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(56) Documents Cited:
GB 2545702 A **EP 0220373 A2**
DE 010049552 C1 **DE 003912140 A1**
US 20050198873 A1
JPS62174411
ThePipeMac, 23/10/2021, The PipeMac featured on the cover and in an extended article in The Clancy Group Imagine magazine, [online], Available from https://thepipemac.com/the-pipemac-featured-on-the-cover-and-in-an-extended-article-in-the-clancy-group-imagine-magazine/ [Accessed 04/11/2021]

(58) Field of Search:
INT CL **E01C, E02D, E03F**
Other: **WPI, EPODOC, INTERNET**

(54) Title of the Invention: **Pipe laying apparatus**
Abstract Title: **Compactor mechanism for laying pipes**

(57) A compactor mechanism for compacting aggregate about a pipe in a trench comprising a single powered compacting element 3 configured to be movable in a reciprocating motion along the length of a pipe. The mechanism is preferably rotatable from a central position about an angle of at least 90 degrees in two directions to compact aggregate on both sides of a pipe. The mechanism may be integrated into a quick hitch coupler and attachable to a two hose hydraulic circuit of an excavator arm 13. The element may be submerged beneath the aggregate at all times when in use to lay a gravity sewer. Further disclosed is a method for compacting aggregate about a pipe comprising a step of inserting a compacting element beneath an aggregate surface to compact the aggregate.

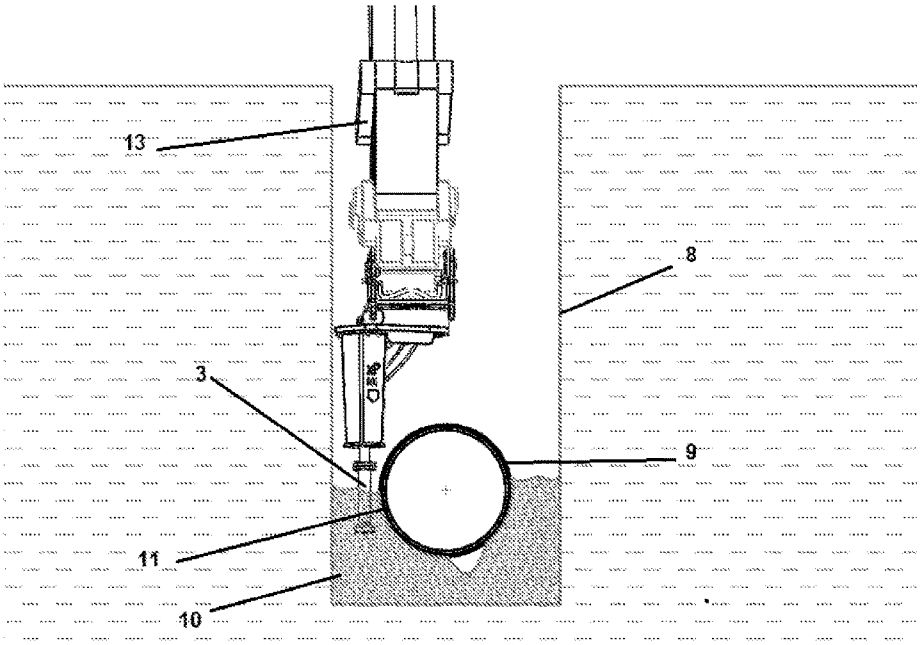

Figure 6

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Figures

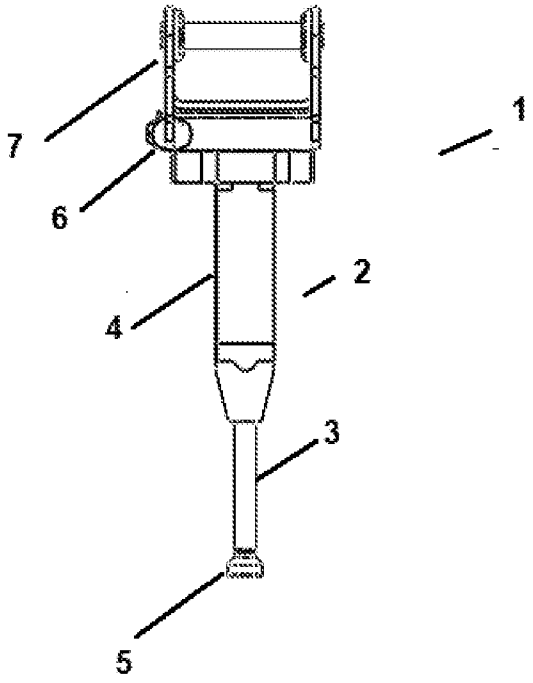

Figure 1

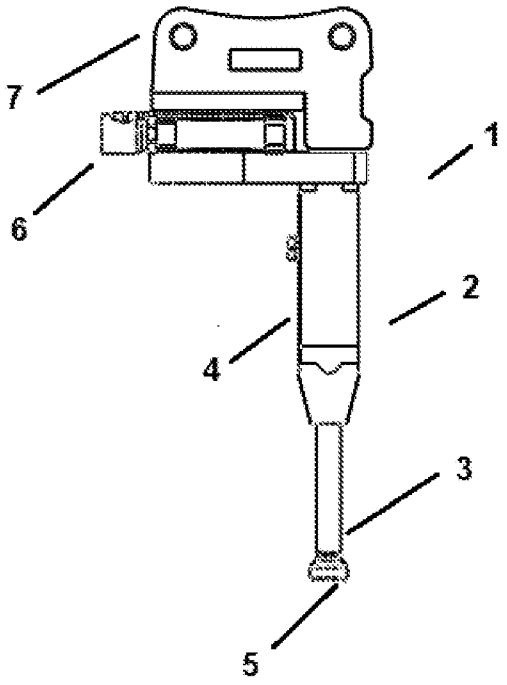

Figure 2

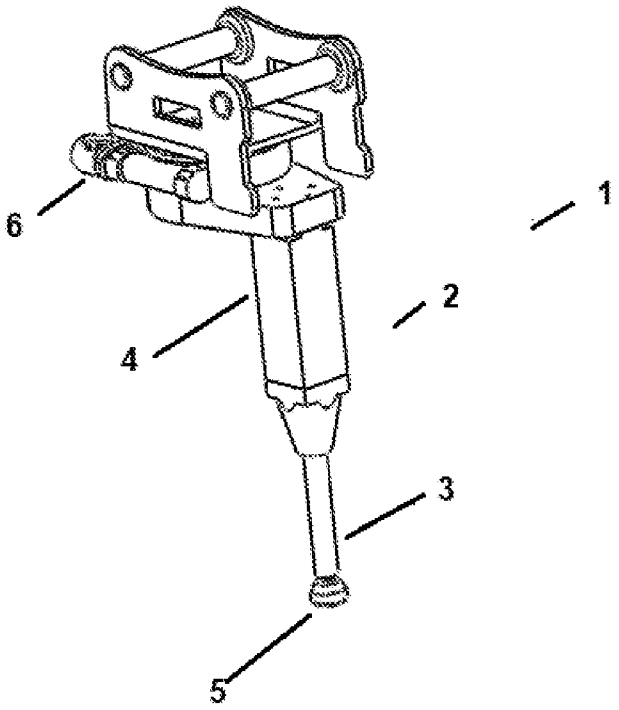

Figure 3

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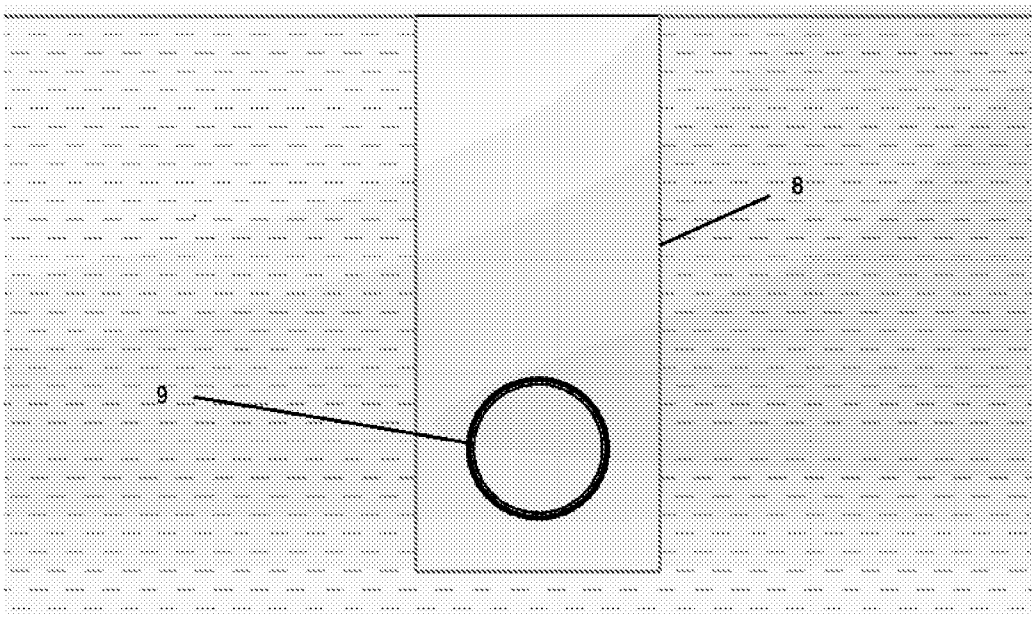

Figure 4

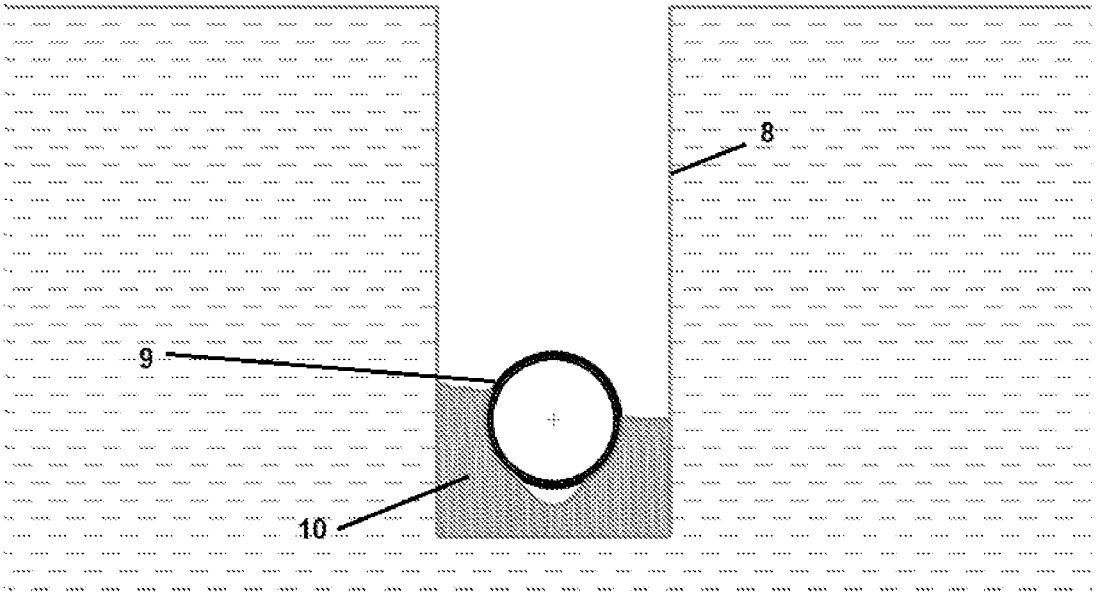

Figure 5

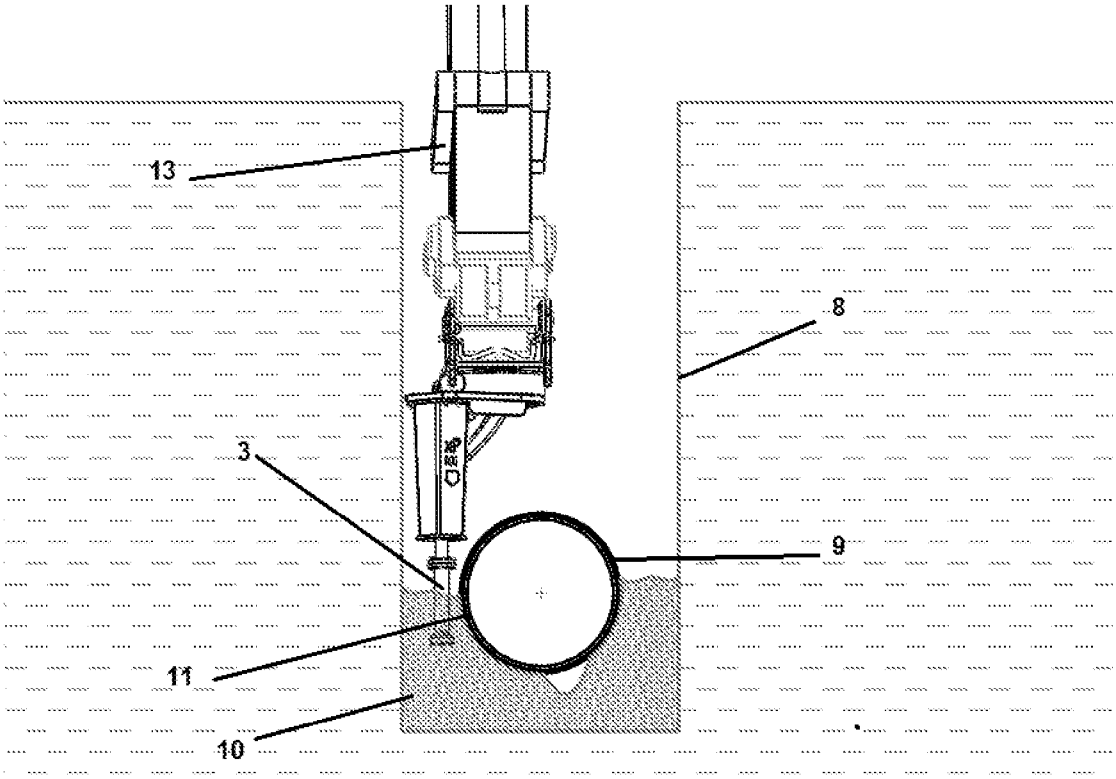

Figure 6

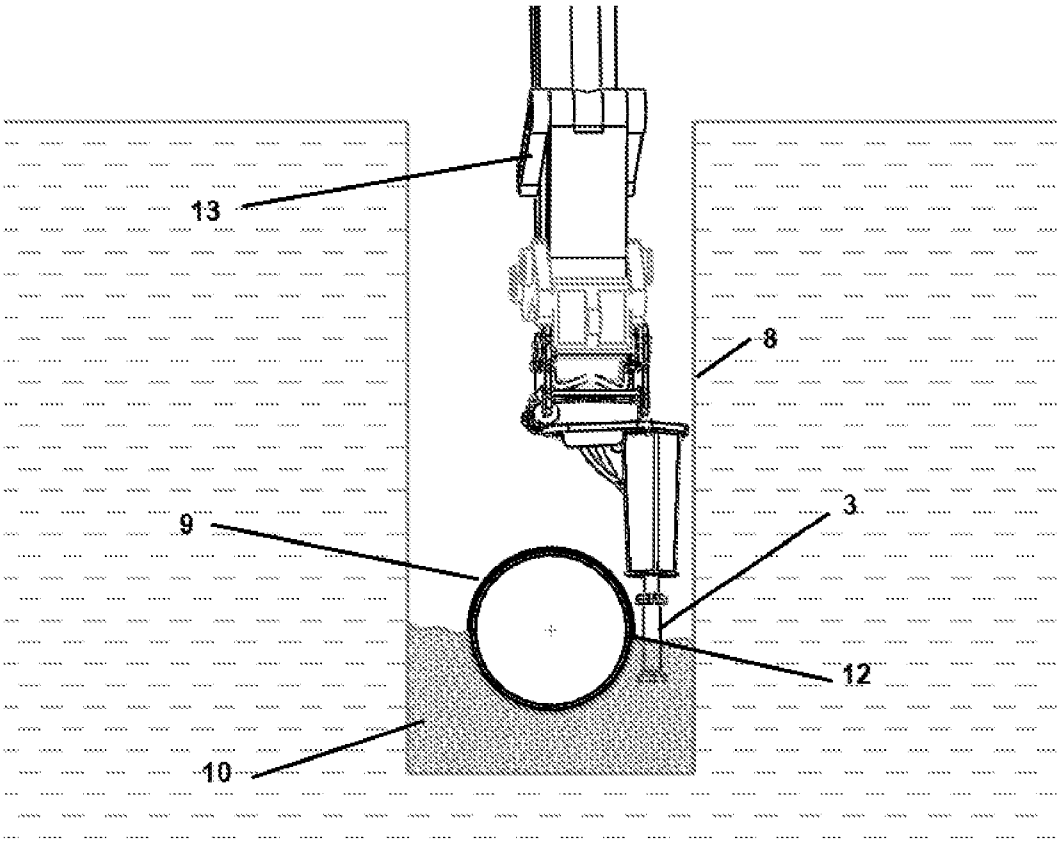

Figure 7

Pipe Laying Apparatus

Field of the Invention

The present invention relates to an apparatus for laying a pipe in a trench and in particular to the compaction of bedding material about and under the pipe.

Background to the Invention

In conventional practice the process of laying gravity sewers in trenches involves workers working within the confines of the trench which is a hazardous environment. This has been achieved by workers within the trench first placing a compacted layer of gravel on the bottom of the trench such that the uppermost surface of this gravel is exactly aligned with the prescribed design gradient of the pipe. The pipe is then inserted into the previously laid pipe and rested on this layer of gravel. The pipe will then be aligned with the precise design gradient Additional gravel is then placed along both sides of the pipe and compacted to support the pipe.

Summary of the Invention

According to an aspect of the present invention, there is provided a compactor mechanism for compacting of aggregate material about a pipe in a trench, the pipe having a predetermined pipe gradient, wherein the compactor mechanism comprises: a single powered compacting element, the compacting element being configured to be moveable in a reciprocating motion along the length of a placed pipe for simultaneously compacting the aggregate to a pre-defined minimum density about the bed and side of the pipe along the length of the pipe to maintain the pipe gradient.

An advantage of this arrangement is that a single integrated apparatus is provided which provides for compaction of aggregate material about the pipe in order to maintain the gradient of the pipe. The compactor mechanism operates to ensure that no voids are left beneath the pipe in the bedding area which is a frequent problem with manual compaction. Furthermore, compaction is provided about the haunch of the pipe. In this manner, a reliably compacted bed and haunch layer is provided to support the pipe and maintain the pipe gradient without the intervention of workers in the trench. Maintaining a pipe gradient when laying pipe is critical in pipes for fluid

flow. Failure to maintain a pipe gradient can lead to problems such as pipe blockage, leakage, pressure build up and ultimately failure of the pipe and pipe network. Some known compacting devices attempt to provide compaction about both sides of a pipe at the same time. However, such devices can typically only provide low compaction force. Furthermore, the compacting action provided is limited to widths of pipe that can be accommodated between the compacting elements of such devices. A single powered compacting element however provides for compaction about a first side of a pipe following by compaction about a second side of a pipe. In this manner, the compaction may be provided about pipes of any diameter. Furthermore, the compacting force which can be provided by a single compactor can be considerably increased compared to devices where simultaneous compaction about two sides of a pipe is attempted.

The compactor mechanism may further comprise a rotatable element, wherein the single powered compacting element is attached to the rotatable element. This provides for manoeuvring and position of the compacting element.

The rotatable element may be rotatable from a central position through an angle of at least 90 degrees in a first direction for positioning of the single powered compacting element alongside a first side of the pipe and through an angle of at least 90 degrees in a second direction for positioning of the single powered compacting element alongside a second side of the pipe. This provides that the compacting element may be placed along one side of pipe for compaction of aggregate about that side and then rotated such that it may be placed along the second side of pipe for compaction of aggregate about that side of the pipe.

In use, the compacting element may be submerged beneath the aggregate material at all times when compacting the aggregate. This provides for optimal compaction. It further provides superior compaction compared to surface compactors, such as plate type compactors. The single compacting element may be fully or partially submerged.

The compacting elements may be elongate elements. This provides that the elements are easily submergible beneath an aggregate surface in order to commence reciprocating motion for compaction. This is in contrast, for example, to plate type

compactors wherein the compacting plate surface is configured to remain on the surface of the aggregate.

The compactor mechanism may be integrated into a quick hitch coupler. This provides for ease of attachment to an excavator vehicle and allows that the compactor may be readily attached and detached.

The compacter mechanism may be attachable to a hydraulic circuit of an excavator arm. This provides that the compactor mechanism is powerable by a hydraulic system already integrated into an excavator vehicle.

The compacter mechanism may be attachable to a hydraulic circuit of an excavator arm via a two-hose connection. This provides for both an ease of connection to the excavator vehicle and further provides that the full power and pressure of the excavator vehicle hydraulic system may be transferred to the compactor mechanism. The fact that this hydraulic pressure is not divided means that considerable additional compacting force may be provided by a single compactor compared to a device with multiple compacting elements.

The compacting element may have stroke reciprocating distance of about 50 mm.

The frequency of the reciprocating motion is adjustable. This is advantageous as it provides that the frequency of the reciprocating motion may be set to correspond to a frequency for optimal compaction of aggregate material for a particular pipe diameter.

The pipe is at least 400 mm in diameter. For pipes of this diameter and larger, the single compactor element provides for optimum compaction of aggregate material. This is due to the fact that larger pipes have greater mass and therefore will not move laterally during the compaction of one side only of the pipe in the first instance. Also, as the pipe is larger, the volume of bedding gravel deposited by an excavator bucket either side of the pipe for compaction is also larger and therefore provides more lateral support against the opposing compaction forces about the bed and side of the pipe.

According to an aspect of the present invention, there is provided a method for compacting aggregate about a pipe having a predetermined pipe gradient; the method comprising: inserting a single powered compacting element beneath an aggregate surface; providing a reciprocating motion to the single powered compacting element to compact the aggregate; extracting the single powered compacting element from beneath the aggregate surface when the aggregate is compacted to a pre-defined minimum density.

The method may further comprise moving the powered compacting element along the length of the pipe about a first side of the pipe; removing the single powered compacting element from beneath the aggregate surface; moving the powered compacting element along the length of the pipe about a second side of the pipe. When performing the method, the single compacting element may be submerged beneath the aggregate material at all times when compacting the aggregate. The single compacting element may be fully or partially submerged. The single compacting element may be an elongate element.

Description of the Drawing

Figure 1 is a schematic representation of the compactor mechanism of the invention in front view

Figure 2 is a schematic representation of the compactor mechanism of the invention in side view

Figure 3 is a schematic representation of the compactor mechanism of the invention in perspective view

Figure 4 is a schematic representation of a pipe in a trench

Figure 5 is a schematic representation of a pipe in a trench with non-compacted aggregate material about the sides and under the pipe

Figure 6 is a schematic representation of the compactor mechanism of the invention in position for compaction of aggregate about a first side of a pipe

Figure 7 is a schematic representation of the compactor mechanism of the invention in position for compaction of aggregate about a second side of a pipe after compaction of aggregate about a first side of the pipe

Detailed Description of the Drawings

Figures 1 to 3 show a schematic representation of the compactor mechanism 1 of the invention. The compactor mechanism comprises a single compacting element 2. The compacting element is configured as an elongate element or piston rod 3, within a housing 4 and moveable within the housing. The rod further comprises a head element 5. The rod performs a reciprocating action to strike aggregate material, such as gravel, which has been placed about the pipe below the surface of the material. The rod 3 provides for allowing the head to be inserted into the gravel and remain submerged during the entire compacting process. The reciprocating motion of the rod causes the head to compact the aggregate material beneath the surface. This provides for simultaneously compacting the aggregate to a pre-defined minimum density about the bed and sides of the pipe along the length of the pipe to maintain the pipe gradient. The mechanism further comprises a rotatable element or rotator 6. This provides that the compacting element may be rotated in one direction to be placed about one side of a pipe and further rotated in a second direction to be placed about the opposite side of a pipe. The rotator thus has a range of motion of at least 90 degrees in each direction. While in the examples below, it is described that the rotator is rotated through the full 90 degrees before placement of the compacting element into the aggregate, a partial rotation through a lesser angle than 90 degrees may also be performed before placement of the compacting element into the aggregate.

The reciprocating action may be hydraulically powered or alternatively may be pneumatically powered. The reciprocating action may further be electrically powered.

The compactor mechanism is moveable at a predetermined speed along the length of a pipe for compacting of the aggregate about the length of the pipe. The compactor mechanism is moveable via an arm of an excavator vehicle (not shown). The compactor mechanism further comprises a bracket 7 for attachment to the the arm of the excavator. The speed of movement of the compactor mechanism along the length of the pipe is adjustable by adjustment of the extension and retraction speed of the arm as controlled by an operator.

Pre-Compaction

In use for laying a pipe, the compactor mechanism is used in conjunction with other pipe laying equipment as follows:

With reference to **Figure 4**, it is shown that a trench 8 is excavated below the design bottom level of the pipe to be laid. Using an excavator (not shown) or other equipment a pipe 9 is then lowered into the trench 8. Using the excavator controls, the pipe may be connected to and aligned with any previously laid pipe in the trench. With the pipe still held in aligned positon by the excavator, aggregate material, such as gravel is then discharged along the top centre line of the pipe. With reference to **Figure 5**, it is shown that the aggregate 10 material falls down the sides and underneath the pipe, thus providing partial fill of the pipe bed and haunch zones. Furthermore, the aggregate material is delivered in sufficient volume that upon striking the top centre line of the pipe, it is subsequently directed by the curved top surface of the pipe into the trench about both sides of the pipe simultaneously. It can be seen from Figure 5, that when the aggregate material is delivered, typically a void remains beneath the pipe. This void may be filled by compaction of the aggregate as will be described below. It is also noted that the delivered aggregate may not rise evenly on both sides of the pipe, i.e. the surface of the aggregate on one side of the pipe may be at a higher level than the opposite side of the pipe. Again, this highlights a difficulty with providing compaction of material about both sides of the pipe simultaneously, as it is not possible to submerge compactors to the same depth on both sides of the pipe. This leads to an uneven distribution of compaction forces.

Compaction

The compactor mechanism is then attached to the arm of the excavator. The compactor mechanism may be integrated into a quick hitch coupler to allow for ease of connection to the excavator arm. Upon being first attached to the excavator arm 13, the rotator 6 may be in a central position in line with the arm of the excavator. Thus, in order to be placed in position along the side of the pipe, the rotator 6 is rotated through 90 degrees such that it is offset from the central position. When in this position, the compacting element 3 is inserted under the surface of the aggregate material (**Figure 6**) alongside a first side 11 of the pipe 9. The reciprocating motion of the compacting element is then activated. This pushes the aggregate material under the pipe and compacts the material both under and on one side of the pipe. Note with

respect to Figure 6, this also has the effect of partially filling the void beneath the pipe. The powered compacting element may be moved along the length of the pipe about the first side of the pipe to ensure compaction along the length of the pipe. The compacting element is then extracted from the aggregate when the aggregate is compacted to a pre-defined minimum density on the first side of the pipe. Once extracted the compacting element is moved via the rotator 6 through 90 degrees to the central position and then further through another 90 degrees so that it is again offset from the central position but in the opposite direction. When in this position, the compacting element 3 is inserted under the surface of the aggregate material (**Figure 7**) alongside the second side 12 of the pipe 9, opposite the first side.

The compacting element is now in position along the second side of the pipe, opposite the first side (**Figure 7**). The compacting element is re-submerged and the reciprocating motion of the compacting element is then activated. This again pushes the aggregate material under the pipe and compacts the material both under and on the second side of the pipe. Again, the powered compacting element may be moved along the length of the pipe about the second side of the pipe to ensure compaction along the length of the pipe. The compacting element is then extracted from the aggregate when the aggregate is compacted to a pre-defined minimum density.

Once both sides of the pipe have had compaction of aggregate performed to a required degree of 95% proctor density, a suitable compacted bed and haunch layer for the pipe is provided which is at the required level for alignment with the previously laid pipe. This provides sufficient support about the pipe sides to prevent settlement or subsequent lateral movement of the pipe. The compacting element is extracted from the aggregate and the pipe laying apparatus is manoeuvred away from the freshly laid pipe. The pipe installation is now complete and the process may begin again with a further section of pipe. The above is described in relation to a pipe being laid subsequent to a previously laid pipe. The same process is followed for each subsequent pipe section to be laid.

For the reasons of safety improvement, and to further increase the efficiency of pipe laying, there is a need to remove the requirement for workers to be in the trench at any time during the pipe installation. There exists devices which attach to an excavator

arm and which can place and connect a gravity pipe such that it may be aligned to a gradient without workers being in the trench. However, while such devices may provide for placement of a pipe, they do not provide for subsequent compaction of material to support the pipe. To remove the need for workers to be in the trench during compaction of the gravel around the pipe there is a need for a device to remotely compact the pipe bedding and side fill gravel simultaneously to a high density in order to structurally support the pipe and to maintain the pipe at the precise gradient after the trench has been infilled.

A single compacting element as described provides a number of advantages over devices with pairs or other amounts of compactors. For smaller pipes (for example from 150mm to 375mm in diameter) it is desirable to compact the pipe bedding gravel simultaneously on either side of the pipe. The volume of pipe bedding gravel required to fill the bed underneath and the along the sides of these smaller pipes is relatively small and requires a low compaction force to compact the gravel to a high density. Such a low compaction force may be provided by a multiple compactor type device.

However, for larger pipes (for example, of 400mm diameter and greater and especially gravity flow pipes) a single compactor is more desirable for a number of reasons. Without workers being in the trench it is not possible to place the compacted gravel beneath the pipe such that the resulting top surface is precisely aligned with the prescribed design pipe gradient. Therefore it is not possible to rest a pipe on this gravel top surface so that the pipe will be set on the desired pipe gradient.
As such, to remove the need for workers to be in the trench it is therefore necessary to remotely place the gravel underneath and about the sides of a pipe simultaneously after the pipe has been installed and held along the precise line and design gradient This gravel is then compacted about the underneath and sides of the pipe simultaneously to provide that the pipe will remain held along the correct line and gradient.

To achieve this compaction it is necessary to insert a single powered compacting element into the placed gravel. This will strike the gravel beneath the surface to simultaneously compact both beneath and along the sides of the installed pipe. It is found that the optimum depth of submergence of the reciprocating compactor is 150

mm. Note that this device differs from plate type compactors which deliver blows to the top surface of material over a large surface area. Therefore these compaction forces will have no compaction effect beyond circa 200mm depth below the surface of the gravel and will not compact the gravel underneath the pipe.

Some known compacting devices attempt to provide compaction of gravel about both sides of the gravity pipe at the same time but these devices are not effective for pipe diameters of 400mm diameter and greater. For pipes of 400mm diameter and upwards the use of a single compactor, which compacts the gravel one side of the pipe at a time, is more desirable than a pair of compactors compacting both sides of the pipe at the same time as set out below.

Larger pipes have greater mass and therefore will not move laterally during the compaction of only one side of the pipe. Also, as the pipe is larger, the volume of bedding gravel deposited by the excavator bucket either side of the pipe is larger and therefore provides more lateral support against the opposing compaction forces.

In order to achieve optimum compaction, the outer end/head element 5 of the reciprocating compactor must be submerged beneath the top surface of the gravel, at all times (during compaction). If the reciprocating head 5 is resting on the gravel surface, or above it, then no compaction will take place. It has been found that the optimum depth of submergence was circa 150mm below the surface. When placing the large volume of aggregate, such as gravel, either side of the pipe with an excavator bucket it is not possible to provide a uniform top surface level of deposited gravel (as per Figure 5). As such, it is not possible to maintain the correct submergence level for a pair of compactors working simultaneously. Many times this results in a first compactor being submerged by the optimum amount of circa 150 mm and the second compactor being above the gravel surface and thereby delivering no compaction force to the gravel. This deposited gravel top surface level varies along the length of the pipe in a wave like form and from one side of the pipe to the other. It was found that simultaneous equivalent depth of submergence for a pair of compactors was not possible to achieve with any degree of reliability. Thus, sub optimal compaction would result.

Furthermore, for larger pipes of 400 mm diameter and greater, the volume of aggregate to be compacted is larger than for smaller diameter pipes and thus must be moved further to reach the middle bottom of the pipe. It was found in experimentation that high compaction forces were required to achieve this compaction, resulting in high reaction forces occurring in the compacting members and attached mounting frame. It was found that, on larger pipes, when using a pair of compactors simultaneously that full compaction on one side of the pipe may occur before the other side. Therefore, the resulting reaction forces in the compactor on the compacted side were suddenly much higher than the side where full compaction had not yet been achieved. This resulted in a torsional moment being induced into the compactor mounting frame and causing both compactors and the excavator arm to vibrate. This vibration is undesirable from a structural viewpoint but can also cause the compactor drive mechanism, for example a reciprocating oil switching valve, to vibrate. This can cause the compactor mechanism to misfire on a number of reciprocating strokes.

Another advantage of the operating a single compactor is in relation to the hydraulic oil hose connections on an excavator. The compactor mechanism is attachable to a hydraulic circuit of an excavator arm. More commonly an excavator will be fitted with a hydraulic circuit to operate an attachment such as a rock breaker. A single compactor may be connected via a simple two hose connection to this circuit at the base of the excavator dipper arm. However with the simultaneous operation of a pair of separate compactors, oil from the circuit must be divided between the two compactors. As pointed out above, the compaction reaction forces induced in the compactors can simultaneously vary. This can cause "rough running" of the compaction reciprocation motion because the oil flow and pressure is being shared from a single excavator hydraulic rock breaker circuit. It should be noted that rough running of a compactor results in poor a compaction effect being delivered. Attempts to use pressure compensated hydraulic oil flow dividers to solve this problem proved to be inconsistent and unreliable due to the unpredictable variation in the induced reaction forces within the pair of compactors.

The words "comprises/comprising" and the words "having/including" when used herein with reference to the present invention are used to specify the presence of

stated features, integers, steps or components but do not preclude the presence or addition of one or more other features, integers, steps, components or groups thereof.

It is appreciated that certain features of the invention, which are, for clarity, described in the context of separate embodiments, may also be provided in combination in a single embodiment. Conversely, various features of the invention which are, for brevity, described in the context of a single embodiment, may also be provided separately or in any suitable sub-combination.

CLAIMS

1. A compactor mechanism for compacting of aggregate material about a pipe in a trench, the pipe having a predetermined pipe gradient, wherein the compactor mechanism comprises:

a single powered compacting element, the compacting element being configured to be moveable in a reciprocating motion along the length of a placed pipe for simultaneously compacting the aggregate to a pre-defined minimum density about the bed and sides of the pipe along the length of the pipe to maintain the pipe gradient.

2. The compactor mechanism of claim 1 further comprising a rotatable element, wherein the single powered compacting element is attached to the rotatable element.

3. The compactor mechanism of claim 2 wherein the rotatable element is rotatable from a central position through an angle of at least 90 degrees in a first direction for positioning of the single powered compacting element alongside a first side of the pipe and through an angle of at least 90 degrees in a second direction for positioning of the single powered compacting element alongside a second side of the pipe.

4. The compactor mechanism of any of claims 1 to 3 wherein, in use, the compacting element is submerged beneath the aggregate material at all times when compacting the aggregate.

5. The compactor mechanism of any of claims 1 to 4, wherein the compacting element is an elongate element.

6. The compactor mechanism of any of claims 1 to 5, the compactor mechanism being integrated into a quick hitch coupler.

7. The compacter mechanism of any preceding claim wherein the compactor mechanism is attachable to a hydraulic circuit of an excavator arm.

8. The compacter mechanism of claim 7 wherein the compactor mechanism is attachable to a hydraulic circuit of an excavator arm via a two hose connection.

9. The compactor mechanism of any preceding claim wherein the compacting element has stroke reciprocating distance of about 50 mm.

10. The compactor mechanism of any of any preceding claim, wherein the frequency of the reciprocating motion is adjustable.

11. The compactor mechanism of any preceding claims for compacting of aggregate material about a pipe of at least 400 mm in diameter.

12. A method for compacting aggregate about a pipe having a predetermined pipe gradient; the method comprising:

inserting a single powered compacting element beneath an aggregate surface;

providing a reciprocating motion to the single powered compacting element to compact the aggregate;

extracting the single powered compacting element from beneath the aggregate surface when the aggregate is compacted to a pre-defined minimum density.

13. The method of claim 12, further comprising:

moving the single powered compacting element along the length of the pipe about a first side of the pipe;

extracting the single powered compacting element from beneath the aggregate surface;

moving the single powered compacting element along the length of the pipe about a second side of the pipe.

14. The method of claim 12 or 13 wherein the single compacting element is submerged beneath the aggregate material at all times when compacting the aggregate.

15. The method of any of claims 12 to 14, wherein the single compacting element is an elongate element.

Intellectual Property Office

Application No:	GB2106551.1	**Examiner:**	Jacob Swatton
Claims searched:	1-15	**Date of search:**	4 November 2021

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	1-12	ThePipeMac, 23/10/2021, The PipeMac featured on the cover and in an extended article in The Clancy Group Imagine magazine, [online], Available from https://thepipemac.com/the-pipemac-featured-on-the-cover-and-in-an-extended-article-in-the-clancy-group-imagine-magazine/ [Accessed 04/11/2021] see discussion relating to the article featured in 'Imagine' detailing prior disclosure of the invention
X	1; and 4-15	EP0220373 A2 (HITACHI), Figures 12, 13a, noting excavator-mounted submerged compacting element 68a
X	1-3; and 5-11	US2005/0198873 A1 (SCRODE RAINER), Whole document, noting excavator mountable rotatable compacting element 18
X	1; and 5-11	DE10049552 C1 (UHRIG), Whole document, noting excavator mountable compacting element 4
X	1; and 5-11	JPS62174411 A (HITACHI), Figures 10, 11, noting excavator mounted compacting element 60
X	1, 4, 5, 9; and 11-15	DE3912140 A1 (TRITZSCHAK), Whole document, noting compacting element 4
A	-	GB2545702 A (GATELY), Whole document

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^{X} :

Intellectual Property Office

Worldwide search of patent documents classified in the following areas of the IPC

E01C; E02D; E03F

The following online and other databases have been used in the preparation of this search report

WPI, EPODOC, INTERNET

International Classification:

Subclass	Subgroup	Valid From
E03F	0003/06	01/01/2006
E01C	0019/34	01/01/2006
E01C	0019/38	01/01/2006
E02D	0003/046	01/01/2006
E02D	0003/054	01/01/2006