



(51) International Patent Classification:

B29C 48/025 (2019.01) *B62D 55/08* (2006.01)
B29C 48/09 (2019.01)

(21) International Application Number:

PCT/AU2021/050671

(22) International Filing Date:

25 June 2021 (25.06.2021)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

2020902572 23 July 2020 (23.07.2020) AU

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(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, IT, 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, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS, ZA, ZM, ZW.

(54) Title: EXTRUSION PLANT LOCOMOTION SYSTEM

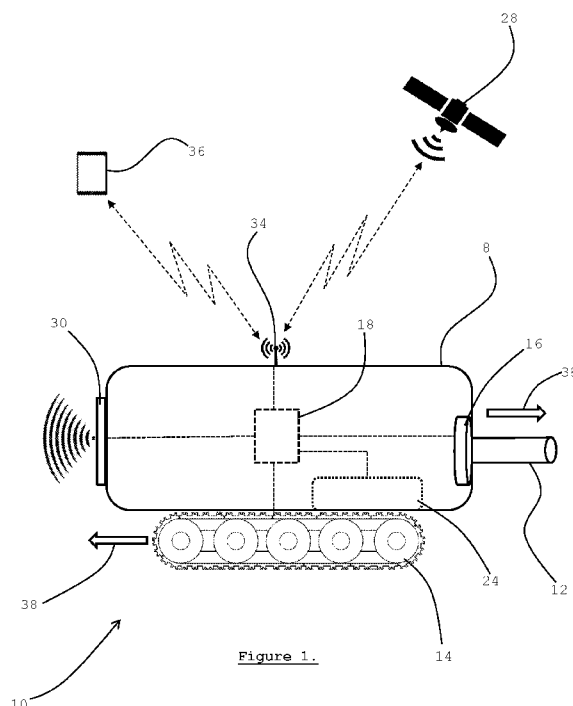


Figure 1.

(57) Abstract: Provided is a locomotion system (10) for an extrusion plant (8) operatively producing monolithic pipe. The locomotion system (10) comprises a continuous track assembly (14) mountable to the extrusion plant (8) and is configured to move the extrusion plant (8) at a particular extrusion rate. System (10) also includes a sensing arrangement (16) configured to sense dynamically such extrusion rate at which the extrusion plant (8) discharges extruded pipe (12), as well as a controller (18) arranged in signal communication with the continuous track assembly (14) and sensing arrangement (16), said controller (18) configured to control the track assembly (14) such that the extrusion plant (8) is displaced commensurate with the dynamically sensed extrusion rate, so that discharged pipe is able to be laid in situ.

(84) Designated States (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

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

Published:

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

EXTRUSION PLANT LOCOMOTION SYSTEM

TECHNICAL FIELD

[0001] This invention relates broadly to the field of plastics extrusion, and more specifically to a locomotion system for a mobile plastics extrusion plant for producing monolithic lengths of pipe.

BACKGROUND ART

[0002] The following discussion of the background art is intended to facilitate an understanding of the present invention only. The discussion is not an acknowledgement or admission that any of the material referred to is or was part of the common general knowledge as at the priority date of the application.

[0003] Applicant has developed technology relating to a mobile plastics extrusion plant capable of producing continuous or monolithic pipe, as described in **Australian Patent No. 2012220369**. Such extrusion plant is generally used for manufacturing an extruded plastics product, such as pipeline, in a remote location. In order to achieve this, the plant comprises a number of assemblies that are typically housed on semitrailers so that the plant can be moved and deployed at a remote location where pipeline installation is required.

[0004] In order to continuously manufacture the extruded monolithic pipe, the plant is situated where required and deployed in a stationery position, with guide rollers supporting and guiding the extruded pipe from an elevated

height of the mobile plant to ground level. With such guide rollers, the pipeline is then expelled and pushed where needed as it exits the extrusion plant.

[0005] Applicant has developed an improvement to the operational practices of its mobile extrusion plant, particularly in remote locations where the positioning of such monolithic pipelines is problematic due to rough or uneven terrain.

[0006] The current invention was conceived with this problem in mind.

SUMMARY OF THE INVENTION

[0007] According to a first aspect of the invention there is provided a locomotion system for an extrusion plant operatively producing monolithic pipe, said locomotion system comprising:

- a continuous track assembly mountable to the extrusion plant and configured to move the extrusion plant at a particular extrusion rate;

- a sensing arrangement configured to sense dynamically such extrusion rate at which the extrusion plant discharges extruded pipe; and

- a controller arranged in signal communication with the continuous track assembly and sensing arrangement, said controller configured to control the track assembly such that the extrusion plant is displaced commensurate with the dynamically sensed extrusion rate, so that discharged pipe is able to be laid *in situ*.

[0008] Typically, the continuous track assembly comprises a tractor unit to which the extrusion plant is hitchable.

[0009] In such an embodiment, the continuous track assembly includes a suitable mount for mounting to the extrusion plant, such as a turntable hitch, a semi-trailer coupling, a fifth wheel coupling, a drawbar, or the like.

[0010] Typically, the continuous track assembly includes a prime mover, such as an internal combustion engine, electric motor, or the like. The prime mover may include a suitable gearbox, torque converter, or the like.

[0011] In an embodiment, the continuous track assembly comprises a demountable continuous track configured to be fitted about existing wheels of a trailer on which parts of the extrusion plant are supported.

[0012] Typically, the sensing arrangement comprises an existing extrusion management system of the extrusion plant which is configured to report the extrusion rate as part of the extrusion process.

[0013] In an embodiment, the sensing arrangement comprises a transducer configured to transform a rate at which extruded pipe is discharged from the extrusion plant into a signal receivable by the controller as the extrusion rate, such as a digitizer, or the like.

[0014] In an embodiment, the transducer comprises a linear position sensor, an ultrasonic sensor for monitoring a wall thickness of extruded pipe, a linear variable differential transformer, and/or the like.

[0015] Typically, the controller is configured to be programmed with a predetermined route along which extruded pipe is to be laid, said controller configured to automatically follow such route using GNSS tracking. It is to be appreciated that reference herein to 'GNSS' generally refers to any suitable Global Navigation Satellite System able to provide autonomous geo-spatial positioning, including the GPS, GLONASS, Galileo, Beidou and other regional satellite systems.

[0016] Typically, the controller includes input sensors to facilitate autonomous or semi-autonomous operation, such as camera, radar, lidar and/or the like.

[0017] Typically, the controller includes a wireless signal transceiver via which the controller is remote operable by means of a suitable remote control.

[0018] Typically, the controller includes a human-machine interface to allow manual control of the locomotion system.

[0019] Typically, the controller comprises any suitable processor or microcontroller configured to receive input, perform logical and arithmetical operations on a suitable instruction set, and provide output, as well as transitory and/or non-transitory electronic storage, such as a programmable logic controller (PLC), or the like.

[0020] In an embodiment, the locomotion system includes a pipe fixture for securing pipe thereto so that pipe can be drawn or pulled from the extrusion plant by the locomotion system when said plant is stationery.

[0021] According to a second aspect of the invention there is provided an extrusion plant for producing monolithic pipe, said plant comprising:

a continuous track assembly configured to move the extrusion plant at a particular extrusion rate;

a sensing arrangement configured to sense dynamically such extrusion rate at which the extrusion plant discharges extruded pipe; and

a controller arranged in signal communication with the continuous track assembly and sensing arrangement, said controller configured to control the track assembly such that the extrusion plant is displaced commensurate with the sensed extrusion rate, so that discharged pipe is able to be laid *in situ*.

[0022] Typically, the continuous track assembly comprises a tractor unit mounted to the extrusion plant via a suitable decoupleable mounting.

[0023] Typically, the continuous track assembly includes a prime mover, such as an internal combustion engine, electric motor, or the like. The prime mover may include a suitable gearbox, torque converter, or the like.

[0024] In an embodiment, the continuous track assembly comprises a demountable continuous track fitted about existing wheels of a trailer on which parts of the extrusion plant are supported.

[0025] Typically, the sensing arrangement comprises an existing extrusion management system of the extrusion plant which is configured to report the extrusion rate as part of the extrusion process.

[0026] In an embodiment, the sensing arrangement comprises a transducer configured to transform a rate at which extruded pipe is discharged from the extrusion plant into a signal receivable by the controller as the extrusion rate, such as a digitizer, or the like.

[0027] In an embodiment, the transducer comprises a linear position sensor, an ultrasonic sensor for monitoring a wall thickness of extruded pipe, a linear variable differential transformer, and/or the like.

[0028] Typically, the controller is configured to be programmed with a predetermined route along which extruded pipe is to be laid, said controller configured to automatically follow such route using GNSS tracking.

[0029] Typically, the controller includes input sensors to facilitate autonomous or semi-autonomous operation, such as camera, radar, lidar and/or the like.

[0030] Typically, the controller includes a wireless signal transceiver via which the controller is remote operable by means of a suitable remote control.

[0031] Typically, the controller includes a human-machine interface to allow manual control of the locomotion system.

[0032] In an embodiment, the locomotion system includes a pipe fixture for securing pipe thereto so that pipe can be drawn or pulled from the extrusion plant by the locomotion system when said plant is stationery.

[0033] According to a third aspect of the invention there is provided a method of extruding monolithic pipe via an extrusion plant, said method comprising the steps of:

sensing, via a sensing arrangement, an extrusion rate at which the extrusion plant discharges extruded pipe;

moving, via a continuous track assembly mounted to the extrusion plant, the extrusion plant at the sensed extrusion rate; and

controlling, via a controller arranged in signal communication with the continuous track assembly and sensing arrangement, the track assembly such that the extrusion plant is displaced commensurate with the sensed extrusion rate, so that discharged pipe is able to be laid *in situ*.

[0034] According to a yet further aspect of the invention, there is provided a locomotion system for an extrusion plant, an extrusion plant for producing monolithic pipe and a method of extruding monolithic pipe via an extrusion plant, substantially as herein described and/or illustrated.

BRIEF DESCRIPTION OF THE DRAWINGS

The description will be made with reference to the accompanying drawings in which:

Figure 1 is a diagrammatic overview representation of an embodiment of a locomotion system for an extrusion plant operatively producing monolithic pipe, in accordance with an aspect of the present invention;

Figure 2 is a diagrammatic side-view representation of a tractor unit of an embodiment of the locomotion system of Figure 1;

Figure 3 is diagrammatic side-view representation of another tractor unit of an embodiment of the locomotion system of Figure 1;

Figure 4 is a diagrammatic side-view representation of the tractor unit of Figure 2 mounted to an extrusion plant;

Figure 5 is a diagrammatic side-view representation of a further embodiment of the locomotion system, in accordance with an aspect of the present invention; and

Figure 6 is a diagrammatic side-view representation of the locomotion system of Figure 1 being used to draw extruded pipe from a stationery extrusion plant.

DETAILED DESCRIPTION OF EMBODIMENTS

[0035] Further features of the present invention are more fully described in the following description of several non-limiting embodiments thereof. This description is included solely for the purposes of exemplifying the present invention to the skilled addressee. It should not be understood as a restriction on the broad summary, disclosure or description of the invention as set out above.

[0036] In the figures, incorporated to illustrate features of the example embodiment or embodiments, like reference numerals are used to identify like parts throughout. Additionally, features, mechanisms and aspects well-known and understood in the art will not be described in detail, as such features, mechanisms and aspects will be within the understanding of the skilled addressee.

[0037] With reference now to the accompanying figures, there is shown broad embodiments of a locomotion system 10 for an extrusion plant 8 for operatively producing monolithic pipe 12. Such an extrusion plant is described in Applicant's Australian Patent No. 2012220369 and United States Patent Application No. 20130330434 and is typically used to produce long lengths, i.e. >50 meters, of monolithic pipe for pipeline installations.

[0038] The locomotion system 10 of the present invention may take a variety of forms, some of which are exemplified below. Broadly, the locomotion system 10 comprises a continuous track assembly 14, a sensing arrangement 16 and a controller 18.

[0039] The continuous track assembly 14 is generally mountable to the extrusion plant 8 and is configured to move or displace the extrusion plant 8 at a particular extrusion rate, as described in more detail below. In the example shown in Figures 2 and 3, the continuous track assembly 14 comprises a tractor unit 20 to which the extrusion plant 8 is hitchable. In such an embodiment, the continuous track assembly 14 may include any suitable mount 22 for mounting to the extrusion plant 8, such as a turntable hitch, a semi-trailer coupling, a fifth wheel coupling, a drawbar, or the like.

[0040] In the embodiment shown in Figure 5, another example of the continuous track assembly 14 may comprise a demountable continuous track 26 which is configured to be fitted about existing wheels of a trailer on which parts of the extrusion plant 8 are supported. In such an example, the continuous track is fitted over the wheels of the trailer, as

shown, to move one or more of the trailers directly. If a plurality of trailers is used to support the extrusion plant, each trailer may have its own continuous track 26 fitted with movement synchronised via controller 18.

[0041] In either example, the continuous track assembly 14 generally includes a prime mover 24, such as an internal combustion engine, an electric motor, and/or the like. The prime mover 24 may include a suitable gearbox, torque converter, or the like, as is known in the art of automotive engineering.

[0042] The sensing arrangement 16 is configured to sense dynamically the extrusion rate at which the extrusion plant 8 discharges extruded pipe 12. In an embodiment, the sensing arrangement comprises a transducer configured to transform a rate at which extruded pipe is discharged from the extrusion plant into a signal receivable by the controller 18 as the extrusion rate, such as a digitizer, or the like. Such a transducer may comprise a linear position sensor, an ultrasonic sensor for monitoring a wall thickness of extruded pipe, a linear variable differential transformer, and/or the like. In another embodiment, the sensing arrangement 16 may include an existing extrusion management system of the extrusion plant 8 which is configured to report the extrusion rate as part of the extrusion process, or the like.

[0043] The skilled addressee is to appreciate that the extrusion rate 38 of the extrusion plant 8 may vary, depending on operating characteristics, such as required pipe diameter, material used, temperature variations, or the like. For this reason, dynamic sensing of the extrusion rate is important, as such extrusion rate varies. If movement of the

extrusion plant or drawing-off of the extruded pipe 38 is not commensurate with the extrusion rate 38, the pipe 12 may suffer complications when it is laid *in situ*, i.e. positioning issues, compromising of pipe strength, undesired misalignment, etc.

[0044] Locomotion system 12 further includes the controller 18 which is arranged in signal communication with the continuous track assembly 14 and sensing arrangement 16. The controller 18 is generally configured to control the track assembly 14 such that the extrusion plant 8 is displaced commensurate with the dynamically sensed extrusion rate 38, so that discharged pipe 12 is able to be laid *in situ*. Similarly, where the tractor unit 20 is used to draw the pipe from a stationery extrusion plant 8, as shown in Figure 6, a speed of the tractor unit 20 is determined by the controller 18.

[0045] The skilled addressee is to appreciate that reference herein to '*in situ*' generally refers to the pipe being in a desired or appropriate position. For example, instead of extruding pipe which must then be placed or moved into the desired position, by moving or displacing the extrusion plant at the same rate at which pipe is produced, i.e. the extrusion rate, allows simpler and more efficient installation of pipeline.

[0046] The skilled addressee is further to appreciate that the typical extrusion rate is relatively slow, for example 300mm every 5 minutes, or the like. As such, the track assembly 14 is also controlled such that the extrusion plant 8 is displaced commensurate with the dynamically sensed

extrusion rate 38 at such a relatively slow rate, as required.

[0047] In one embodiment, the controller 18 is configured to be programmed with a predetermined route along which extruded pipe is to be laid, the controller 18 being configured to automatically follow such route using GNSS tracking 28, as is known in the art. Typically, the controller 18 includes input sensors 30 to facilitate autonomous or semi-autonomous operation, such as camera, radar, lidar and/or the like.

[0048] In an embodiment, the controller 18 includes a wireless signal transceiver 34 via which the controller 18 is remote operable by means of a suitable remote control 36. The controller 18 also generally includes a human-machine interface to allow manual control of the locomotion system 10, e.g. such as the operator cabin shown in Figure 2, or the like.

[0049] As mentioned above, the locomotion system 10 may also include a pipe fixture 32 for securing pipe thereto so that pipe can be drawn or pulled from the extrusion plant 8 by the locomotion system 10 when said plant 8 is stationery. For example, when pipe is to be laid up a hill or over rough terrain which may present difficulties when moving the extrusion plant 8 over such terrain, the plant 8 may be parked or kept stationery and the locomotion system 10 in the form of a tractor unit 20 may engage the extruded pipe 12 in order to draw or pull such pipe over the rough terrain at the sensed extrusion rate 38.

[0050] The skilled addressee is also to appreciate that the present invention includes an associated a method of extruding monolithic pipe via the extrusion plant 8. Such a method generally comprises the steps of sensing, via the sensing arrangement 16, the extrusion rate 38 at which the extrusion plant 8 discharges extruded pipe 12, moving, via the continuous track assembly 14 mounted to the extrusion plant 8, the extrusion plant 8 at the sensed extrusion rate 38, and controlling, via the controller 18 arranged in signal communication with the continuous track assembly 14 and sensing arrangement 16, the track assembly 14 such that the extrusion plant 8 is displaced commensurate with the sensed extrusion rate 38, so that discharged pipe is able to be laid *in situ*.

[0051] Applicant believes it particularly advantageous that the present invention provides for a locomotion system 10 whereby extrusion plant 8 is able to be moved along at the same rate at which monolithic pipe is continuously extruded therefrom. Such locomotion system 10 provides for *in situ* laying or installation of long lengths of monolithic pipe, which increases efficiency and reduces otherwise necessary handling of the extruded pipe to place it in a required position.

[0052] Optional embodiments of the present invention may also be said to broadly consist in the parts, elements and features referred to or indicated herein, individually or collectively, in any or all combinations of two or more of the parts, elements or features, and wherein specific integers are mentioned herein which have known equivalents in the art to which the invention relates, such known equivalents are deemed to be incorporated herein as if

individually set forth. In the example embodiments, well-known processes, well-known device structures, and well-known technologies are not described in detail, as such will be readily understood by the skilled addressee.

[0053] The use of the terms "a", "an", "said", "the", and/or similar referents in the context of describing various embodiments (especially in the context of the claimed subject matter) are to be construed to cover both the singular and the plural, unless otherwise indicated herein or clearly contradicted by context. The terms "comprising," "having," "including," and "containing" are to be construed as open-ended terms (i.e., meaning "including, but not limited to,") unless otherwise noted. As used herein, the term "and/or" includes any and all combinations of one or more of the associated listed items. No language in the specification should be construed as indicating any non-claimed subject matter as essential to the practice of the claimed subject matter.

[0054] Spatially relative terms, such as "inner," "outer," "beneath," "below," "lower," "above," "upper," and the like, may be used herein for ease of description to describe one element or feature's relationship to another element(s) or feature(s) as illustrated in the figures. Spatially relative terms may be intended to encompass different orientations of the device in use or operation in addition to the orientation depicted in the figures. For example, if the device in the figures is turned over, elements described as "below" or "beneath" other elements or features would then be oriented "above" the other elements or features. Thus, the example term "below" can encompass both an orientation of above and below. The device may be otherwise oriented (rotated 90

degrees or at other orientations) and the spatially relative descriptors used herein interpreted accordingly.

[0055] It is to be appreciated that reference to "one example" or "an example" of the invention, or similar exemplary language (e.g., "such as") herein, is not made in an exclusive sense. Various substantially and specifically practical and useful exemplary embodiments of the claimed subject matter are described herein, textually and/or graphically, for carrying out the claimed subject matter.

[0056] Accordingly, one example may exemplify certain aspects of the invention, whilst other aspects are exemplified in a different example. These examples are intended to assist the skilled person in performing the invention and are not intended to limit the overall scope of the invention in any way unless the context clearly indicates otherwise. Variations (e.g. modifications and/or enhancements) of one or more embodiments described herein might become apparent to those of ordinary skill in the art upon reading this application. The inventor(s) expects skilled artisans to employ such variations as appropriate, and the inventor(s) intends for the claimed subject matter to be practiced other than as specifically described herein.

[0057] Any method steps, processes, and operations described herein are not to be construed as necessarily requiring their performance in the particular order discussed or illustrated, unless specifically identified as an order of performance. It is also to be understood that additional or alternative steps may be employed.

CLAIMS

1. A locomotion system for an extrusion plant operatively producing monolithic pipe, said locomotion system comprising:

a continuous track assembly mountable to the extrusion plant and configured to move the extrusion plant at a particular extrusion rate;

a sensing arrangement configured to sense dynamically such extrusion rate at which the extrusion plant discharges extruded pipe; and

a controller arranged in signal communication with the continuous track assembly and sensing arrangement, said controller configured to control the track assembly such that the extrusion plant is displaced commensurate with the dynamically sensed extrusion rate, so that discharged pipe is able to be laid *in situ*.

2. The locomotion system of claim 1, wherein the continuous track assembly comprises a tractor unit to which the extrusion plant is hitchable, said tractor unit having a suitable mount for mounting to the extrusion plant, such as a turntable hitch, a semi-trailer coupling, a fifth wheel coupling, a drawbar, or the like.

3. The locomotion system of claim 1, wherein the continuous track assembly comprises a tractor unit having a pipe fixture for securing pipe thereto so that pipe can be drawn or pulled from the extrusion plant by the locomotion system when said plant is stationery.

4. The locomotion system of claim 1, wherein the continuous track assembly comprises a demountable continuous track

configured to be fitted about existing wheels of a trailer on which parts of the extrusion plant are supported.

5. The locomotion system of claim 4, wherein the continuous track assembly includes a prime mover, such as an internal combustion engine, electric motor, or the like.

6. The locomotion system of claim 5, wherein the prime mover includes a suitable gearbox, torque converter, or the like.

7. The locomotion system of any of claims 1 to 6, wherein the sensing arrangement comprises a transducer configured to transform a rate at which extruded pipe is discharged from the extrusion plant into a signal receivable by the controller as the extrusion rate.

8. The locomotion system of claim 7, wherein the transducer comprises a linear position sensor, an ultrasonic sensor for monitoring a wall thickness of extruded pipe, a linear variable differential transformer, and/or a digitiser.

9. The locomotion system of any of claims 1 to 8, wherein the sensing arrangement comprises an existing extrusion management system of the extrusion plant which is configured to report the extrusion rate as part of the extrusion process.

10. The locomotion system of any of claims 1 to 9, wherein the controller is configured to be programmed with a predetermined route along which extruded pipe is to be laid, said controller configured to automatically follow such route using GNSS tracking.

11. The locomotion system of any of claims 1 to 10, wherein the controller includes input sensors to facilitate autonomous or semi-autonomous operation of displacing the extrusion plant, such as a camera, radar and/or lidar.

12. The locomotion system of any of claims 1 to 11, wherein the controller includes a wireless signal transceiver via which the controller is remote operable by means of a suitable remote control.

13. The locomotion system of any of claims 1 to 12, wherein the controller includes a human-machine interface to allow manual control of the locomotion system.

14. An extrusion plant for producing monolithic pipe, said plant comprising a locomotion system in accordance with any of claims 1 to 13 to facilitate discharged pipe to be laid *in situ*.

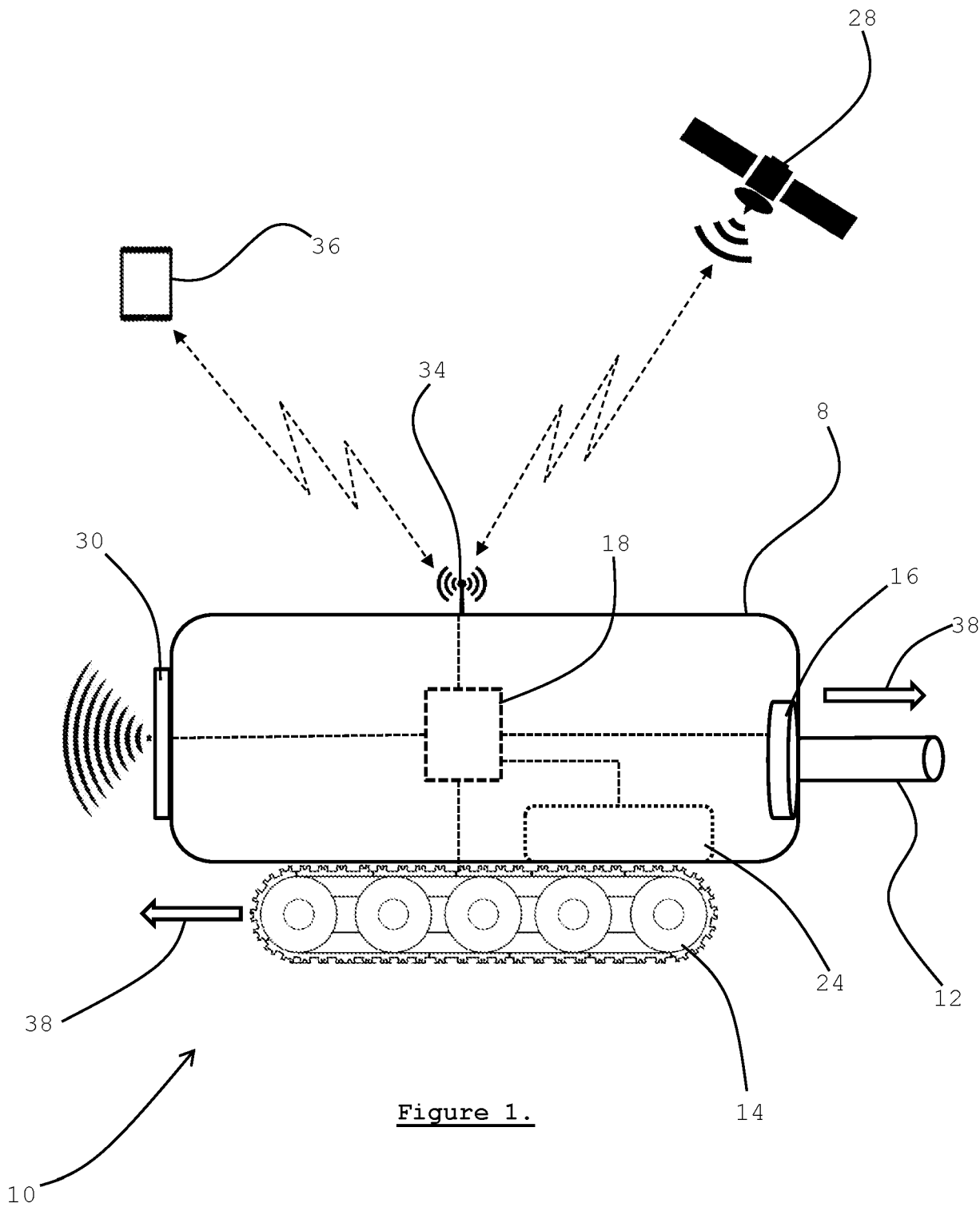
15. A method of extruding monolithic pipe via an extrusion plant, said method comprising the steps of:

sensing, via a sensing arrangement, an extrusion rate at which the extrusion plant discharges extruded pipe;

moving, via a continuous track assembly mounted to the extrusion plant, the extrusion plant at the sensed extrusion rate; and

controlling, via a controller arranged in signal communication with the continuous track assembly and sensing arrangement, the track assembly such that the extrusion plant is displaced commensurate with the sensed extrusion rate, so that discharged pipe is able to be laid *in situ*.

16. A method of extruding monolithic pipe via an extrusion plant using a locomotion system in accordance with any of claims 1 to 13.



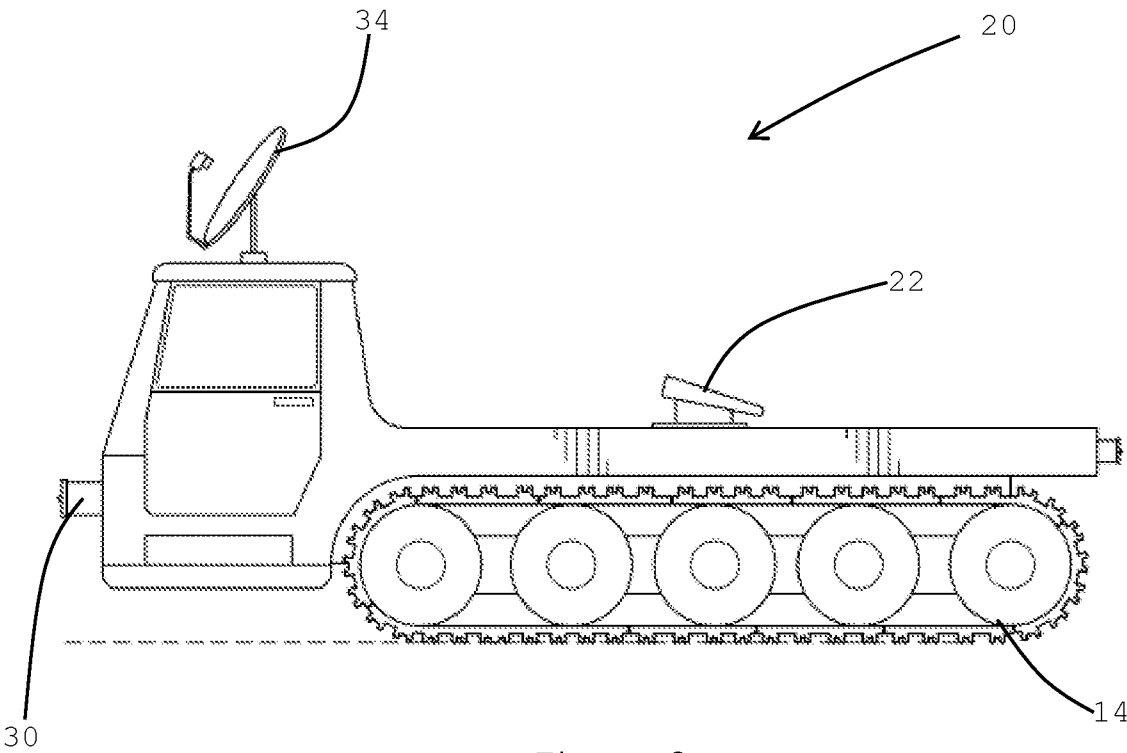


Figure 2.

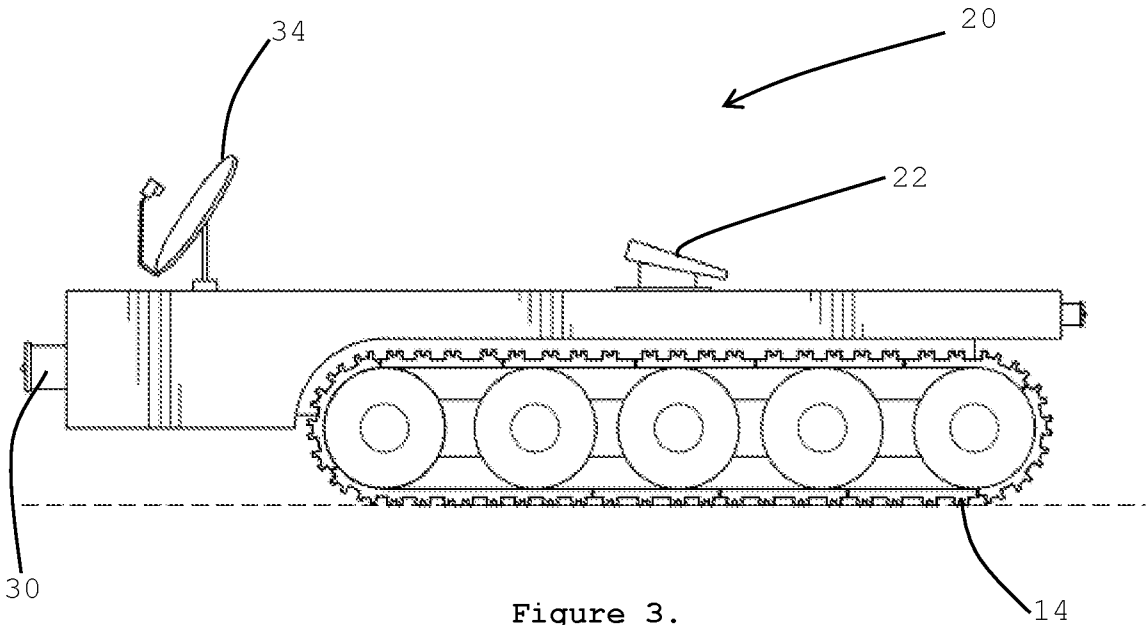


Figure 3.

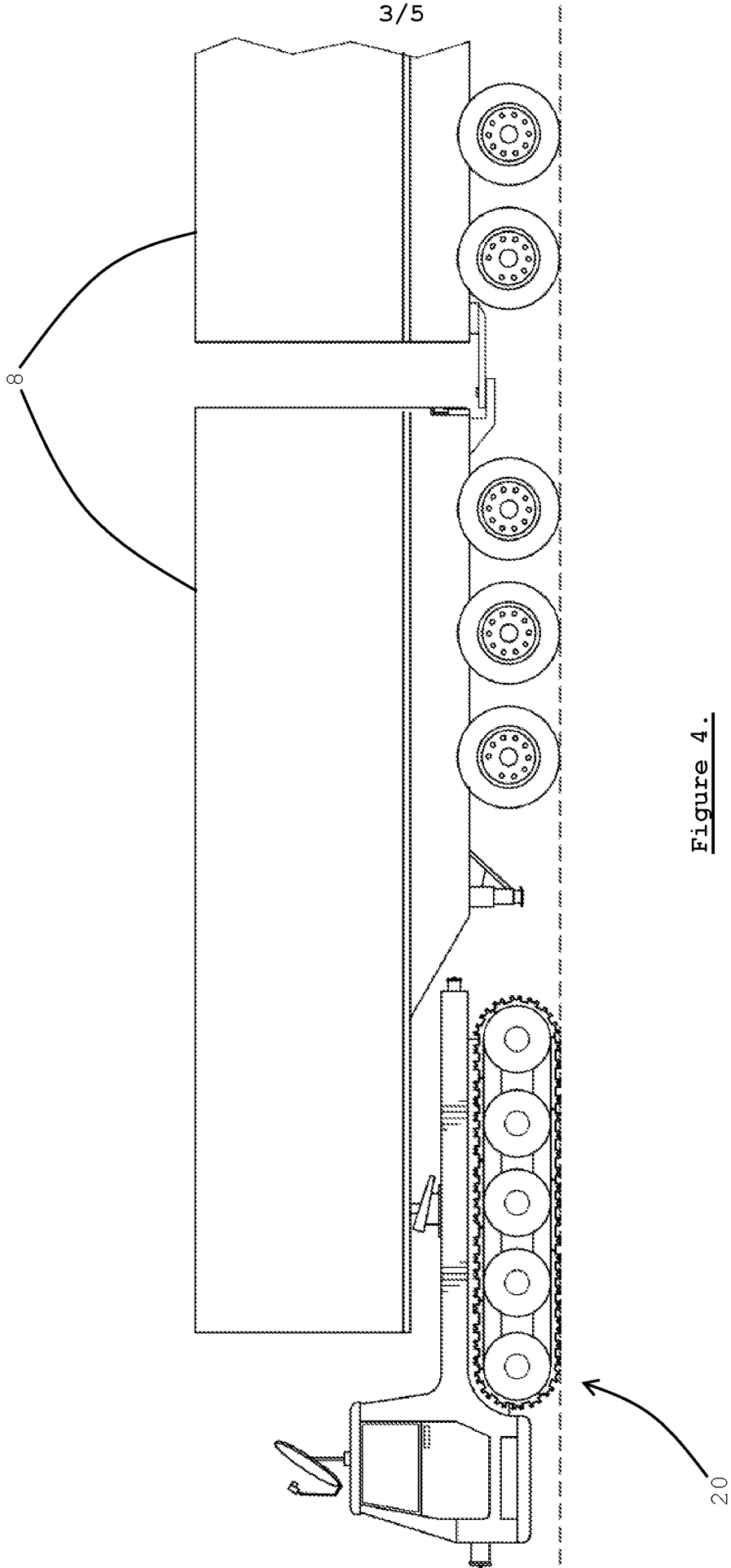


Figure 4.

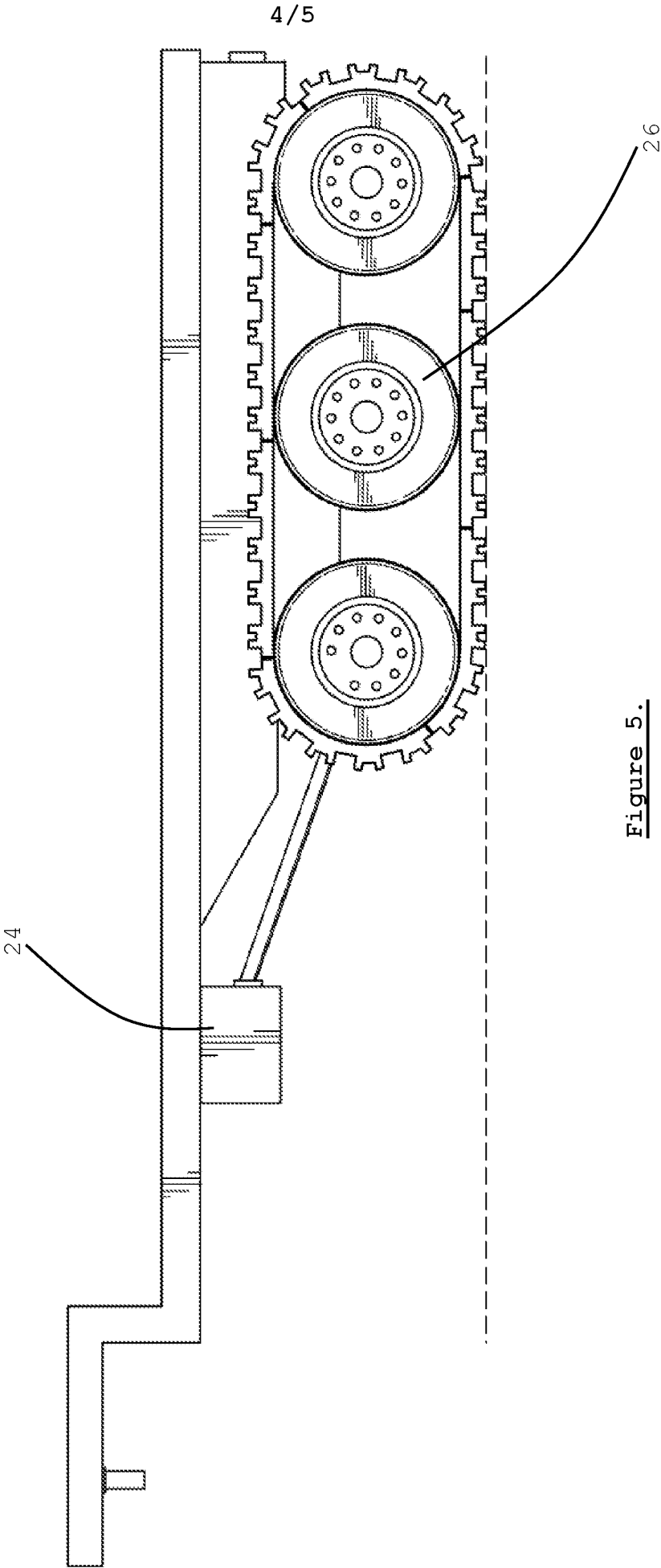


Figure 5.

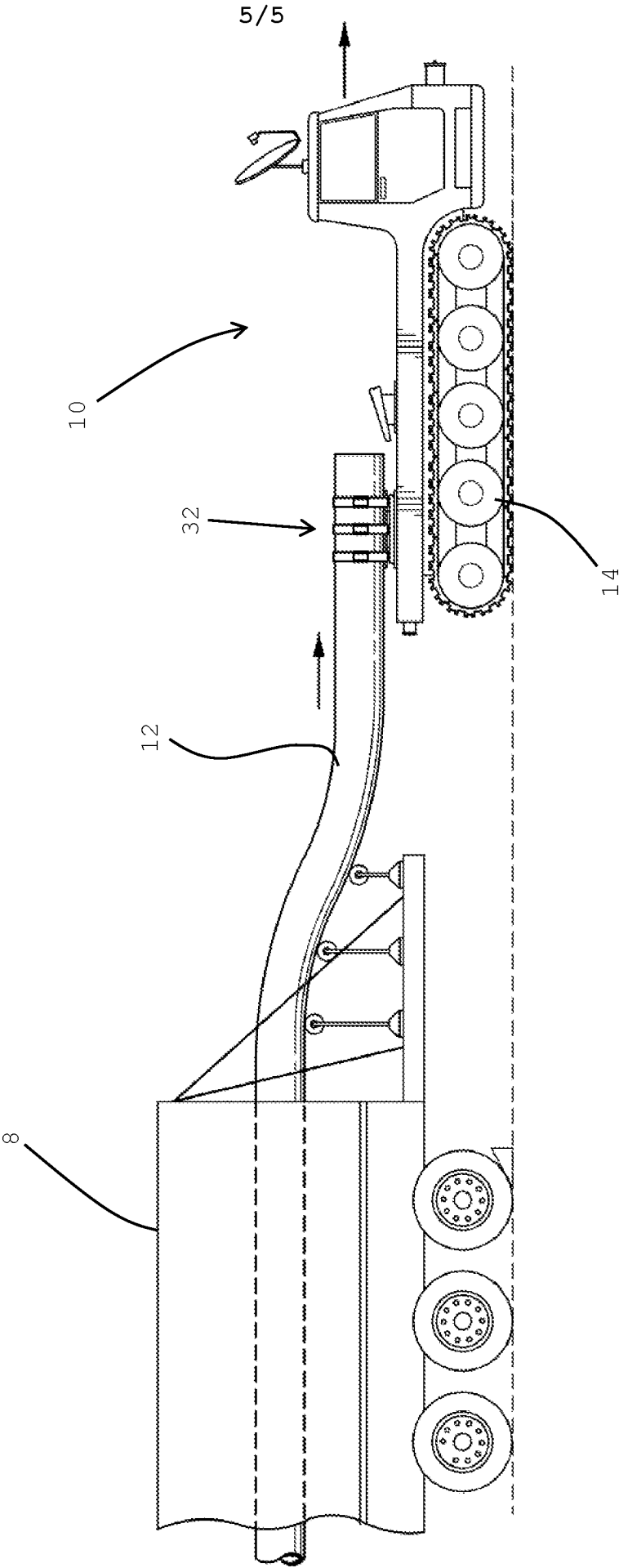


Figure 6.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2021/050671

A. CLASSIFICATION OF SUBJECT MATTER

B29C 48/025 (2019.01) B29C 48/09 (2019.01) B62D 55/08 (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)

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

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

PATENW: CPC/IPC Marks- B29C48/09, B62D55/08/LOW, B29C48/LOW, B29C2948/LOW, B29C48/92, B29C2948/9258, B29C2948/92438, F16L9/12, F16L11/06, F16L1/LOW, B29D23/00, B29D23/LOW with Key Words- MOV+, DISPLAC+, TRACK?, RAIL, LOCOMOTION?, TRACTOR?, SENS+, MONITOR+, RATE?, SPEED? and like words

GOOGLE PATENTS: Word Search in various combination of- Pipe, Extrusion/Extrude, Rate/Speed, Sensor/Monitor, Mobile/Track/Locomotion

Applicant/Inventor name search in DOCDB, DWPI and Internal Databases of IP Australia

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	Documents are listed in the continuation of Box C	



Further documents are listed in the continuation of Box C



See patent family annex

* Special categories of cited documents:	
"A" document defining the general state of the art which is not considered to be of particular relevance	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"D" document cited by the applicant in the international application	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E" earlier application or patent but published on or after the international filing date	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&" document member of the same patent family
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search
31 August 2021

Date of mailing of the international search report
31 August 2021

Name and mailing address of the ISA/AU

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INTERNATIONAL SEARCH REPORT		International application No.
C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		PCT/AU2021/050671
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 4558971 A (DAVID) 17 December 1985 column 1, line 57-column 2, line 24; column 3, line 64-column 4, line 28; fig 1	1, 2, 4-16
Y	WO 2012/113035 A1 (POLYLINE PIPING SYSTEMS PTY LTD.) 30 August 2012 & AU2012220369 abstract; fig 1	1, 2, 4-16
A	CN 101614301 A (NINGHAI XINCHENG AUTOMOBILE AC) 30 December 2009 abstract; fig 1	
A	US 4072453 A (OLTMANNNS et al.) 07 February 1978 abstract; fig 1	
A	WO 2007/101818 A1 (SOCOTHERM S.P.A) 13 September 2007 abstract; fig 1	

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INTERNATIONAL SEARCH REPORT		International application No.			
Information on patent family members		PCT/AU2021/050671			
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