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(54) **PIPE POSITION LOCATOR**

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(57) **ABSTRACT**

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At least one sensor is mounted for monitoring the vertical position of an elevator relative to selected features on a pipe string. Mounting for a variety of sensor types is provided. Optional mounting arrangement permits the sensors to be situated close to a pipe free to move laterally, excess lateral movement of the pipe to move the mounting with reduced shock to the sensors.

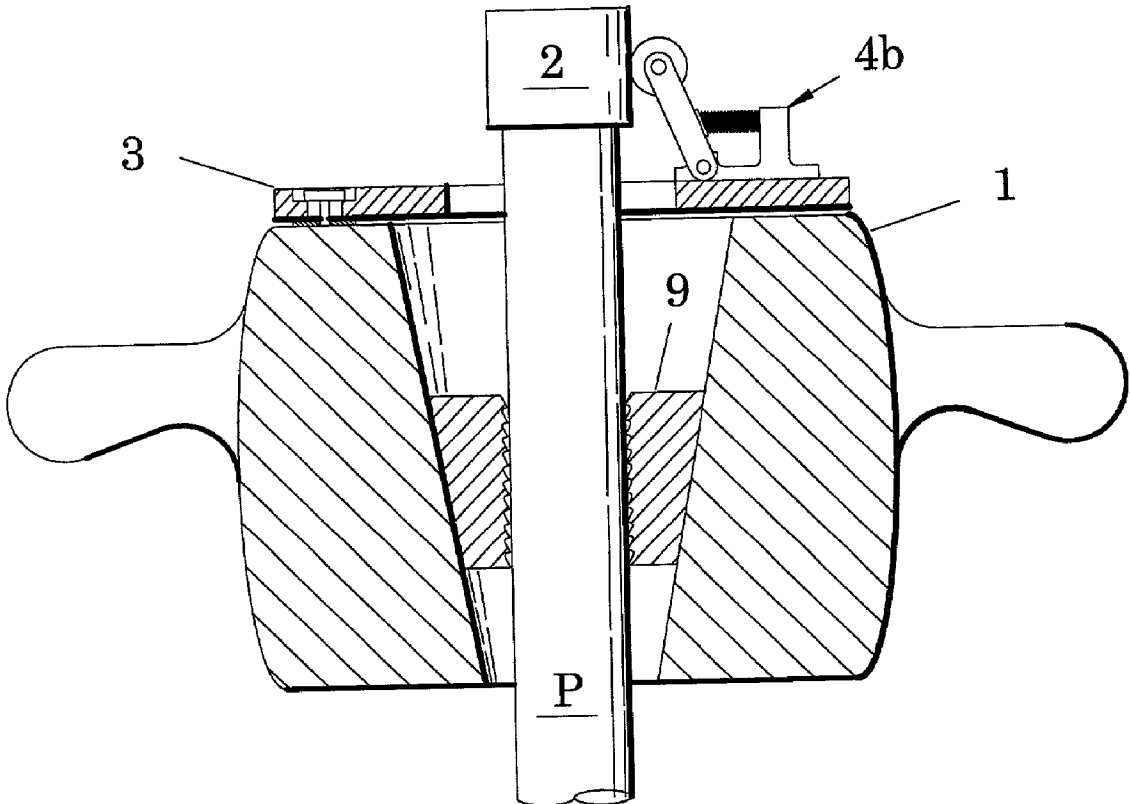


FIG. 1

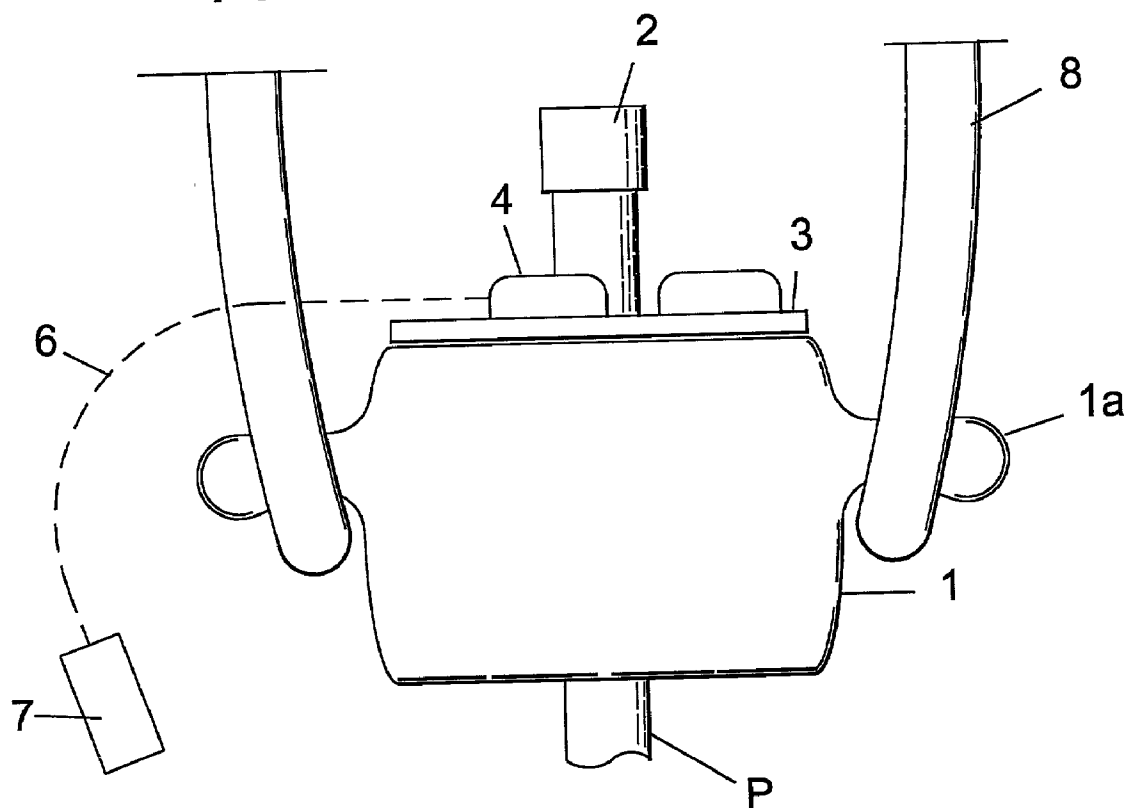


FIG. 2

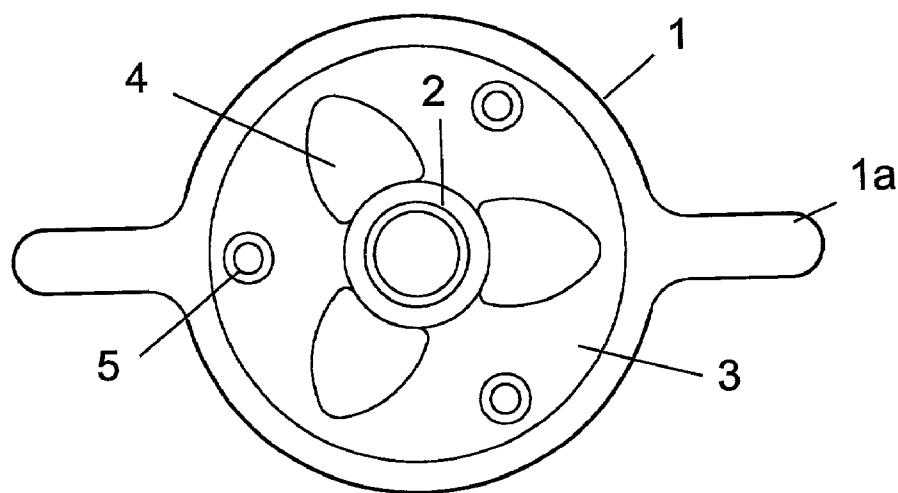


FIG. 3

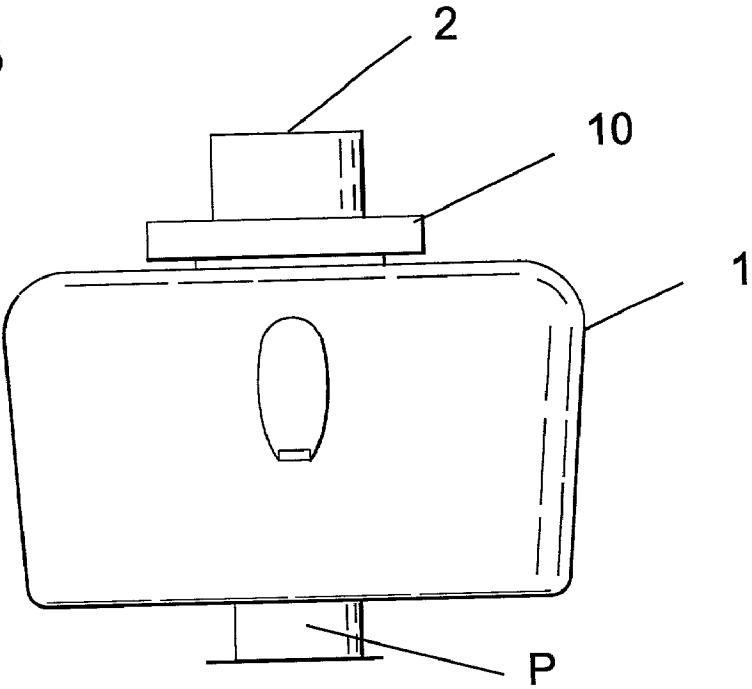


FIG. 4

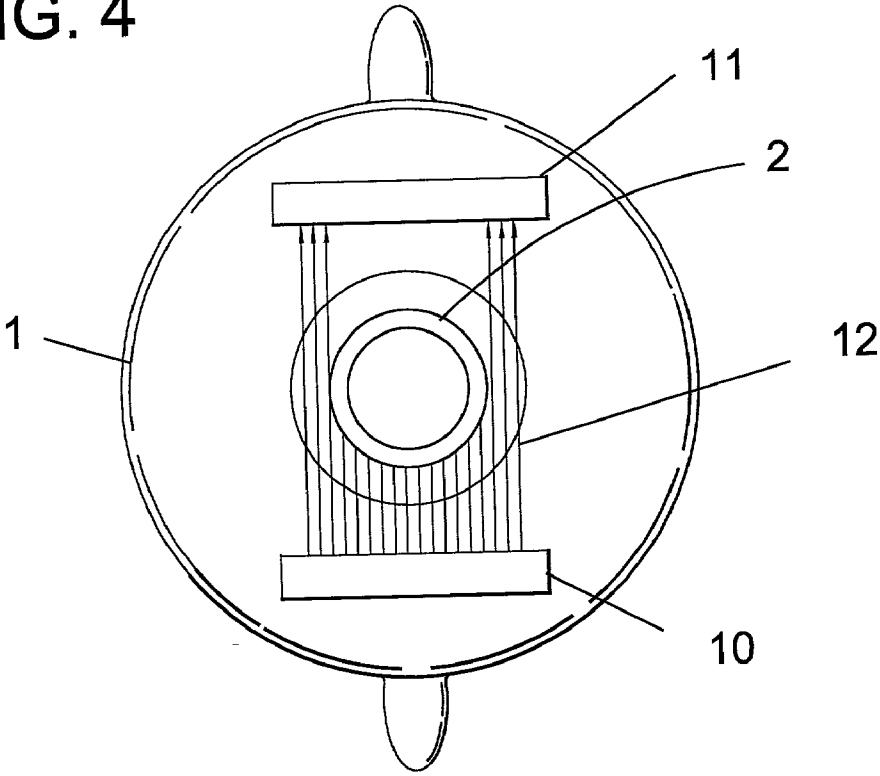


FIG. 5

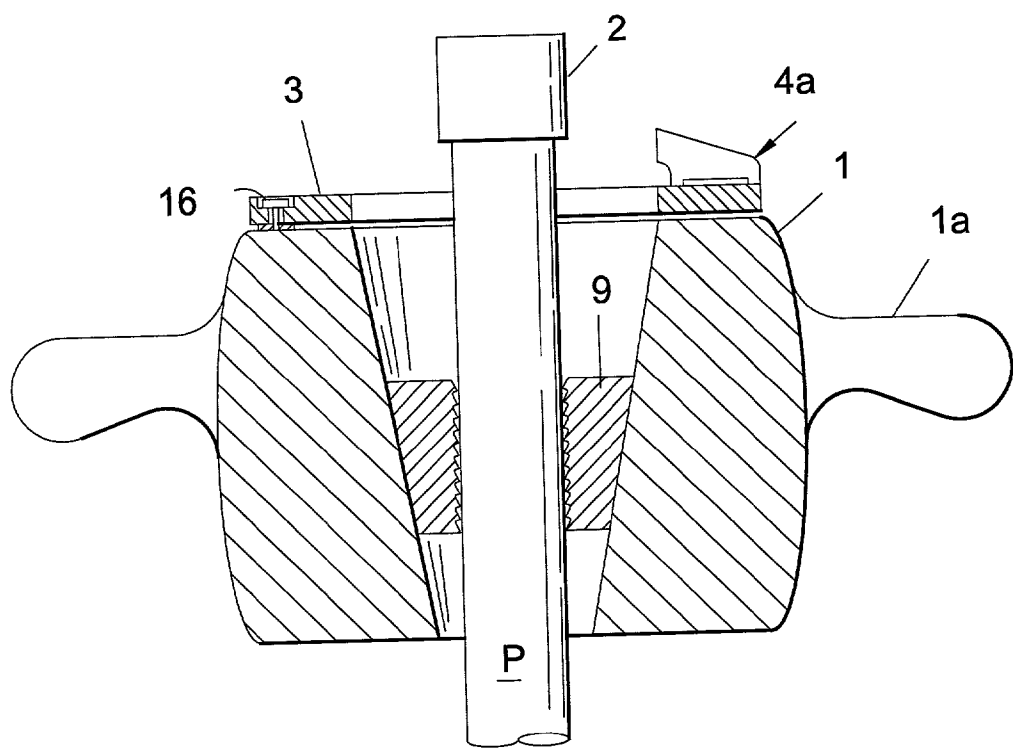


FIG. 6

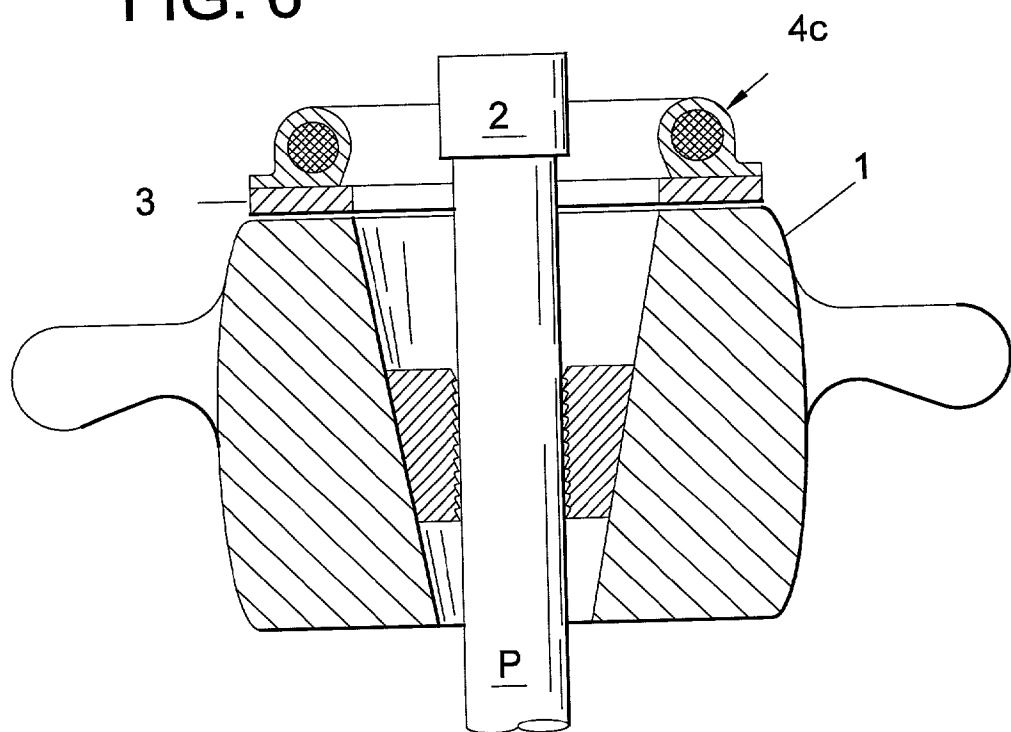


FIG. 7

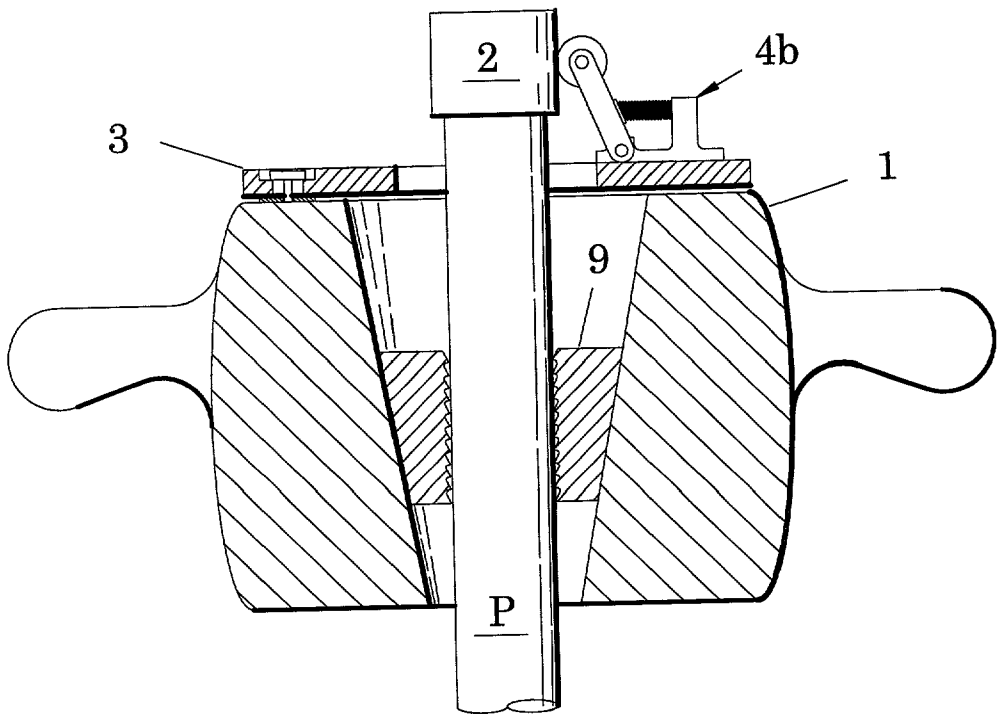


FIG. 8

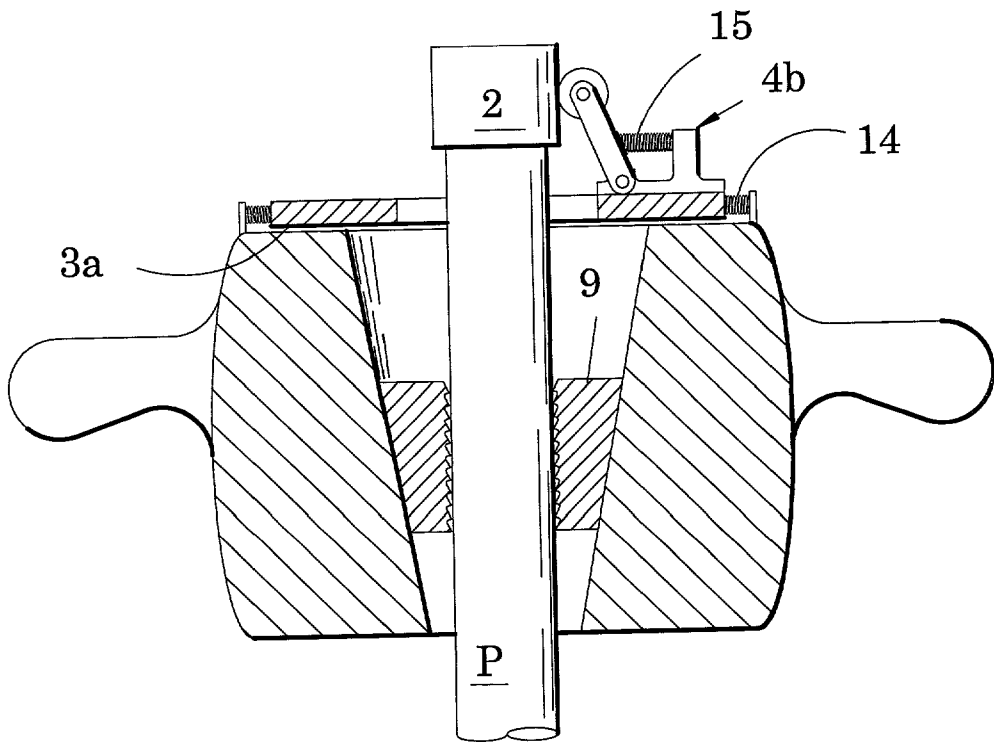


FIG. 9

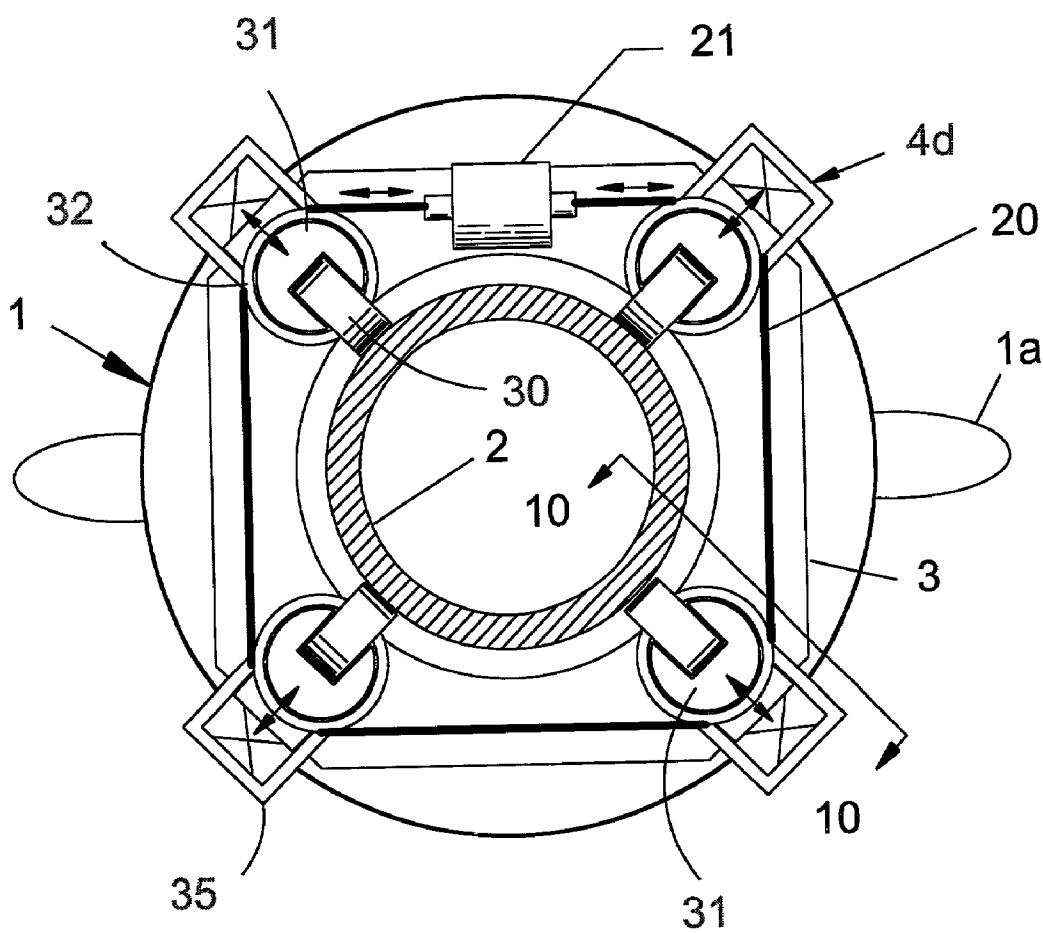


FIG. 10

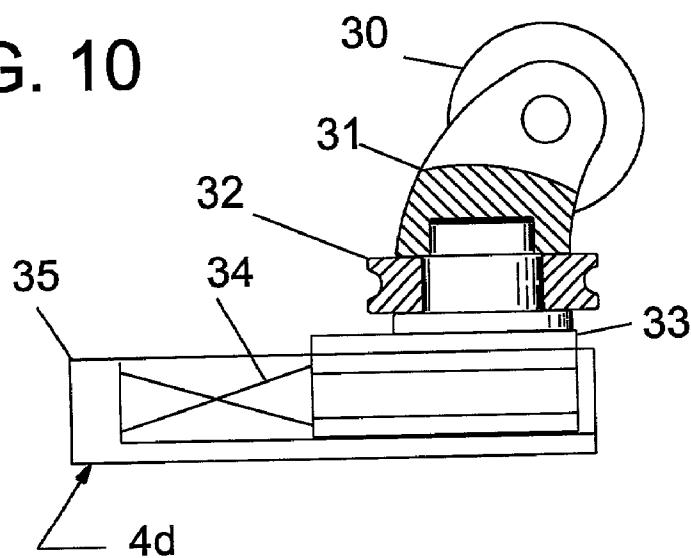


FIG. 11

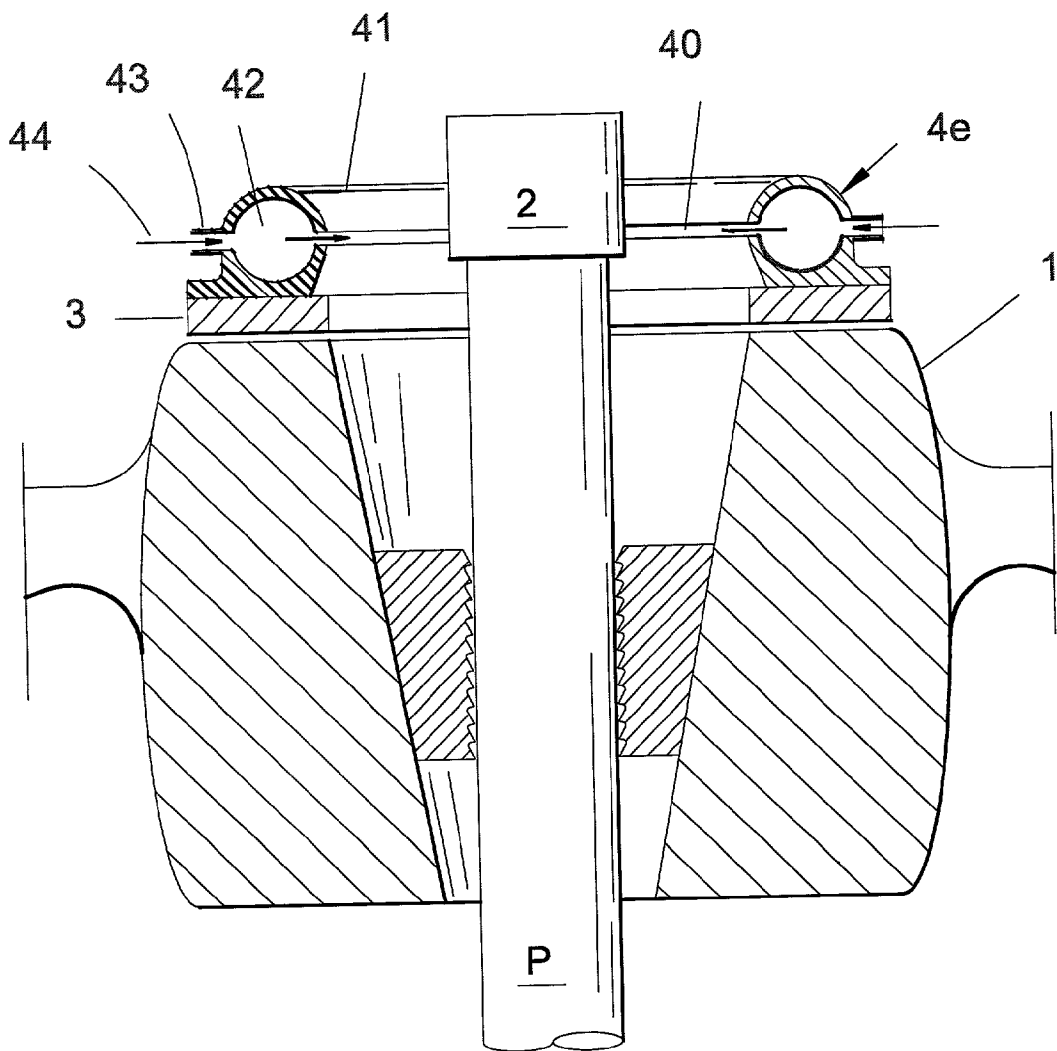
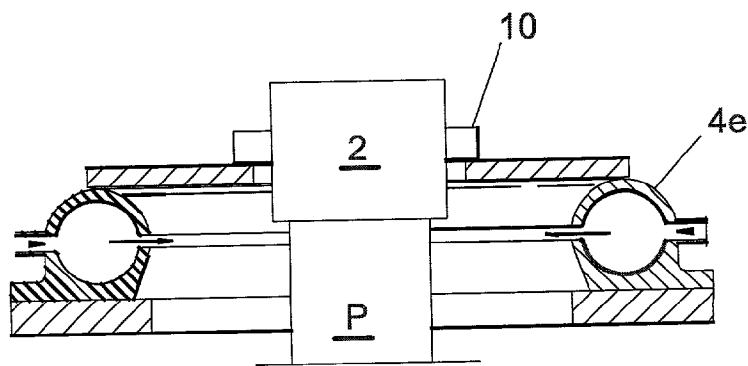


FIG. 12



PIPE POSITION LOCATOR

[0001] This invention pertains to means for locating pipe characteristics relative to pipe string gripping and lifting means such as elevators on drilling and servicing rigs. More specifically in terms of the immediate need but not in a limiting sense, the apparatus detects a change in pipe characteristics and produces a signal for use of the human or a signal usable directly by rig equipment when the diameter of the pipe string changes. Pipe characteristics changes can indicate features such as the end of pipe or the location of collars and areas on the pipe that are safe for elevator gripping.

RELATED ART

[0002] The present invention is expected to supplement the apparatus of U.S. Pat. Nos. 4,67,312; 5,791,410, and 5,909,768

BACKGROUND

[0003] It is well known that workers on oil field drilling and servicing rigs are operating in a dangerous environment. The development and availability of higher technology makes it increasingly easy to replace personnel in particularly dangerous and unpleasant activities. Many machines can do the usual manual function of personnel. People, however, are natural sensors of considerable scope and that function is not readily available in machines.

[0004] On manually operated rigs, people are usually the sensors where pipe positioning is concerned. Hand signals have been well developed and serve the communication function well when exercised by experienced personnel. When rigs are mechanized, the people are usually still there but have more power at hand to carry out their purpose. When the rig is automated, people are usually replaced. The human sensor function has been removed, and it usually has to be replaced.

[0005] When pipe is being assembled into a pipe string in a well by a manually operated or mechanized rig, a stabber is needed. A stabber is a man who works about forty feet above the derrick floor in about the epicenter of engine fumes, glaring lights, and a noise level rarely experienced elsewhere. He usually aligns the top of a pipe section with the well centerline so that threads will run, without binding, during the section adding process. Another of his functions is to signal the driller who is in control of the draw works that the elevator has the right elevation to safely engage the upper end of the pipe string for safe lifting.

[0006] When it is needed to dispense with the stabber, he will not be there to affirm that the pipe is suitably positioned for closing the elevator on a pipe location for safely supporting the pipe string load. A pipe position sensor is needed such that the driller, or automatic driller, will know the pipe position is safe for closing the elevators and opening the spider.

[0007] The sensor will preferably ride the elevator, or related structure, to simplify indication of information relative to the elevator position.

[0008] At times, the area above the pipe string, along its extended centerline, is occupied and that space cannot always be used for a pipe end sensor. A connector coupling,

or a substitute, is usually somewhat larger in diameter than the pipe being connected. Sensing the connector, or other preselected feature, can provide the needed information for selecting the elevator position relative to the pipe, before clamping the elevator on the pipe string. Clamping the elevator on the pipe string is essential before releasing the slips on the spider.

[0009] To sense diameter change when pipe can move laterally, a plurality of some commonly available distance sensors can be used, distributed around the periphery of the elevator central opening. Collectively, they can indicate the diameter, or change in sensed characteristics, of pipe string components that will often be displaced from the general centerline of the gripping apparatus. In principle of operation, there are several concepts that are candidates. Examples include at least those listed below.

-
1. Sound ranging, much like sonar.
 2. Magnetic proximity detection.
 3. Light, several beam formats are possible.
 4. Air flow interference.
 5. Mechanical contact.
 6. Capacitive
-

[0010] Some of the principles of operation listed above suggest three or more sensors distributed about the periphery of the pipe to be measured. Capacitive, air interference, and a form of magnetic detection may be subject to simple peripheral wrap of one sensor. Because of the lateral range of movement of the pipe, until gripped, the sensors have to be some distance from the pipe outer surface, or accept movement by the lateral excursions of the pipe. All sensors considered usable are subject to mounting on structure that can move the sensors, collectively, in lateral directions with little sacrifice of ruggedness.

[0011] A sensor with a single peripheral wrap can be described, for instance, as a short tubular capacitor with an axis of symmetry coincident with an extended pipe centerline. An equivalent magnetic sensor would be a single coil, of one or more conductor turns, distributed much like the capacitor. An air impact equivalent would be a peripheral slit nozzle projecting air radially inward along the entire periphery.

[0012] The preference for first utilization is the mechanical feeler sensor. The mechanical sensor can directly operate elevator slip actuator inhibitor apparatus without adding a special communication or sensor power assistance to the elevator. Also, a mechanical contact mechanism is easy to arrange for calibration, and certification can be simple.

SUMMARY OF INVENTION

[0013] A mounting and handling system is provided for using a variety of interchangeable sensors to sense the vertical position of pipe string characteristics relative to an elevator. The sensors are adjustable for diameters sensed and for vertical distance above the elevator slips. The sensors all serve much the same function but different sensors are compatible with different environments or circumstance of use. The preferred system will work with different sensors and require a minimum of change in the overall system to accommodate the sensor changes.

[0014] An object of the invention is to provide means that enable operating personnel to assure that pipe string elevators are in a position, relative to the pipe to be gripped, to activate pipe gripping dies to grip the pipe string in a stable location, for safety and other reasons. Diameter differences between pipe string components usually have a known vertical relationship to safe gripping areas on the pipe. In some cases, there are no pipe diameter changes suitably located relative to acceptable pipe gripping areas on the pipe string. In such cases, there are usually other detectable features, such as knurled surfaces, peripheral grooves and other features that can be sensed by some physical feature sensor. Combinations of features may be present to offer assurance that what is sensed is not an unexpected anomaly. Features and combinations of features may be referred to herein as characteristics. That is anticipated by and is within the scope of the claims.

[0015] To accept the lateral movement of the pipe within the elevator, before the slips are closed, the sensor means is optionally mounted on a transition, or adapter, plate that can move laterally on top of the elevator a selected amount in all lateral directions. That reduces the maximum distance between the pipe and the diameter, or feature, sensor means. The sensor means may be a single sensor surrounding the pipe, or a plurality of independent sensors distributed around the pipe.

[0016] A measuring system called a light curtain is reasonably independent of distance to object problems and is a separate category needing no transition plate.

[0017] Signal conditioner modules are available to receive sensor output signals that do not directly serve the intended purpose and they process the signal, usually by media conversion or computational processes. Multiple sensors distributed peripherally around a pipe string will rarely produce a directly usable signal from each sensor. A geometric equation usually has to be solved and a usable resultant produced. Air valves that receive signals in the form of mechanical movement and produce changes in air flow, still to be used as a signal elsewhere, is a form of signal conditioner. If the rig is automated, the signal will be adapted to satisfy the input needed for the particular apparatus involved. Signal distribution is adaptable to circumstances and may include, singly or collectively, display for human observation or machine usable data. Additionally, the signal may be used directly by the elevator to inhibit, or compel, selected actions.

[0018] The vertical position of the pipe string can be derived from features of the pipe string, such as changes in diameter as the pipe moves relative to the elevator. Such features of the pipe are known and can be related to a suitable pipe gripping area. The signal that the diameter of the pipe has changed can be used to immediately close the elevator slips if the sensor is situated a sufficient distance above the slips. If the pipe is cylindrical below the connector sensed, the slips can normally be closed as soon as the diameter change is sensed. In case the pipe has a long taper below the connector, operating personnel either position the sensor a sufficient distance above the slip to clear the taper, or the operating personnel move the elevator a selected distance after the sensed diameter change for the slips to be situated below the tapered surface.

[0019] Sensors utilizing light are usable for diameter determination. In one form, known as a thin profile light

curtain, a light beam is projected across a selected area at selected lateral intervals. The traversing beam elements can be very close together if necessary. The number of beams occluded define the lateral dimension of the occluding object.

BRIEF DESCRIPTION OF DRAWINGS

[0020] FIG. 1 is a side elevation of a typical elevator suspended by the usual bails from the traveling block.

[0021] FIG. 2 is a top view of the elevator of FIG. 1, without bails.

[0022] FIG. 3 is a top view of a light curtain sensor mounted on an elevator

[0023] FIG. 4 is a side view of the assembly of FIG. 3.

[0024] FIG. 5 is a side view of the elevator of FIG. 1 with no bails but having a transition plate to carry the sensors.

[0025] FIG. 6 is similar to FIG. 5 but fitted with a single peripheral magnetic sensor.

[0026] FIG. 7 is similar to FIG. 5 but is fitted with an alternate sensor arrangement.

[0027] FIG. 8 is similar to FIG. 7 but is fitted with a plurality (one shown) of mechanical feeler sensors mounted on a transition plate that is spring centered.

[0028] FIG. 9 is similar to FIG. 8 but rigged to amplify the signal from each transducer to increase the magnitude of the mechanical output signal.

[0029] FIG. 10 is a side view of one sensor and mounting means shown in FIG. 9.

[0030] FIG. 11 is a side view, mostly in cut-away, of an air curtain detector system.

[0031] FIG. 12 is a side view, simplified, of a stacked sensor arrangement.

DETAILED DESCRIPTION OF DRAWINGS

[0032] FIGS. 1 and 2 show a common drilling rig slip-type elevator 1 with a pipe P extending through the central opening and terminating with collar 2. Sensors 4 respond to changes in detectable characteristics of pipe P. The pipe can move some distance in any lateral direction before the slips are set. The sensors 4 read at some distance from the pipe but if the reading distance is greater than a certain amount, transition plate 3 can be used to carry the sensors and move a small amount in any lateral direction if hit by the pipe.

[0033] The movable plate 3, best seen in FIG. 5 has vertically confining shoulder screws in laterally loose holes. Caption 16 notes the assembly. The sensors can be mounted closer to the pipe yet allow the pipe to move a greater lateral distance before damaging sensors.

[0034] FIGS. 3 and 4 show a multiple beam light projector and receiver arrangement known as a light curtain. It is usable as a remote sensor to measure features by the number of light beams occluded. Housing 10 projects the plural beams of light 12 across the area to be partly occluded by pipe, and housing 11 receives the surviving light beams and produces a consequent signal output usable by the-

operating personnel or ancillary apparatus. The signal processing gear is normally situated in one of the housings. Light curtains are purchasable items.

[0035] FIG. 5 shows a general purpose sensor mounting arrangement to be considered in view of FIG. 1. Sensor 4a is symbolic of magnetic, capacitive, sound, light, or contact sensors, or a combination of more than one type sensor.

[0036] The sensor detects the change in diameter, or other detectable characteristics, when the pipe is moving through the elevator. The change will, cause the sensor to send a signal along communication link 6 (FIG. 1) to read out near the operating personnel. If an automatic driller is in charge, unit 7 (FIG. 1) will be the input receiver for the device involved. Link 6 may include any form of communication and may extend to a number of end user entities.

[0037] Ordinarily, the elevator slips could be closed as soon as the collar 2a is sensed if the sensors are in the positions, relative to the slips, as shown.

[0038] FIG. 6 shows a single sensor 4c distributed peripherally around the pipe. The transition plate is shown but may not be needed in all cases. Sensor 6 can be a magnetic coil, capacitive plate, or air flow interference. Controlling processors are not shown, can be mounted on the elevator or elsewhere, and are established in the art.

[0039] FIG. 7 is similar to FIG. 5 but has mechanical contact feeler sensors 4b that are spring biased toward the pipe. Position sensors detect the position of all feelers and convey the information to a computer cell that may be in the sensors, mounted on the transition plate, or located elsewhere. The computer will indicate the diameter of the pipe or just the change in diameter, indicating in this figure that a collar is sensed. FIG. 8 shows a related version in more detail.

[0040] FIG. 8 is identical to FIG. 7 except for a spring bias arrangement 14 that tend to center modified plate 3a but allows the springs 15 on the sensor feelers to collectively influence the position of the transition plate, to reduce shock imposed by plate travel limits.

[0041] FIGS. 9 and 10 are a more detailed description of the mechanical sensor equipped system of FIGS. 7 and 8. Elevator 1 is fitted with transition plate 3 (already described) carrying sensor assemblies 4d. The mechanical contact sensors move radially from the pipe centerline. A wire line, or filament, 20 circumnavigates the pulleys 32 carried by the sensor slides 33. Spring 34 urges slide 33 toward the pipe and urges slideway 35 away from the pipe being sensed (not shown). The collective bias applied to the slideways centralizes plate 11 relative to the pipe being sensed. The system will work without plate 3 but the slideways may need to be longer to extend the travel of the slides. The standard (stanchion) 31 connects wheel 30 and the slide 33.

[0042] The filament 20 responds to the radial movement of the sensors collectively and moves the input to sensor 21 an amount approximating 2.8 times the sensed change in diameter of the related pipe string component. The filament is a simple way to process the input signals from the sensors collectively. Any equivalent system may be used. Sensor 21 is a pneumatic valve which controls air flow related to slip closure in the elevator. In converting movement of said filament to changes in fluid flow resistance, the valve serves

as a form of signal conditioner. The air circuitry controllable is now operational in the elevators related to the referenced US patents.

[0043] FIG. 11 shows what is often called a thin profile air curtain sensor 4e. The annular chamber 42 is contained in housing 41 and is supplied an air stream 44 through supply tube 43. Slit nozzle 40 is peripherally distributed around the central opening in elevator 1. Air projected radially inward from the slit nozzle 40 causes a back pressure in chamber 42 that is influenced by any object encountered by the moving air stream. With a given air flow 44 the pressure in chamber 42 is a specific amount if no object is in the elevator central opening. With any object in the central opening, the chamber pressure is higher. It is higher an amount that is proportional to the objects effective diameter. The chamber pressure can be read directly by a driller from a gauge extended some distance from the elevator, or the pressure can be converted to other signal forms for use by people or machines.

[0044] FIG. 12 shows a stacked sensor arrangement. No elevator is shown. Sensor 10 of FIG. 3 is situated above sensor 4e of FIG. 11. If sensor 10 senses the diameter of the collar and sensor 4e senses the diameter of the pipe, the different signals from the sensors will indicate the collar-to-pipe transition is between the two sensors. This arrangement should work as well with the single point sensors without distributing them around the object to be sensed, even of the pipe can move laterally some limited amount.

[0045] From the foregoing, it will be seen that this invention is one well adapted to attain all of the ends and objects hereinabove set forth, together with other advantages which are obvious and which are inherent to the invention.

[0046] It will be understood that certain features and sub-combinations are of utility and may be employed without reference to other features and sub-combinations. This is contemplated by and is within the scope of the claims.

[0047] As many possible embodiments may be made of the locator of this invention without departing from the scope thereof, it is to be understood that all matter herein set forth or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

The invention having been described, we claim:

1. A pipe string feature locator for detecting the vertical position of a pipe string suspended in a well relative to the rig elevator, the locator comprising:

- a) a drilling rig elevator to function as a carrier for pipe feature sensors and related mounting means; and
- b) at least one said pipe feature sensors mounted on said elevator and arranged to sense selected characteristics of pipe extending through the elevator and to produce an output signal indicative of the presence of selected pipe characteristics.

2. The pipe string feature locator according to claim 1 wherein said output signal is a change in the resistance to the flow of fluid through a valve actuated in response to changes in the pipe feature changes.

3. The pipe string feature locator according to claim 1 wherein said output is an electrical signal, at least part, in a digital format.

4. The pipe string feature locator according to claim 1 wherein said diameter sensor is part of a plurality of sensors,

each of which has a mechanical element extending from the sensor to the surface of pipe extending through the elevator.

5. The pipe string feature locator according to claim 4 wherein said plurality of sensors, each, contribute part of the total signal.

6. The pipe string feature locator according to claim 5 wherein said sensors each carry a pulley that moves radially in sympathy with changes in sensed pipe diameter, a filament reeved about all said pulleys such that the movement of the pulleys, collectively, results in a consequent proportional change in the length of filament needed to complete the circuit about all pulleys, said change in needed filament length being satisfied by movement of an input member of a signal conditioner which produces the output signal.

7. The pipe string feature locator according to claim 1 wherein said sensor projects a stream of air toward the surface of said pipe, and detects a change in resistance to the air flow caused by changes in the characteristics of the pipe.

8. The pipe string feature locator according to claim 7 wherein said signal is conveyed as a pressure change.

9. The pipe string feature locator according to claim 1 wherein said sensors are mounted on a transition plate which is laterally movable, within limits, relative to the elevator to which it is attached, by which the sensors can be mounted closer to a pipe capable of lateral movement within the elevator.

10. The pipe string feature locator according to claim 1 wherein said sensors emit sound to impinge upon the surface of the pipe, and respond to echo characteristic to determine distance between reference features in the sensor and the pipe, said output signals from each sensor being processed to produce sensed pipe feature related information.

11. The pipe string feature locator according to claim 1 wherein the function of said sensor is achieved by the arrangement of at least two sensors on different vertical

locations, by which process the sensors collectively accommodate lateral movement of said pipe, both sensing the movement, and the feature change being sensed when one sensor detects pipe string features the other sensor does not detect.

12. The pipe string feature locator according to claim 1 wherein said sensor is a light curtain comprising a plurality of laterally spaced light beams projected horizontally across space said pipe may occupy.

13. The pipe string feature locator according to claim 1 wherein said sensor is a magnetic field producing and responding arrangement.

14. The pipe string feature locator according to claim 1 wherein said sensor is a capacitive arrangement arranged to respond to the proximity of pipe and sensor to change electrical characteristics of the sensor to be interpreted in terms of changes in pipe diameter.

15. A pipe string feature locator for detecting when a selected characteristic on a pipe string suspended in a well has a preselected vertical relationship to the rig elevator, the locator comprising:

- a) sensor means to detect at least one characteristic of the pipe that has a known vertical relationship to a location on the pipe selected for gripping with elevator mounted pipe gripping means and to produce an output signal when the characteristic is sensed;
- b) a sensor mounting arrangement that places the sensor means the same distance and direction from the elevator pipe gripping means as the known distance and direction between the characteristic to be sensed and the location on the pipe selected for gripping.

* * * * *