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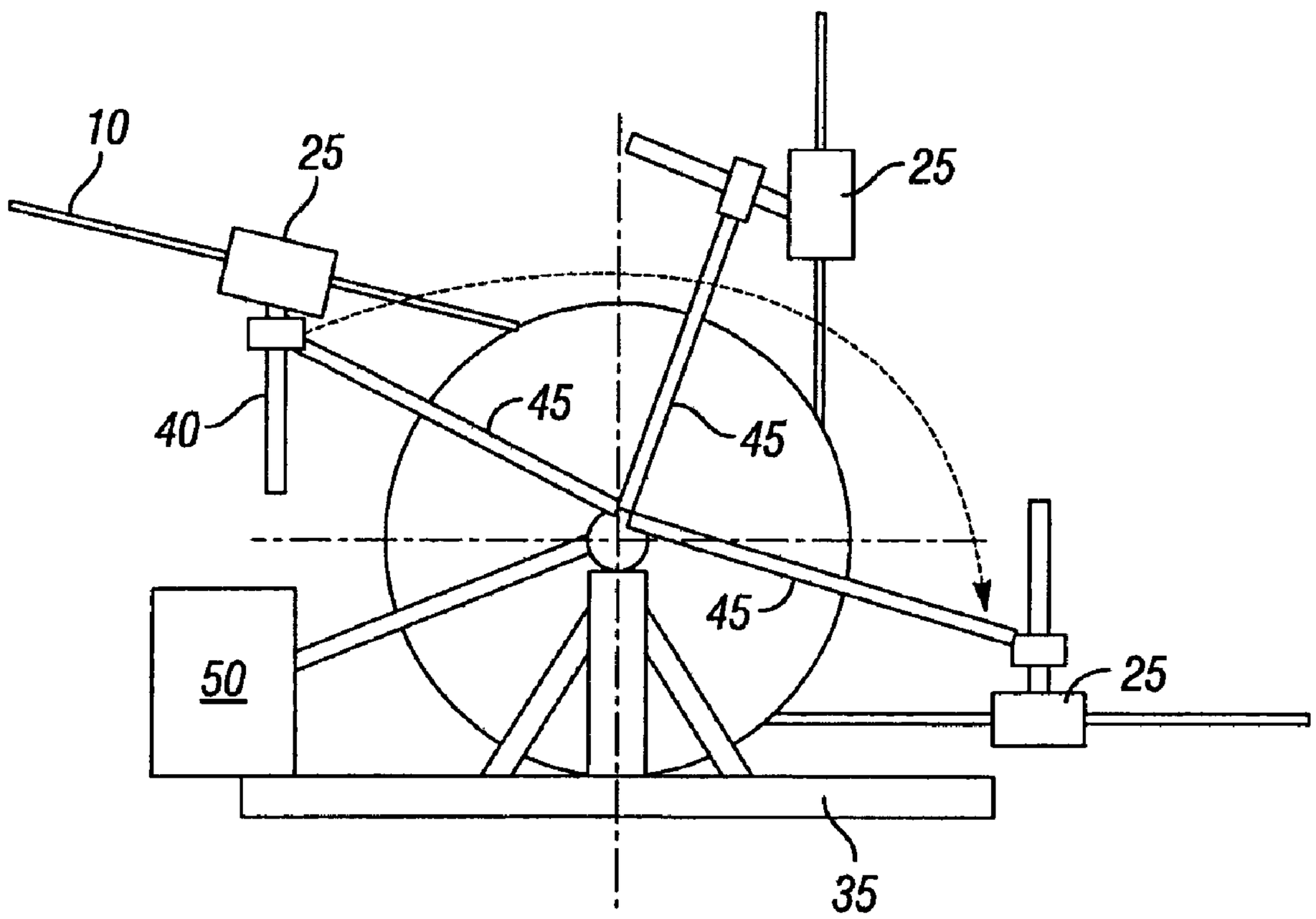
(54) Title: SYSTEM AND METHOD FOR SPOOLING COILED TUBING



(57) Abrégé/Abstract:
A system and method for spooling coiled tubing is provided, the system including a second levelwind mechanism. The second levelwind is positioned adjacent ground level, thereby eliminating the need for personnel to work at heights associated with traditional spooling of coiled tubing from one reel to another. Coiled tubing is transferred from one reel to another reel on the low side of the spool so that personnel may work at ground level.

ABSTRACT

A system and method for spooling coiled tubing is provided, the system including a second levelwind mechanism. The second levelwind is positioned adjacent ground level, thereby eliminating the need for personnel to work at heights associated with traditional spooling of coiled tubing from one reel to another. Coiled tubing is transferred from one reel to another reel on the low side of the spool so that personnel may work at ground level.

PATENT

CANADIAN PATENT APPLICATION

for

SYSTEM AND METHOD FOR SPOOLING COILED TUBING

by

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BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a system and method for spooling coiled tubing for use in the oil and gas industry. More particularly, the present invention relates to a system and method for spooling coiled tubing from one spool to another at ground/deck level, thereby eliminating the need for working at heights.

Description of the Related Art

There are many desirable applications for using coiled tubing in oil and gas wells. More and more of these applications require longer strings of coiled tubing for work in deeper wells, require larger diameter coiled tubing, or require both longer strings of larger diameter tubing. Due to weight and/or height limitations, it is common to transport multiple smaller reels of coiled tubing to a well site wherein the coiled tubing is re-spooled onto a master spool before being injected into the wellbore. This is particularly true for offshore wells where more and more crane restrictions require lighter and lighter loads of coiled tubing strings, drums and related equipment. This is especially true for larger diameter tubing such as $2^3/_8$ inch and $2^7/_8$ inch coiled tubing strings. Once the smaller and lighter reels of coiled tubing are transported to location, the various strings of coiled tubing are connected together and spooled onto a master reel.

Once on location, spooling of coiled tubing from one coiled tubing reel to the other is normally performed at a height determined by the height of the equipment used,

especially the coiled tubing reels themselves. This can be several meters high at a minimum. The coiled tubing is transferred from one reel to the other on the high side of the coiled tubing drums. Personnel performing the work for this operation are required to work at these heights on either temporary platforms or specially designed equipment. Spooling devices (e.g., a levelwind) for correctly spooling the coiled tubing on and off the coiled tubing reels are required and one is provided as standard on most coiled tubing reel foundations. The larger the coiled tubing size, the more difficult the process becomes due to the coiled tubing residual bend forces involved and handling them at height.

Any time an operator is working with large diameter coiled tubing (i.e., 2 inch diameter and larger pipe), the operator is working with some of the largest reels in the industry. These reels which store the large diameter coiled tubing and operate the coiled tubing are typically much larger than conventional coiled tubing reels. Hence, the drum diameter and the flange diameter of these larger coiled tubing reels may be on the order of twice the size of conventional coiled tubing reels. Because of this additional height, the conventional levelwinds for spooling the pipe to allow the tubing to be spooled off the drum and to feed onto the drum is mounted even higher on top of the coiled tubing assembly. Consequently, work associated with the coiled tubing operations, such as maintenance work on the levelwind or threading the coiled tubing through the levelwind, must be performed at working heights upwards of 5½ to 6½ meters above ground level or deck level.

Thus, there is a need for a system and process for spooling coiled tubing from one spool to another that improves safety and work conditions for such operations. There is also a need for improved control over coiled tubing, especially the larger sizes, allowing controlling of bending and pulling forces in a more suitable manner. The present invention addresses one or more of these needs.

SUMMARY OF THE INVENTION

According to one embodiment of the present invention, by adding a spooling device (i.e., a second levelwind) to the back of a conventional coiled tubing reel, the present invention enables personnel to work at ground/deck level with the coiled tubing being spooled on/off the low side of the coiled tubing reels. Improved safety and working conditions are a direct result of eliminating the need for personnel to work at heights. Additional types of work can be performed, including cutting out or adding sections of coiled tubing, installing or removing spoolable connectors or performing welding work. The portable spooling device can be moved to either coiled tubing drum, as required by the direction of coiled tubing movement. Alternatively, a second levelwind may be added to both the supply reel and the service reel. Especially for the larger coiled tubing sizes (i.e., 2 inches and above), improved control of the spooling process without having to work at height is realized.

An alternative embodiment uses a single levelwind wherein the levelwind is adapted to rotate about the reel from a spooling position adjacent to ground level to an

operational position for conventional operations running coiled tubing to the injector an on into a well.

The foregoing summary is not intended to summarize each potential embodiment or every aspect of the subject matter of the present disclosure. Other objects and features of the invention will become apparent from the following description with reference to the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a schematic of the traditional way of spooling coiled tubing from one reel to another on the high side of the reels using the conventional levelwinds;

Figure 2 is a schematic of one embodiment of the present invention illustrating coiled tubing being transferred from one reel to the other on the low side of the reels;

Figure 3 is a more detailed schematic of one embodiment of the invention using a second levelwind mounted adjacent ground/deck level;

Figure 4 illustrates an elevating man rider system for access to the upper conventional levelwind;

Figure 5 is a schematic of an alternative embodiment of the invention having a single levelwind rotatable between an operational position and a spooling position; and

Figure 6 illustrates one embodiment for pivoting the elevating man rider system and the rotatable levelwind shown in Figure 5.

While the invention is susceptible to various modifications and alternative forms, specific embodiments have been shown by way of example in the drawings and will be

described in detail herein. However, it should be understood that the invention is not intended to be limited to the particular forms disclosed. Rather, the intention is to cover all modifications, equivalents and alternatives falling within the spirit and scope of the invention as defined by the appended claims.

Description of Illustrative Embodiments

Illustrative embodiments of the invention are described below as they might be employed in the use of a safer system and method for spooling coiled tubing at a well site. In the interest of clarity, not all features of an actual implementation are described in this specification. It will of course be appreciated that in the development of any such actual embodiment, numerous implementation-specific decisions must be made to achieve the developers' specific goals, such as compliance with system-related and business-related constraints, which will vary from one implementation to another. Moreover, it will be appreciated that such a development effort might be complex and time-consuming, but would nevertheless be a routine undertaking for those of ordinary skill in the art having the benefit of this disclosure.

When using large diameter coiled tubing, it is important to use correspondingly large diameter coiled tubing reels. The large diameter reels are required because they reduce the bending loads on the coiled tubing that would occur on smaller diameter reels. However, due to the weight of such large diameter reels, it is common to transport the reels either empty or only partially loaded with coiled tubing. Once on location, the entire length of coiled tubing needed for a particular well (or wells) may be spooled onto

the service reel. Several shipping or supply reels with shorter lengths (e.g., 6000 feet of $2^7/_8$ inch tubing or less) may be required to provide the length of coiled tubing needed for a particular application. The shipping reels are lighter weight due to the shorter lengths of coiled tubing stored on them. Special connectors such as Duralink connectors from BJ Services Company, may be used to connect the various lengths of coiled tubing when spooling the coiled tubing off of the supply reels and onto the master service spool. Such connectors are described in U.S. Patent Application Serial Number 10/394,392, filed March 21, 2003, entitled "Composite Low Cycle Fatigue Coiled Tubing Connector," the disclosure of which is incorporated herein by reference in its entirety.

Figure 1 illustrates the traditional way of spooling coiled tubing 10 from a shipping/supply reel 15 to a second reel 20, typically referred to as the service reel. The spooling is typically accomplished by transferring the coiled tubing from one reel to another on the high side using the conventional levelwind mechanisms 25 associated with each reel. Due to the diameters of the reels, the coiled tubing is being transferred at a working height of 15 to 20 feet above ground level.

One exemplary embodiment of the present invention is illustrated in Figure 2. In this embodiment, a second levelwind is used with at least service reel 20. More preferably, a second levelwind is used with each coiled tubing reel. The second levelwinds 30 are located on the backside of the reels adjacent to the bottom of the reels. In a preferred embodiment, the second levelwinds are inverted in their orientation relative to the conventional levelwinds attached to each reel. According to one embodiment, the second inverted levelwinds are skid mounted (not shown) and may be attached to the

frame of the reels by any suitable means such as pinning the second levelwind skid to the base skid of the reel. The second levelwind may be attached to the reel on location thereby allowing lighter lifts of the reels and portable second levelwinds.

Figure 3 illustrates an exemplary preferred embodiment of the invention in more detail. Reel 18 includes a self supporting base structure 35. Coiled tubing 10 is spooled about reel 18. One of skill will understand that reel 18 may be either a supply reel or a service reel. Levelwind 25 is shown in the normal levelwind position for conventional operations running coiled tubing to the injector head (not shown). Levelwind 25 is supported on telescoping pole 40. Telescoping pole 40 allows extension of the levelwind when the wrapping diameter changes on the drum. Pole 40 is attached to one end of arm 45, the other end of arm 45 extending to the axis of reel 18. A comparable arm extends from the axis on the other side of reel 18 (not shown). A portable second levelwind 30 is mounted behind the reel for spooling at ground/deck level. Preferably, the second levelwind is inverted (relative to levelwind 25) to facilitate diameter changes about the drum as the coiled tubing 10 is unwrapped from (or wrapped onto) the drum. Levelwind 30 may be integral to base 35 or may be mounted to its own separate stand alone base (not shown). In the latter case, the base for levelwind 30 may be connected to reel base 35 by pinning or other suitable means.

Figure 3 also illustrates an alternative safety feature of the present invention. Elevating man rider apparatus 50 extends from pivotable arms 55 connected to the axis of reel 18. Elevating man rider apparatus 50 provides access to the upper conventional levelwind 25. Apparatus 50 may be a basket or platform or other suitable structure that

allows one or more personnel to work safely upon the upper levelwind as needed (e.g., maintenance on the levelwind, threading coiled tubing 10 through levelwind 25, etc.). Apparatus 50 may be raised or lowered by pivoting arms 55 relative to the axis of the reel either hydraulically, electrically or pneumatically. In a preferred embodiment, arms 55 may be raised or lowered by telescoping hydraulical cylinders 60 (shown in Figure 6) that are connected to support members on base 35. Apparatus 50 may be raised by extending hydraulic cylinders 60, and lowered by retracting the cylinders. Figure 4 illustrates the man rider apparatus in an elevated position. Figure 4 also illustrates an alternative embodiment wherein pole 40 and arms 45 are inverted relative to levelwind 25, thereby providing a less obstructive work area for personnel in man rider apparatus 50.

The separate, second levelwind spooling system on the coiled tubing reel facilitates spooling of the coiled tubing from the shipping/supply reel to the service reel at ground level, thus eliminating working at heights. When utilizing the present invention, personnel would typically be working at heights ranging from 1½ to 3 feet above ground level. Thus, maintenance work, welding, making connections and the like may be performed at a safer working height compared to traditional spooling operations.

The levelwind according to the preferred embodiment is a traditional levelwind mechanism which tracks on a double worm screw to feed coiled tubing across the width of the reel from flange to flange. Telescopic pole 40 allows the levelwind mechanism to float up and down to accommodate varying heights as the coiled tubing is spooled and unspooled from the reel.

In an alternative embodiment shown in Figure 5, a single levelwind mechanism 25 may be used on the high side of the spool for running the coiled tubing in and out of a wellbore, and may also be used to transfer the tubing from one reel to another on the low side of the reel. When receiving tubing from another spool, the levelwind 25 could be rotated relative to the reel from the high side to the back side of the reel (i.e., rotated approximately 180° about the axis of the reel as indicated by the depiction of levelwind 25 and arm 45). Arms 45 are rotated about the axis of the spool by suitable hydraulic, electric or pneumatic means. The levelwind preferably works inverted so an operator would not have to disconnect the pipe when converting from injecting operations to spooling operations, or vice versa. Once the spooling has been finished, an operator could cut the coiled tubing 10 and then rotate the levelwind about the axis of the reel. In this way, the coiled tubing 10 would not have to be removed from the levelwind when converting from one operation to another.

Figure 6 illustrates one embodiment for rotating levelwind 25 between the operational position and the spooling position. Telescoping hydraulic cylinders 65 are connected to arms 45 on one end and support members of base 35 on the other end. The levelwind may be rotated between the operational and spooling positions by the retraction or extension of cylinders 65.

The present invention provides improved control over the coiled tubing, especially for larger sizes, allowing control of bending and pulling forces in a more suitable manner. Coiled tubing that is spooled off of a reel retains a residual bend from the wrapping diameter of the drum that it was spooled on. Thus, the tubing does not

come off the reel perfectly straight. In order to connect two ends of coiled tubing together, an operator must attempt to straighten the ends of the tubing to be joined together. Coiled tubing connectors, such as Duralink connectors, require additional equipment (e.g., jigs and clamps) to help align, manipulate and straighten the tubing ends for installation of such connectors. Using such equipment at ground level facilitates and expedites the installation of the connectors as well as improves the safety conditions surrounding the installation process.

Although various embodiments have been shown and described, the invention is not so limited and will be understood to include all such modifications and variations as would be apparent to one skilled in the art. Accordingly, the invention is not to be restricted except in light of the attached claims and their equivalents.

CLAIMS

WHAT IS CLAIMED IS:

1. A system for spooling coiled tubing, the system comprising:

a first tubing reel adapted to spool coiled tubing;

a first levelwind adjacent to a high side of the first tubing reel; and

a second levelwind adjacent to a bottom side of the first tubing reel.

2. A system as defined in claim 1, wherein the second levelwind is inverted relative to the first levelwind.

3. A system as defined in claim 1, the system further comprising:

a pivoting arm connected to an axis of the first tubing reel; and

an elevating apparatus connected to the pivoting arm, whereby the elevating apparatus can be moved relative to the axis of the first tubing reel.

4. A system as defined in claim 1, the system further comprising a second tubing reel having a first levelwind adjacent a high side of the second tubing reel and a second levelwind adjacent to a bottom side of the second tubing reel, whereby the second levelwind of the second tubing reel is adapted to receive the tubing reel from the second levelwind of the first tubing reel.

5. A system as defined in claim 1, wherein the second levelwind is positioned at a height ranging up to 3 feet above ground level.

6. A system as defined in claim 3, wherein the pivoting arm comprises a telescoping hydraulic cylinder used to move the elevating apparatus relative to the axis of the first tubing reel.

7. A system as defined in claim 3, wherein the first levelwind is inverted such that a distal end of a telescoping pole attached to the first levelwind extends in an upward direction.

8. A system for spooling coiled tubing, the system comprising:

a supply reel adapted to spool coiled tubing; and

a levelwind adjacent the supply reel, the levelwind being adapted to rotate about an axis of the supply reel.

9. A system as defined in claim 8, wherein the levelwind is allowed to rotate at least 180 degrees around the axis of the supply reel.

10. A system as defined in claim 8, wherein the levelwind is connected to the supply reel via a pivoting arm, the system further comprising a telescoping hydraulic cylinder having a first and second end, the first end being connected to the pivoting arm and the

second end being connected to a base used to support the supply reel, wherein the levelwind is rotated about the axis of the supply reel via the pivoting arm.

11. A system as defined in claim 8, the system further comprising an elevating apparatus adapted to rotate around the axis of the supply reel.

12. A system as defined in claim 8, the system further comprising a service reel having a levelwind adjacent a bottom side of the service reel, the levelwind of the service wheel being adapted to receive the coiled tubing from the levelwind of the supply reel.

13. A method for spooling coiled tubing, the method comprising the steps of:

(a) providing the coiled tubing to a first levelwind of a supply reel, the first levelwind being adjacent a top side of the supply reel; and

(b) providing the coiled tubing to a second levelwind of the supply reel, the second levelwind being adjacent a bottom side of the supply reel.

14. A method as defined in claim 13, the method further comprising the step of spooling the coiled tubing from the second levelwind of the supply reel to a service reel.

15. A method as defined in claim 14, wherein the step of spooling the coiled tubing to the service reel further comprises the steps of:

spooling the coiled tubing from the second level wind of the supply reel to a second levelwind of the service reel, the second levelwind of the service reel being adjacent a bottom side of the service reel; and

providing the coiled tubing to a first levelwind of the service reel, the first levelwind being adjacent a top side of the service reel.

16. A method as defined in claim 13, the method further comprising the step of rotating an elevating apparatus about an axis of the supply reel, the elevating apparatus adapted to allow an operator access to the first levelwind of the supply reel.

17. A method for spooling tubing about a tubing reel, the method comprising the steps of:

(a) providing the tubing to a levelwind of the tubing reel located adjacent a top side of the tubing reel;

(b) spooling the tubing about the tubing reel; and

(c) rotating the levelwind about an axis of the tubing reel to a location adjacent a bottom side of the tubing reel.

18. A method as defined in claim 17, wherein step (c) further comprises the step of severing the tubing before rotating the levelwind about the axis of the tubing reel.

19. A method as defined in claim 17, the method further comprising the step of spooling the tubing to a separate tubing reel.

20. A method as defined in claim 17, the method further comprising the step of retracting the levelwind from the bottom side location back to the top side location.

21. A method as defined in claim 17, the method further comprising the step of rotating an elevating apparatus about an axis of the tubing reel, the elevating apparatus adapted to allow an operator access to the levelwind of the tubing reel.

22. A system for spooling coiled tubing, the system comprising:

a tubing reel adapted to spool coiled tubing;

a levelwind adjacent to a high side of the first tubing reel; and

an elevating apparatus connected to the tubing reel, whereby the elevating apparatus can be rotated relative to the axis of the tubing reel.

23. A system as defined in claim 22, wherein the elevating apparatus is connected to the tubing reel via a pivoting arm, the pivoting arm comprising a telescoping hydraulic cylinder used to move the elevating apparatus relative to the axis of the tubing reel.

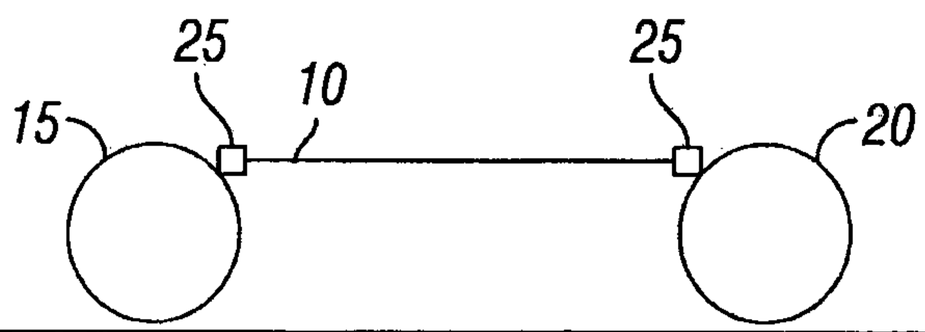


FIG. 1
(Prior Art)

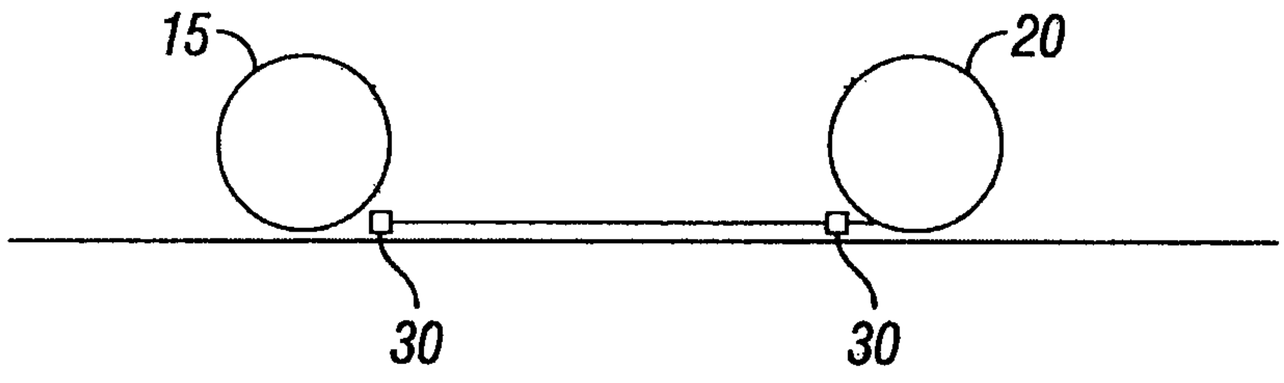


FIG. 2

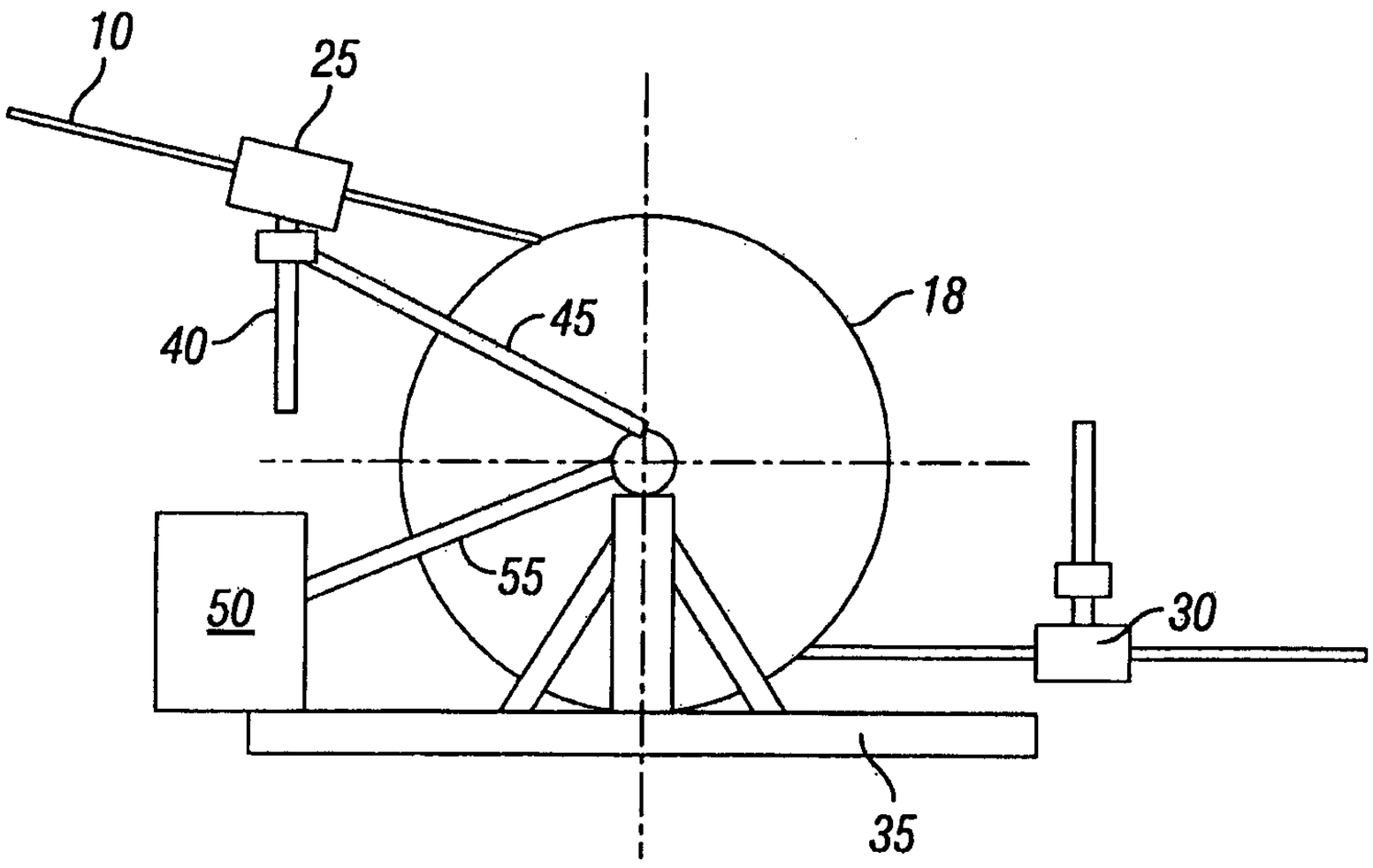


FIG. 3

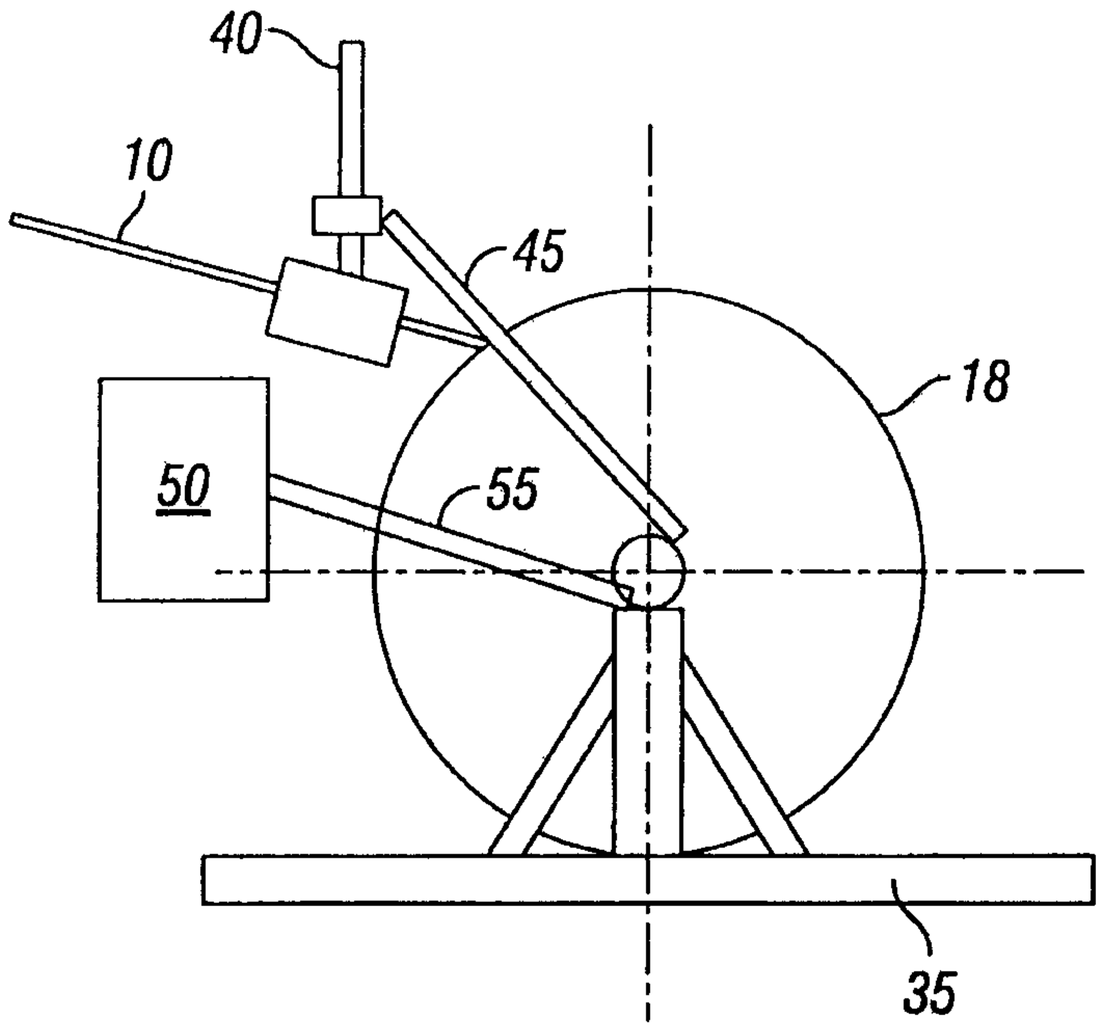


FIG. 4

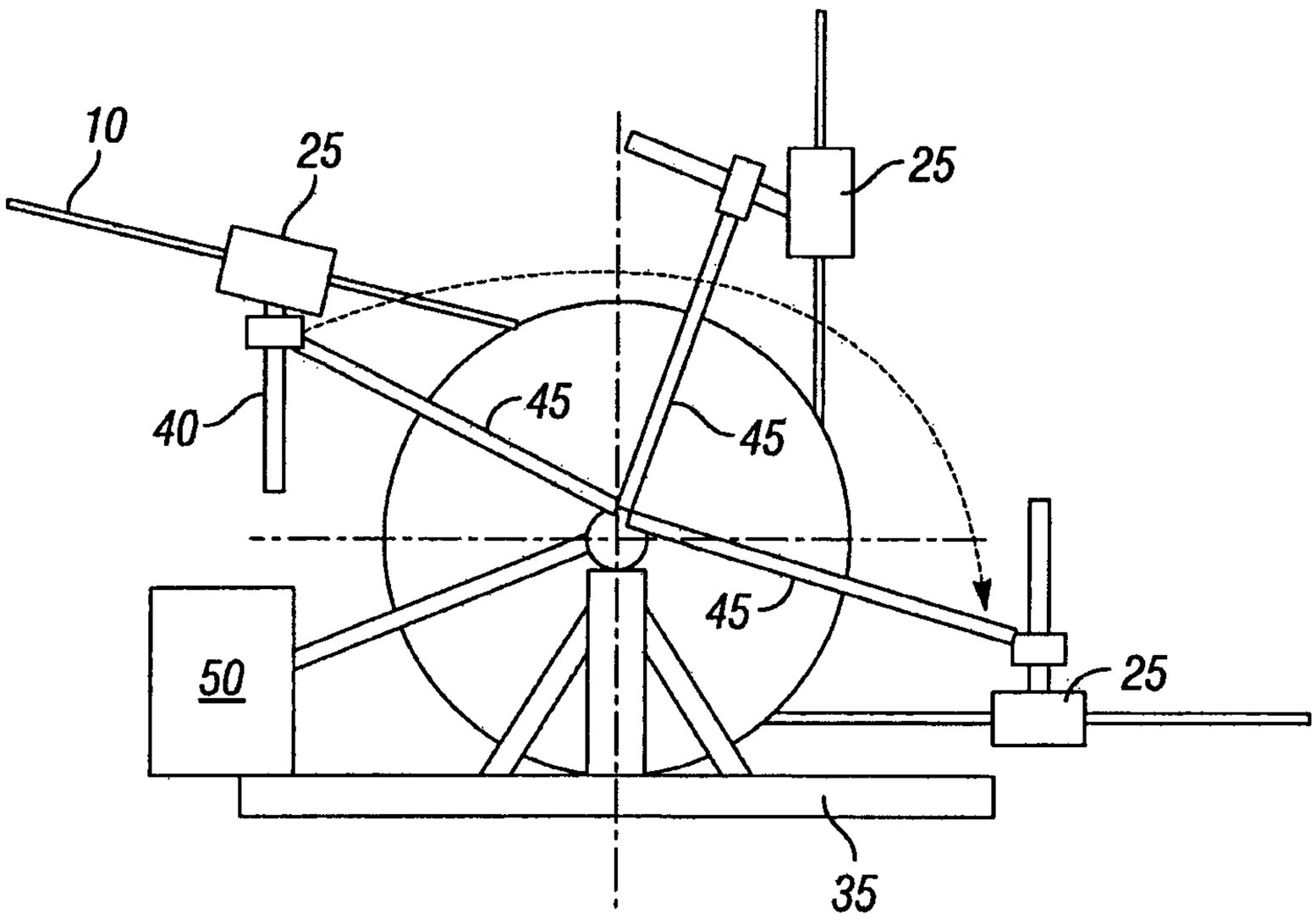


FIG. 5

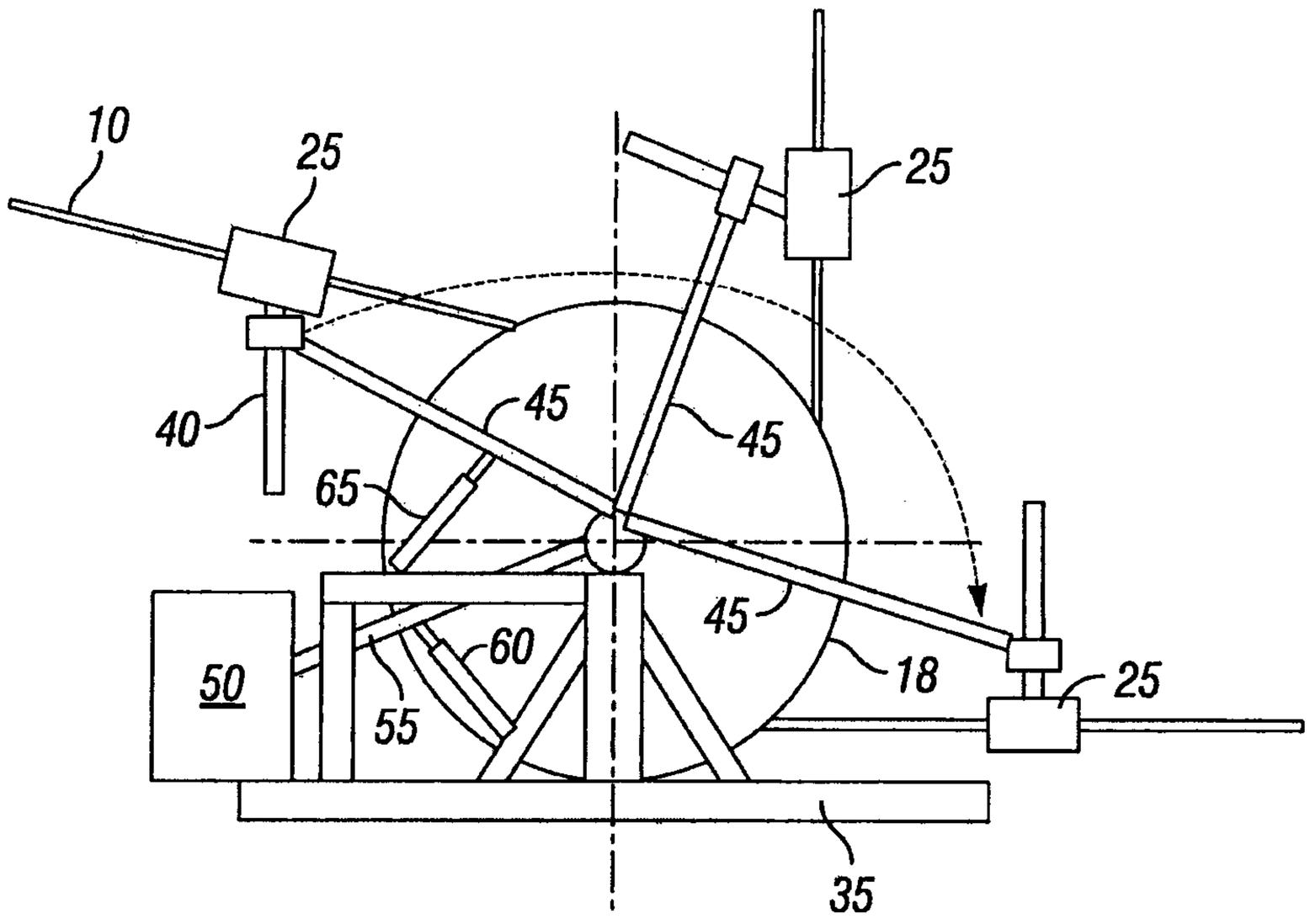
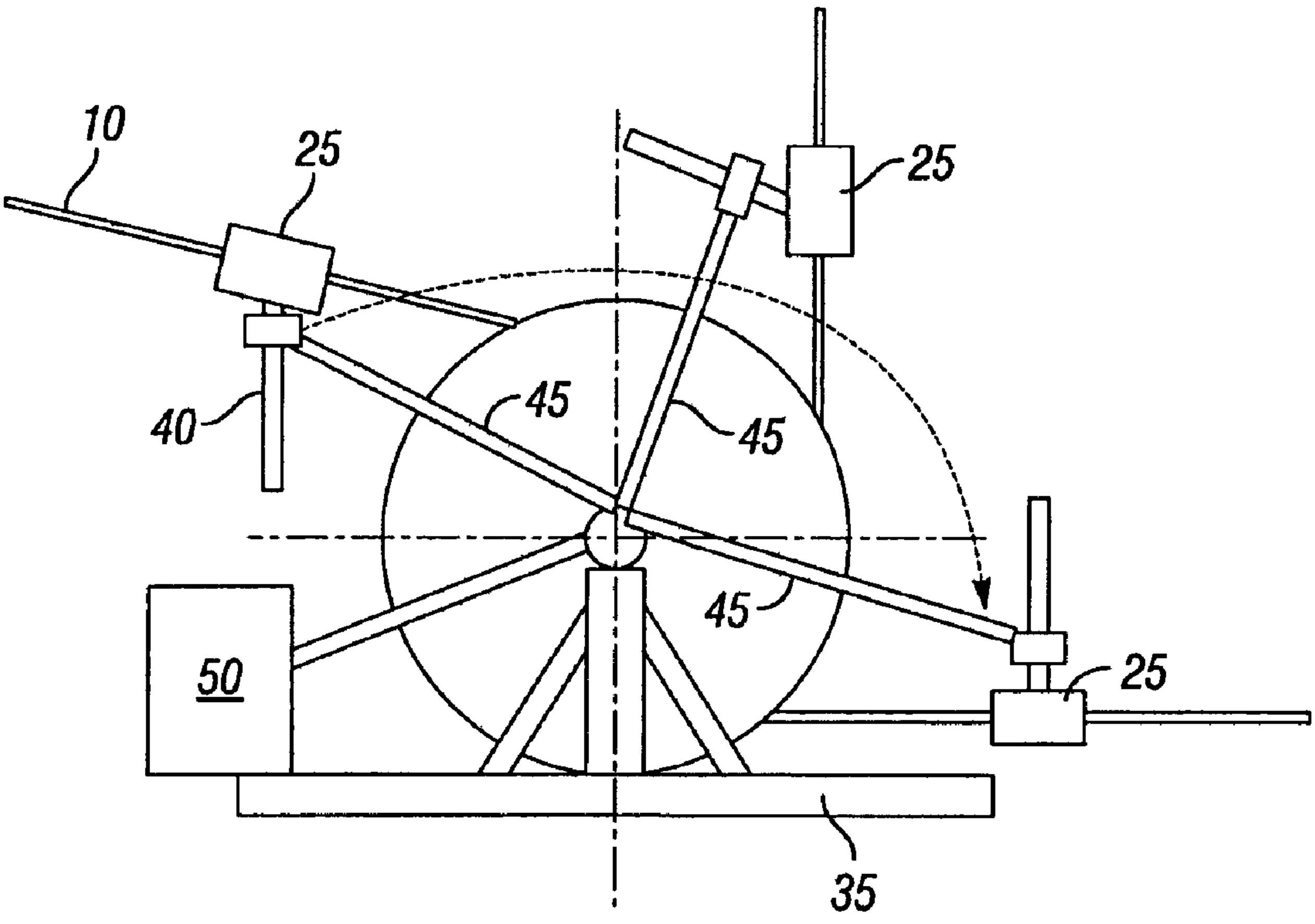


FIG. 6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