



(51) International Patent Classification:

*E01C 19/12* (2006.01)      *A01C 7/20* (2006.01)  
*A01C 15/00* (2006.01)      *E01H 10/00* (2006.01)  
*A01C 7/08* (2006.01)

(21) International Application Number:

PCT/CA2017/050790

(22) International Filing Date:

29 June 2017 (29.06.2017)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

62/361,122      12 July 2016 (12.07.2016)      US

(71) Applicant: **SALFORD GROUP INC.** [CA/CA]; 364018  
McBeth Road, Salford, Ontario N0J 1W0 (CA).

(72) Inventors: **GRAY, Geof J.**; 814377 Muir Line, Burford,  
Ontario N0E 1A0 (CA). **AVERINK, John Mark**; 29 Mar-  
shall Drive, Norwich, Ontario N0J 1P0 (CA). **BAKER,**  
**Bradley William**; 105 Mercer Street, Stratford, Ontario  
N5A 6J8 (CA). **DYCK, Jesse Abram**; 26-980 Cheapside

Street, London, Ontario N5Y 4M5 (CA). **BULK, Arie**  
**Frank**; 225418 Otterville Rd., Otterville, Ontario N0J 1R0  
(CA).

(74) Agent: **BRUNET & CO. LTD.**; 401 Bay St., Suite 1600,  
Toronto, Ontario M5H 2Y4 (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, BN, BR, BW, BY, BZ,  
CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO,  
DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN,  
HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP,  
KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME,  
MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ,  
OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA,  
SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN,  
TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every  
kind of regional protection available): ARIPO (BW, GH,  
GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ,  
UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ,  
TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK,

(54) Title: PARTICULATE MATERIAL DISTRIBUTION APPARATUS AND METHOD

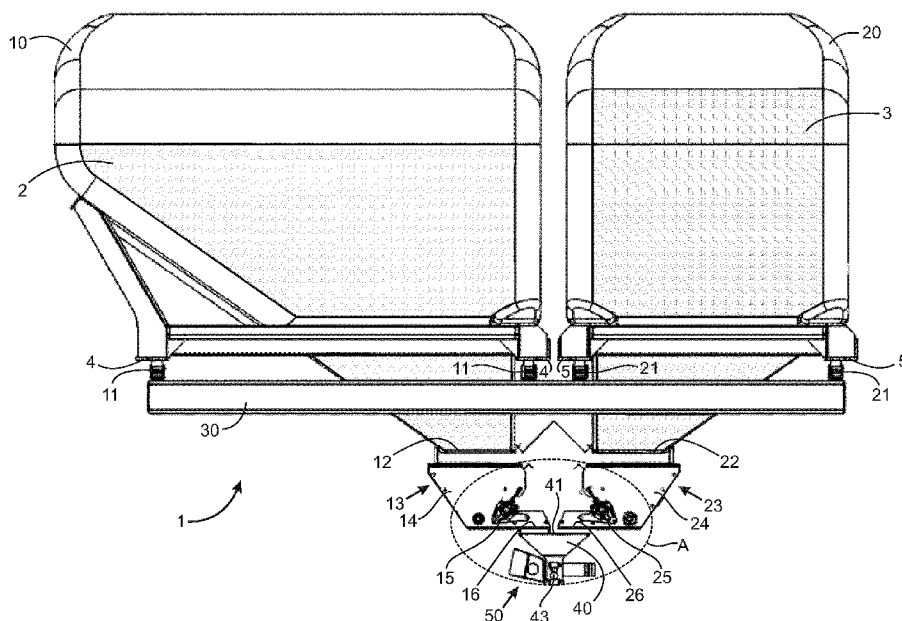


Fig. 1A

(57) Abstract: An apparatus for distributing particulate material has a plurality of independently weighed hoppers from which particulate materials are metered into a common collector and distributed to the environment with a common venturi air system. Metering devices associated with at least two of the hoppers may be oriented in a face-to-face configuration.

WO 2018/010012 A1

EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV,  
MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM,  
TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW,  
KM, ML, MR, NE, SN, TD, TG).

**Declarations under Rule 4.17:**

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

**Published:**

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

## PARTICULATE MATERIAL DISTRIBUTION APPARATUS AND METHOD

Cross-reference to Related Applications

This application claims the benefit of United States Provisional Patent Application  
USSN 62/361,122 filed July 12, 2016, the entire contents of which is herein incorporated  
5 by reference.

Field

This application relates to apparatuses and methods for distributing particulate  
material from more than one hopper using a venturi air system.

Background

10 The distribution of particulate material into the environment is a necessary  
component of a number of different operations including spreading salt, sand or other  
material on roadways, and spreading seed and/or fertilizer in agricultural fields. In many  
cases, it is desirable to be able to distribute more than one type of particulate immediately  
sequentially or during the same operation using the same equipment. In addition, it is  
15 often desirable to be able to independently determine the amounts of different particulate  
material being used and/or to be able to accurately alter the mix of different particulate  
materials being distributed simultaneously.

There remains a need to be able to perform two or more of such functions using  
common spreading equipment and to be able to change functions on the fly without  
20 changing equipment.

Summary

In one aspect, there is provided an apparatus for distributing particulate material,  
the apparatus comprising: a first hopper for containing a first particulate material, the first  
hopper comprising a first feed outlet for the first particulate material; a first weighing  
25 device operatively connected to the first hopper configured to weigh the first hopper; a  
second hopper for containing a second particulate material, the second hopper  
comprising a second feed outlet for the second particulate material; a second weighing  
device operatively connected to the second hopper configured to weigh the second  
hopper independently of the first hopper; a first metering device configured to receive the  
30 first particulate material from the first feed outlet; a second metering device configured to  
receive the second particulate material from the second feed outlet; a collector disposed

proximate the first and second metering devices, the collector having a common inlet configured to receive particulate material metered from both the first and second metering devices, the collector having an exit port through which the particulate material exits the collector; and, a venturi air system in communication with the exit port of the collector for receiving the particulate material from the collector and distributing the particulate material to the environment.

In another aspect, there is provided an apparatus for distributing particulate material, the apparatus comprising: a first hopper for containing a first particulate material, the first hopper comprising a first feed outlet for the first particulate material; a second hopper for containing a second particulate material, the second hopper comprising a second feed outlet for the second particulate material; a first metering device configured to receive the first particulate material from the first feed outlet; a second metering device configured to receive the second particulate material from the second feed outlet; a collector disposed proximate the first and second metering devices, the collector having a common inlet configured to receive particulate material metered from both the first and second metering devices, the first metering device facing the second metering device with the first and second particulate materials being metered toward each other as the metering devices meter the particulate materials into the common inlet, the collector having an exit port through which the particulate material exits the collector; and, a venturi air system in communication with the exit port of the collector for receiving the particulate material from the collector and distributing the particulate material to the environment.

The hoppers are storage containers for particulate material. There may be 2, 3, 4 or more hoppers, each one containing the same or different particulate material than any one or more of the other hoppers. The hoppers may be supported on transportation, for example a truck, trailer or the like, the transportation comprising a frame supported on wheels to permit transportation of the distribution apparatus from place to place. Some examples of transportation include, for example, seed carts, fertilizer carts and hybrid seed/fertilizer carts for agricultural applications, and salt/sand spreader trucks for road safety applications. The hoppers may be supported on the frame of the transportation. The transportation may comprise one or more frames for supporting the hoppers and/or for being supported on the wheels.

In some embodiments, the hoppers are not connected rigidly together. A lack of rigid connection between the hoppers facilitates independent weighing of the individual hoppers. In one embodiment, the first and second hoppers may be disposed adjacent to

each other, for example supported adjacent to each other on the frame of the transportation. In another embodiment, the second hopper may be disposed within the first hopper.

The weighing devices may be mechanical or electronic, preferably electronic.

5 There may be one or more weighing devices for weighing any given hopper, for example there may be 1, 2, 3, 4 or more weighing devices per hopper. In one embodiment, at least one of the weighing devices may comprise a load cell system supporting one of the hoppers. Each hopper may be supported on its own load cell system. The load cell system may comprise one or more load cells, for example 1, 2, 3, 4 or more load cells.

10 The load cells may be mounted on the frame with the hoppers supported freely on their respective load cells so that the load cells measure the weight of their respective hoppers independently. As particulate material is fed out of the hopper, the weight loss as measured by the weighing devices is a measure of the amount of particulate material being fed from the hopper and the amount of particulate material remaining in the hopper.

15 The hoppers may be open top or closed, but the contents of the hoppers are not required to be under pressure. Particulate material may be gravity fed through feed outlets on the hoppers to respective metering devices associated with each hopper. Each metering device may independently comprise one or more metering elements, preferably rotatable metering elements. Rotatable metering elements include, for example, meter

20 rollers and/or endless belts. Meter rollers include, for example pegged output rollers, fluted output rollers, high output rollers, etc. The metering elements may be housed in housings, each housing comprising one or more metering inlets configured to receive particulate material from the respective hoppers and one or more metering outlets configured to deliver particulate material to the collector. In one embodiment, the first

25 metering device faces the second metering device with the first and second particulate materials being metered toward each other as the metering devices meter the particulate materials into the common inlet of the collector. A face-to-face arrangement of metering devices is particularly advantageous because the arrangement avoids the necessity to stack metering systems, which avoids needing to reduce the size of one of the hoppers to

30 accommodate stacked metering systems thereby maximizing the size of both hoppers.

At least the first and second metering devices meter particulate material into a collector through a common inlet of the collector. The collector may be disposed below the metering devices in order to receive a gravity feed of the particulate material. In one embodiment, the collector has no ultimate rigid attachment to more than one hopper so

35 that the hoppers remain independently weighable. If the collector was ultimately attached

to more than one hopper, then at least a portion of the weight of one hopper could be transferrable to another hopper, which would create difficulty for weighing the hoppers independently. In one embodiment the metering devices are attached to respective hoppers, and the collector may be attached to one metering device or neither metering  
5 device, but not to more than one metering device. In one embodiment, the collector may comprise a funnel. The funnel may have a large opening at a top acting as the common inlet and tapering side walls to direct the particulate material to one or more exit ports at a bottom of the funnel. The one or more exit ports may feed particulate material to one or more airstreams in one or more air lines of the venturi air system.

10 The venturi air system preferably comprises air lines (e.g. hoses) and an air moving device (e.g. a fan) for providing airstreams in the air lines. At least one of the airstreams flowing in the air lines is configured to receive the particulate material from the exit port of the collector and entrains the particulate material exiting the collector to carry  
15 the particulate material to outlet ports in the air lines, thereby distributing the particulate material to the environment. In one embodiment, the particulate material exits the collector in a direction substantially perpendicular to a direction of flow of the airstream. The venturi air system does not require pressurizing the hoppers. One or more air lines may be employed providing one or more airstreams in which particulate material may be carried to the outlet ports. Each airstream may be carried in separate air lines. There may  
20 be one or more than one metering element in a given metering device associated with each airstream, so a single airstream may receive product from one or more than one metering element of a given metering device. Because the collector is common to the metering devices, a single air system has the ability to distribute particulate material from different hoppers at different times using common airstreams, to distribute particulate  
25 material from different hoppers using different airstreams or to distribute particulate material from different hoppers at the same time using common airstreams. The one or more outlet ports of the air lines may be located on any desired implement, for example booms, tillage implements, seed drills, fertilizer drills and the like.

The ability to distribute particulate material from different hoppers at the same  
30 time using common airstreams permits mixing of different particulate material in a common airstream for simultaneous distribution to the same location in the environment. Adjusting the metering rate of each particulate material can adjust the proportion of different particulate materials in the same airstream being delivered to the same location at the same time. Such adjustments may be made on the fly, the nature of the adjustment  
35 depending on environmental conditions (e.g. soil conditions) or other considerations. The

particulate material may comprise seed, fertilizer and the like for agricultural applications, or road salt, sand and the like for road safety applications.

5 The apparatus may further comprise a control system to control one or more of the air moving device, shut-off valves in the apparatus (e.g. between individual hoppers and their metering devices, in the exit ports of the collector, in the air lines, etc.) and the rate of feed of the particulate material from individual metering devices to the collector. The control system may also control any other aspect of the apparatus. Of especial importance is the ability to control the rate of feed of particulate material from any given hopper to the collector for reasons discussed above.

10 The control system may comprise a computer, an output device and an input device, the computer comprising a microprocessor, for example a programmable microprocessor, for controlling operations and a non-transient electronic storage medium for storing information about the weight of the hoppers, the type of particulate materials in the hoppers, metering rates of the particulate materials, other operational parameters of the apparatus, and/or for storing computer executable code for carrying out instructions  
15 for implementing operations. The computer may further comprise a transient memory (e.g. random access memory (RAM)) accessible to the microprocessor while executing the code. A plurality of computer-based apparatuses may be connected to one another over a computer network system and geographically distributed. One or more of the  
20 computer-based apparatuses in the computer network system may comprise a microprocessor for controlling operations and a non-transient electronic storage medium for storing information as described above, and the computer-based apparatuses in the network may interact so that the apparatus may be controlled from remote locations. The output device may be a monitor, a printer, a device that interfaces with a remote output  
25 device or the like. The input device may be a keyboard, a mouse, a microphone, a device that interfaces with a remote input device or the like.

Further features will be described or will become apparent in the course of the following detailed description. It should be understood that each feature described herein may be utilized in any combination with any one or more of the other described features,  
30 and that each feature does not necessarily rely on the presence of another feature except where evident to one of skill in the art.

#### Brief Description of the Drawings

For clearer understanding, preferred embodiments will now be described in detail by way of example, with reference to the accompanying drawings, in which:

Fig. 1A depicts a schematic diagram of an apparatus for distributing particulate material, in which two independently weighed hoppers deliver particulate material to respective meter roller assemblies in a face-to-face configuration for delivery of the particulate material to a common funnel;

Fig. 1B depicts a magnified view of region **A** in Fig. 1A;

Fig. 2 depicts a schematic diagram of an apparatus for distributing particulate material, in which three independently weighed hoppers deliver particulate material to respective metering devices for delivery of the particulate material to a common funnel;

Fig. 3 depicts a schematic diagram of an apparatus for distributing particulate material, in which two independently weighed hoppers deliver particulate material to respective meter roller assemblies in a stacked configuration for delivery of the particulate material to a common funnel; and,

Fig. 4 depicts a schematic diagram of an apparatus for distributing particulate material in context of a seed and fertilizer cart.

#### Detailed Description

With reference to Fig. 1A and Fig. 1B, in one embodiment, an apparatus **1** for distributing particulate material, in particular seed and/or fertilizer, comprises a first hopper **10** and a second hopper **20** supported adjacent to each other on a frame **30** of a seed/fertilizer cart (not shown). The first hopper **10** contains a first particulate material **2** (e.g. seed or fertilizer) and is supported freely on the frame **30** by four load cells **11** (only two shown). Likewise, the second hopper **20** contains a second particulate material **3** (e.g. seed or fertilizer) and is supported freely on the frame **30** by four load cells **21** (only two shown). The hoppers **10, 20** are physically unattached to each other either directly or indirectly through the rest of the apparatus **1**. The hoppers **10, 20** are supported on, but are not fixedly connected to, the load cells **11, 21** and the frame **30**. The hoppers **10, 20** may be constrained from lateral movement by respective cradles **4, 5** so that the hoppers **10, 20** do not fall off the frame **30** while the apparatus is in motion. In one embodiment, the cradles may comprise bolts loosely inserted into threaded holes in the load cells, the threads of the bolts treated with a thread locker (e.g. Loctite™), and the bolts preventing the hoppers from moving about laterally. The load cells **11, 21** are in electronic

communication with a control system (not shown), the load cells **11**, **21** transmitting weight information about hoppers **10**, **20**, respectively, to the control system for processing and/or display on an output device of the control system.

The particulate materials **2**, **3** in the hoppers **10**, **20** are gravity fed through hopper outlets **12**, **22**, respectively, into respective first and second metering mechanisms **13**, **23** attached to respective hoppers **10**, **20** and disposed below the hopper outlets **12**, **22**. The first and second metering mechanisms **13**, **23** comprise first and second meter boxes **14**, **24**, respectively, the first and second meter boxes **14**, **24** housing first and second meter roller assemblies **15**, **25**, respectively. Each of the meter roller assemblies **15**, **25** may comprise one or a plurality of meter rollers. The meter rollers of a given meter roller assembly may be driven on a common shaft or a plurality of shafts. Each of the meter boxes **14**, **24** may have one or more cells that receive the particulate materials **2**, **3** from respective hoppers **10**, **20**. The first and second meter boxes **14**, **24** have one or more outlets **16**, **26**, respectively, from which the particulate materials **2**, **3** are metered into a common upper opening **41** of a common funnel **40** disposed below the first and second metering mechanisms **13**, **23**. The first and second meter roller assemblies **15**, **25** are configured in a face-to-face configuration so that the particulate material **2** from the first meter roller assembly **15** is metered toward the second meter roller assembly **25**, and the particulate material **3** from the second meter roller assembly **25** is metered toward the first meter roller assembly **15**. If both the first particulate material **2** and the second particulate material **3** are being metered simultaneously, the particulate materials **2**, **3** fall together under the influence of gravity into the common upper opening **41** of the funnel **40** where they mix together.

The funnel may be fixedly connected to one or the other of the first and second meter boxes, or to neither but not to both. The funnel is not fixedly connected to both meter boxes to facilitate continued independent measurement of the weight of the hoppers by the load cells. In Fig. 1A and Fig. 1B, the funnel **40** is fixedly connected to the first meter box **14** by ties **42** so that the upper opening **41** of the funnel **40** is below both the first and second meter roller assemblies **15**, **25** to receive the particulate materials **2**, **3**, respectively, being metered by the meter roller assemblies **15**, **25**. The funnel **40** further comprises a lower opening **43** through which the particulate materials **2**, **3** exit the funnel **40**. The lower opening **43** has smaller cross-sectional dimensions than the cross-sectional dimensions of the upper opening **41**, thereby gathering the particulate materials **2**, **3** for delivery through the lower opening **43** into a venturi air system **50**. The funnel **40** comprises a lower chamber **44** into which the lower opening **43** opens. The lower

chamber **44** is blocked from the upper opening **41** by a separating wall **45**, although the lower chamber **44** and the upper opening **41** are in fluid communication through the lower opening **43**. The lower chamber **44** is provided with apertures to which ports of the air system may be attached.

5           The venturi air system **50** comprises an air supply port **51** in fluid communication with the lower chamber **44** to which an air supply hose (not shown) may be attached for fluidly connecting the lower chamber **44** to a fan (not shown). The air system **50** also comprises an air delivery port **52** in fluid communication with the lower chamber **44** to which an air delivery hose (not shown) may be attached for fluidly connecting the lower  
10 chamber **44** to an outlet port (not shown) of the air delivery hose to deliver the particulate material to the environment. The air delivery port **52** is shown as being directly across the lower chamber **44** from the air supply port **51**, but other arrangements may be possible. The particulate materials **2, 3** exit the lower opening **43** into the lower chamber **44** where the particulate materials **2, 3** are entrained in an airstream flowing from the air supply port  
15 **51** to the air delivery port **52**, and then out through the outlet port of the air delivery hose. When the meter boxes comprise a plurality of cells, the funnel may comprise a plurality of compartments aligned with the plurality of cells for feeding the particulate materials into a plurality of lower chambers through a plurality of lower openings into air streams in a plurality of air hoses for distribution of the particulate materials out of a plurality of outlet  
20 ports distributed on an implement (e.g. a boom, tillage implement, drill or the like).

With the apparatus **1**, different particulate materials may be metered into a common air system through a common funnel at different times for distribution separately into the environment. Also, without any changes to the apparatus **1**, different particulate materials may be metered simultaneously into a common air stream for distribution  
25 simultaneously into the same location in the environment.

With reference to Fig. 2, an apparatus **100** for distributing particulate material is illustrated comprising first, second and third independently weighed hoppers **110, 120, 130**, respectively, to deliver up to three different particulate materials **101, 102, 103** to a common funnel **140** into a common venturi air system **150** for delivery into the  
30 environment. The first hopper **110** is supported freely on a first set of load cells **111**, which independently weigh the first hopper **110**. The second hopper **120** is supported freely on a second set of load cells **121**, which independently weigh the second hopper **120**. The third hopper **130** is supported freely on a third set of load cells **131**, which independently weigh the third hopper **130**. The three sets of load cells **111, 121, 131** may  
35 be supported on a frame (not shown) and each of the three hoppers **110, 120, 130** may

be supported on their respective sets of load cells **111**, **121**, **131** without being fixedly connected to the frame or any of the other hoppers.

In the apparatus **100**, the particulate material **101** is metered from the first hopper **110** by a first endless belt **115**, the particulate material **102** is metered from the second hopper **120** by a second endless belt **125**, and the particulate material **103** is metered from the third hopper **130** by a meter roller **135**. The endless belts **115**, **125** meter particulate materials **101**, **102**, respectively, in a face-to-face configuration with the particulate material **103** metered by the meter roller **135**. The common funnel **140** comprises a common upper opening **141** that receives the particulate materials **101**, **102**, **103**, the particulate materials **101**, **102**, **103** being collected and funneled to a lower compartment **144** to be entrained in an airstream **155** flowing from an air supply port **151** to an air delivery port **152** connected to the lower compartment **144**. Air flow is provided through hoses (not shown) by a fan (not shown), and particulate materials entrained in the airstream are carried in an air delivery hose connected to the delivery port **152** to be distributed to the environment through an outlet port of the air delivery hose. Like previously discussed, the particulate materials **101**, **102**, **103** from the first, second and third hoppers **110**, **120**, **130** may be metered at different times or simultaneously into the common funnel **140**.

Where a plurality of endless belts and/or meter rollers are disposed with each hopper for metering the particulate materials to the funnel, the funnel may comprise a plurality of compartments aligned with the plurality of endless belts and/or meter rollers for feeding the particulate materials into a plurality of air streams in a plurality of air hoses for distribution of the particulate materials out of a plurality of outlet ports distributed on an implement (e.g. a boom, tillage implement, drill or the like).

With reference to Fig. 3, in another embodiment, an apparatus **200** for distributing particulate material, in particular seed and/or fertilizer, comprises a first hopper **210** situated toward a front of a seed/fertilizer cart and a second hopper **220** supported adjacent and to a rear of the first hopper **210** on a frame **230** of the cart. The first hopper **210** contains a first particulate material **202** (e.g. seed or fertilizer) and is supported freely on horizontal frame members **231** (only one shown) of the frame **230** by engagement of four support flanges **232** (only two shown) with four load cells **211** (only two shown) mounted on the horizontal frame members **231**. Likewise, the second hopper **220** contains a second particulate material **203** (e.g. seed or fertilizer) and is supported freely on horizontal frame members **231** (only one shown) of the frame **230** by engagement of four support flanges **233** (only two shown) with four load cells **221** (only two shown)

mounted on the horizontal frame members **231**. The support flanges **232, 233** are fixedly secured to the respective hoppers **210, 220** and rest on the respective load cells **211, 221** so that the entire weight of each hopper **210, 220** is borne by the respective load cells **211, 221**. The hoppers **210, 220** are physically unattached to each other either directly or indirectly through the rest of the apparatus **200**. The hoppers **210, 220** are supported on, but are not fixedly connected to, the load cells **211, 221** and the frame members **231**. The hoppers **210, 220** may be constrained from lateral movement by the frame members **231** surrounding the hoppers **210, 220** are so that the hoppers **210, 220** do not fall off the frame **230** while the apparatus is in motion. The load cells **211, 221** are in electronic communication with a control system (not shown), the load cells **211, 221** transmitting weight information about hoppers **210, 220**, respectively, to the control system for processing and/or display on an output device of the control system.

The particulate materials **202, 203** in the hoppers **210, 220** are gravity fed through hopper outlets **212, 222**, respectively, into respective first and second metering mechanisms **213, 223** attached to respective hoppers **210, 220** and disposed below the hopper outlets **212, 222**. The first and second metering mechanisms **213, 223** comprise first and second meter roller assemblies **215, 225**, respectively. Each of the meter roller assemblies **215, 225** may comprise one or a plurality of meter rollers. The meter rollers of a given meter roller assembly may be driven on a common shaft or a plurality of shafts. As described in connection with Fig. 1, the metering mechanisms may comprise meter boxes, and each of the meter boxes may have one or more cells that receive the particulate materials from respective hoppers. The particulate materials **202, 203** are metered into a common funnel **240** disposed below the first and second metering mechanisms **213, 223**. The first and second metering mechanisms **213, 223** are configured in a stacked configuration with the first metering mechanism **213** at a higher elevation than the second metering mechanism **223**. If both the first particulate material **202** and the second particulate material **203** are being metered simultaneously, the particulate materials **202, 203** fall together under the influence of gravity into the common funnel **240** where they mix together.

The **240** funnel may be fixedly connected to lower horizontal frame members **235** (only one shown) so that the funnel **240** is not fixedly connected to either the first or second metering mechanisms **213, 223** to facilitate continued independent measurement of the weight of the hoppers **210, 220** by the load cells **211, 221**. The funnel **240** further comprises a lower opening **243** through which the particulate materials **202, 203** exit the funnel **240**. The lower opening **243** has smaller cross-sectional dimensions than the

cross-sectional dimensions of an upper opening **241**, thereby gathering the particulate materials **202**, **203** for delivery through the lower opening **243** into a venturi air system **250**. The funnel **240** comprises a lower chamber **244** into which the lower opening **243** opens. The lower chamber **244** is provided with apertures to which ports of the air system  
5 **250** may be attached.

The venturi air system **250** comprises an air supply port **251** in fluid communication with the lower chamber **244** to which an air supply hose **255** may be attached for fluidly connecting the lower chamber **244** to a fan **256**. The air system **250** also comprises an air delivery port **252** in fluid communication with the lower chamber  
10 **244** to which an air delivery hose (not shown) may be attached for fluidly connecting the lower chamber **24** to an outlet port (not shown) of the air delivery hose to deliver the particulate material to the environment. The air delivery port **252** is shown as being directly across the lower chamber **244** from the air supply port **251**, but other arrangements may be possible. The particulate materials **202**, **203** exit the lower opening  
15 **243** into the lower chamber **244** where the particulate materials **202**, **203** are entrained in an airstream flowing from the air supply port **251** to the air delivery port **252**, and then out through the outlet port of the air delivery hose.

Fig. 4 depicts an apparatus **300** for distributing particulate materials in context of a seed and fertilizer cart. Here, the apparatus **300** is shown comprising a cart frame **330**  
20 supported on tandem wheels **335** and having a hitch **333** to permit towing the cart. Independently weighed first and second hoppers **310**, **320**, respectively, are supported on respective sets of load cells (not shown) mounted on the frame **330**. A first endless belt **315** meters particulate material from the first hopper **310** and a second endless belt **325** disposed below the first endless belt **315** meters particulate material from the second  
25 hopper **320** so that the particulate materials from both hoppers **310**, **320** are metered into a common opening of a common funnel **340**. The funnel **340** is mounted on the frame **330**, and collects the particulate materials metered from the first and second endless belts **315**, **325** to deliver the particulate materials to a common venturi air system **350** for distribution in the environment. Like previously discussed, the particulate materials from  
30 the first and second hoppers **310**, **320** may be metered at different times or simultaneously.

The novel features will become apparent to those of skill in the art upon examination of the description. It should be understood, however, that the scope of the claims should not be limited by the embodiments, but should be given the broadest  
35 interpretation consistent with the wording of the claims and the specification as a whole.

Claims:

1. An apparatus for distributing particulate material, the apparatus comprising:
  - a first hopper for containing a first particulate material, the first hopper comprising a first feed outlet for the first particulate material;
  - 5 a first weighing device operatively connected to the first hopper configured to weigh the first hopper;
  - a second hopper for containing a second particulate material, the second hopper comprising a second feed outlet for the second particulate material;
  - a second weighing device operatively connected to the second hopper
  - 10 configured to weigh the second hopper independently of the first hopper;
  - a first metering device configured to receive the first particulate material from the first feed outlet;
  - a second metering device configured to receive the second particulate material from the second feed outlet;
  - 15 a collector disposed proximate the first and second metering devices, the collector having a common inlet configured to receive particulate material metered from both the first and second metering devices, the collector having an exit port through which the particulate material exits the collector; and,
  - a venturi air system in communication with the exit port of the collector for
  - 20 receiving the particulate material from the collector and distributing the particulate material to the environment.
2. The apparatus according to claim 1, wherein the first and second hoppers are not connected rigidly together, and wherein the apparatus further comprises a frame supported on wheels wherein:
  - 25 the first weighing device comprises a first load cell system mounted on the frame, the first hopper supported on the first load cell system; and,
  - the second weighing device comprises a second load cell system mounted on the frame, the second hopper supported on the second load cell system.

3. The apparatus according to claim 2, wherein the first load cell system comprises at least two load cells and the second load cell system comprises at least two load cells.
4. The apparatus according to claim 2 or 3, wherein the first and second hoppers are supported on the frame adjacent to each other.
- 5 5. The apparatus according to any one of claims 1 to 4, wherein the first metering device faces the second metering device with the first and second particulate materials being metered toward each other as the metering devices meter the particulate materials into the common inlet of the collector.
6. The apparatus according to any one of claims 1 to 3, wherein the second hopper  
10 is disposed within the first hopper.
7. The apparatus according to any one of claims 1 to 6, wherein the first metering device comprises a meter roller or an endless belt and the second metering device comprises a meter roller or an endless belt.
8. The apparatus according to any one of claims 1 to 7, wherein the collector  
15 comprises a funnel.
9. The apparatus according to any one of claims 1 to 8, wherein the air system comprises air lines and a fan providing airstreams in the air lines, at least one of the airstreams configured to receive the particulate material from the exit port of the collector.
10. The apparatus according to claim 9, wherein the particulate material exits the  
20 collector in a direction substantially perpendicular to a direction of flow of the airstream.
11. The apparatus according to any one of claims 1 to 10, further comprising:
- a third hopper for containing a third particulate material, the third hopper comprising a third feed outlet for the third particulate material;
  - a third weighing device operatively connected to the third hopper configured to  
25 weigh the third hopper independently of the first and second hoppers; and,
  - a third metering device configured to receive the third particulate material from the third feed outlet, the third metering device configured to meter the third particulate material into the common inlet of the collector.
12. An apparatus for distributing particulate material, the apparatus comprising:

a first hopper for containing a first particulate material, the first hopper comprising a first feed outlet for the first particulate material;

a second hopper for containing a second particulate material, the second hopper comprising a second feed outlet for the second particulate material;

5 a first metering device configured to receive the first particulate material from the first feed outlet;

a second metering device configured to receive the second particulate material from the second feed outlet;

10 a collector disposed proximate the first and second metering devices, the collector having a common inlet configured to receive particulate material metered from both the first and second metering devices, the first metering device facing the second metering device with the first and second particulate materials being metered toward each other as the metering devices meter the particulate materials into the common inlet, the collector having an exit port through which the particulate material exits the collector;  
15 and,

a venturi air system in communication with the exit port of the collector for receiving the particulate material from the collector and distributing the particulate material to the environment.

13. The apparatus according to claim 12, wherein the first and second hoppers are supported on the frame adjacent to each other.  
20

14. The apparatus according to claim 12 or 13, wherein the collector comprises a funnel.

15. A cart comprising an apparatus as defined in any one of claims 1 to 14 supported thereon.

25

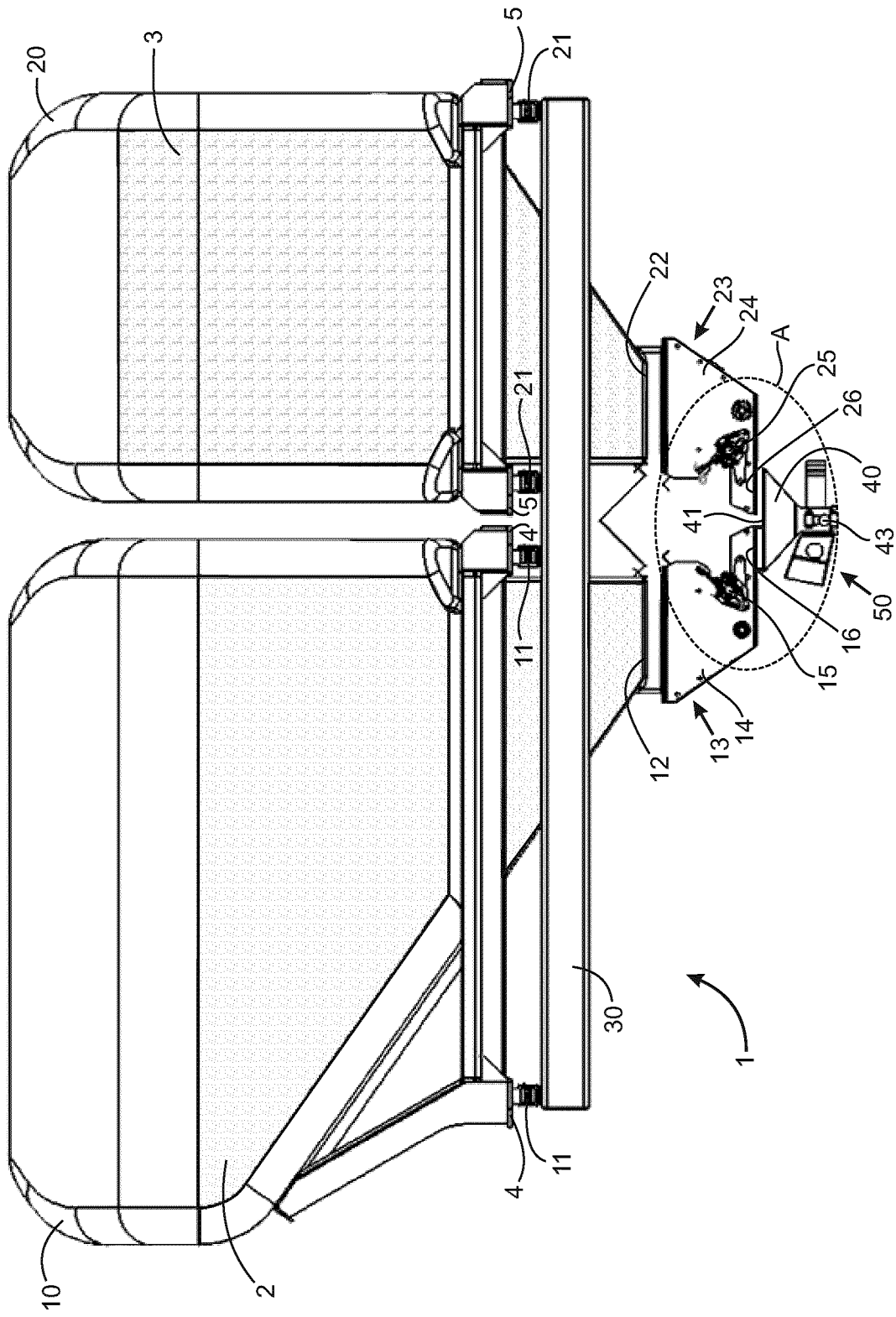


Fig. 1A

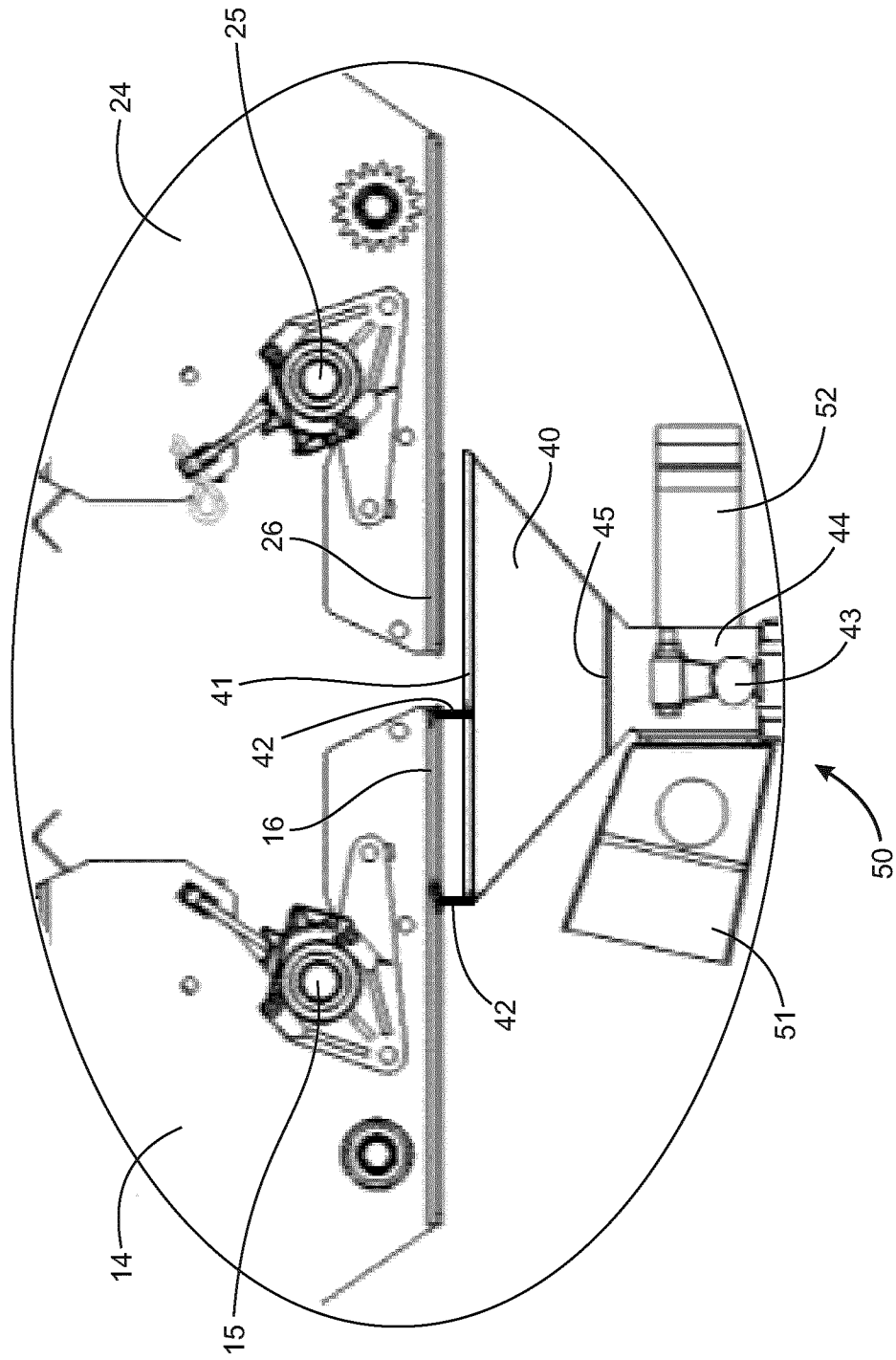


Fig. 1B

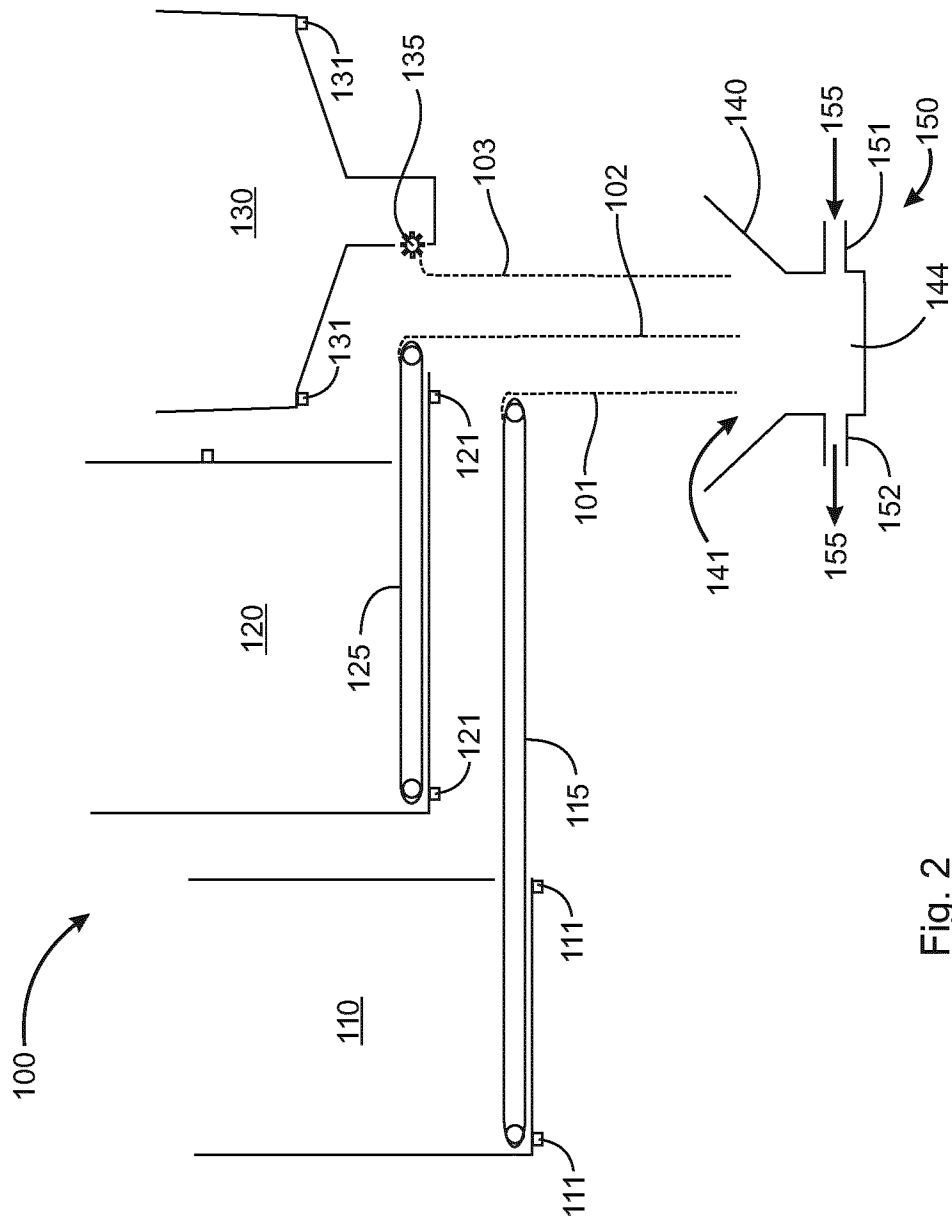


Fig. 2



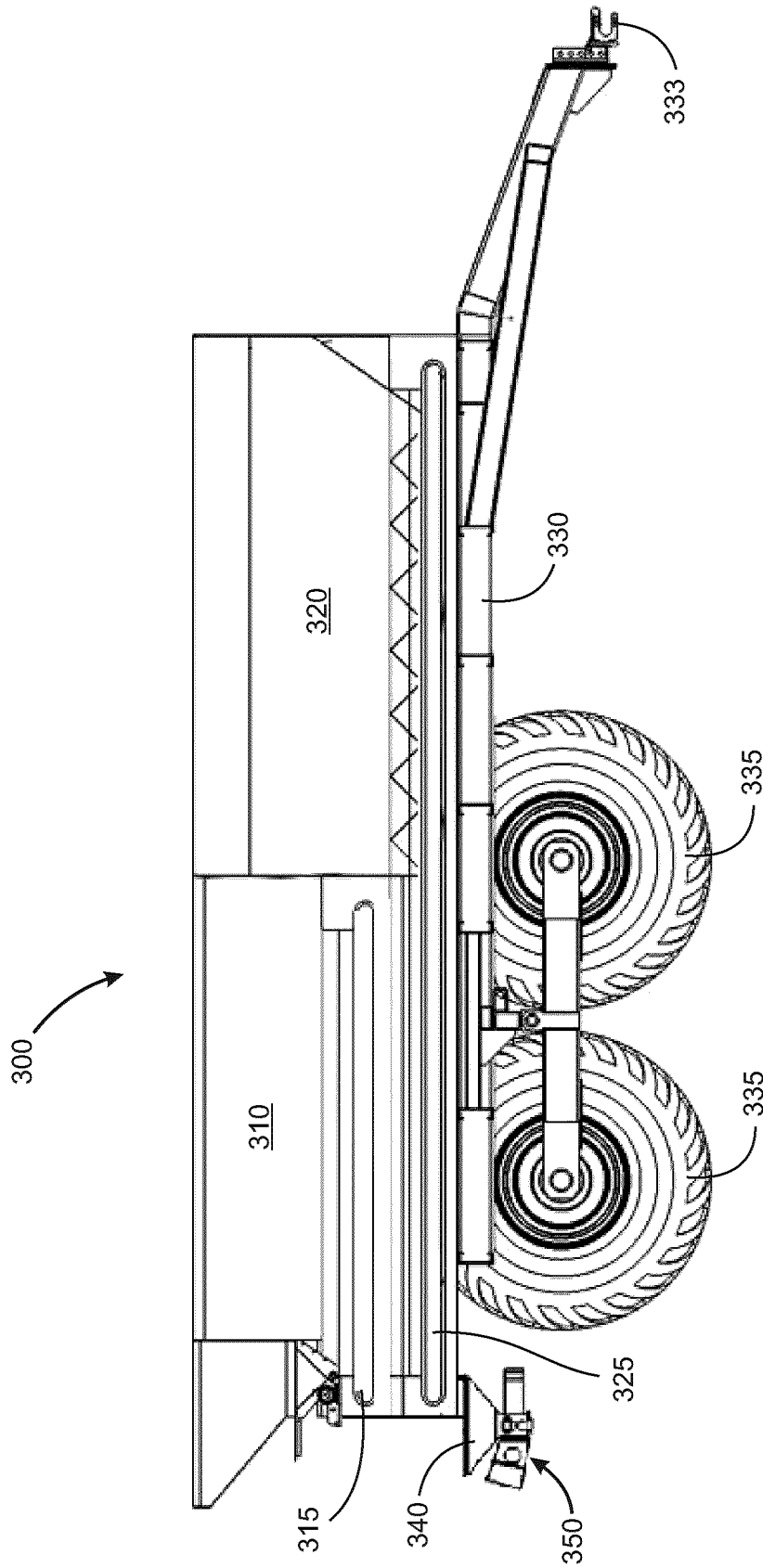


Fig. 4

## INTERNATIONAL SEARCH REPORT

International application No.  
**PCT/CA2017/050790**

A. CLASSIFICATION OF SUBJECT MATTER  
 IPC: **E01C 19/12** (2006.01), **A01C 15/00** (2006.01), **A01C 7/08** (2006.01), **A01C 7/20** (2006.01),  
**E01H 10/00** (2006.01)

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)  
 : **E01C 19/12** (2006.01), **A01C 15/00** (2006.01), **A01C 7/08** (2006.01), **A01C 7/20** (2006.01),  
**E01H 10/00** (2006.01)

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

Electronic database(s) consulted during the international search (name of database(s) and, where practicable, search terms used)  
 Questel-Orbit (Fampat)  
 (Keywords: hopper, metering, outlet, exit, air, venturi, mixing, blending)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages                                                       | Relevant to claim No. |
|-----------|------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| X         | US 2015359165 A1 (ROBERGE, M. J., et al.) 17 December 2015 (17-12-2015)<br>*Abstract; Figs. 1-4; Paras. 0007 – 0023; Claims*             | 1 to 15               |
| X         | US 8371238 B2 (DEAN, B. F., et al.) 12 February 2013 (12-02-2013)<br>*Abstract; Figs. 1-26; Col. 2, line 27 to Col. 12, line 58; Claims* | 1 to 15               |
| X         | US 2016120100 A1 (THOMPSON, D. G., et al.) 05 May 2016 (05-05-2016)<br>*Abstract; Figs. 1-5; Paras. 0004-0038; Claims *                  | 1 to 15               |
| X         | US 2011035163 A1 (LANDPHAIR, D. K.) 10 February 2011 (10-02-2011)<br>*Abstract; Figs. 1-5; Paras. 0003-0039; Claims*                     | 1 to 15               |
| A         | US 4842449 A (NELSON, M. L.) 27 June 1989 (27-06-1989)<br>*Whole document*                                                               | 1 to 15               |

Further documents are listed in the continuation of Box C.

See patent family annex.

|                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|--------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| *<br>"A"<br>"E"<br>"L"<br>"O"<br>"P" | Special categories of cited documents:<br>document defining the general state of the art which is not considered to be of particular relevance<br>earlier application or patent but published on or after the international filing date<br>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)<br>document referring to an oral disclosure, use, exhibition or other means<br>document published prior to the international filing date but later than the priority date claimed | "T"<br>"X"<br>"Y"<br>"&" | 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<br>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<br>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<br>document member of the same patent family |
|--------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

Date of the actual completion of the international search  
24 August 2017 (24-08-2017)

Date of mailing of the international search report  
21 September 2017 (21-09-2017)

Name and mailing address of the ISA/CA  
 Canadian Intellectual Property Office  
 Place du Portage I, C114 - 1st Floor, Box PCT  
 50 Victoria Street  
 Gatineau, Quebec K1A 0C9  
 Facsimile No.: 819-953-2476

Authorized officer

Colin Watts (819) 639-7669

## INTERNATIONAL SEARCH REPORT

International application No.

**PCT/CA2017/050790**

| C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT |                                                                                    |                       |
|-------------------------------------------------------|------------------------------------------------------------------------------------|-----------------------|
| Category*                                             | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
| A                                                     | US 4779765 A (NEUMEYER, L. H.) 25 October 1988 (25-10-1988)<br>*Whole document*    | 1 to 15               |
| A                                                     | US 4215824 A (WEISTE, H.) 05 August 1980 (05-08-1980)<br>*Whole document*          | 1 to 15               |
| A                                                     | GB 1205724 A (WEISTE, H.) 16 September 1970 (16-09-1970)<br>*Whole document*       | 1 to 15               |

**INTERNATIONAL SEARCH REPORT**  
Information on patent family members

International application No.  
**PCT/CA2017/050790**

| Patent Document Cited in Search Report | Publication Date              | Patent Family Member(s) | Publication Date               |
|----------------------------------------|-------------------------------|-------------------------|--------------------------------|
| US 2015359165 A1                       | 17 December 2015 (17-12-2015) | US2015359165A1          | 17 December 2015 (17-12-2015)  |
|                                        |                               | US9686903B2             | 27 June 2017 (27-06-2017)      |
|                                        |                               | CA2893255A1             | 17 December 2015 (17-12-2015)  |
| US 8371238 B2                          | 12 February 2013 (12-02-2013) | US2012132115A1          | 31 May 2012 (31-05-2012)       |
|                                        |                               | AU2008301161A1          | 26 March 2009 (26-03-2009)     |
|                                        |                               | AU2008301161B2          | 27 February 2014 (27-02-2014)  |
|                                        |                               | CA2622428A1             | 21 March 2009 (21-03-2009)     |
|                                        |                               | CA2622428C              | 29 December 2009 (29-12-2009)  |
|                                        |                               | CA2635401A1             | 21 March 2009 (21-03-2009)     |
|                                        |                               | CA2635401C              | 24 November 2009 (24-11-2009)  |
|                                        |                               | DE112008002561T5        | 26 August 2010 (26-08-2010)    |
|                                        |                               | RU2010115583A           | 27 October 2011 (27-10-2011)   |
|                                        |                               | RU2495556C2             | 20 October 2013 (20-10-2013)   |
|                                        |                               | US2009078178A1          | 26 March 2009 (26-03-2009)     |
|                                        |                               | US7555990B2             | 07 July 2009 (07-07-2009)      |
|                                        |                               | US2009079624A1          | 26 March 2009 (26-03-2009)     |
|                                        |                               | US7690440B2             | 06 April 2010 (06-04-2010)     |
|                                        |                               | US2010132600A1          | 03 June 2010 (03-06-2010)      |
|                                        |                               | US8141504B2             | 27 March 2012 (27-03-2012)     |
|                                        |                               | WO2009036575A1          | 26 March 2009 (26-03-2009)     |
| US 2016120100 A1                       | 05 May 2016 (05-05-2016)      | US2016120100A1          | 05 May 2016 (05-05-2016)       |
|                                        |                               | CA2904294A1             | 04 May 2016 (04-05-2016)       |
| US 2011035163 A1                       | 10 February 2011 (10-02-2011) | US2011035163A1          | 10 February 2011 (10-02-2011)  |
|                                        |                               | US8504310B2             | 06 August 2013 (06-08-2013)    |
|                                        |                               | AR074333A1              | 05 January 2011 (05-01-2011)   |
|                                        |                               | AR077711A1              | 14 September 2011 (14-09-2011) |
|                                        |                               | AR081672A1              | 10 October 2012 (10-10-2012)   |
|                                        |                               | AR087652A1              | 09 April 2014 (09-04-2014)     |
|                                        |                               | AU2009314034A1          | 20 May 2010 (20-05-2010)       |
|                                        |                               | AU2010202295A1          | 24 February 2011 (24-02-2011)  |
|                                        |                               | AU2010202295B2          | 31 March 2016 (31-03-2016)     |
|                                        |                               | AU2011203120A1          | 19 January 2012 (19-01-2012)   |
|                                        |                               | AU2012216315A1          | 14 March 2013 (14-03-2013)     |
|                                        |                               | BRPI1102359A2           | 20 November 2012 (20-11-2012)  |
|                                        |                               | BR102012018113A2        | 23 August 2016 (23-08-2016)    |
|                                        |                               | CA2710718A1             | 05 February 2011 (05-02-2011)  |
|                                        |                               | CA2743288A1             | 20 May 2010 (20-05-2010)       |
|                                        |                               | CA2743519A1             | 30 December 2011 (30-12-2011)  |
|                                        |                               | CA2786376A1             | 25 February 2013 (25-02-2013)  |
|                                        |                               | EP2281426A2             | 09 February 2011 (09-02-2011)  |
|                                        |                               | EP2281426A3             | 06 July 2011 (06-07-2011)      |
|                                        |                               | EP2281426B1             | 26 December 2012 (26-12-2012)  |
|                                        |                               | EP2359383A1             | 24 August 2011 (24-08-2011)    |
|                                        |                               | EP2409558A1             | 25 January 2012 (25-01-2012)   |
|                                        |                               | EP2409558B1             | 13 February 2013 (13-02-2013)  |
|                                        |                               | EP2561744A1             | 27 February 2013 (27-02-2013)  |
|                                        |                               | ES2401864T3             | 25 April 2013 (25-04-2013)     |
|                                        |                               | ES2406263T3             | 06 June 2013 (06-06-2013)      |
|                                        |                               | MX2011005153A           | 30 May 2011 (30-05-2011)       |
|                                        |                               | MX2012009151A           | 25 February 2013 (25-02-2013)  |
|                                        |                               | RU2010132836A           | 10 February 2012 (10-02-2012)  |
|                                        |                               | RU2536051C2             | 20 December 2014 (20-12-2014)  |
| RU2011121881A                          | 20 December 2012 (20-12-2012) |                         |                                |
| RU2011124520A                          | 27 December 2012 (27-12-2012) |                         |                                |
| RU2012134216A                          | 20 February 2014 (20-02-2014) |                         |                                |

## INTERNATIONAL SEARCH REPORT

International application No.

**PCT/CA2017/050790**

|              |                                |                |                                |
|--------------|--------------------------------|----------------|--------------------------------|
|              |                                | UA104583C2     | 25 February 2014 (25-02-2014)  |
|              |                                | US2011303137A1 | 15 December 2011 (15-12-2011)  |
|              |                                | US8618465B2    | 31 December 2013 (31-12-2013)  |
|              |                                | US2010116974A1 | 13 May 2010 (13-05-2010)       |
|              |                                | US2010264163A1 | 21 October 2010 (21-10-2010)   |
|              |                                | WO2010056834A1 | 20 May 2010 (20-05-2010)       |
| US 4842449 A | 27 June 1989 (27-06-1989)      | US4842449A     | 27 June 1989 (27-06-1989)      |
|              |                                | CA1300432C     | 12 May 1992 (12-05-1992)       |
| US 4779765 A | 25 October 1988 (25-10-1988)   | US4779765A     | 25 October 1988 (25-10-1988)   |
|              |                                | AU1458988A     | 13 October 1988 (13-10-1988)   |
|              |                                | AU592931B2     | 25 January 1990 (25-01-1990)   |
|              |                                | CA1297735C     | 24 March 1992 (24-03-1992)     |
| US 4215824 A | 05 August 1980 (05-08-1980)    | US4215824A     | 05 August 1980 (05-08-1980)    |
|              |                                | ATA755377A     | 15 March 1979 (15-03-1979)     |
|              |                                | AT353044B      | 25 October 1979 (25-10-1979)   |
|              |                                | AU3940578A     | 06 March 1980 (06-03-1980)     |
|              |                                | CA1098926A     | 07 April 1981 (07-04-1981)     |
|              |                                | DE2838445A1    | 26 April 1979 (26-04-1979)     |
|              |                                | DE2838445B2    | 20 March 1980 (20-03-1980)     |
|              |                                | DE2838445C3    | 27 November 1980 (27-11-1980)  |
|              |                                | FR2406382A1    | 18 May 1979 (18-05-1979)       |
|              |                                | FR2406382B1    | 18 March 1983 (18-03-1983)     |
| GB 1205724 A | 16 September 1970 (16-09-1970) | GB1205724A     | 16 September 1970 (16-09-1970) |
|              |                                | FR2003453A1    | 07 November 1969 (07-11-1969)  |