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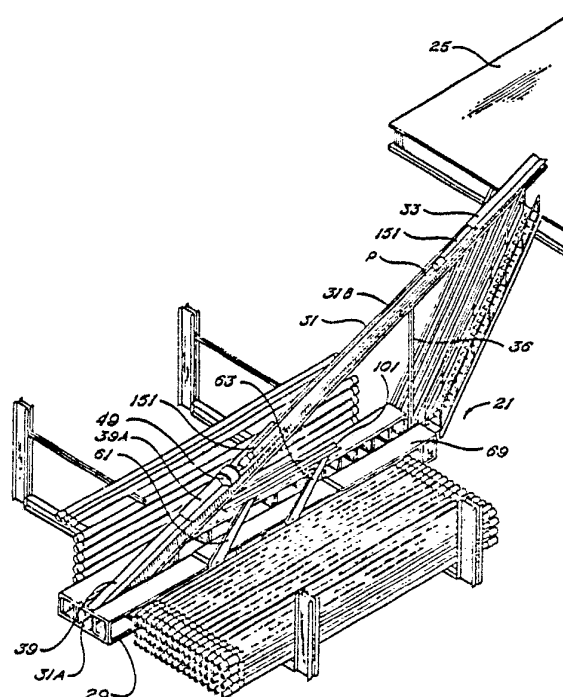
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(54) Title: PIPE HANDLING SYSTEM WITH APRON AND STACKING ARMS

(57) Abstract

A system for transferring lengths of pipe laterally between a pipe rack and a pipe handling apparatus. The system comprises two spaced apart arms (61, 63) located on one side of the pipe handling apparatus next to the rack (27). Each arm has one end pivotally coupled to a support (29) such that its opposite end may move upward and downward. The two arms are located in line with each other for pivotal movement about generally parallel axes respectively. A trough (101) capable of supporting a length of pipe is pivotally coupled to each of the arms at their opposite ends such that the trough will move upward and downward with the opposite ends of the arms. Tilting mechanisms (103, 105) are provided for tilting the trough laterally in opposite directions. In addition, cylinders (71, 73) are provided for moving the arms about their axes respectively for moving the opposite ends of the arms and the trough upward and downward. An elongated trough (151) is slidably located on a vertically pivoted trough (31) to carry pipe from a derrick floor (25) to a pipe rack (27) when there is little or no height differential between the derrick floor and the pipe rack. The slidable trough may be removed when the height differential is such that pipe will slide down the vertically pivoted trough by gravity.



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PIPE HANDLING SYSTEM WITH APRON AND STACKING ARMS

Figure 1 is a perspective view of a pipe handling apparatus with the pipe transfer system of the present invention located on one side of the apparatus next to a pipe rack.

Figure 2 is a side view of the pipe transfer system of Figure 1.

Figure 3 is an enlarged end view of the tilting mechanism for the stacking and unstacking trough of the pipe transfer system of Figures 1 and 2.

Figure 4 is an enlarged side view of the tilting mechanism for the stacking and unstacking trough of the pipe transfer system of Figures 1 and 2.

Figure 5 is an end view of the pipe transfer system of Figures 1 and 2 with its stacking and unstacking trough shown at different elevations and positions.

Figure 6 illustrates a hydraulic system for operating the pipe transfer system of Figures 1-5.

Figure 7 is a top view of the vertical, pivoted trough of the pipe handling apparatus of Figure 1.

Figure 8 is a side view of the vertically pivoted trough of the pipe handling apparatus of Figure 1.

Figure 9 is a side view of the vertically pivoted trough of the pipe handling apparatus of Figure 1 showing the trough pivoted to an inclined position by hydraulic cylinders.

Figure 10 is a cross-section of Figure 8 taken along the lines 10-10 thereof.

Figure 11 is a cross-section of Figure 8 taken along the lines 11-11 thereof.

Figure 12 is a cross-section of Figure 8 taken along the lines 12-12 thereof.

Figure 13 is a cross-section of Figure 8 taken along the lines 13-13 thereof.



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Figure 14 is a top view of a slidable apron attachable to the pipe moving device of the pipe handling apparatus of Figure 1.

Figure 15 is a side view of the apron and pipe moving device of Figure 14.

Figure 16 is an end view of the pipe moving device of Figures 14 and 15.

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DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to the drawings, there will be described first the pipe handling apparatus 21 for raising pipe P such as casing, drill pipe, collars, or tubing up to a derrick floor 25 of a drilling rig (not shown) and for removing the pipe P from the derrick floor 25. The pipe P is stored in racks 27 on both sides of the apparatus 21. The apparatus 21 comprises an elongated frame 29 which supports a trough 31 which may be pivoted upward to an inclined position in alignment with a fixed trough 33 as shown in Figures 1 and 9 or downward to a horizontal position as shown in Figures 5 and 10-13. Hydraulic cylinders 34 are provided for pivoting the trough 31 upward or downward. The cylinders are pivotally attached to the frame 29 and their pistons are pivotally attached to the trough 31. The rear end of the trough 31 is pivotally coupled to the frame 29 at 35. The fixed trough 33 is supported in an inclined position by the derrick floor 25 and support structure 36. The trough 31 comprises elongated frame members 37A-37D which support a V-shaped floor 39 along which the pipe P slides. An intermediate portion 39A of the V-shaped floor 39 is tiltable laterally in either direction when the trough 31 is horizontal, to dump pipe on either side of the apparatus 21 for storage in the racks 27. The intermediate position 39A is tiltable by hydraulic cylinders 41. The cylinders 41 have their lower ends pivotally coupled to structure 43 which is connected to frame members 37A and 37B and their pistons 41A pivotally coupled to the intermediate portion 39A. Figure 12 illustrates the intermediate portion 39A being tilted laterally to the left. The cylinders 49 move up and down with the trough 31 as it is pivoted up and down.

Also provided is a movable member 49 driven by an endless chain 51 for movement along trough 31 in either

direction between its ends 31A and 31B. The bottom 53 of the movable member 49 is V-shaped and slides along the floor 39. The bottom of the floor 39 has an elongated slot 53 formed therethrough. A lug 55 having a thin neck 56 extends from the bottom of the movable member 49. The neck 56 extends through the slot 53 and the lug 55 is connected to the chain 51 below the floor 39. Means, not shown, is provided for driving the chain 51 in either direction.

When it is desired to move pipe from either of the racks 27 upward to the derrick floor, the following operations take place. The trough 31 is located in its horizontal position and the movable member 49 is located at the rear end 31A of the trough 31. A length of pipe is transferred from one of the racks 27 into the trough 31 where it rests on the V-shaped floor 39. Trough 31 next is pivoted upward to be in alignment with the fixed trough 33. The endless chain 51 is driven to move member 49 up the trough 31 to its end 31B. The front end 49A of member 49 engages the lower end of the pipe P and pushes the pipe P upward in the troughs 31 and 33 until the pipe overlies the derrick floor. The pipe then is lifted into the derrick by cable hoists and/or elevators. The member 49 is retracted to the rear end 31A of the trough 31; the trough 31 is lowered to a horizontal position; and the process is repeated.

In moving pipe downward from the derrick floor 25, the trough 31 is raised to be in alignment with the fixed trough 33 and member 49 moved to an upward position along trough 31. The cable hoist locates a length of pipe in troughs 33 and 31 and member 49 is moved downward to the lower end of trough 31 to allow the pipe to slide downward in the trough 31 to position the pipe on the intermediate portion 39A of the floor 39. The trough 31 then is lowered to a horizontal position and intermediate position 39A is tilted laterally to dump the pipe on either side of the apparatus 21 for storage in one of the racks 27.

The pipe transfer system for transferring pipe between the racks 27 and the pipe handling apparatus 21 comprises



a pair of aligned arms 61 and 63 located on the side of the pipe handling apparatus 21 and next to one of the pipe racks 27. In Figure 1, one pair of arms 61 and 63 are shown on the right of the apparatus 21 next to the right rack 27. The ends 61A and 63A of arms 61 and 63 are pivotally coupled to the frame 29 at 65 and 67. The opposite ends 61B and 63B of arms 61 and 63 may move to an upper position above the catwalk 69 and to a lower position below the catwalk 69 as shown in Figures 1, 2, and 5. In Figure 2 the arms 61 and 63 are shown in dashed form in their upper positions.

A hydraulic system is employed for moving the ends 61B and 63B of arms 61 and 63 together to upward or downward positions or to any level in between. The hydraulic system comprises a pair of cylinders 71 and 73 having their ends pivotally coupled to the frame 29 at 75 and 77. The pistons 81 and 83 of the cylinders 71 and 73 are pivotally coupled to arms 61 and 63. In Figure 2, the pistons 81 and 83 are shown pivotally coupled at 85 and 87 to ears 89 and 91 which are connected to arms 61 and 63 respectively. When the pistons 81 and 83 are forced outward of their cylinders, the ends 61B and 63B of arms 61 and 63 are moved upward and when the pistons 81 and 83 are moved inside of their cylinders, the ends 61B and 63B of arms 61 and 63 are moved downward. Referring to Figure 6, the hydraulic system for operating the cylinders 71 and 73 comprises an oil reservoir 93, a pump 95, a four-way directional control valve 97 and appropriate flow lines.

Pivotally coupled to the ends 61B and 63B of arms 61 and 63 is a stacking and unstacking trough 101 for carrying pipe between the rack 21 and the pipe handling apparatus 21. The trough 101 can be pivoted laterally in either direction to allow pipe to be loaded onto and from the trough 101. Referring to Figures 2-6, the mechanisms for coupling the trough 101 to the ends 61B and 63B of the arms 61 and 63 and for tilting the trough 101 will be described. Tilting mechanisms 103 and 105 are provided at each end of the trough 101. The ends 61B and 63B of arms 61 and 63 have

lugs 107 and 108 secured thereto respectively and which extend laterally outward. The lugs 107 and 108 are rotatably coupled to tilting mechanisms 103 and 105 respectively allowing the arms 61 and 63 to move up or down together carrying the length of the trough 101 in a horizontal position. Each of tilting mechanisms 103 and 105 is the same. Tilting mechanism 103 will be described in detail. The lug 107 is rotatably located in an aperture 109 formed through a bearing member 111. Member 111 is rotatably mounted on an upper shaft 113 which is supported by two mounts 115 and 117 fixedly secured to the trough 101. The shaft 113 freely extends through apertures 115A and 117A formed through mounts 115 and 117 and through aperture 111A formed through member 111 whereby the mounts 115 and 117 can rotate about the shaft 113 and the shaft 113 can rotate relative to member 111. A rotary actuator 121 is fixedly secured to the trough 191 by way of a plate 123 which is secured to the actuator 121 and to the trough 101. The actuator 121 has a lower shaft 125 which can be rotated in opposite directions. The lower shaft 125 is fixedly secured to a linkage 127 which is coupled to the shaft 113. The linkage 127 has an aperture 127A which freely receives the shaft 113 whereby the linkage can rotate about the shaft 113. When the actuator 121 rotates its shaft 125 in one direction, the linkage 127 is rotated causing the linkage to turn about the shaft 113 and hence tilt the actuator 121 and the trough 101. In Figure 3, the trough 101 is shown in dotted lines tilted laterally in opposite directions. In Figure 3, the actuator 121 is not shown tilting with the trough for purposes of clarity.

The rotary actuator 121 is a commercially available actuator hydraulically actuated. Referring to Figure 6, it comprises a cylinder 129 having two pistons 131 and 133, with a rack 135 connected between the pistons. The rack 133 engages a pinion 139. The shaft 125 is an extension of the pinion 139. When pressure is imposed on one side of the cylinder 129 it drives the piston and the rack in one direction

to rotate the pinion 139 and hence the shaft 125. On the opposite side of the cylinder the pressure is released. In Figure 6, member 140 is the cylinder for the rotary actuator 141 for the tilting mechanism 105. Actuator 141 is the same as actuator 121. The cylinder 140 has two pistons 142 and 143 and a rack 145 connected between the pistons for rotating a pinion 146 from which extends a shaft similar to shaft 107. Both actuators of mechanisms 103 and 105 are operated simultaneously by hydraulic fluid from reservoir 93 and pump 95 for driving their shafts in the same direction for tilting the trough 101. Four way valve 143 is employed for controlling the direction in which the two actuators 121 and 141 rotate their shafts and hence the direction in which the trough 121 is tilted.

The arms 61 and 63 and trough 101 operate in the following manner to transfer pipe between the rack 27 and the pipe handling apparatus 21. Assume that pipe is to be transferred from apparatus 21 upward to the rack 27. The arms 61 and 63 will be located such that the trough 101 will be just below the catwalk 69 in a non-tilted position whereby the V of the trough 101 will be straight up. In this position, the upper edge of the trough 101 is located close to the catwalk 69 with very little space between the trough edge and the catwalk 69 such that pipe rolling outward on the catwalk 69 will roll into the trough 101. The intermediate position 39A of the floor 39 of the trough 31 is tilted laterally to dump a length of pipe onto the catwalk 69. From the catwalk, the pipe will roll into the trough 101. The arms 61 and 63 then are raised simultaneously to raise the trough 101 with the trough held in a non-tilted position. As the trough is raised, its length will be held horizontal. The trough thus will cradle and carry the pipe upward with no longitudinal movement of the pipe in the trough 101. Thus the pipe cannot roll off of the trough, nor can it slide off of the trough longitudinally. When the trough 101 reaches the top of the rack 27, upward movement of the arms 61 and 63 will be terminated and the trough 101

will be tilted laterally in a direction to dump the length of pipe onto the top of the rack 27. The trough 101 will be moved to a non-tilted position and the arms 61 and 63 and trough 101 moved downward to repeat the process.

For transferring pipe from the rack 27 to the pipe handling apparatus 21, the arms 61 and 63 and trough 101 operate in the following manner. Assume that pipe is to be transferred from an upper row of pipe on the rack 27 to the pipe handling apparatus 21. The arms 61 and 63 will be located such that the trough 101 will be just below the top row of the pipe on the rack 27 with the trough 101 in a non-tilted position whereby the V of the trough 101 will be straight up. A length of pipe will be pushed into the trough 101. The arms 61 and 63 will then be lowered simultaneously with the trough 101 carrying the length of pipe downward in a horizontal position. When the trough 101 reaches the level of the catwalk 69, downward movement of the arms 61 and 63 will be terminated and the trough 101 will be tilted laterally in a direction to dump the length of pipe into the catwalk 69 where it will roll into the trough 31. The trough 101 will be moved to a non-tilted position and the arms 61 and 63 and trough 101 moved upward to repeat the process.

A pair of arms 61 and 63 and a laterally tiltable trough 101 as described above will be located on both sides of the apparatus 21 for transferring pipe between either rack 27 and the apparatus 21.

When the incline of the troughs 31 and 33 is small, the pipe may not slide down the trough from the derrick floor by gravity. Referring now to Figures 1, 7, 8, 11, 12, and 14-16, there will be described in slidable apron 151 removably attachable to the pipe moving device 49 of the pipe handling apparatus 21 for carrying pipe from the derrick floor 25 down the troughs 33 and 31 when there is little or no height differential between the derrick floor 25 and the frame 29 of the pipe handling apparatus 21. The apron 151 comprises a V-shaped member slidable on the floor 39 of the trough 31.

An aperture 153 is formed close to the rear end 151A of the apron 151 into which is fitted a triangular shaped securing member 155 which projects upward from a forward extension of the neck 56 of member 49. The aperture 153 does not extend all of the way to the rear end 151A of the apron 151 but is spaced therefrom a short distance. The member 153 slants downward toward its forward end whereby the member 155 may be inserted into the aperture 153 by moving the member 49 forward while the apron 151 will ride upward on the member 155 as it moves forward until it reaches full length of the aperture 153 at which time the apron will drop down with the member 155 located in the aperture 153. When the member 49 is moved forward by the chain, its front end 49A will engage the rear end 151A of the apron and push the apron 151 forward along the trough 31. For drawing pipe from the derrick floor, the apron 151 will be pushed onto the fixed trough 33. A length of pipe will be loaded onto the apron 151 and the member 49 will be moved backward by the chain 51 pulling the apron 151 and hence the pipe backward whereby the pipe may be loaded onto the rack 27. When the member 49 moves backward the rear end 155A of the member 155 engages the rear end 153B of the aperture 153, pulling the apron 151 backward. As seen in Figures 7, 11, and 12, the intermediate or dump portion 39A of the floor 39 of the trough 31 has two elongated apron holding strips 161 and 163 formed along its top outer edges. When the apron 151 is pulled onto the intermediate portion 39A, the outer edges 151B and 151C of the apron slide under the strips 161 and 163 whereby the apron is held to the intermediate or dump portion 39A. Thus when the trough 31 is lowered to a horizontal position and the dump portion 39A is pivoted laterally, the apron 151 also will be tilted laterally allowing the pipe to be dumped onto the catwalk 69 for loading onto a rack 27 next to the apparatus 21. During dumping operations by the dump portion 39A, member 49 will not be located above the dump portion 39A. When the apron 151 is tilted laterally by the dump portion 39A, its aperture

153 is moved above the member 155. However, when the apron is moved back in place by the dump portion 39A, the aperture 153 will fit around the member 155 whereby the movable member 49 may push the apron along the trough 31 to the fixed trough 33.

Although the apron 151 is used primarily for drawing pipe from the derrick floor for loading on the rack, it is to be understood that it could be used for moving pipe from the rack 27 to the derrick floor. The apron 151 also has advantages in that it protects the main troughs 31 and 33 from wear. A teflon like coating may be applied to the underside of the apron 151 to minimize friction.

When the height differential between the derrick floor 25 and the frame 29 is sufficient such that the pipe will slide down troughs 33 and 31 by gravity, the apron 151 may be removed as well as the securing member 155. Member 155 may be removably secured to the forward extension of the neck 56 of member 49 by bolts.

Instead of employing the strips 61 and 63 to hold the apron 151 to the dump portion 39A, the apron 151 may have a thin neck extending down from its bottom with an enlarged lug attached to the thin neck. The thin neck will extend through the slot 53 with the enlarged lug located below the floor 39. This arrangement allows the apron 151 to slide on the floor 39 yet holds the apron 151 to the dump portion when it is tilted for dumping purposes. In this embodiment, the apron 151 may be coupled to the member 49 by securing member 155 to the forward extension of the neck 56 of member 49 through the aperture 153 of the apron 151 when the aperture 153 of the apron 151 is over the forward extension of the neck. The apron 151 may be removed by removing member 155 and by sliding the apron forward when the trough 31 is at a slightly inclined position to remove the lower thin neck of the apron from the slot 53 at the forward end of the trough 31.

Preferably the apron 151 will be longer than the length of pipe it will carry.

We claim:

1. Apparatus for transferring pipe or the like between the floor of a drilling rig and pipe rack means, comprising, an elongated main support frame adapted to be located close to the pipe rack means,

an elongated pivotal trough means having one end pivotally coupled to said main support frame such that said pivotal trough means can be pivoted upward to an inclined position relative to said main support frame and downward to a generally horizontal position,

means for moving said pivotal trough means between said inclined position and said generally horizontal position,

said pivotal trough means comprising elongated structural means having opposed elongated side walls, supported by support structure,

movable means supported for movement along the length of said elongated structured means,

means for moving said movable means along the length of said elongated structural means,

movable elongated structure having opposed elongated side walls supported for lengthwise sliding movement on said elongated structural means of said trough means along its length,

means for removably coupling said movable elongated structure to said movable means to allow said movable means to move said movable elongated structure on said elongated structural means of said trough means along its length,

said movable elongated structure means being adapted to receive and carry pipe as it is moved by said movable means on said elongated structural means of said trough means along its length.

2. The apparatus of claim 1, comprising,

an elongated slot formed through said bottom portion of said elongated structural means of said trough means along its length,

said means for moving said movable means along the length of said trough means comprises:

continuous chain means located below said elongated slot and extending along the length thereof,
means for driving said continuous chain means, and
lug means extending through said elongated slot and attached to said continuous chain means and to said movable means such that movement of said continuous chain means moves said lug means and hence said movable means.

3. The apparatus of claim 1, wherein,

said elongated structural means of said pivotal trough means comprises first and second opposite ends with said second end being located such that it moves upward when said pivotal trough means is pivoted upward to said inclined position.

a fixed trough supported from the floor of the drilling rig in a sloping position such that one end extends downward toward said main support frame,

said elongated structural means of said pivotal trough means being in alignment with said fixed trough with said second end of said elongated structural means of said pivotal trough means being located adjacent said one end of said fixed trough when said pivotal trough means is moved to said inclined position,

said movable elongated structure means being movable on said fixed trough when said elongated structural means of said pivotal trough means is in alignment with said fixed trough.

4. The apparatus of claims 1 or 2, comprising,

means for tilting said elongated structural means of said pivotal trough means laterally relative to said support structure when said pivotal trough means is in said generally horizontal position,

holding means for holding said movable elongated structure to said elongated structural means of said pivotal trough means to allow said movable elongated structure to tilt with said elongated structural means of said pivotal trough means,

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said holding means allowing said movable elongated structure to slide lengthwise relative to said elongated structural means of said pivotal trough means.

5. The apparatus of claim 1, wherein,

said elongated structural means of said pivotal trough means comprises first and second opposite end portions and an intermediate portion therebetween,

means for tilting said intermediate portion laterally relative to said first and second opposite end portions and laterally relative to said support structure when said pivotal trough means is in said generally horizontal position,

holding means for holding said movable elongated structure to said intermediate portion when said movable elongated structure overlaps said intermediate portion to allow said movable elongated structure to tilt with said intermediate portion,

said holding means allowing said movable elongated structure to slide lengthwise relative to said intermediate portion.

6. The apparatus of claim 1 wherein said means for removably coupling said movable elongated structure to said movable means comprises,

aperture means formed through the bottom of said movable elongated structure near one end thereof, and

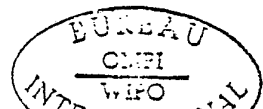
securing means connected to said movable means and extending upward,

said securing means being adapted to be removably fitted into said aperture means from below the bottom of said movable elongated structure.

7. The apparatus of claim 6, comprising,

means for tilting said elongated structural means of said pivotal trough means laterally relative to said support structure when said pivotal trough means is in said generally horizontal position,

holding means for holding said movable elongated structure to said elongated structural means of said pivotal trough means to allow said movable elongated structure to tilt



with said elongated structural means of said pivotal trough means,

said holding means allowing said movable elongated structure to slide lengthwise relative to said elongated structural means of said pivotal trough means.

8. Apparatus for transferring pipe or the like between the floor of a drilling rig and pipe rack means, comprising,

an elongated support frame adapted to be located close to the pipe rack means,

trough means supported by said support frame and comprising elongated structural means having opposed elongated side walls,

movable means supported for movement along the length of said elongated structural means,

means for moving said movable means along the length of said elongated structural means,

movable elongated structure having opposed elongated side walls supported for lengthwise sliding movement on said elongated structural means of said trough means along its length,

means for removable coupling said movable elongated structure to said movable means to allow said movable means to move said movable elongated structure on said elongated structural means of said trough means along its length,

said movable elongated structure means being adapted to receive and carry pipe as it is moved by said movable means on said elongated structural means of said trough means along its length.

9. The apparatus of claim 8 wherein said means for removably coupling said movable elongated structure to said movable means comprises,

aperture means formed through the bottom of said movable elongated structure near one end thereof, and

securing means connected to said movable means and extending upward,

said securing means being adapted to be removably fitted into said aperture means from below the bottom of said movable elongated structure.

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10. A system for transferring lengths of pipe laterally between a pipe rack means and a pipe handling apparatus, said pipe handling apparatus comprising an elongated frame, said pipe rack means being located on one side of said elongated frame, said system comprising,

two spaced apart pivotally supported arms located on said one side of said frame next to said pipe rack means, each arm having one end pivotally coupled to support means such that its opposite end may move upward and downward,

said two arms being located generally in line with each other for pivotal movement about generally parallel pivot axes respectively,

trough means pivotally coupled to said arms at said opposite ends such that said trough means will move upward and downward with said opposite ends of said arms,

said trough means being capable of supporting a length of pipe,

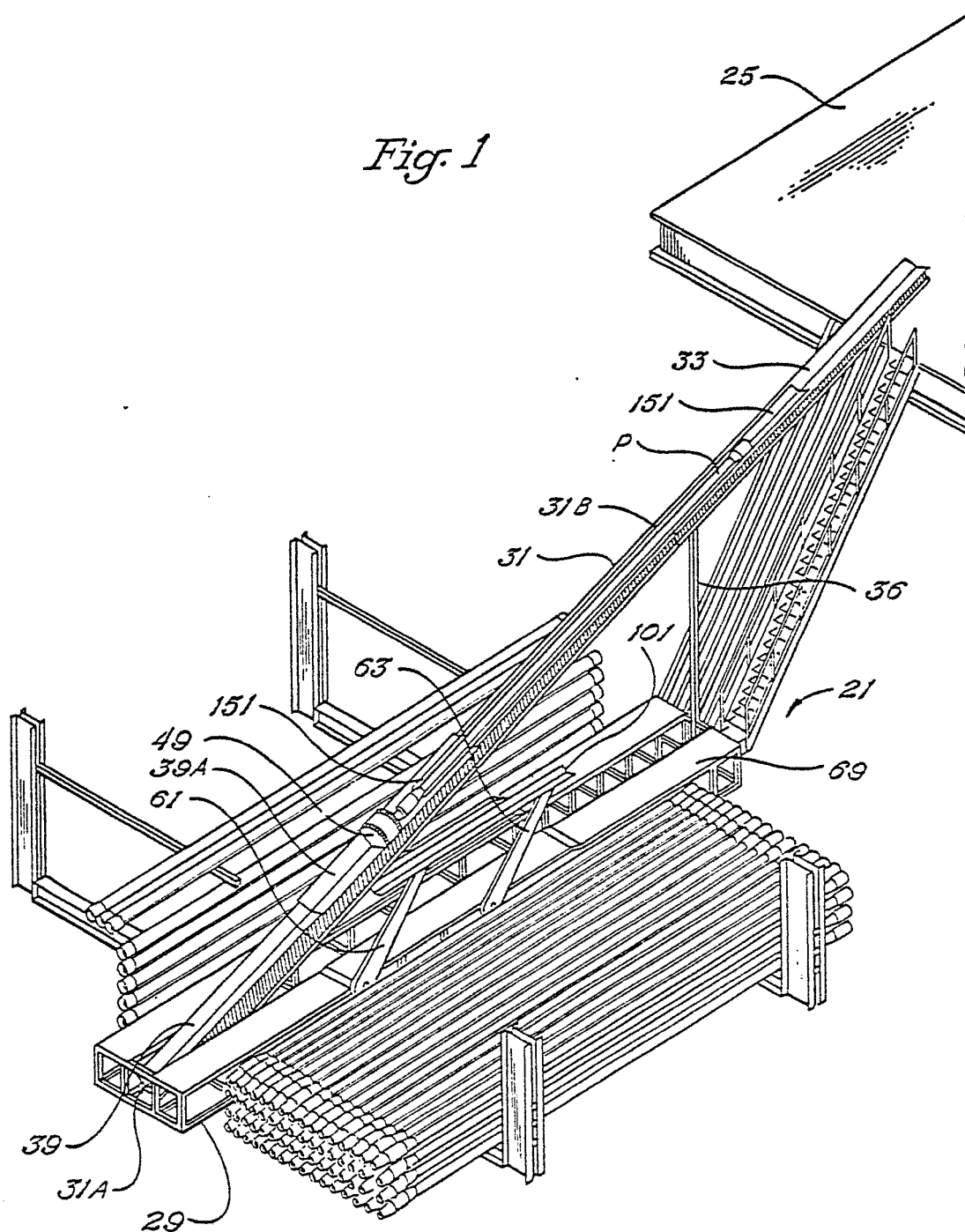
means for tilting said trough means laterally in opposite directions, and

means for moving said arms about their axes respectively for moving said opposite ends of said arms and said trough means upward and downward.

11. The system of claim 10, wherein,

said trough means is pivotally coupled to said opposite ends of said arms such that the length of said trough is held generally horizontal as said opposite ends of said arms are moved upward or downward,

said trough means is supported to be tilted laterally in opposite directions about an axis transverse to said axes.

Fig. 1

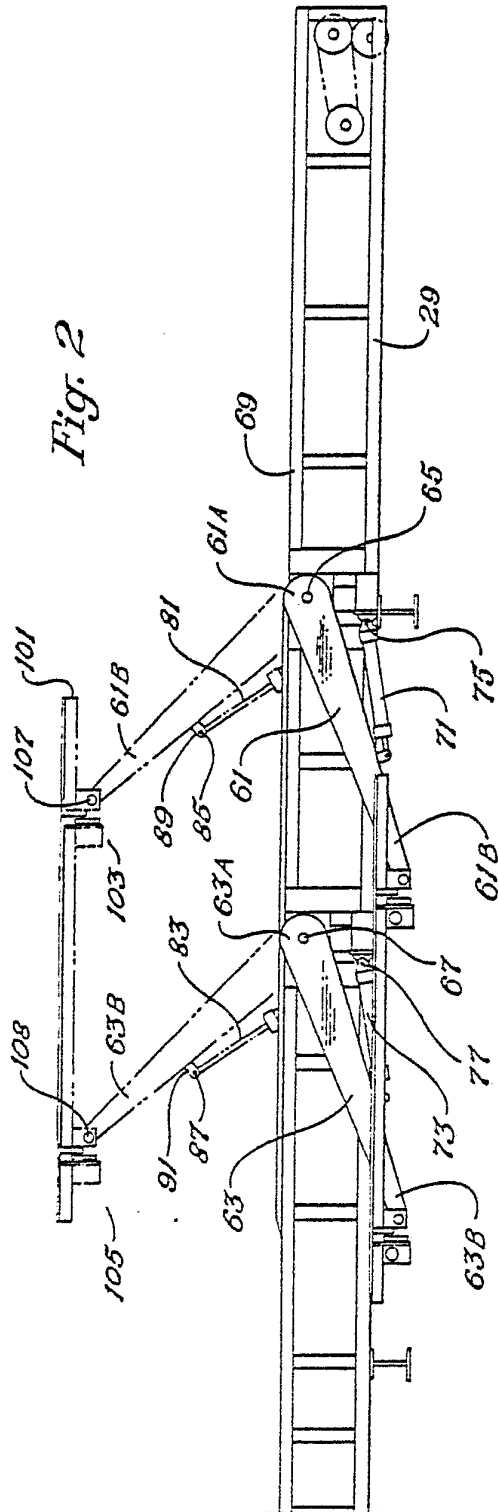


Fig. 2

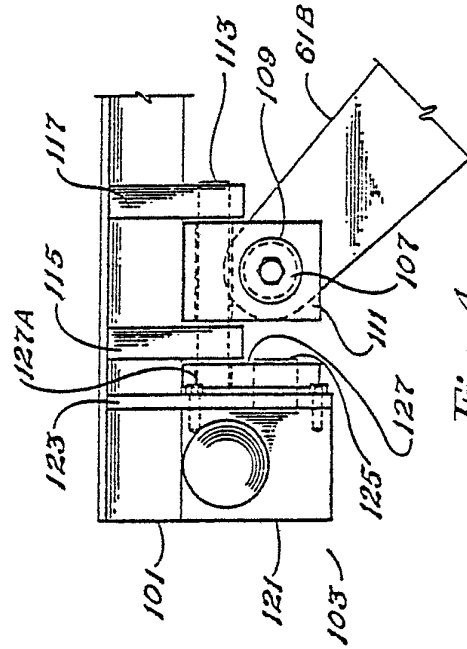


Fig. 4

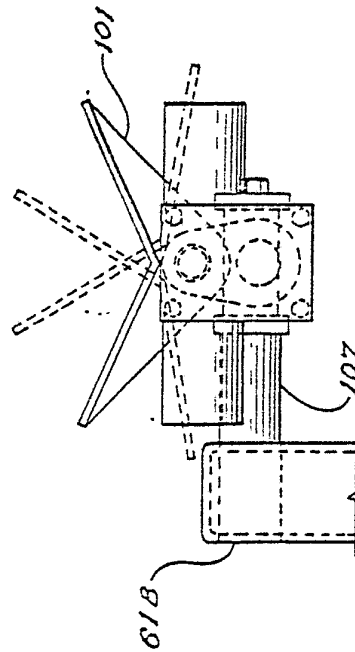


Fig. 3

Fig. 5

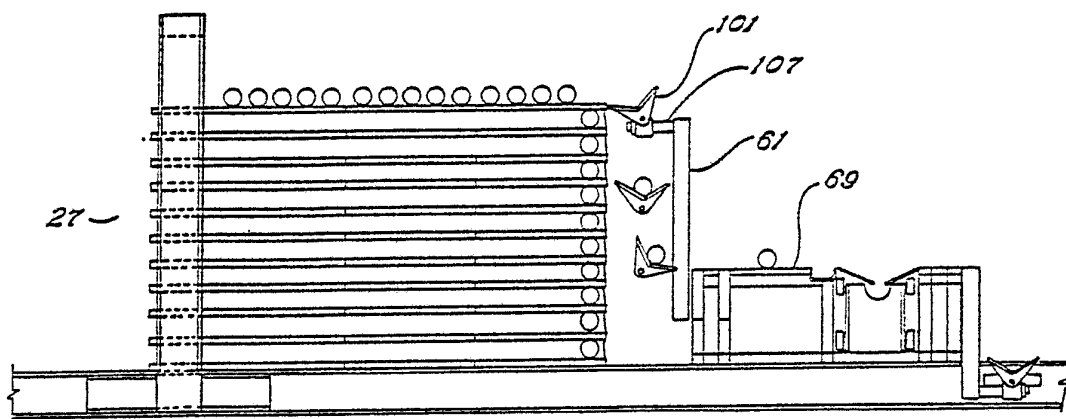


Fig. 6

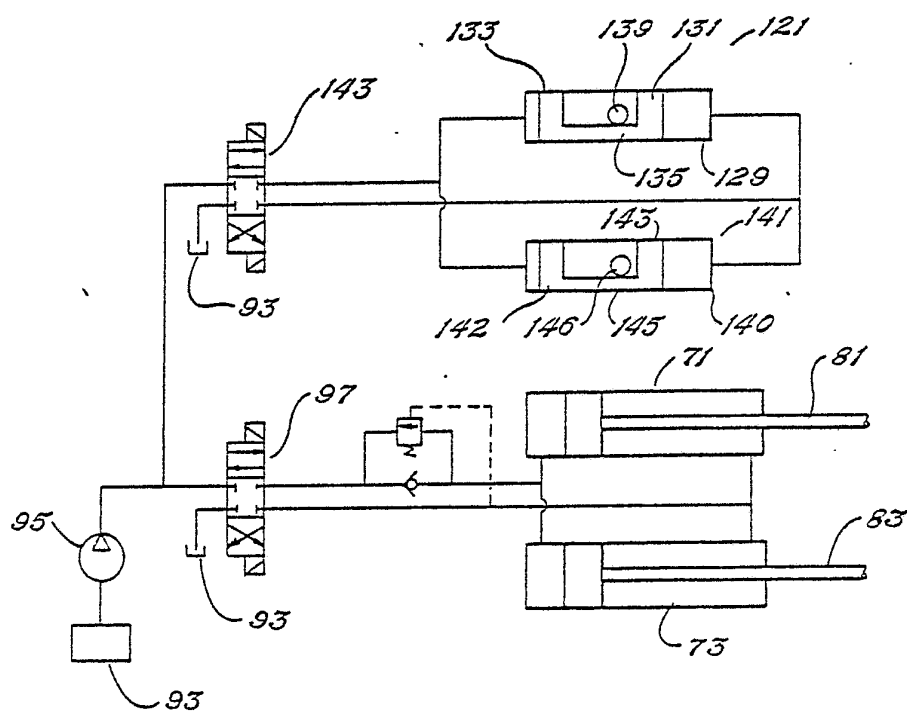


Fig. 7

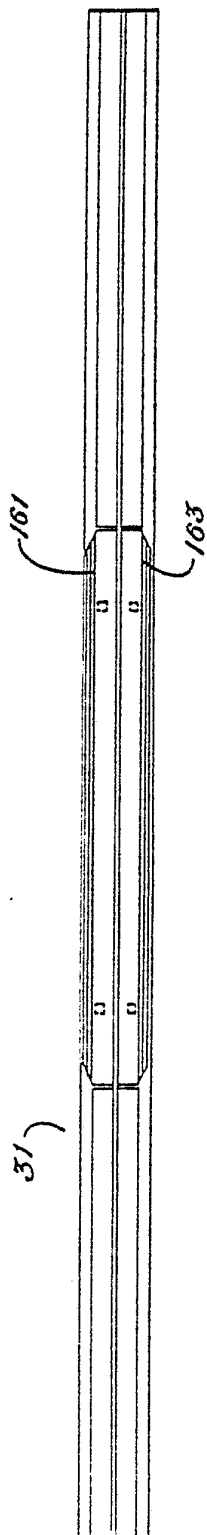
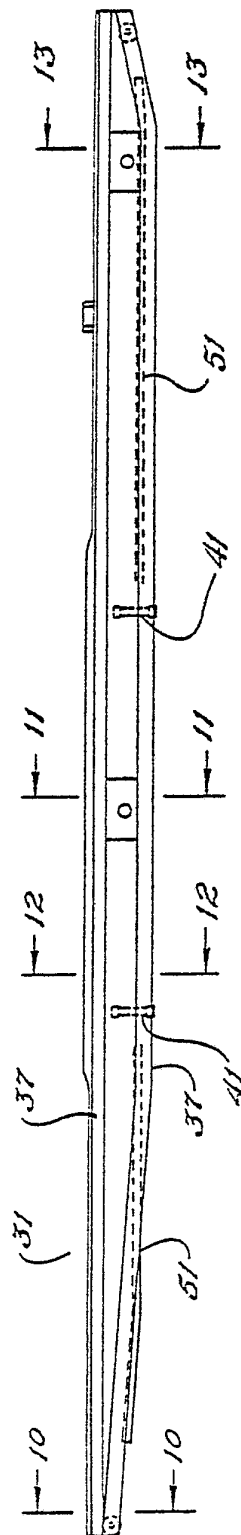


Fig. 8



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Fig. 9

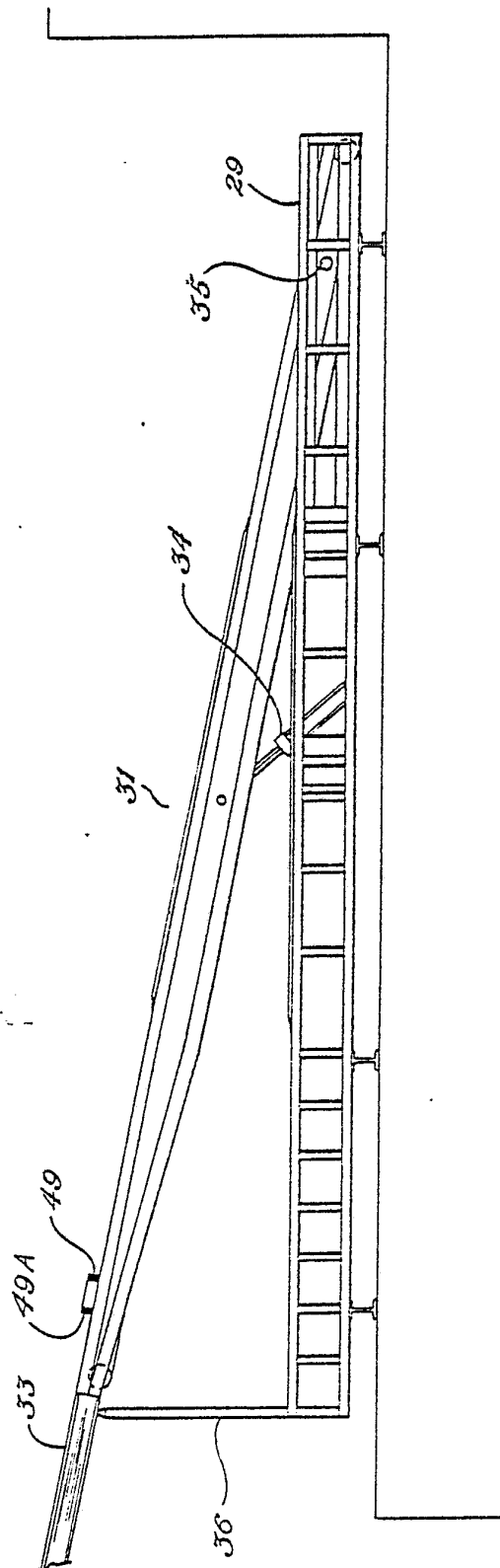


Fig. 10

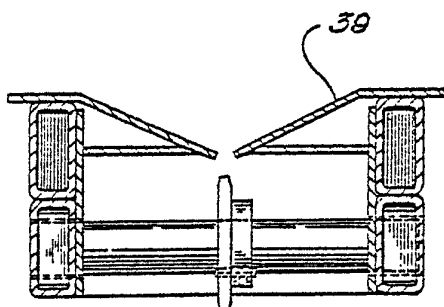


Fig. 11

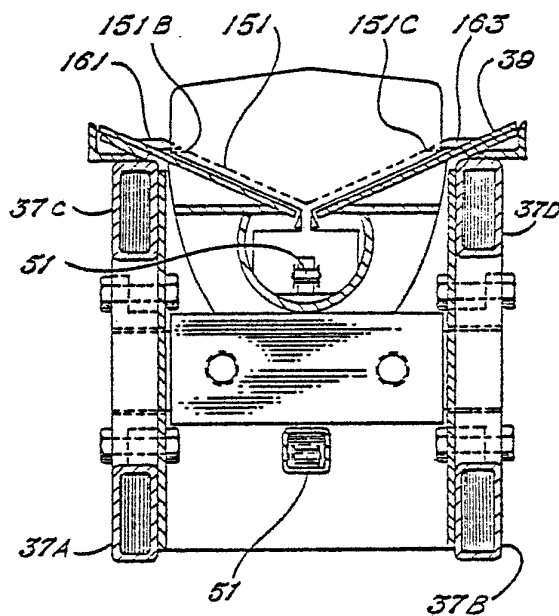
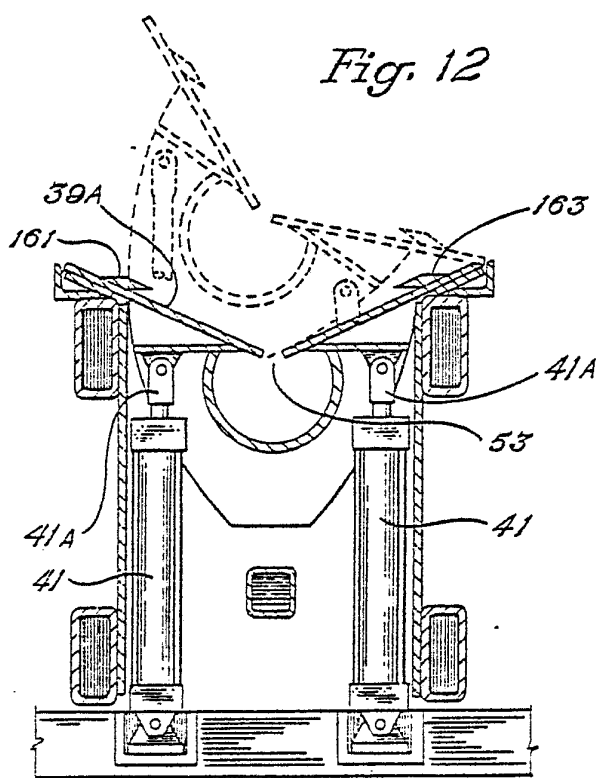


Fig. 12



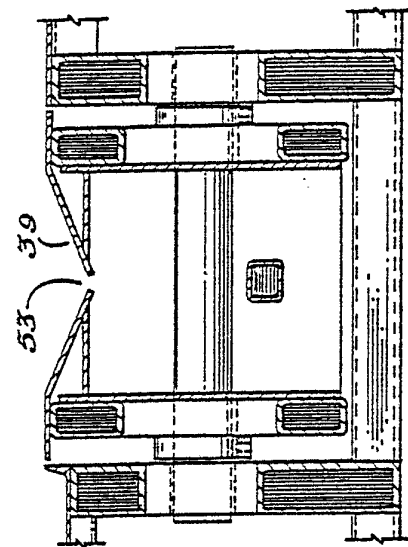


Fig. 13

Fig. 14

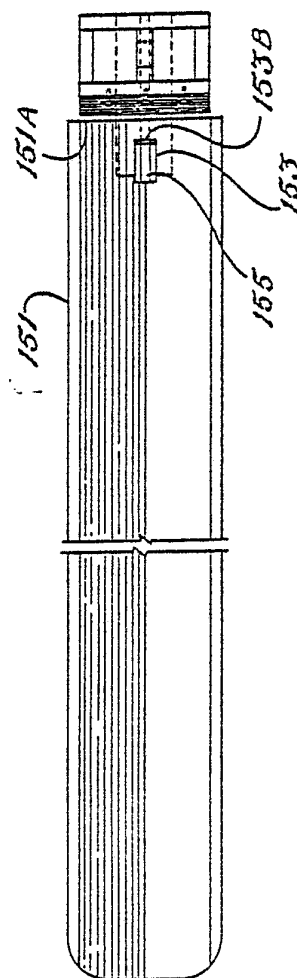


Fig. 15

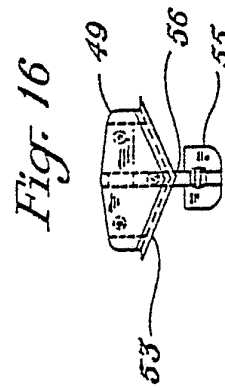
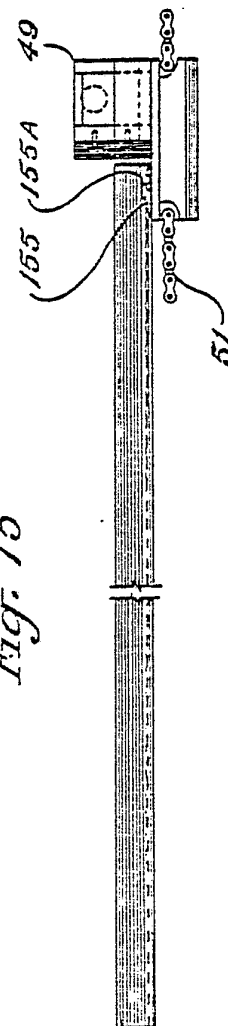
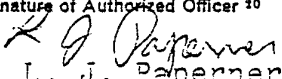
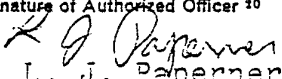
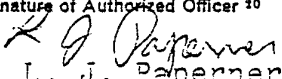


Fig. 16

INTERNATIONAL SEARCH REPORT

International Application No PCT/US 81/01230

I. CLASSIFICATION OF SUBJECT MATTER (If several classification symbols apply, indicate all) ³ According to International Patent Classification (IPC) or to both National Classification and IPC Int. Cl. ³ E21B 19/14 U.S. Cl. 414/22																										
II. FIELDS SEARCHED Minimum Documentation Searched ⁴ <table style="width: 100%; border-collapse: collapse;"> <tr> <th style="width: 25%; border-bottom: 1px solid black;">Classification System</th> <th style="border-bottom: 1px solid black;">Classification Symbols</th> </tr> <tr> <td style="text-align: center; vertical-align: middle; padding: 10px;">US</td> <td style="text-align: center; vertical-align: middle; padding: 10px;">414/22, 276, 745, 747, 748; 175/52, 85; 211/60S</td> </tr> </table> Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched ⁵			Classification System	Classification Symbols	US	414/22, 276, 745, 747, 748; 175/52, 85; 211/60S																				
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• Special categories of cited documents: ¹⁶ "A" document defining the general state of the art "E" earlier document but published on or after the international filing date "L" document cited for special reason other than those referred to in the other categories "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but on or after the priority date claimed "T" later document published on or 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 "X" document of particular relevance																										
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FURTHER INFORMATION CONTINUED FROM THE SECOND SHEET

V. ☐ OBSERVATIONS WHERE CERTAIN CLAIMS WERE FOUND UNSEARCHABLE ¹⁰

This international search report has not been established in respect of certain claims under Article 17(2) (a) for the following reasons:

1. ☐ Claim numbers _____, because they relate to subject matter ¹² not required to be searched by this Authority, namely:

2. ☐ Claim numbers _____, because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out ¹³, specifically:

VI. ☒ OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING ¹¹

This International Searching Authority found multiple inventions in this international application as follows:

I. Claims 1-9.

II. Claims 10-11.

1. ☒ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims of the international application.

2. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims of the international application for which fees were paid, specifically claims:

3. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claim numbers:

Remark on Protest

☐ The additional search fees were accompanied by applicant's protest.

☐ No protest accompanied the payment of additional search fees.