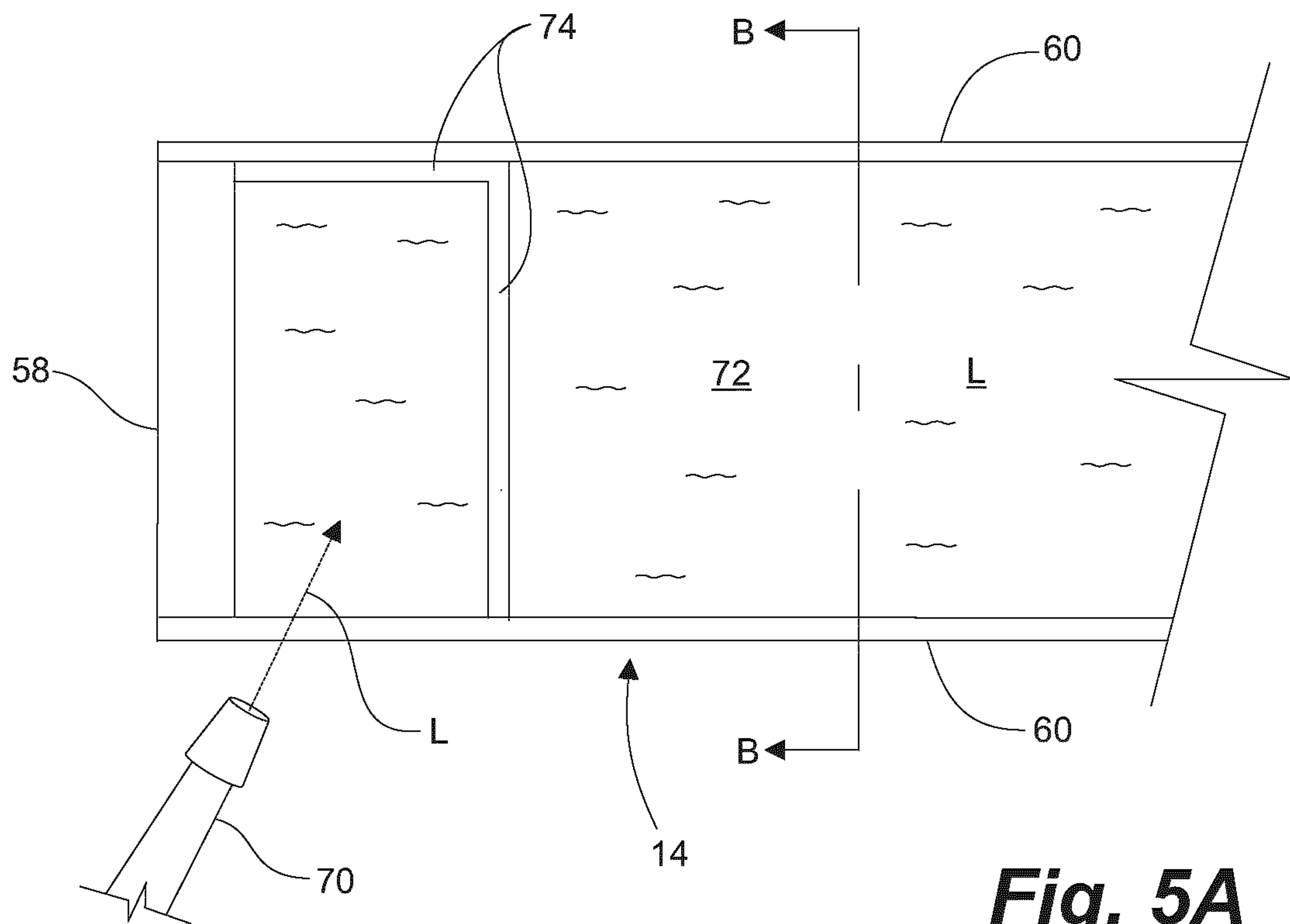
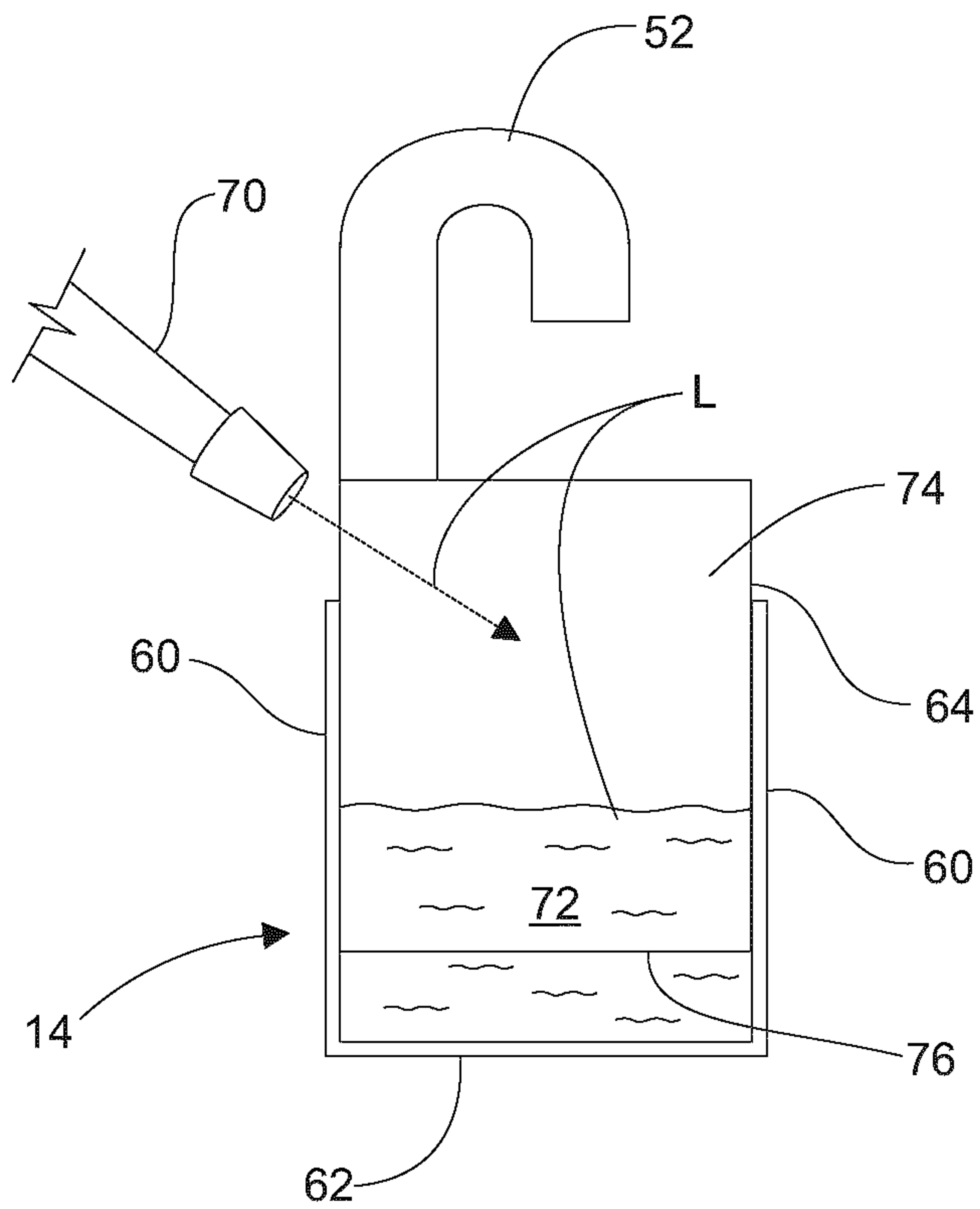


Fig. 1

**Fig. 2**

**Fig. 3**

**Fig. 4**

**Fig. 5A****Fig. 5B**

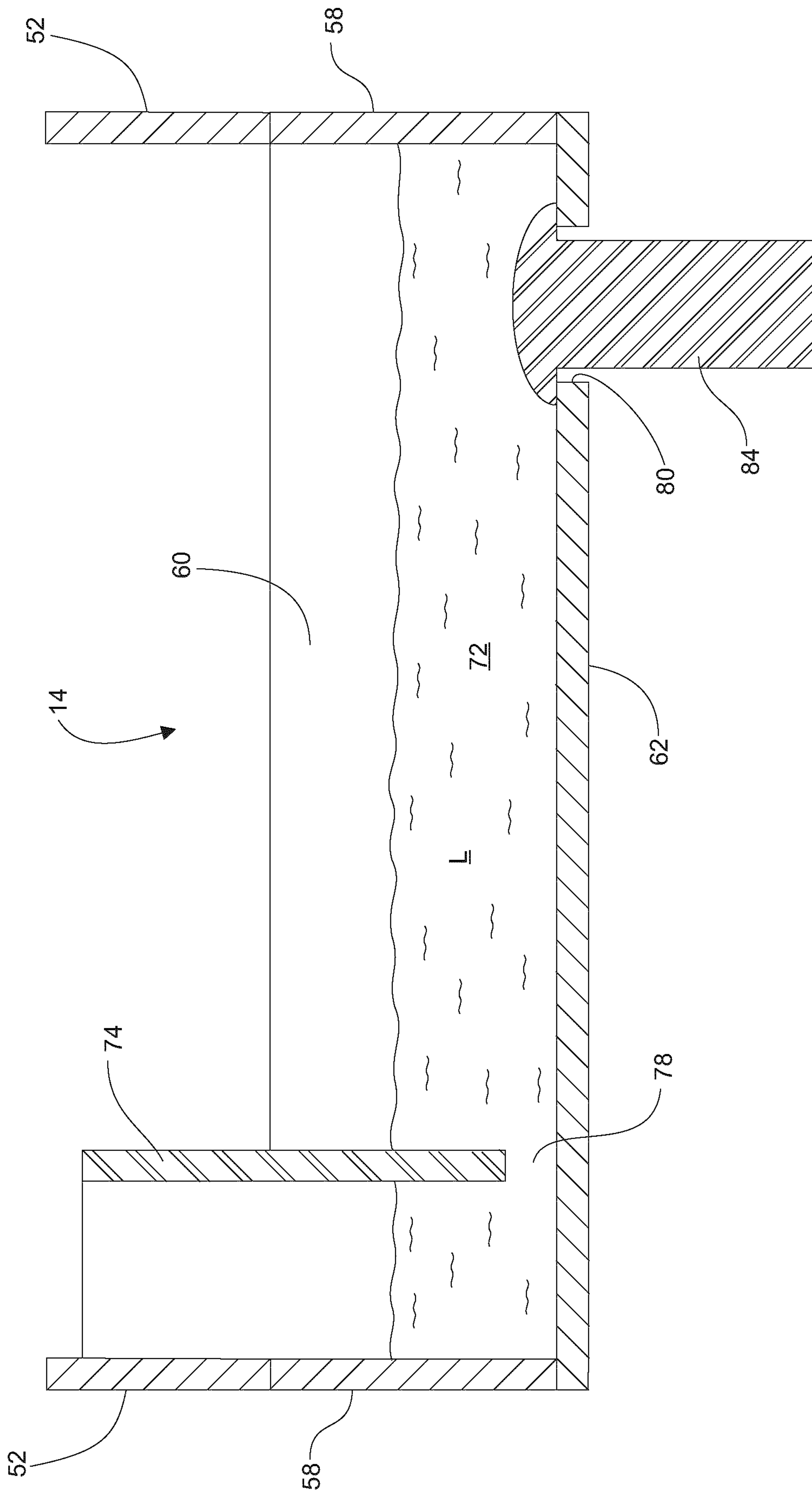
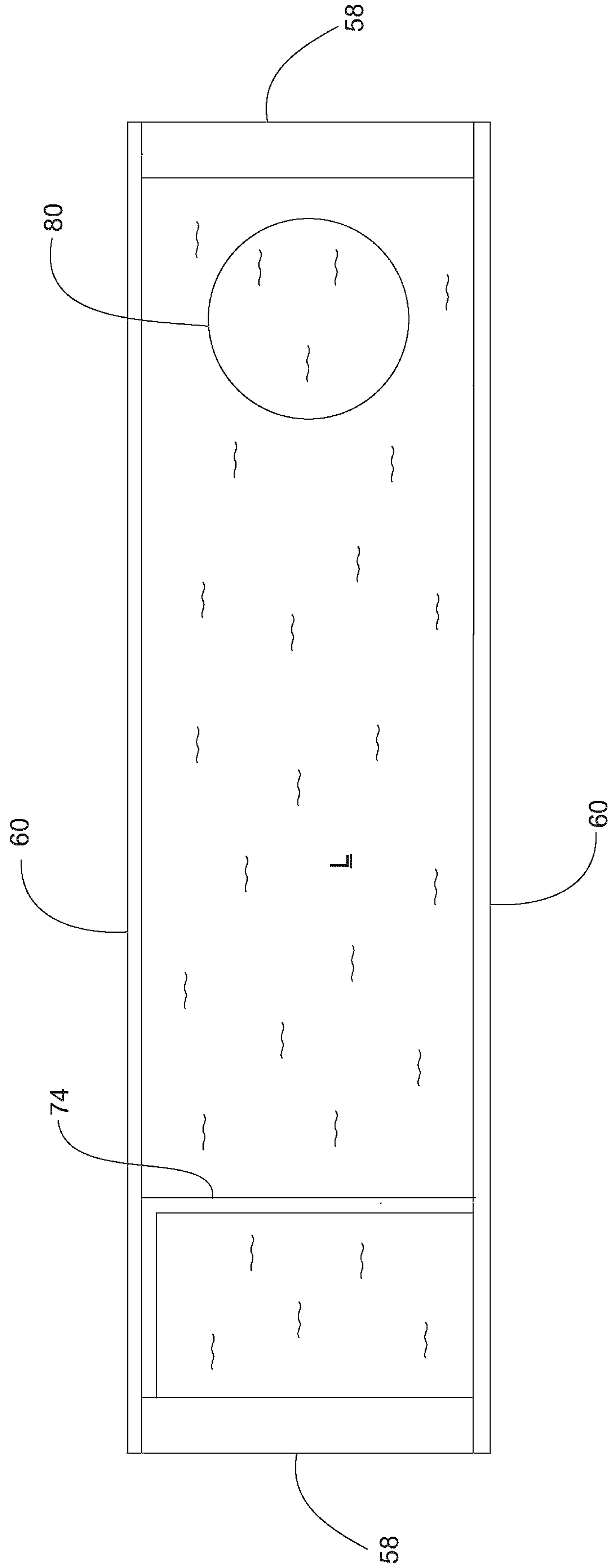
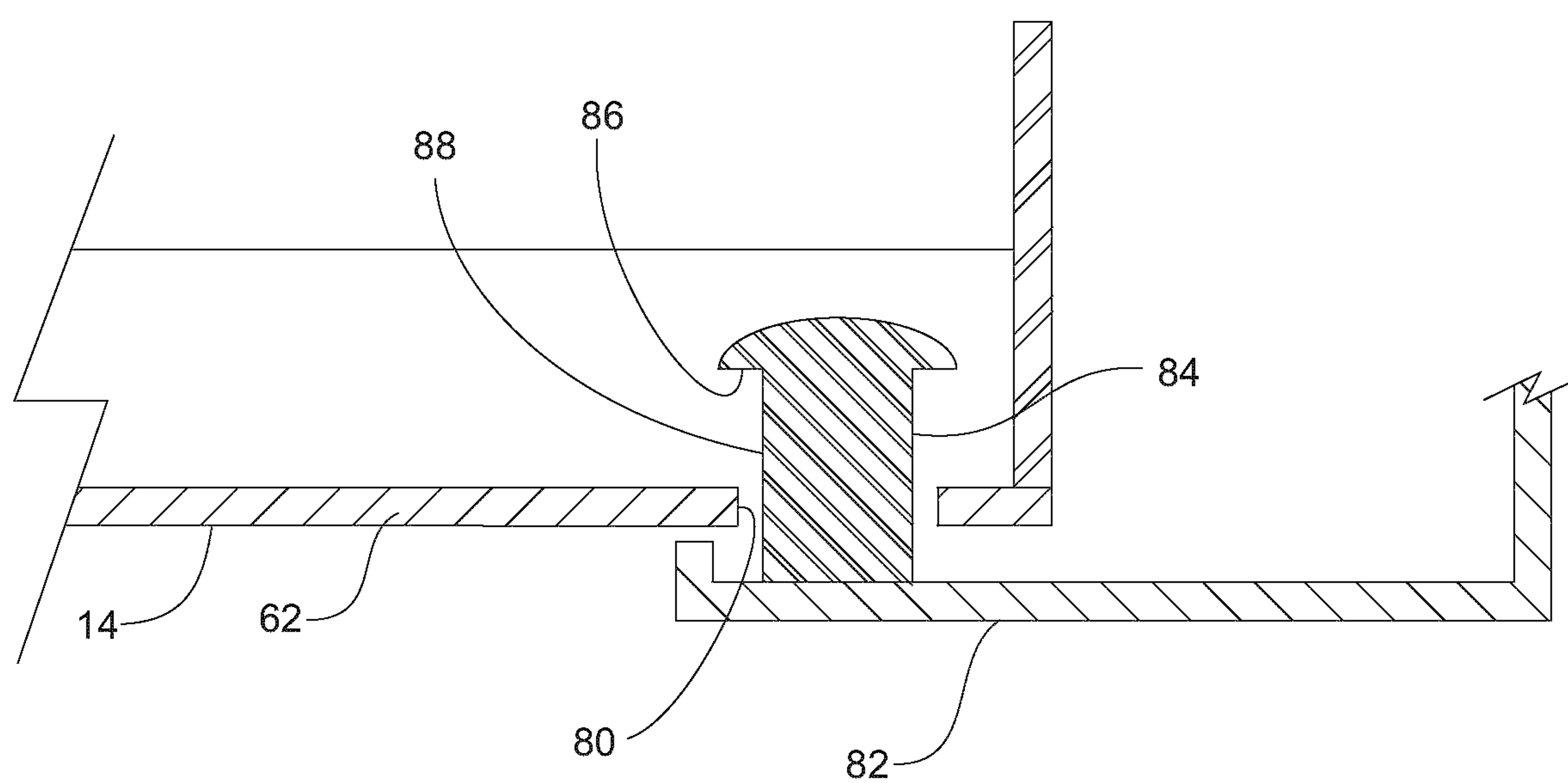
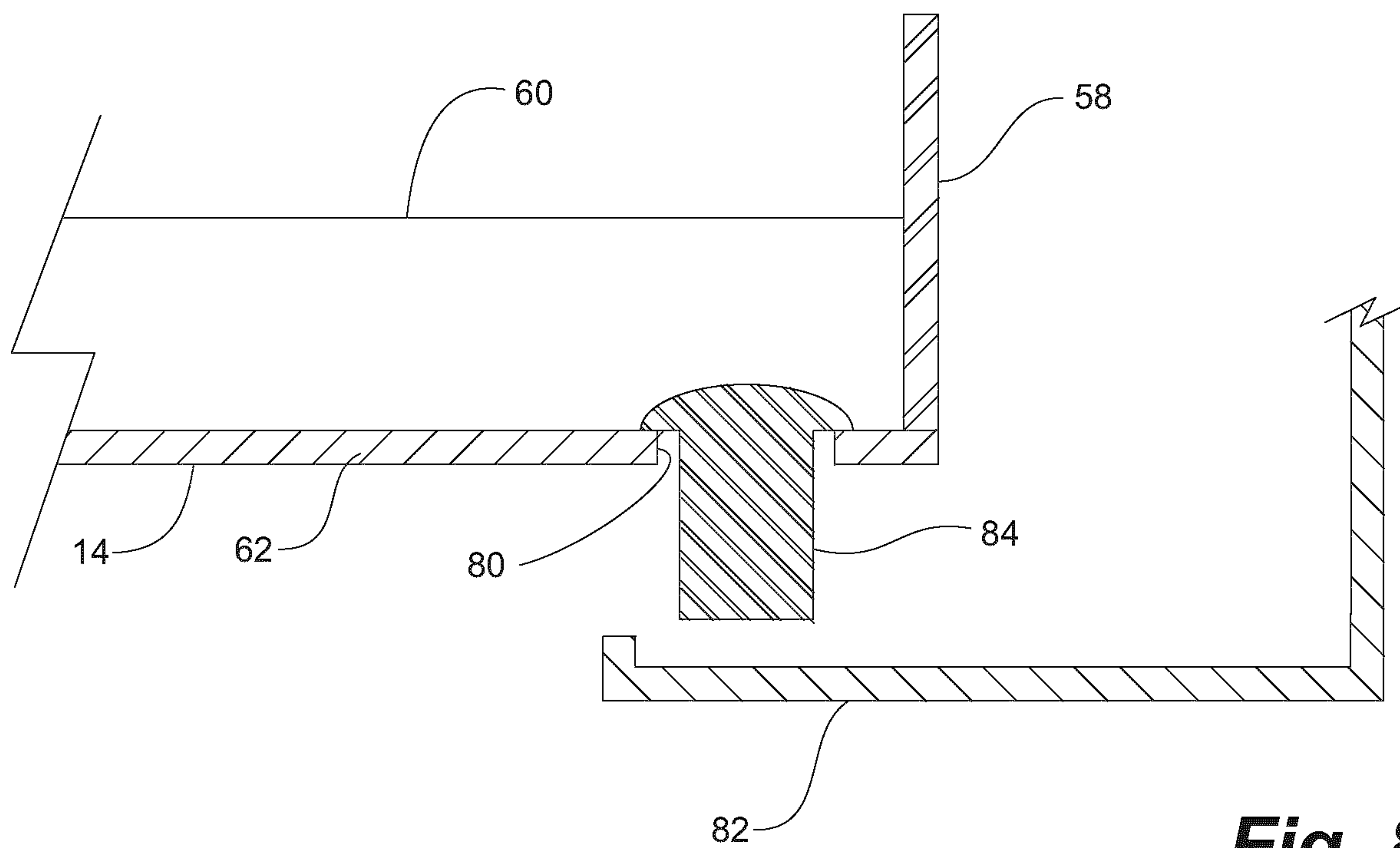
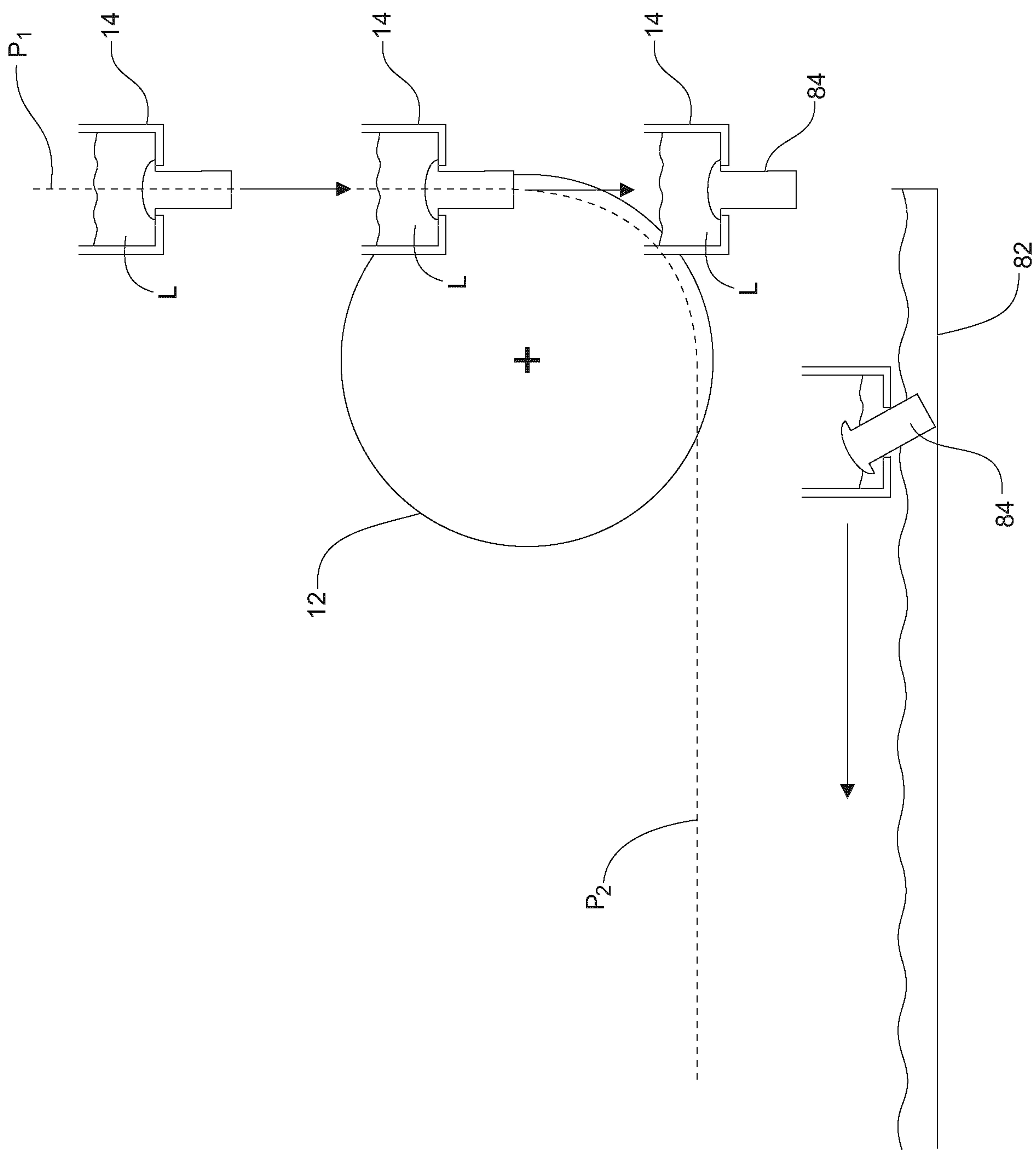
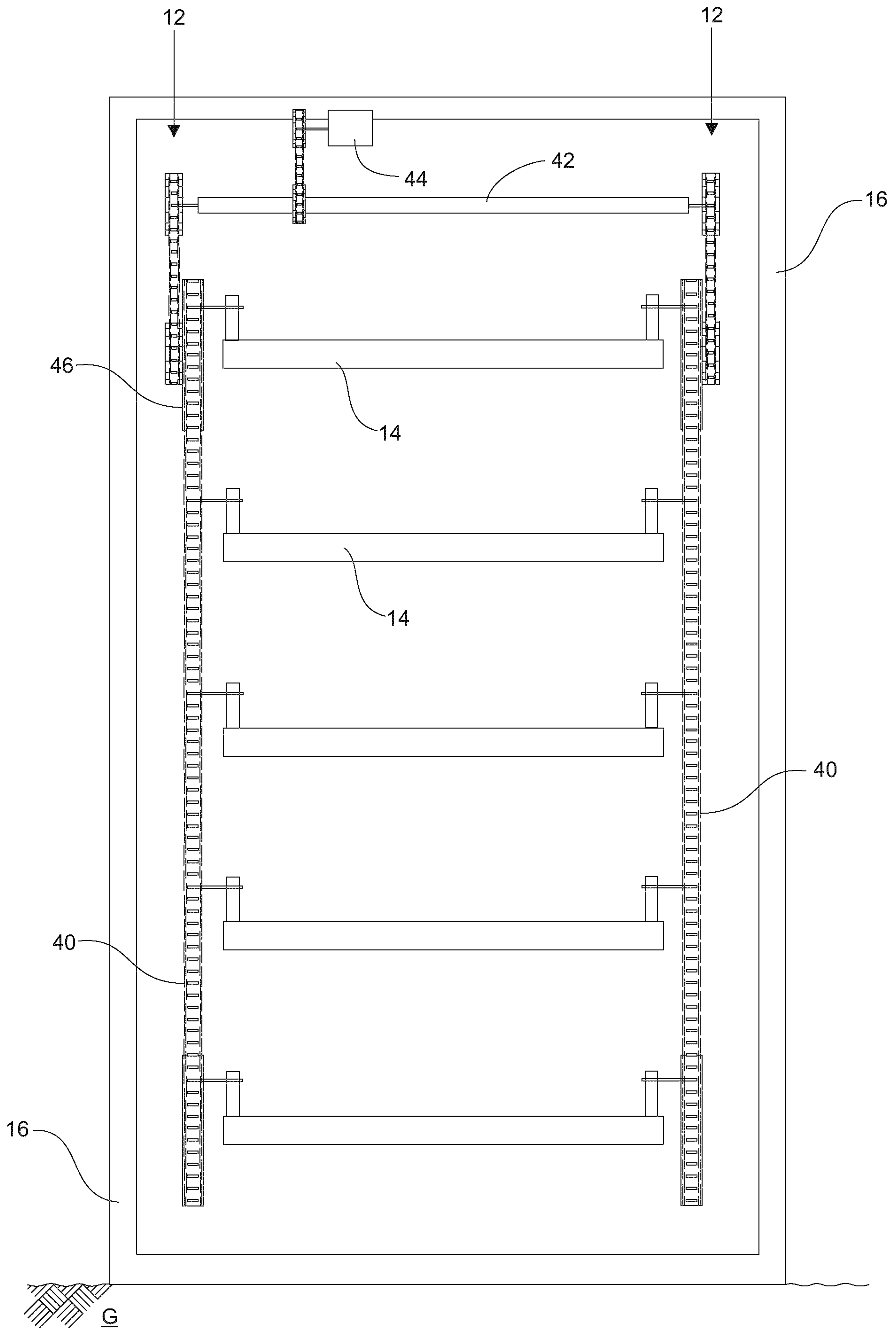


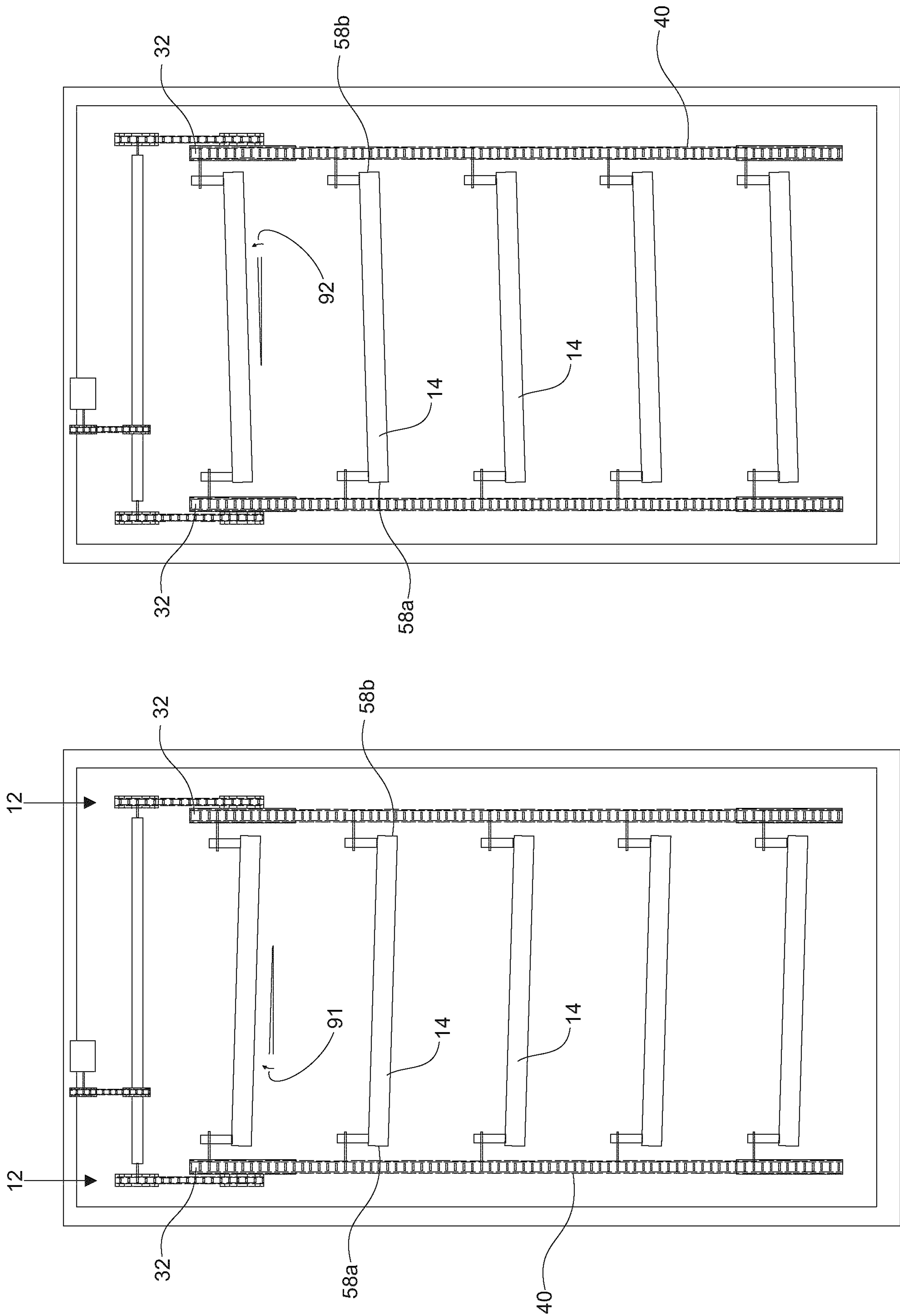
Fig. 6

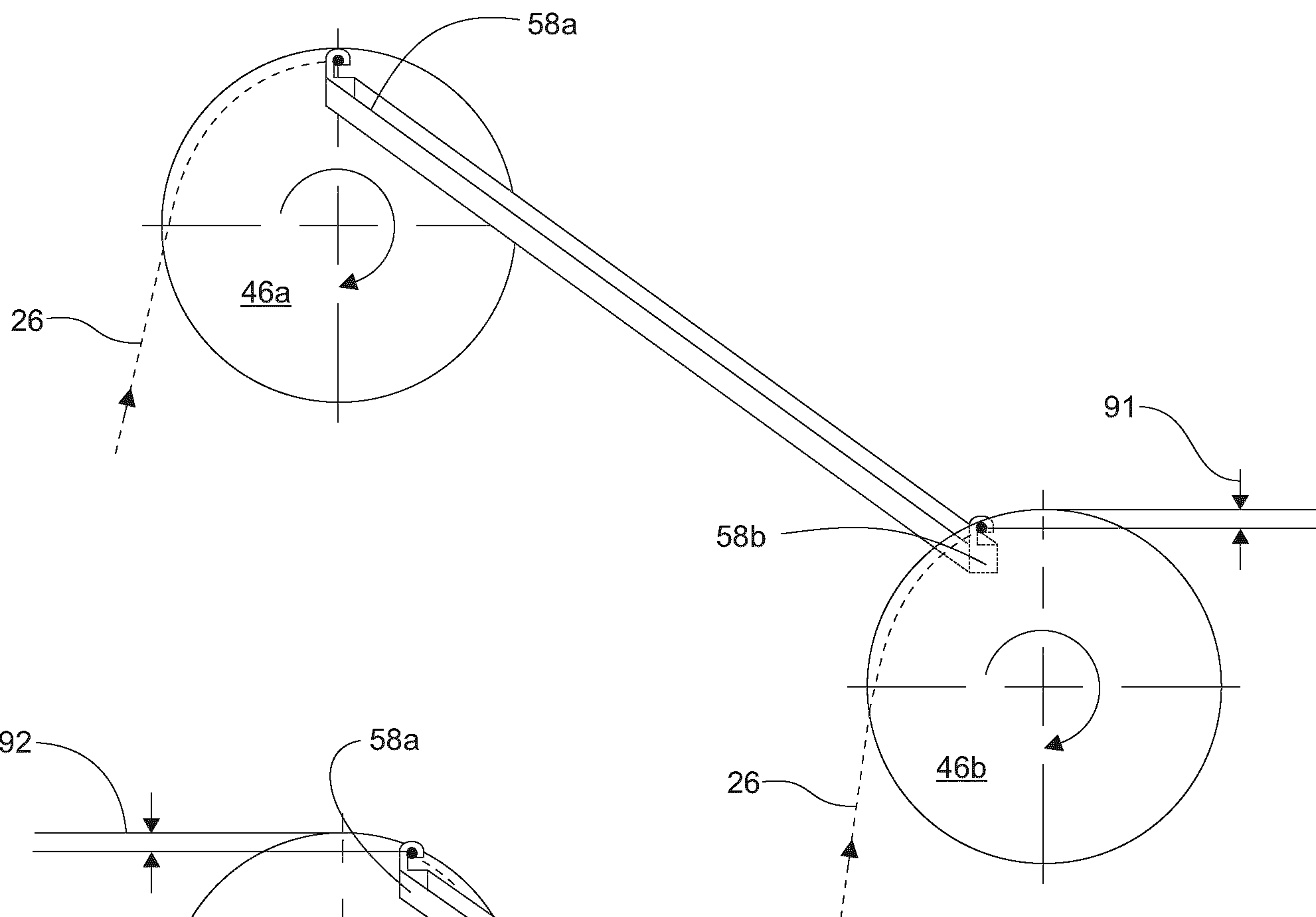
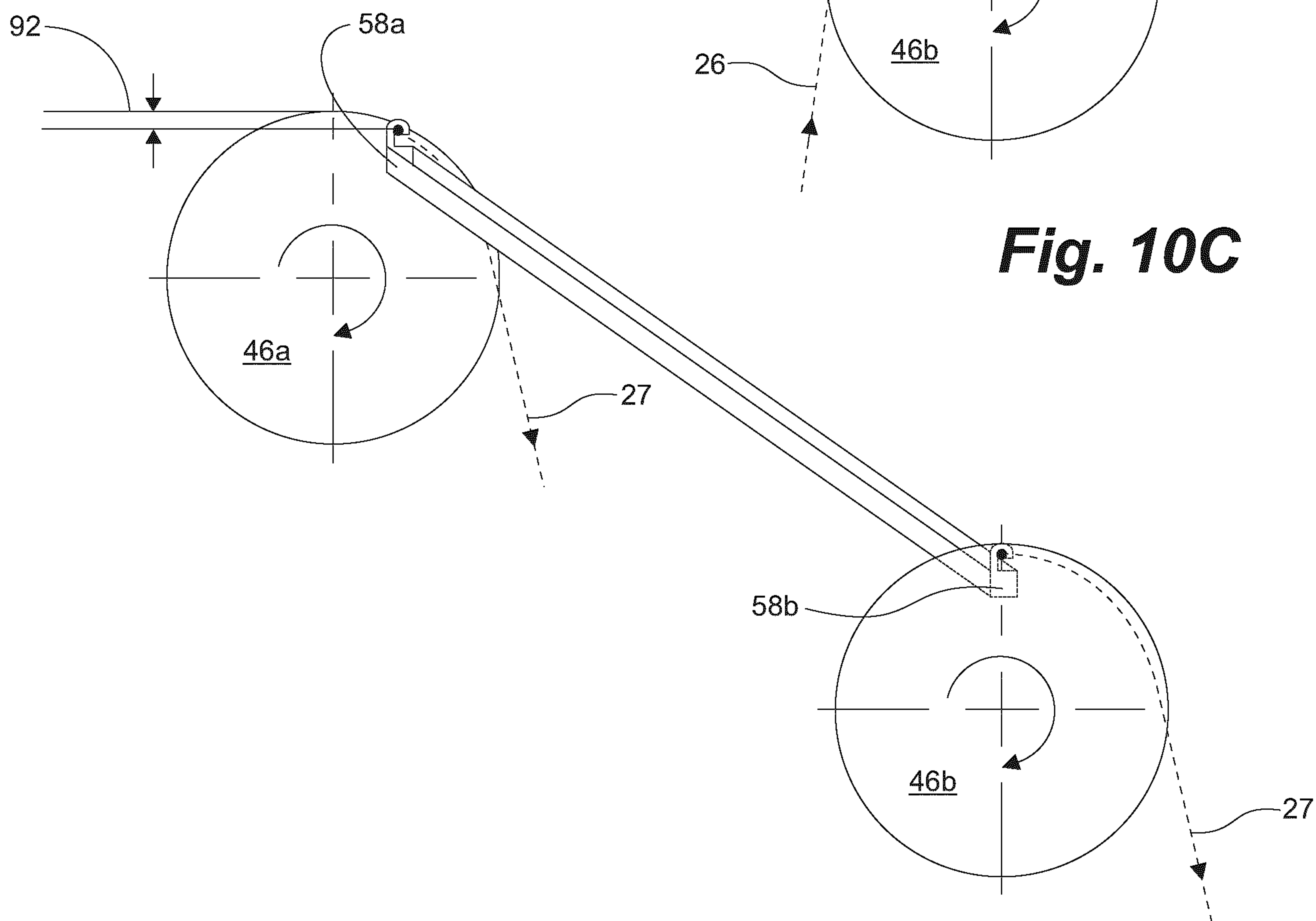
**Fig. 7**

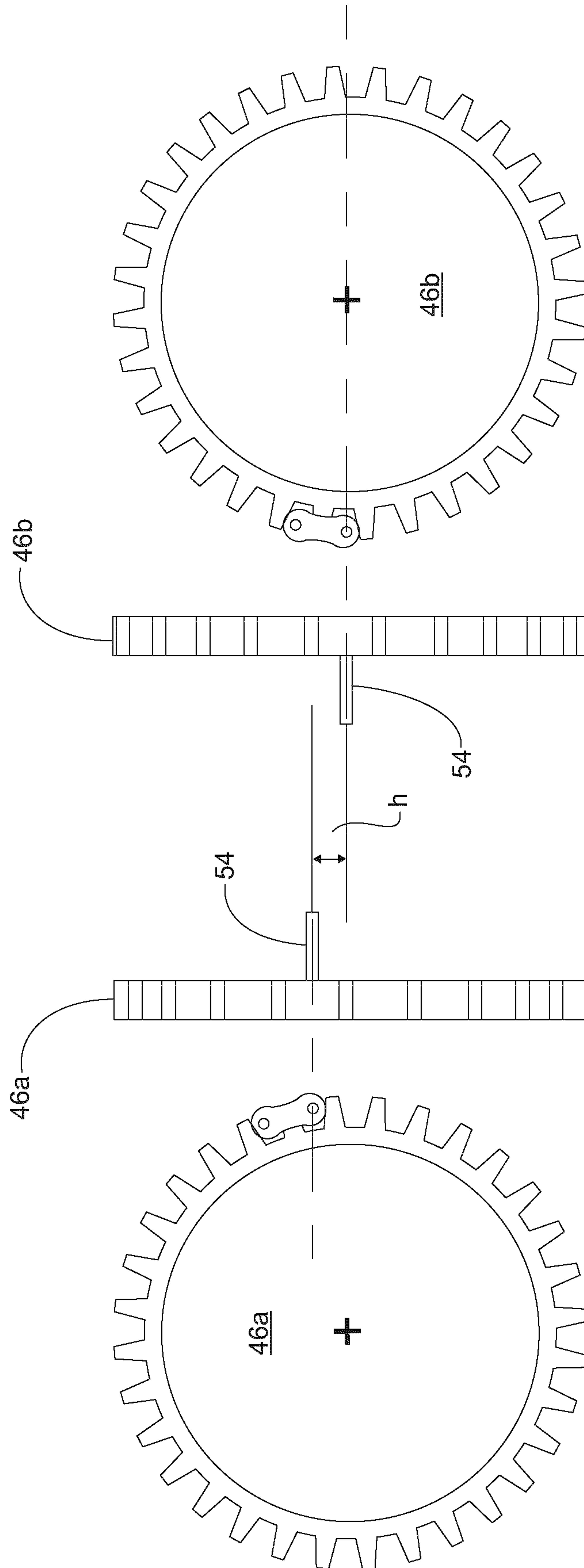


**Fig. 8C**

**Fig. 9**

**Fig. 10B****Fig. 10A**

**Fig. 10C****Fig. 10D**

**Fig. 11**

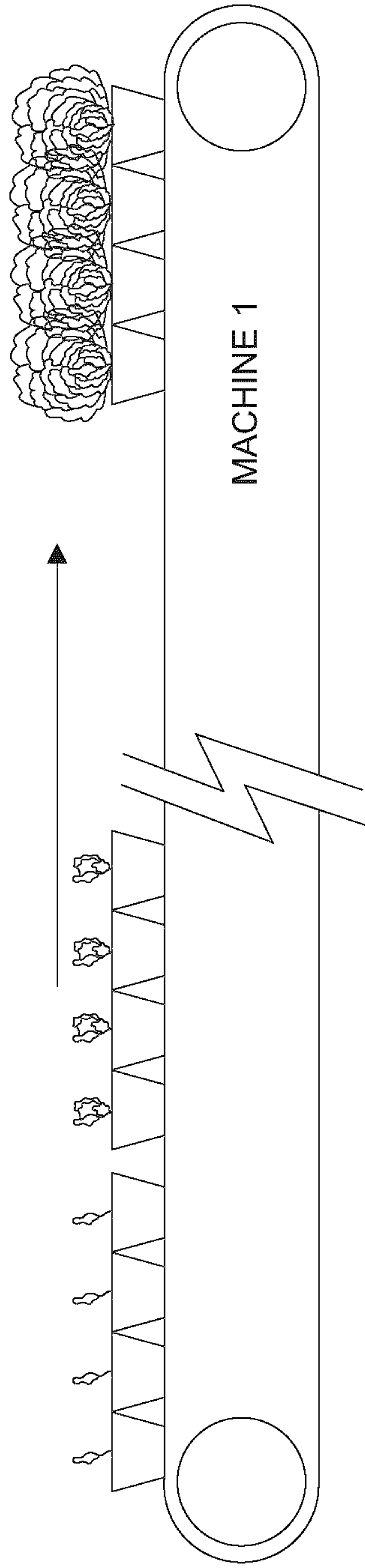


Fig. 12A

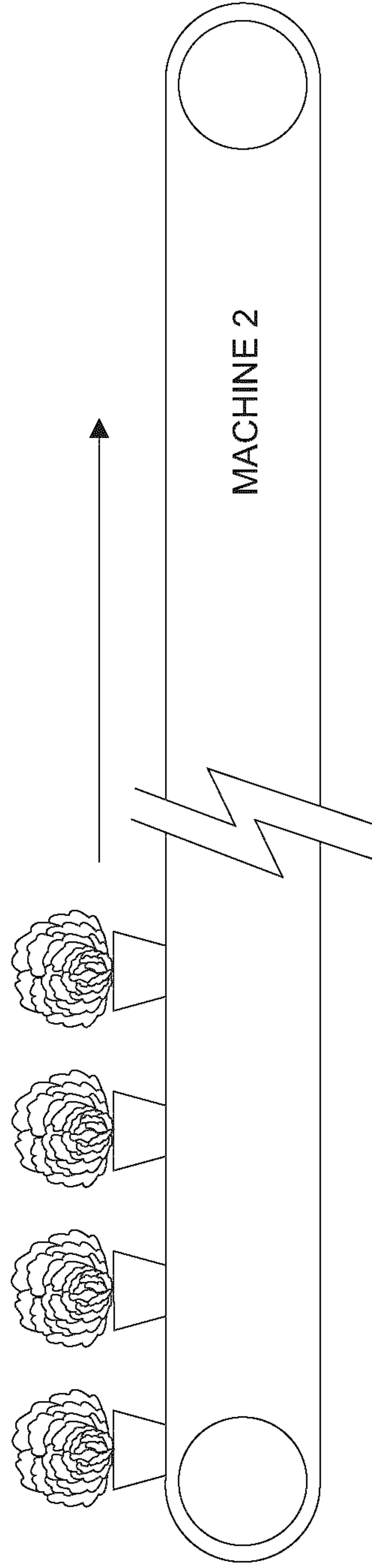
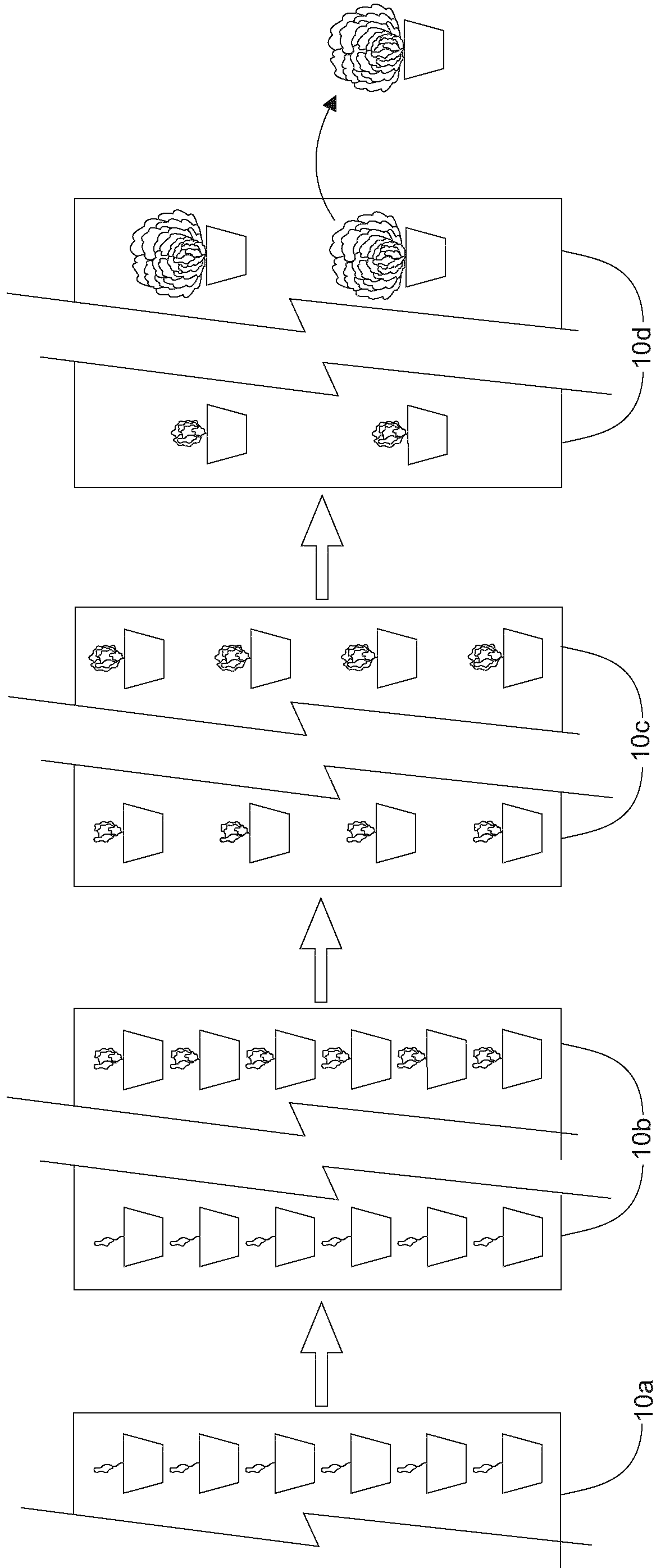
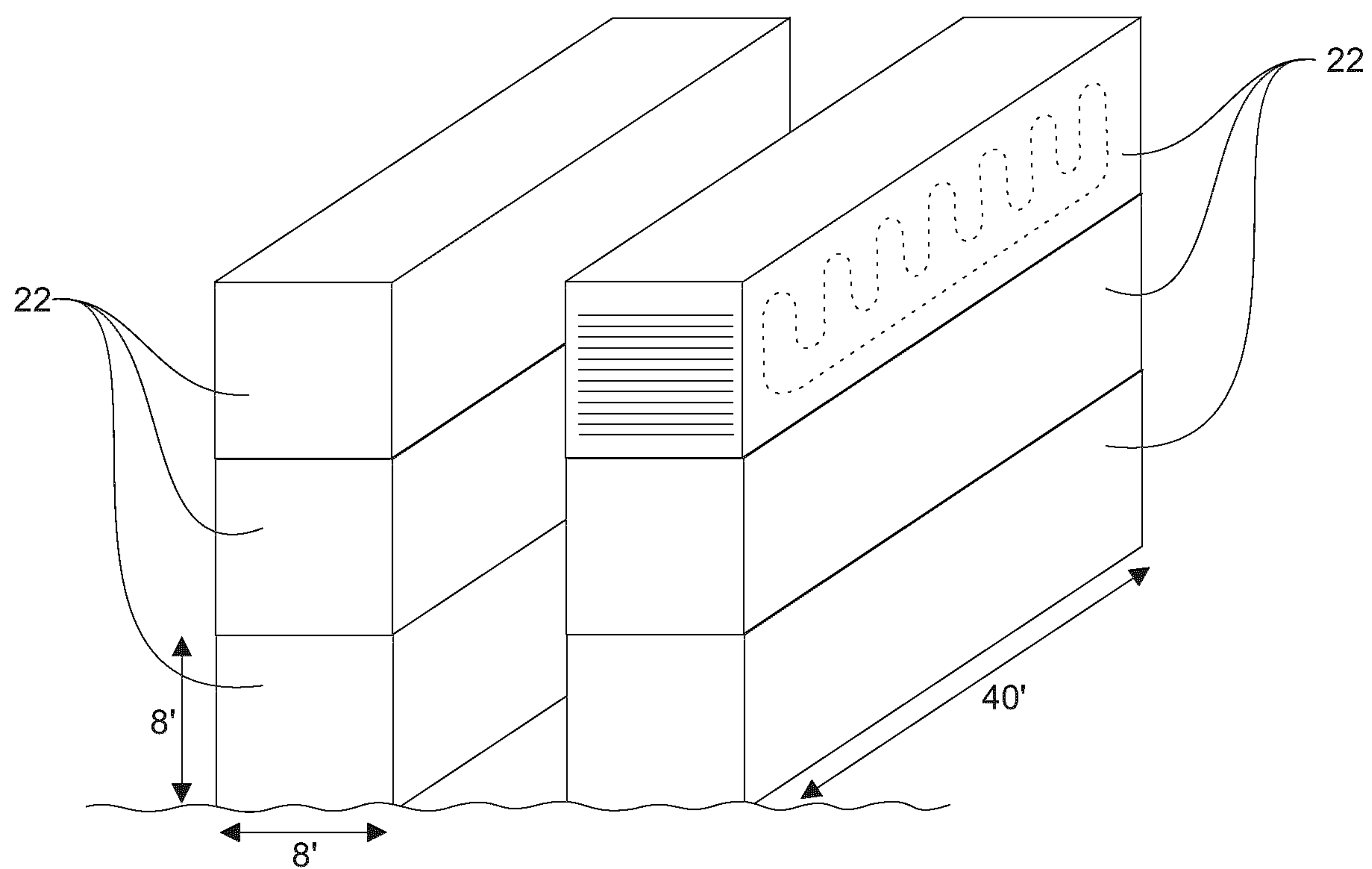
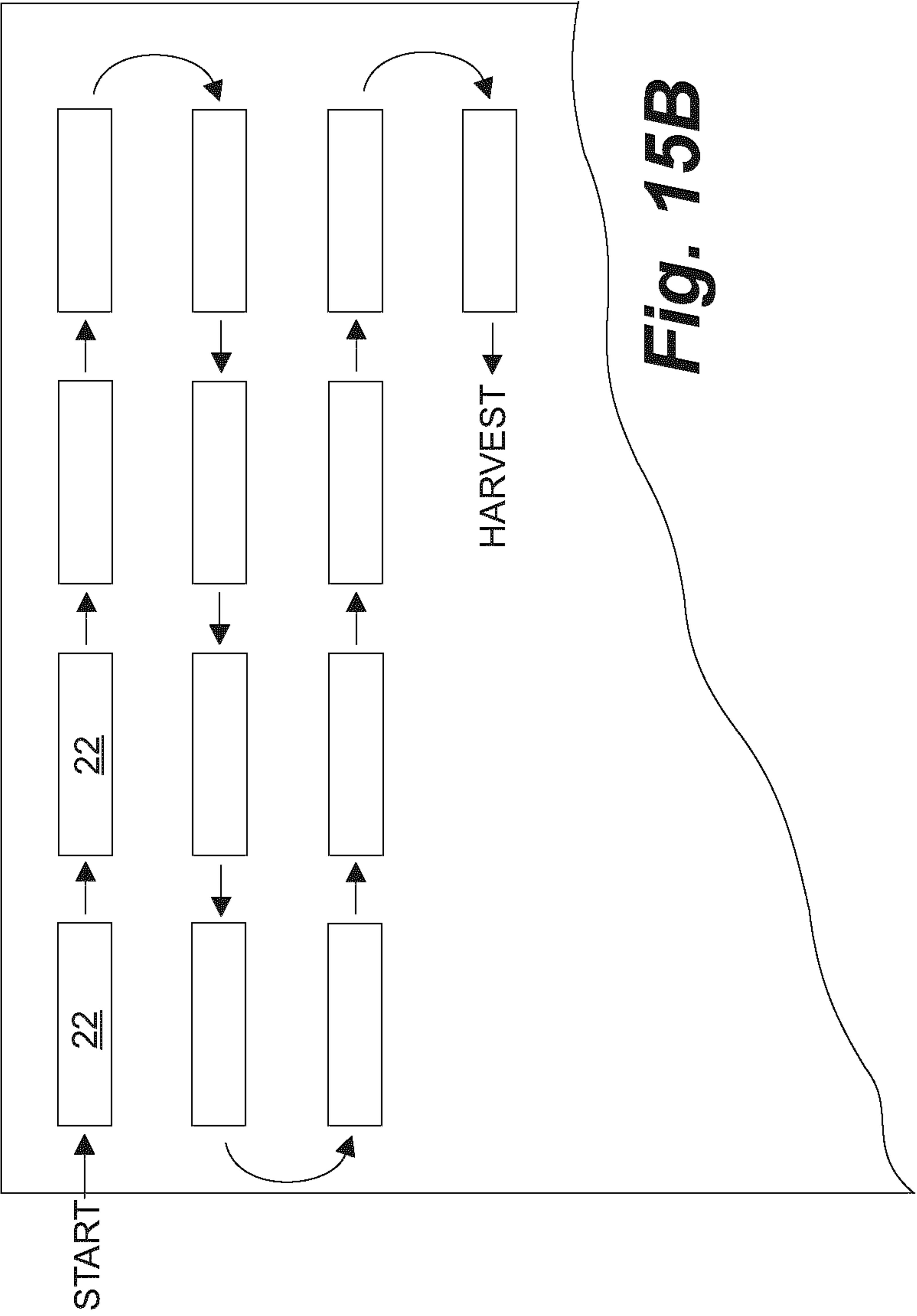
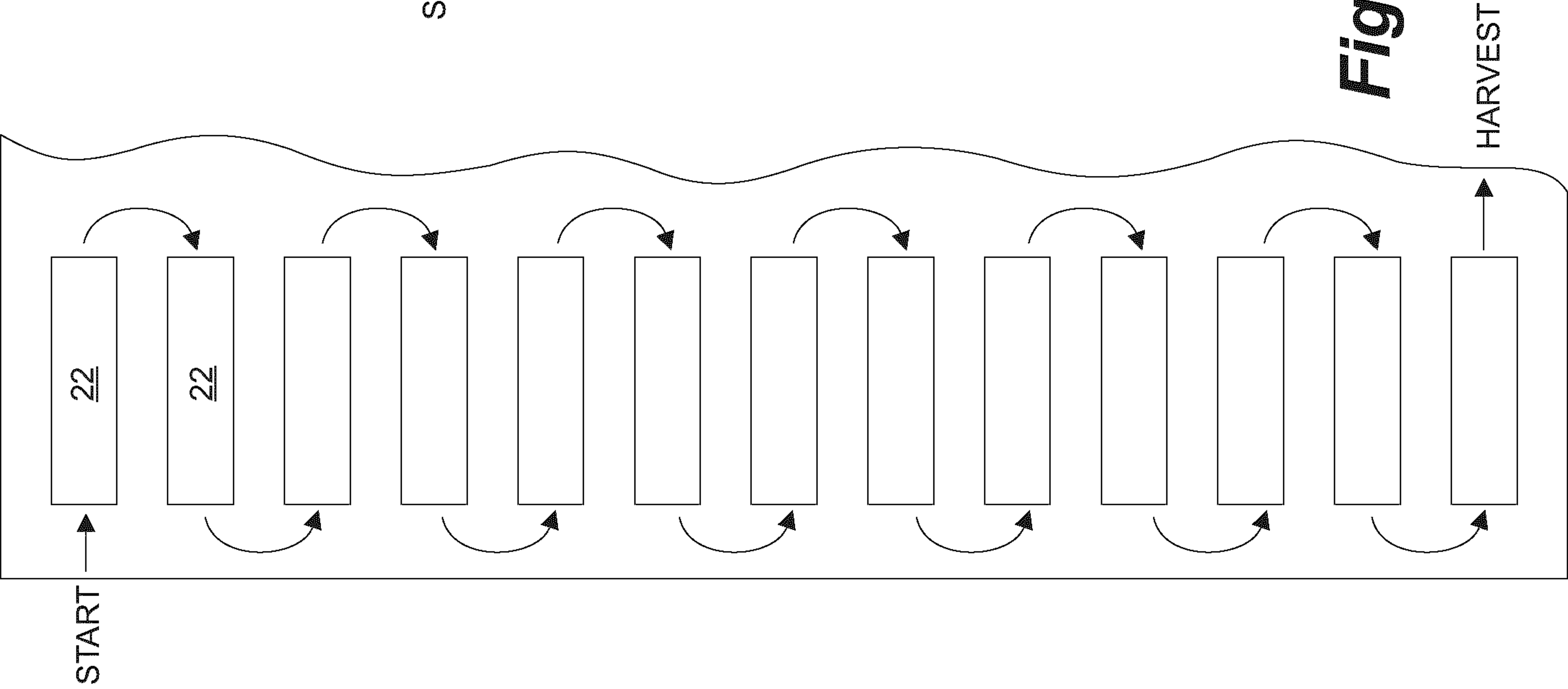


Fig. 12B

15/17

**Fig. 13D****Fig. 13C****Fig. 13B****Fig. 13A**

**Fig. 14**



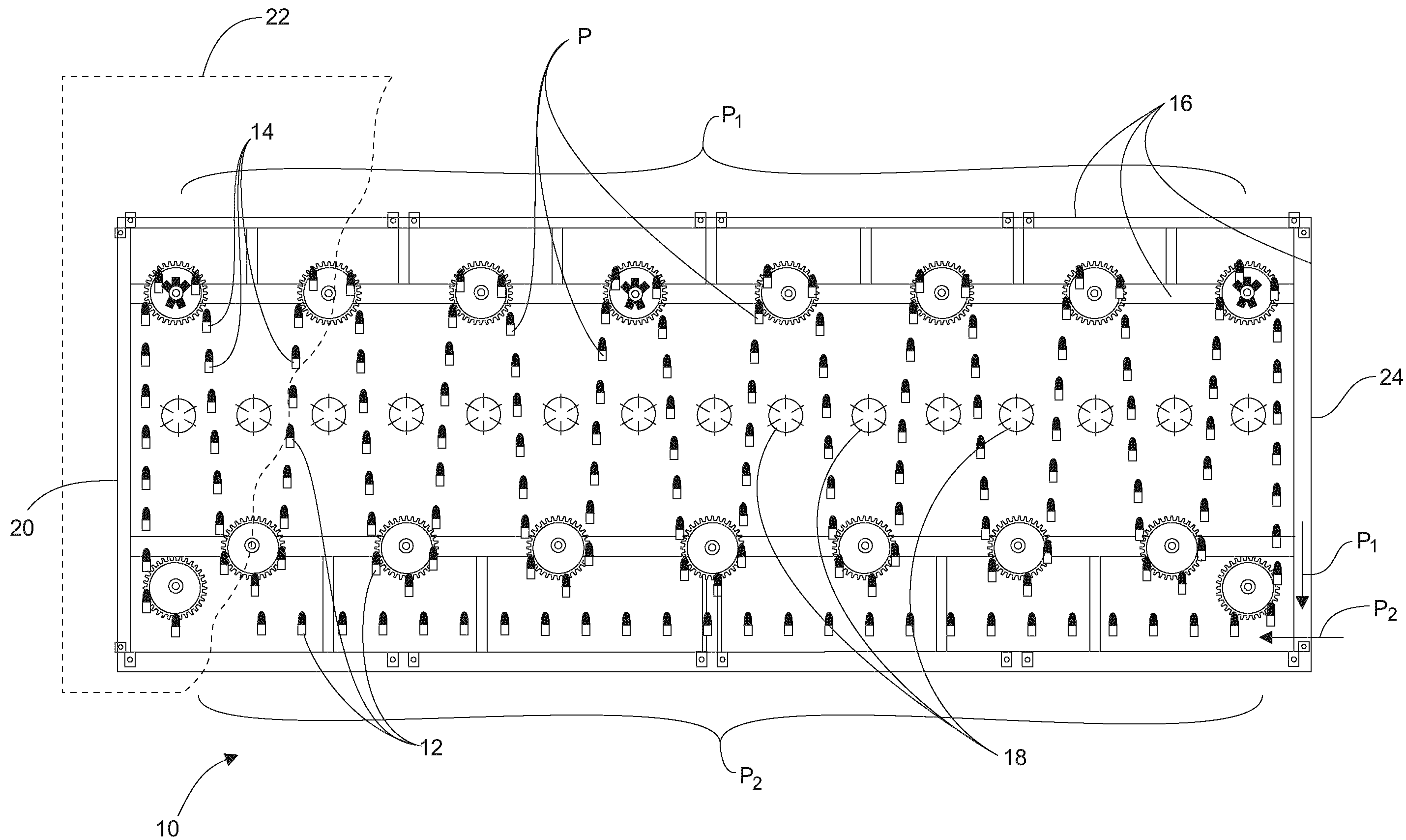


Fig. 1