United States Patent [19]

Tarter et al.

[11] **3,868,964**

[45] **Mar. 4, 1975**

[54] **CONVEYER FOR SLURRY HOSE TRANSPORTATION SYSTEM**

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[73] Assignee: **Continental Oil Company,** Ponca City, Okla.

[22] Filed: **Aug. 21, 1973**

[21] Appl. No.: **389,271**

Related U.S. Application Data

[63] Continuation of Ser. No. 297,113, Oct. 12, 1972, abandoned.

[52] **U.S. Cl.**..... **137/344,** 137/355.17, 302/14, 191/12 R

[51] **Int. Cl.**..... **H02g 11/00,** B65g 53/30

[58] **Field of Search**..... 137/344, 355.16, 615; 302/64, 14, 15, 16; 299/18, 64; 141/279, 280, 387, 388; 74/246

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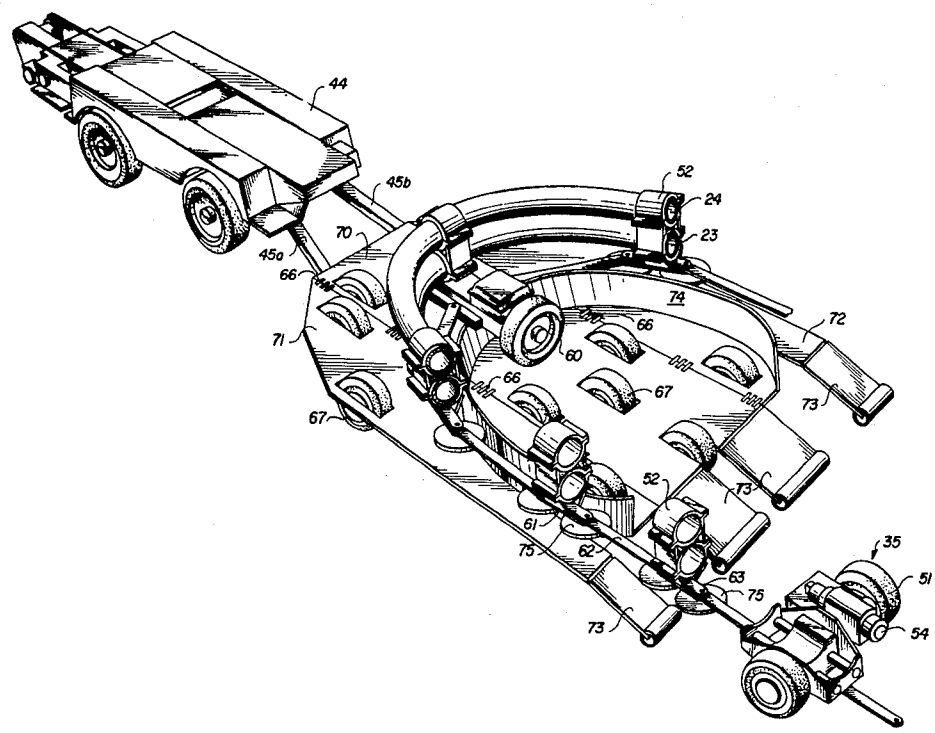
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Primary Examiner—Henry T. Klinksiek
Attorney, Agent, or Firm—William J. Miller

[57] **ABSTRACT**

A conveyer for a slurry hose transportation system which has a plurality of wheel-supported carts and a linkage system interconnecting the carts. The conveyer provides means for transporting the carts and slurry system through a 180° turn by lifting the wheels from engagement with the ground and directing the linkage during the 180° turn. In one form, the linkage is restrained to a particular geometry so that the hose will maintain a predetermined minimum arc, thereby preventing damage to the preferred slurry hose.

6 Claims, 9 Drawing Figures



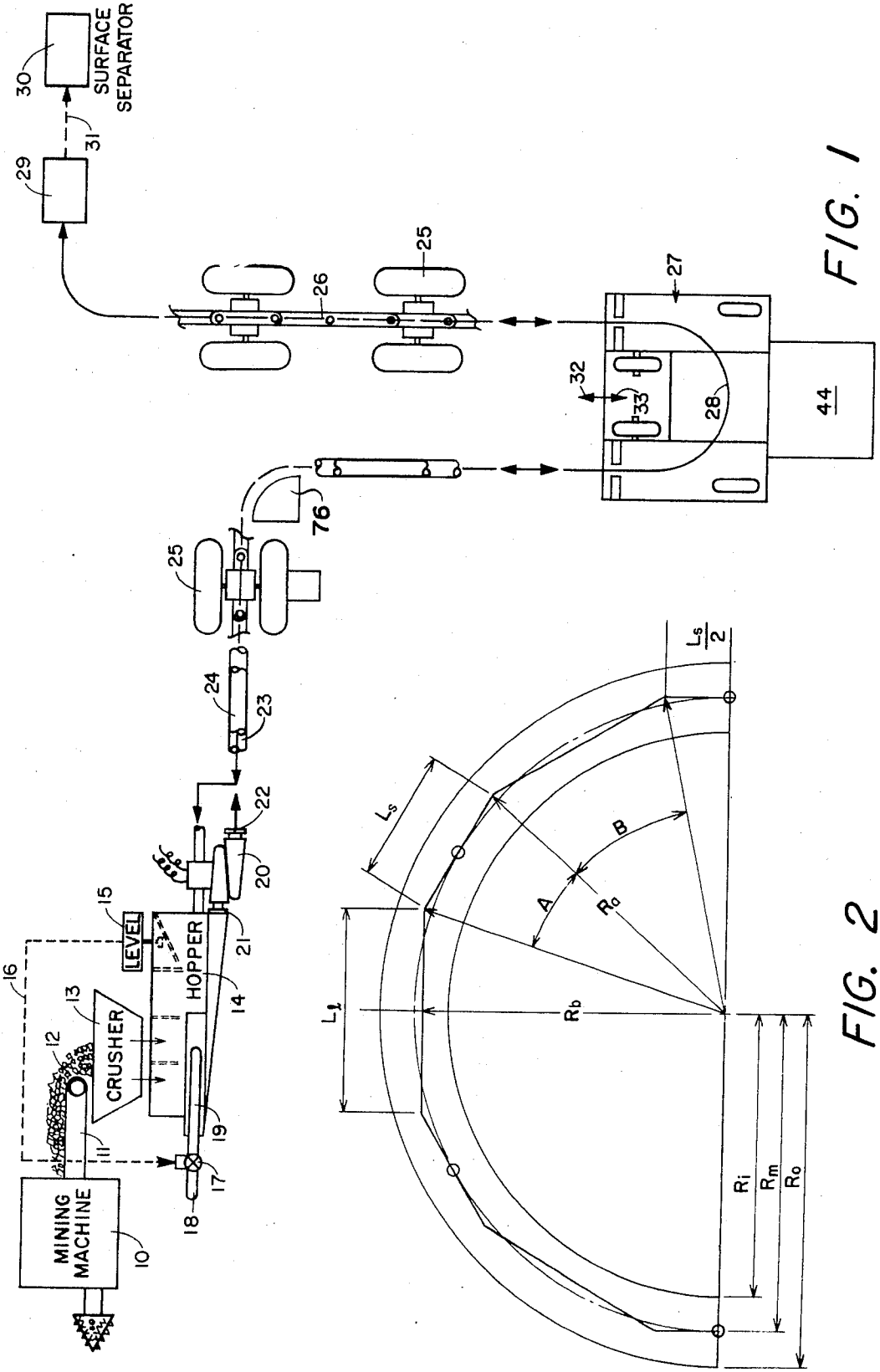

SURFACE SEPARATOR
30
31
29
25
26
27
32
33
28
44
76
25
24
23
22
20
21
15
LEVEL
HOPPER
14
16
13
CRUSHER
12
11
19
17
18
MINING MACHINE
10

FIG. 1

$L_s/2$
L_s
B
A
R_o
L_1
R_b
R_i
R_m
R_o

FIG. 2

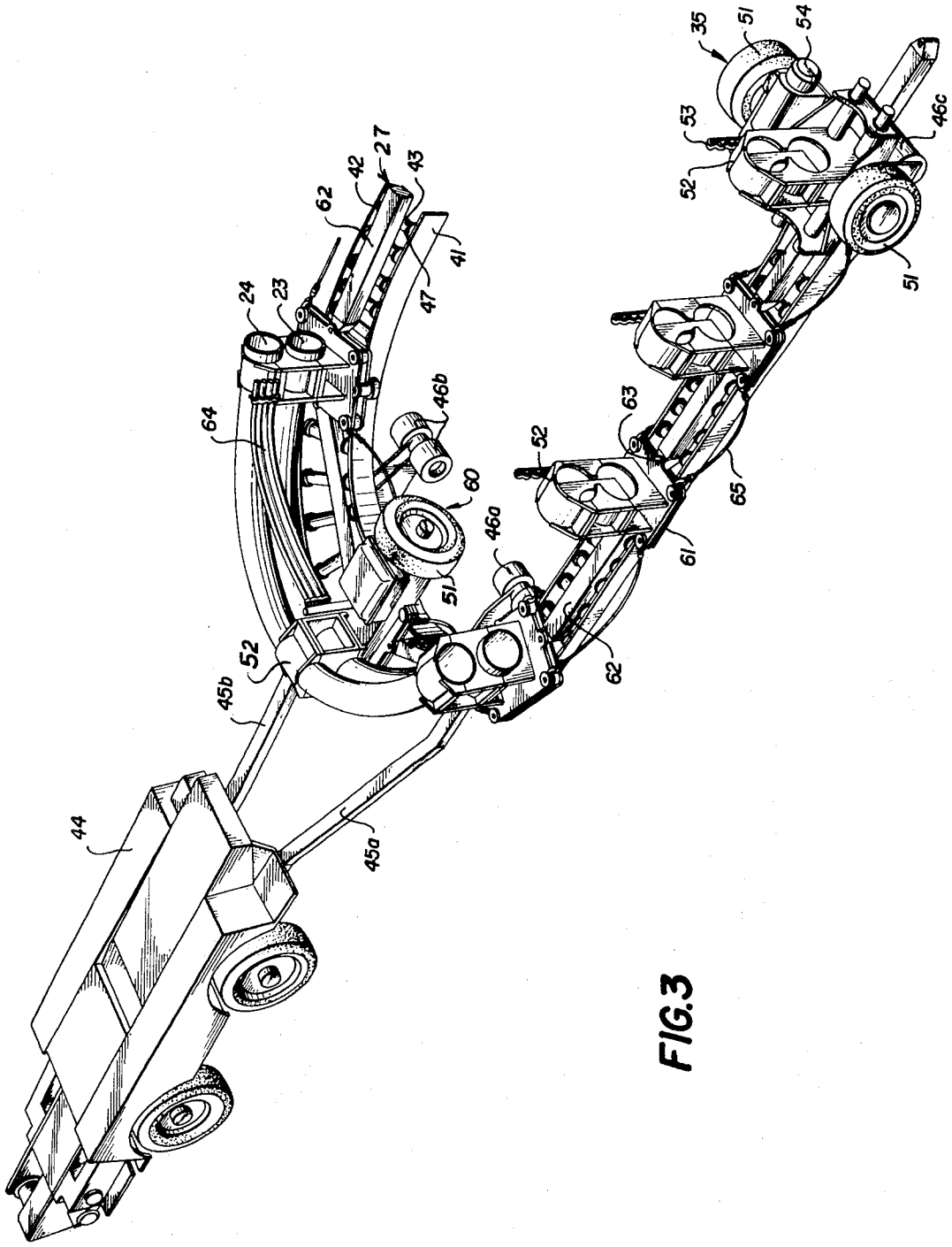

35
51
54
53
46c
52
51
27
42
43
62
41
47
24
23
64
46b
60
63
52
65
46a
61
51
62
52
45b
44
45a

FIG.3

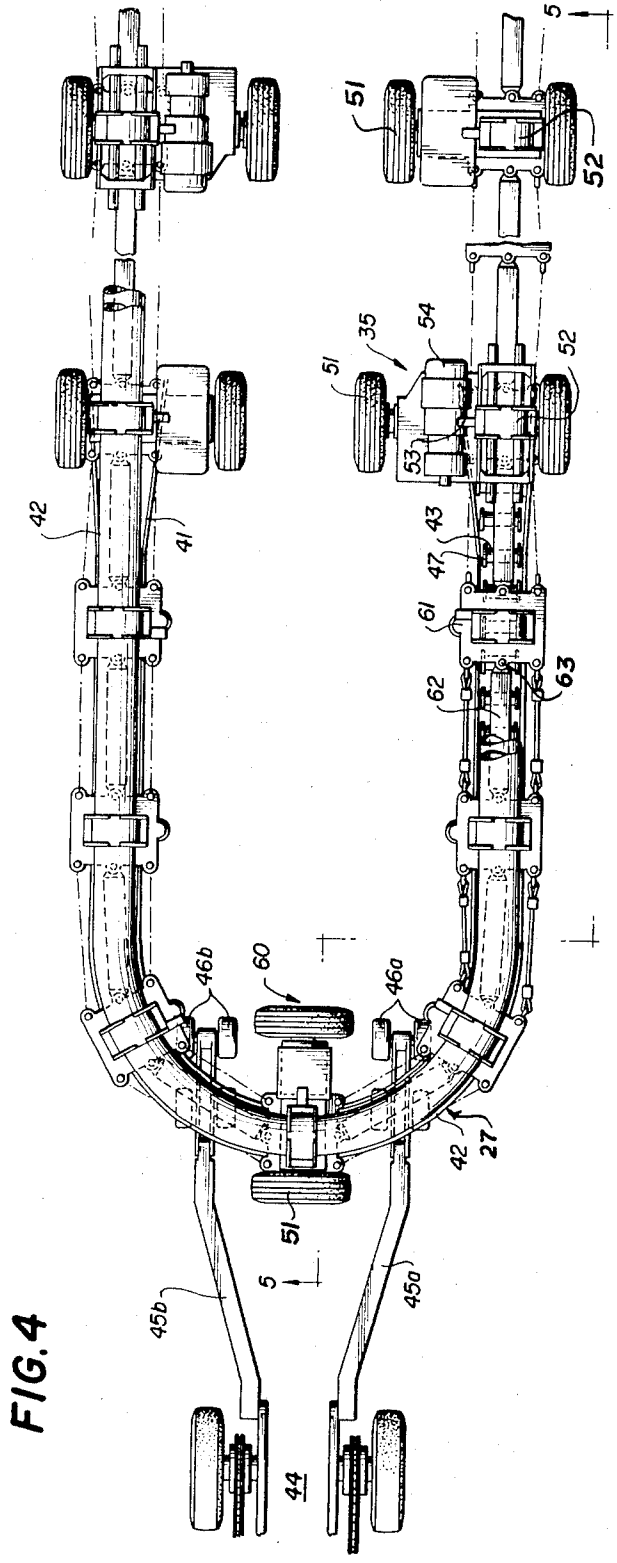

5
51
52
35
54
53
42
41
43
47
61
63
62
46b
60
46a
27
45b
45a
44

FIG. 4

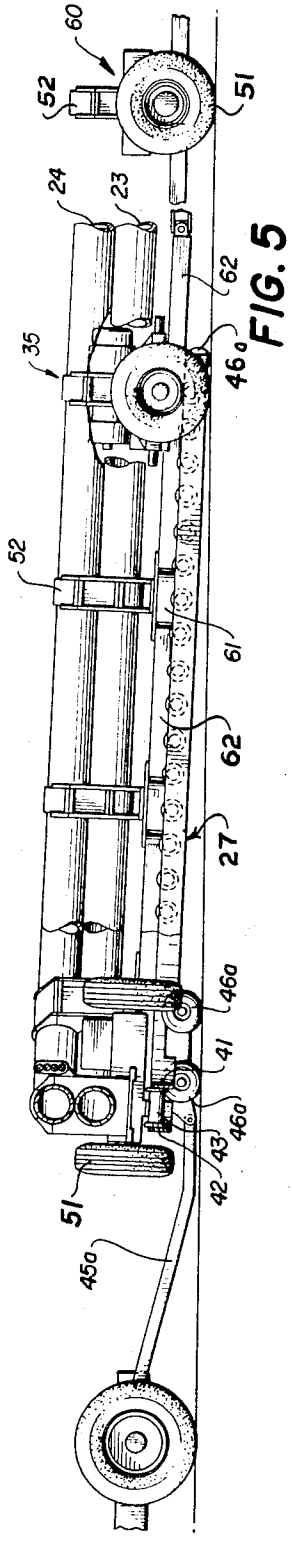
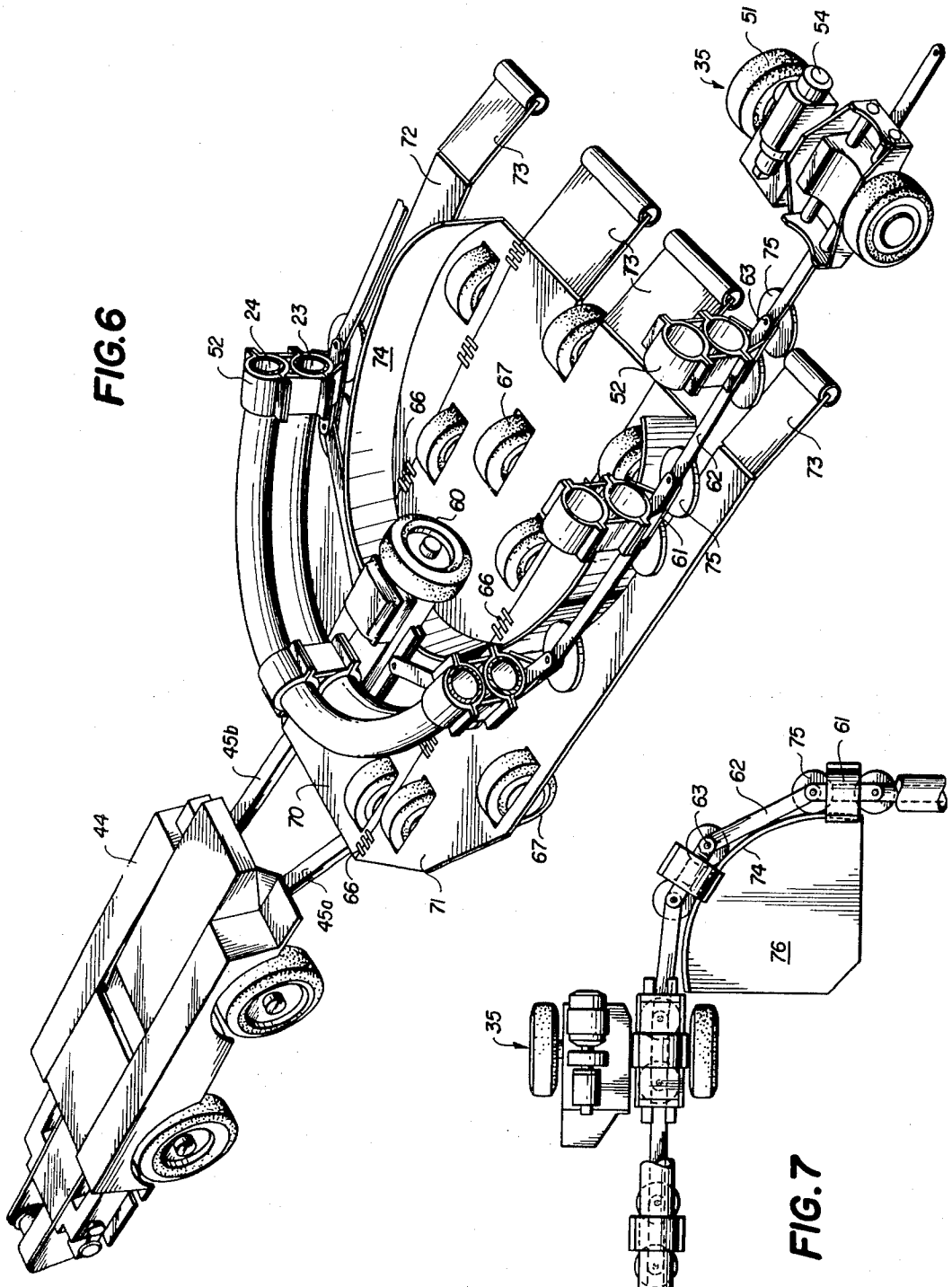

60
52
51
24
23
62
35
46a
61
62
27
41
43
42
45a

FIG. 5

FIG.6


51
54
35
72
73
75
63
24
23
52
74
66
67
60
62
61
45b
70
44
45a
71

75
61
62
63
74
76
35

FIG.7

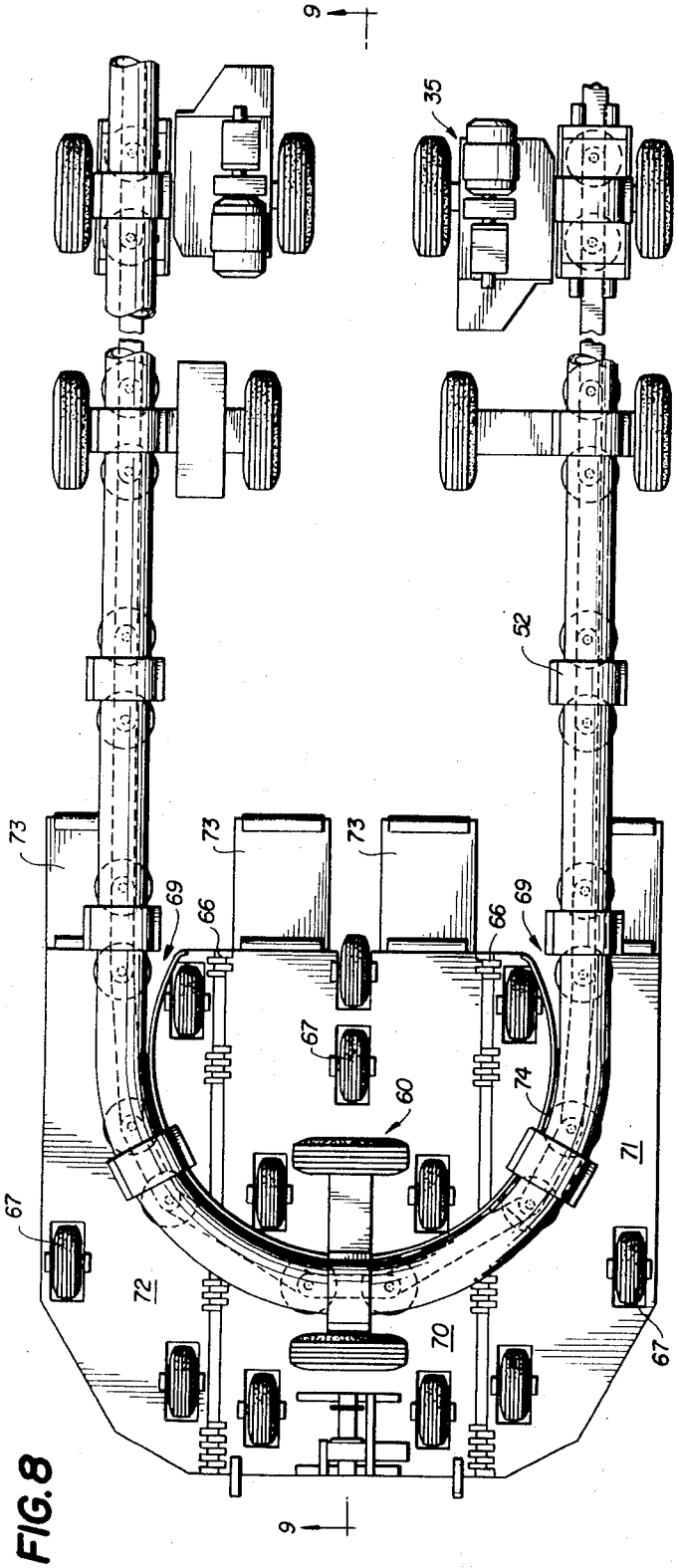


FIG.8

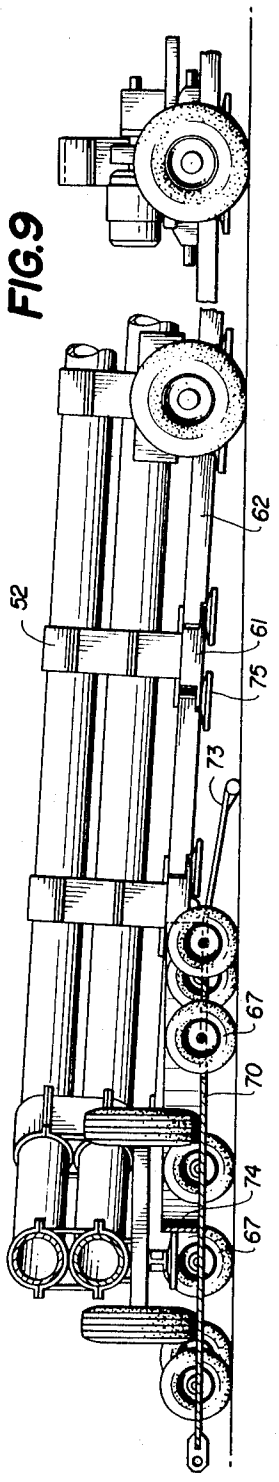


FIG.9

CONVEYER FOR SLURRY HOSE TRANSPORTATION SYSTEM

REFERENCES TO RELATED APPLICATIONS

This is a continuation of co-pending application Ser. No. 297,113 of the same title filed Oct. 12, 1972, now abandoned. Related subject matter is disclosed in application Ser. No. 294,720, filed Oct. 3, 1972 now abandoned and entitled "A Mobile Slurry Handling System," application Ser. No. 298,118, filed Oct. 16, 1972 now abandoned and entitled "Slurry Hopper System"; and application Ser. No. 298,691, filed Oct. 18, 1972, now abandoned and entitled "Linkage Geometry for a Slurry System."

BASIC DESCRIPTION OF THE INVENTION

In the above-mentioned application Ser. No. 297,113 an apparatus is disclosed for handling a flexible slurry pipe or hose which is connected between a terminal and a coal digging machine. The slurry handling system includes two hoses, one for transporting water or other fluid and the second for transporting the slurry which consists of the mined material and the fluid mixed together. Transportation of the hose is provided by a plurality of carts which are spaced along the pair of hoses and not only supports the hoses off of the floor of the mine but also provides mobility to the hoses along the axes thereof. The carts are selectively controlled so that the pair of hoses will follow all movements of the coal digging machine into and out of the room where the coal is being dug. A certain portion of the total length of the pair of hoses is positioned in the mine to provide storage so that the coal digging machine can operate for an extended period of time without requiring for example, the slurry hose system.

This invention relates to a method and apparatus for accomplishing the storage necessary for carrying out the above-described invention. In order to provide an adequate length of slurry hoses in the mine, it is necessary to bend the stored hose through a 180° loop. Since the hose is normally quite fragile, it is imperative that the loop be closely controlled so that it does not become too sharp and result in failure of the hose. To provide the above, a 180° conveyor system was invented which lifts the hose system along with the carts off the floor along with activating the powered carts so that they can apply power to the active portion of the slurry system. When the carts are returned to storage, the powered carts are deactivated so that they cannot be controlled by signals passing down the system. Mobility is provided the conveyer so that it can accomodate changes in the length of the slurry hose in storage.

DISCUSSION OF THE PRIOR ART

Conveyers have been used in the past for many purposes. For example, the U.S. Pat. to Heimaster, No. 3,301,599, illustrates a conveyer supported by wheels and connected to a mine digging machine. This conveyer, however, does not convey or provide mobility to a slurry hose system but rather conveys the product directly on the conveyer to the disposal terminal.

The U.S. Pat. to Eric Reichl, No. 3,260,548, illustrates a mining machine connected through a slurry hose system to a terminal for disposing of the product. This patent, however, discloses hoses which are non-supported but have a slightly greater length than necessary to connect from the terminal to the coal digging machines. As a consequence, some storage is provided by the excessive length of the hoses. The invention thus disclosed, however, does not take into consideration the excessive wear of hoses desired to be used, such as hoses which are made principally of steel reinforced rubber. These hoses may weigh as much as 100 pounds per foot, and movement of a hose of this weight over the rough surface of a mine passage floor will result in early failure of the hose. Furthermore, when the mining machine makes a 90° turn, there is no way disclosed in the Reichl patent to successfully move the hose around the turn.

None of the patents discloses a mobile slurry system where carts, both powered and unpowered, are connected by linkages and where a long length of a slurry hose is stored in the mine. The 180° conveyer is a necessary element in removing the slurry system from storage, conveying it around through 180°, activating the carts, and placing the slurry system in a position where it can actively follow the mining machine.

BRIEF DESCRIPTION OF THE ADVANTAGES OF THIS INVENTION

This invention provides an efficient method for moving a train consisting of powered and unpowered carts connected by a linkage and supporting a pair of slurry hoses, through a 180° turn without overstressing the slurry hoses by stretching, excessively flexing or buckling them. The conveyer further has mobility so that it can follow the lengthening or shortening of that portion of the slurry hose system in storage.

BRIEF DESCRIPTION OF THE FIGURES

FIG. **1** is a schematic of the slurry hose transportation system including its connection to the mining machine;

FIG. **2** is a schematic illustrating the method for determining the geometrical configuration of the linkage coupling the various carts;

FIG. **3** is a perspective view of one embodiment of this invention;

FIG. **4** is a top view of the conveyer illustrated in FIG. **3**;

FIG. **5** is a sectional view of the conveyer shown in FIG. **4** taken through line **5—5**;

FIG. **6** is a perspective view of the conveyer illustrating the preferred embodiment of this invention;

FIG. **7** is a top view of a 90° turn utilizing the principles utilized in FIG. **6**;

FIG. **8** is a top view of the conveyer illustrated in FIG. **6**; and

FIG. **9** is a sectional view of the conveyer illustrated in FIG. **8** taken through lines **9—9**.

Referring to all of the drawings but in particular to FIG. **1**, a mine digging machine **10** has the product loosened by machine **10** and picked up by a conveyer **11**. The product **12** is dropped into a crusher **13**, which may be any usual type crusher such as a roll crusher or three-jaw crusher, and may include means for separating the material that does not need to be crushed and crushing only the larger material. Crushers are well known and will not be further discussed. The material from the crusher is dropped into a hopper **14** which contains water. A water level control **15** applies a continuous signal through line **16** to a valve **17** which is connected to a water line **18**. Another water line **19** is connected to valve **17** and through a plurality of slots (not shown) communicating with the interior of the

hopper. The hopper illustrated herein is for the purposes of assisting in the understanding of the invention and is the subject matter of a patent application entitled "Slurry Hopper System," previously identified.

A slurry pump **20** has its inlet connected to the outlet **21** of hopper **14.** Slurry pump **20** has an outlet **22** connected to a slurry hose **23.** Another hose **24** is connected to water line **18.** Both hoses **23** and **24** are supported upon a slurry transportation system which essentially comprises a plurality of carts **25** connected by linkage **26.** The various links of the linkage **26** are connected together for pivotal movement in a horizontal plane. A conveyer **27** controls the movement of the carts, linkage and hose assembly around 180° turn **28.** The termination of the water hose **24** and slurry hose **23** is at a remote terminal **29.** A surface separator **30** may be connected to remote terminal **29** through any well known system **31** such as a pipe line.

The operation of the overall system functions as follows:

As the mining machine **10** removes product **12,** it is carried up by conveyer **11** and passed to crusher **13** where it is deposited in hopper **14.** Pump **20** pulls the slurry mixture from the hopper and passes it into line **23** where it is eventually received at a remote terminal **29,** pumped to the surface through pipe line system **31,** and separated by separator **30.** As mining machine **10** works in and out of the coal seam, the slurry hose must follow these movements. Carts **25,** through a servomechanism, will follow the in and out movements of the mining machine. A portion of the slurry and water lines between the conveyer **27** and the remote terminal **29** functions as a storage section. Thus as additional length of hose is needed, conveyer **27** will move in the direction of arrow **32,** shortening the amount in storage and lengthening the amount of hose which can penetrate the mine room with the mining machine. In order to accomplish the above, however, conveyer **27** must move the carts **25,** including the slurry and water hoses supported by it, from a position in storage to a position where it can be utilized by the mining machine. Conveyer **27** accomplishes the transition between storage and active use by lifting the carts upon the conveyer surface and moving the carts through 180° while the conveyer itself is moving in the direction of arrow **33** where additional storage is needed or **32** where less storage is needed. The conveyer also preferably restricts the hose to a definite radius, thereby preventing excess flexing or bending.

DETAILED DESCRIPTION OF 180° CONVEYER

A detailed description of the conveyor is as follows:

Two embodiments of 180° conveyer **27** as illustrated in FIG. **1** are described by referring to FIGS. **3** through **6, 8** and **9.** Referring first to the embodiment shown in FIGS. **3** through **5,** conveyer **27** is formed in a 180° configuration and has side panels **41** and **42.** A plurality of conveyer rollers **43** are rotatably journaled between side panels **41** and **42.** Tractor **44,** which may be an electrically driven tractor suitable for use in mines, has a pair of arms **45***a* and **45***b* attached at one end to the tractor and connected at the remaining end to a pair of sets of rollers **46***a* and **46***b.* Side panels **41** and **42** are attached to arms **45***a* and **45***b.* A disc **47** is attached to each end of conveyer rollers **43.** A small roller **46***c* is journaled between panels **41** and **42** at each end of the conveyer to assist in supporting the conveyer on the mine floor.

Referring now to the hose hauler system adapted to utilize the conveyer, a power driven cart comprises a pair of wheels **51,** a hose clamp **52,** and an electric cable clamp **53,** and a motor **54.** The motor **54** may be electric and operates a hydraulic pump which drives a separate hydraulic motor (not shown) coupled to each wheel **51.** The hydraulic motors are controlled by suitable hydraulic motor controls. An unpowered cart **60** differs from a powered cart **35** in that the unpowered cart does not contain a motor coupled to the wheels, but does contain clamp **52** suitable for rigidly holding the hoses, as well as control boxes, etc., for proper operation of the system. Both the powered carts **35** and the unpowered carts **60** are coupled together by a combination of short **61** and long **62** linkages which are pivotally interconnected by pins **63** for pivotal movement in a horizontal plane. The short links **61** also have a hose clamp **52** attached thereto so that the hoses **23** and **24** will be properly anchored. Electric cables **64** (FIG. **3**) are clamped in the clamps **53.** Cables **65** are attached to each side of the carts or linkages to act as a safety measure in case of breakage or excessive bending of the slurry hose.

OPERATION

The operation of the conveyer illustrated in FIGS. **3** through **5** is as follows:

As the conveyer moves in either direction, the long links **62** are supported on the rollers **43** and between the discs **47.** Side panels **41** and **42** are gradually inclined from the rollers **46***c* to the central portion of the conveyer, therefore, as the links **62** enter and roll up (on rollers **43**) the wheels **51** will be lifted from the mine floor, permitting the cart **60** or **35** to make the 180° turn. The links **62** will be retained between discs **47,** restraining the linkage to the exact 180° turn, thus insuring that the total length of links **61** and **62** will always equal the length of the hoses above it. The linkage is preferably designed, and such design will be fully described in a subsequent portion of the specification, so that the length of the linkage, whether lying straight or whether lying in a 180° turn, will always have the same length as the axes of the hoses **23** and **24.** The preferred design will thus prevent the preferred hoses from buckling because the linkage is too long or too short when it passes around the 180° turn. Tractor **44** provides mobility to the conveyer by virtue of the wheels **46***a* and **46***b* and rollers **46***c.* As previously described, the mobility will provide the conveyer with forward or backward movement in accordance with the length of the slurry line being utilized at the moment.

The preferred embodiment of the conveyer is illustrated in FIGS. **6, 8,** and **9** and essentially comprises a center platform section **70,** a first side platform section **71,** and a second side platform section **72.** Attaching means **66,** such as hinges, connects the platform sections to make a unitary structure. Spring biased ramps **73** are connected to the various platform sections **70,** 71, and **72** and provide a method for easing the carts **35** and **60** onto the platform. An arcuate guide panel **74** is attached normal to the surface of each of the platform sections **70, 71** and **72** and functions as a guide rail for the slurry system. Wheels **67** support the conveyer off the mine floor and provide mobility to the

conveyer. Tractor **44** is connected through arms **45***a* and **45***b* to platform section **70.**

Linkages **61** and **62** preferably have attached to each pivot point a disc **75** which is journaled on the respective pin **63.** Otherwise, the design of the linkage in this embodiment is the same as the design of the linkage in the previous embodiment described in FIGS. **3** through **5** and will be further described in a subsequent portion of the specification.

Slots **69** (FIG. **8**) in platform sections **71** and **72** provide clearance for the linkage mechanism **61** and **62** and discs **75** when the carts are traveling up or down ramps **73.** Once the cart wheels **51** are on platform sections **71** and **70** or **72** and **70,** there is adequate clearance for the linkage mechanism and discs.

The operation of this embodiment is as follows

Carts **35** and **60,** whether powered or unpowered, and depending upon their direction of movement, will pass up spring biased ramps **73** onto platform sections **71** and **72** and across **70.** Once a disc **75** hits guide **74,** the disc **75** will act as a roller, controlling the positon of linkages **61** and **62** as they pass around the guide panel. However, it is also contemplated that the discs **75** may be dispensed with and the linkages **62** and/or **61** slide along the guide **74** to control the movement of the flurry system through 180°. As previously mentioned the length of the linkage is important, since the hoses preferably used must pass uniformally around the 180° turn or else they may flex or bend past their critical limit causing damage or failure.

The powered carts are servo-controlled in a manner so that the linkage, when moving, will always be under tension and never under compression. In order to cause movement of the conveyer system, tractor **44** (through linkage arms **45***a* and **45***b*) will cause the conveyer to move forward or backward as required on wheels **67.** Spring biased ramps **73** will lift from the floor of the mine preventing the edge from digging into loose dirt. Only when a wheel **51** strikes a ramp **73** will it engage the floor and provide a stop for the wheels **51** to be lifted from the floor.

A switch engagement means (not shown) may be used on the conveyer to turn on the powered carts **35** as they pass over the conveyer to the active side of the system. The same medium will turn them back off when they pass over the conveyer to the storage side.

Attachment means **66** provides a means for collapsing or disassembly of the conveyer to render it easier to move. Guide panel **74** can also be disassembled.

Referring to FIG. **7,** a 90° turn is illustrated. A plate **76** has a guide panel **74** attached to one edge. The guide panel **74** of the 90° conveyer functions in the same manner as does the guide **74** of the 180° conveyer, except that the 90° conveyer is fixed for each 90° bend needed. It will be understood that a 90° conveyer at each 90° turn required as illustrated in FIG. **1.**

LINKAGE GEOMETRY

In the preferred embodiment of this invention the hose for either the slurry or the water is 1 foot in diameter, measured across the outside of the hose. The hose is made of rubber reinforced with steel. The steel prevents collapse of the hose in case a vacuum should be pulled on the system accidentally.

One of the more important restrictions on the operation of the hose hauler vehicle system using the preferred hose is that during a turn the 1 foot diameter hose must not be bent into a radius less than 5 feet measured to the outside of the hose. The approach chosen to insure that this restriction is not violated is to mount the hoses **23** and **24** on a linkage **61** and **62** which will mechanically restrain the hose from bending into a radius less than the forbidden value. The linkage also serves to support the hose between carts preventing it from dragging on the coal mine floor.

The linkage geometry must be such that the hose length and the linkage length are equal when both are bent into a turn. The critical case is the 180° turn. The convenient linkage geometry to restrain the hose in the desired radius on the 180° turn is based on a semidodecagon as illustrated in FIG. **2.** Since the outside radius R_o of the hose bend is 5 feet (maximum bend permitted for the hose) and the outside diameter D_o of the hose is 1 foot, then the inside radius R_i is 4 feet and the mean radius R_m of the bend is 4.5 feet. A length of hose in a 180° bend is then $\pi R_m = 14.14$ feet.

From FIG. **2** the geometry is set up so that a combination of short links (L_s) and long links (L_L) are calculated so that the central portions of the short links always coincide with the center line of the hose and so that the total linkage length between the points where the hose is clamped is always equal to the length of the hose between the same points. Further, the hose is always clamped to the shortest links.

Referring to FIG. **2,** the following equations can be written:

$$3\,L_L + 3\,L_s = \pi R_m \tag{1}$$

$$\alpha + \beta = \pi/3 \tag{2}$$

$$L_s/2\,R_m = \tan(\alpha/2) \tag{3}$$

$$L_s/2\,R_a = \sin(\alpha/2) \tag{4}$$

$$L_L/2\,R_a = \sin(\alpha/2) \tag{5}$$

With $R_m = 4.5$ feet, equations (1) through (5) may be solved by using appropriate trigonometric identities to obtain $L_s = 1.585$ feet and $L_L = 3.127$ feet.

The carts, either powered or unpowered, must occupy a short link, since the hoses are clamped at the carts and the hose must move laterally across each long link during turns to prevent damage to the preferred hose.

The preferred 1 foot diameter hose is manufactured in lengths no greater than 50 feet. Since the end connections are a significant component of the hose cost, it is desired that the length of individual hose segments be as long as other restraints allow. The hose connections are made with 16 inch diameter flanges and connections on the lower hose should not interfere with those on the upper hose while connections on both should clear the clamping points on the short links.

Calculations show that a practical linkage design for a hose length of approximately 1,000 feet can form a span of four long links and three short links between carts occupying short links. The distance between axles of the carts is then 4 (1.585 = 3.127) = 18.85 feet. If

each powered cart is to tow two unpowered carts, and if the hose line is to be capable of being reversed (implying a powered cart at each end of the hose), then the total length of the linkage is divided into units of 3 × 18.85 = 56.55 feet. If the total hose length is not to exceed 1,000 feet, then 17 units of linkage of 56.55 feet will be used (with 18 powered carts and 34 unpowered carts) and the total length of the linkage will be 17 × 56.55 = 961.4 feet.

In order to prevent the hose flanges from interfering with one another or the clamping points requires that they occur at the midpoints of the long links. Since the midpoints of the long links are spaced at increments equal to 1.585 + 3.127 = 4.712 feet, the hose length must be in increments of this length and no greater than 50 feet. Thus, the hose length is 47.12 feet. If 21 lengths of hose are used each way, the total length of hose would be 989.5 feet, which is 28.12 feet longer than the linkage. It can thus be concluded that **38** lengths of hose 47.12 feet long plus 4 lengths of hose of the length required to make the end connections will be used.

The subject matter of the linkage geometry including the concept of connecting powered carts by a rigid linkage and clamping the hose along the rigid linkage in distance sufficiently close to prohibit expansion of the hose under pressure is the subject matter of a patent application entitled "Linkage Geometry for a Slurry System," identified above.

The concept of conveying the slurry hose and carts from the storage portion to the action portion of the system rendered the slurry hose transportation system feasible. Two embodiments are disclosed which illustrate satisfactory methods for accomplishing the 180° turn. Modifications can be made to the embodiments disclosed herein without departing from the spirit and scope of the invention.

What is claimed is:

1. In a system for transporting a slurry from a mining machine in a mine having a floor, and which includes at least one flexible hose supported by a plurality of wheeled carts spaced along the length of the hose and links pivotally interconnected with one another and the carts for pivotal movement in a horizontal plane, and wherein the hose is required to be transferred in a 180° bend between a storage section and a parallelly located active section as the need for the hose changes, the improvement comprising:

a conveyer movably supporting the hose, carts and links off of the mine floor in the 180° bend portion of the hose, and

means attached to the conveyer for moving the conveyer along the mine floor parallel to the storage section of the hose as the hose is being transferred between the active and storage sections.

2. The improvement defined in claim **1** wherein the conveyer includes a platform extending above the mine floor to support the wheels of the cart and thereby the hose and links.

3. The improvement defined in claim **2** wherein the platform is supported substantially parallel to the mine floor, and characterized further to include ramps extending from the platform to the mine floor arranged to engage the wheels of the carts as the conveyer is moved to move the carts onto and off of the platform.

4. The improvement defined in claim **1** wherein discs are journaled to the links to turn in a horizontal plane, and wherein the conveyer includes a platform extending above the mine floor to support the wheels of the carts, and an arcuate guide plate protruding above the platform arranged to engage the discs and guide the hose, links and carts during movement thereof over the conveyer.

5. The improvement defined in claim **1** wherein the conveyer includes a pair of parallel side panels extending substantially in a semi circle when viewed in plan, and rollers journaled between the side panels arranged to engage and movably support the links and thereby the hose and carts.

6. The improvement defined in claim **5** wherein the side panels slope upwardly from the ends thereof for raising and lowering the links, hose and carts moving over the conveyer.

* * * * *