

[54] **SYSTEM FOR MONITORING THE INSTANTANEOUS VELOCITY OF A PIPE STRING BEING TRIPPED RELATIVE TO A WELL BORE**

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[51] Int. Cl. **G08b 21/00**

[58] Field of Search..... 340/263, 267 R, 18 R, 177 CA, 340/201; 73/151, 151.5; 324/164, 163, 161

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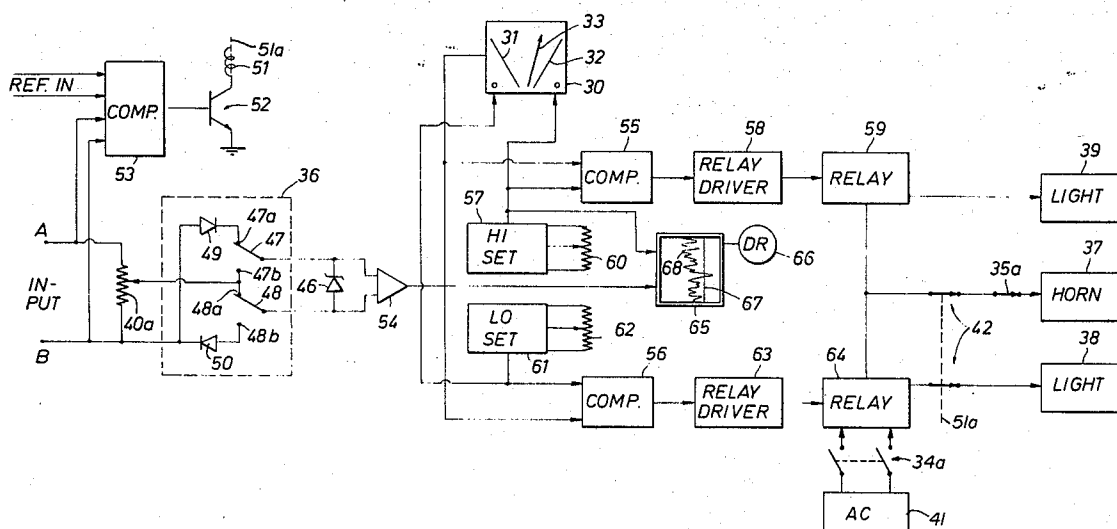
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[57] **ABSTRACT**

A system for monitoring the speed at which a pipe string is lowered into or pulled out of a well bore during a well drilling operation includes a unit which derives an electrical signal as a function of instantaneous pipe speed and a monitoring system which compares signals representative of instantaneous velocities with respect to predetermined velocity limits and provides physiological indications whenever such limits are transgressed. Also included are visual indicator means and recorder means, as well as a system for calibrating the unit to any drilling drawworks.

15 Claims, 5 Drawing Figures



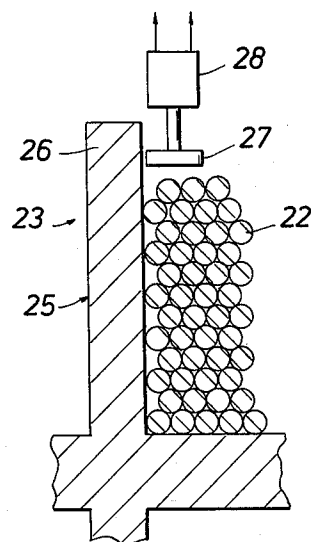
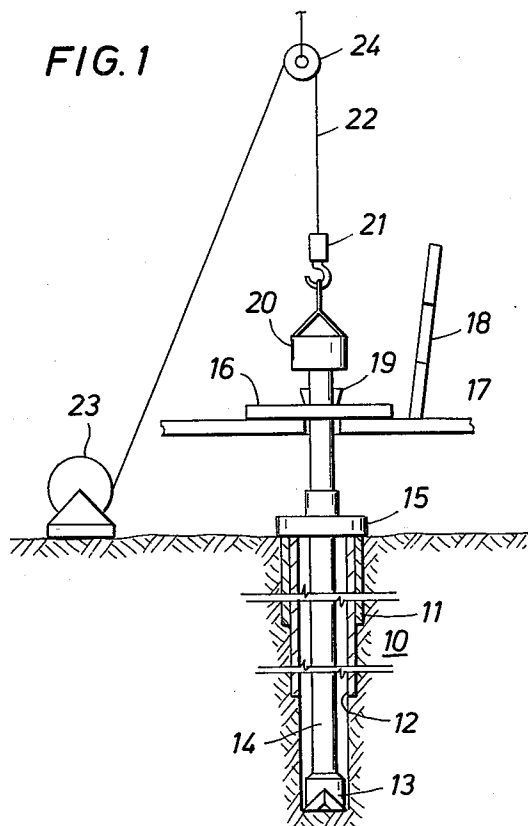
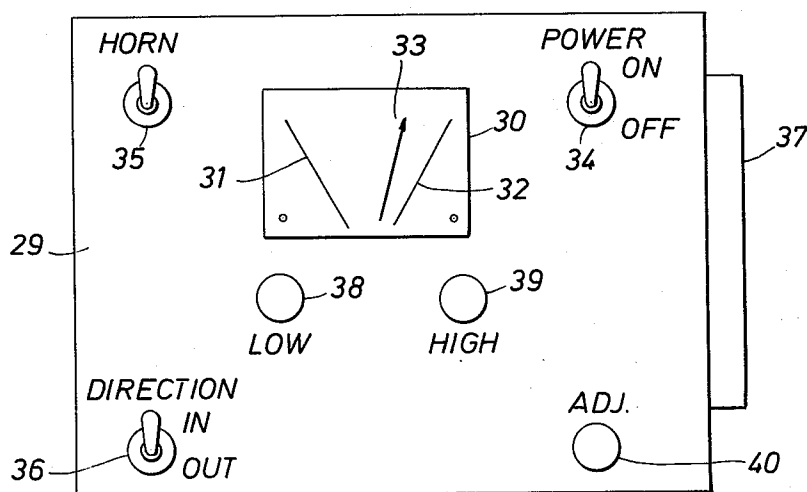


FIG. 2

FIG. 3



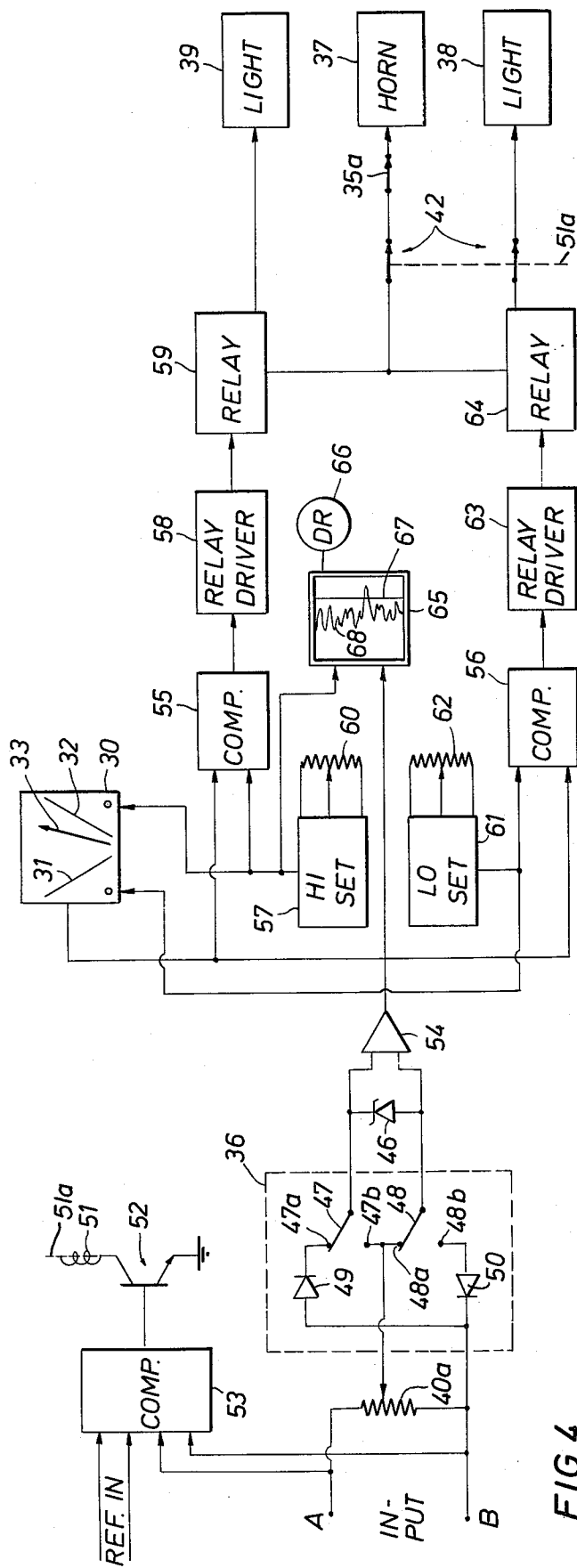


FIG. 4

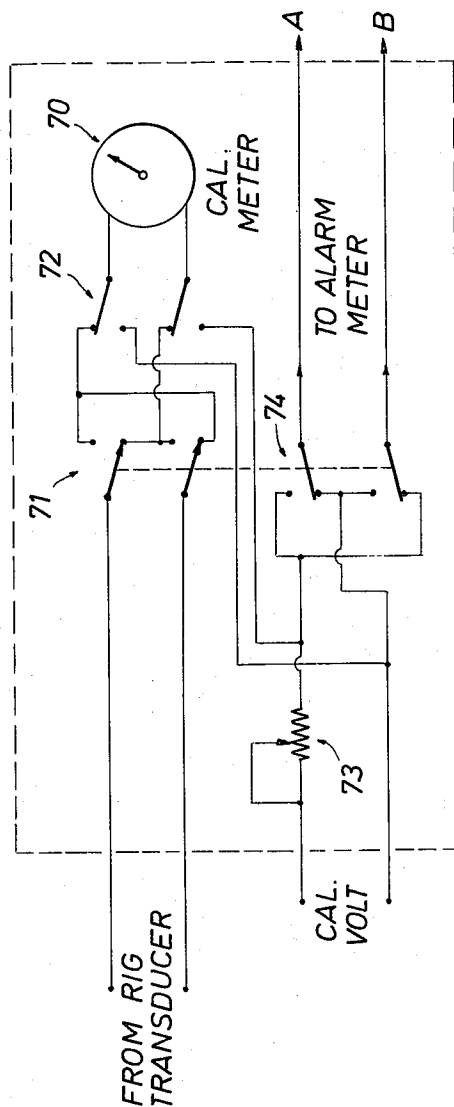


FIG. 5

SYSTEM FOR MONITORING THE INSTANTANEOUS VELOCITY OF A PIPE STRING BEING TRIPPED RELATIVE TO A WELL BORE

BACKGROUND OF THE INVENTION

This invention pertains to methods and apparatus for monitoring and deriving indications of the speed at which a pipe string travels while such pipe string is lowered into or pulled out of a well bore during a well drilling operation.

In a rotary well drilling operation, a drilling bit at the end of a drill string or pipe is rotated to cut into the earth formations. The drill string or string of pipe is made up of pipe joints, usually about 30 feet in length, which are coupled to one another by threaded tool joints. As the well is drilled, additional pipe joints are added to the string of pipe.

From time to time during a rotary drilling operation, the drill string or pipe is removed, for example, to change the bit or to perform another operation, such as obtaining a log of the formations. Thereafter, the pipe is returned to continue drilling or to run a string of casing into the hole. The process of removing and reinserting a string of pipe is called "tripping".

In removing or re-inserting a pipe string, the pipe joints are successively un-coupled or coupled as the case may be and the sections of pipe or joint sections are stacked in the drilling rig. Usually, pipe joints are interconnected lengths of two or three pipe joint sections, sometimes referred to a "doubles" and "threbbles" or "pipe stands" when they are vertically stacked in the drilling rig. In this relationship, the pipe joints also are said to be "racked" in the derrick.

The drilling rig has a device called a rotary table which is used to rotate the drilling string. In the rotary table on the derrick floor of the rig are releasable slips which are used to releaseably support the pipe string in the borehole during the tripping operation. For example, while going in with a pipe string, the slips serve to hold the upper end of the pipe string in the rotary table and prevent the pipe string from dropping into the well. A vertically movable traveling block in the rig derrick is used to bring a double or threbbles pipe length or stand into a position where such a stand can be threadedly coupled to the upper end of the pipe supported in the rotary table. Upon interconnection of a pipe stand to the pipe string, the slips are released and the traveling block supports and lowers the string of pipe into the well bore until the upper end is just above the slips, whereupon the slips in the rotary table are re-engaged with the pipe string. This operation is continued until the bit at the lower end of the pipe string is in drilling position. From the time that the pipe string begins its motion from a stop or rest position, it first accelerates to a "running-in" speed which is essentially a constant speed, and then it decelerates to a stopped condition.

Typically, in well drilling operations a drilling fluid (commonly called "mud") is used where the functions and properties of the drilling fluid are intended to promote a safe and speedy drilling and completion of the well. While the pipe string is being moved into the bore hole or from a bore hole, hydraulic effects or pressure surges relative to the borehole are created which can damage the subsequent productivity of hydrocarbon-bearing formations. Excessive surge pressures can also lead to loss of drilling fluid through pressure induced fractures of the formation which can cause sticking of

the drill pipe, excessive loss of mud and other complications.

When the pipe is removed from the borehole, the above described procedure is reversed in that the pipe joints are racked in the derrick as double or triple stands as they are successively uncoupled from the string of pipe. During the pipe removal operation, the motion of the pipe is first an acceleration to a constant speed and then deceleration to a stop condition. While coming out of the borehole, if the string of pipe is pulled too fast while being removed, a condition known as "swabbing" and other undesirable hydraulic effects can occur. Swabbing is a condition involving a reduction in the total hydraulic pressure in the hole to a less than normal pressure for the hydrostatic pressure of the static drilling fluid column in the well bore. An excessive reduction in hydraulic pressure can cause the well to "kick," that is, formation fluids under their in-situ pressures may enter into the drilling fluid and into the well bore. This action could cause a "blow out." In soft formations, collapse of the borehole walls can also occur because of swabbing effects.

Swab and surge pressures can be minimized by reducing the viscosity characteristics of the drilling fluid, providing adequate borehole to pipe clearances, and minimizing flow constrictions in the pipe string. These factors are considered and taken into account when planning the drilling operations for a well. While a round trip of the pipe string is being made, however, these pressures can only be controlled by driller in control of the pipe speed. Commonly, a listing or schedule with optimum velocities in terms of information such as "pull 10 stands at 85 seconds per stand" etc. is available for use by the driller. This schedule can be computed by hand or by a computer. The driller will then attempt to pull or run the pipe string at a uniform velocity by noting the total time required for moving one stand or a joint of pipe over a given distance. However, the driller cannot give undivided attention to the pipe speed requirements because he must be attentive to the actions of his other crew members in the synchronized operation of moving a pipe string as well as the other equipment under his control.

The schedule, however, cannot always take into consideration miscellaneous factors, which sometime affect velocity, such as the amount of drag on the moving pipe, the position of the hoisting equipment and the behavior of the machinery. Moreover, even if the operation follows the schedule and average speed is within the prescribed limits, it is possible for the instantaneous speeds to be excessive and cause damage.

If the driller simply pulls or runs the pipe very slowly, the hydraulic pressures can be controlled but this is undesirable since it is costly in terms of rig time consumed and furthermore, excessive time periods without mud circulation (as when tripping) may lead to various well difficulties. It should be noted that an optimum velocity varies as a function of the amount of moving pipe in the hole, generally, but not necessarily, decreasing with increasing lengths of moving pipe.

It should be appreciated from the foregoing that tripping the pipe is a synchronized operation of the drilling crew to move the pipe into or out of the borehole in as short a time as possible, not only to reduce costs but also to reduce the risks involved in not having the pipe in the hole where mud control can be maintained. As noted heretofore, the technology to date for the driller

to determine proper run-in or run-out speeds of a string of pipe involves only rudimentary execution procedures based on the elapsed time for moving a section of pipe. A stop watch is sometimes used as the determinant for the velocity, and it will be appreciated that this can only establish average values for velocities. This technique has the very obvious disadvantage that excessive velocities may occur even though the average velocity is kept within limits and the impreciseness of the operation can unknowingly cause well damage.

SUMMARY OF THE PRESENT INVENTION

By means of the present invention a preselected or desired velocity range for moving the pipe can be established and the instantaneous pipe speed monitored relative to the preselected velocity range so that the driller can optimize the speed of the operation while eliminating or minimizing the risks of excessive speeds. This is accomplished by apparatus which includes means for deriving an indication of the instantaneous speed or velocity of the pipe in terms of an electrical signal and means for comparing the electrical signal relative to preset signal values for providing an output indication whenever velocity limits are exceeded. The system is further provided with means for selectively limiting effective operation of the system to movement of the pipe in one direction, means for dropping out the alarm indicator upon stopping of the pipe, and a system for calibrating the indicating means.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention may be more easily understood and will become more apparent from the following description when taken in conjunction with the drawings, in which:

FIG. 1 is a schematic illustration of a drilling system for drilling a well bore,

FIG. 2 is a partial view in cross-section of a drum for a drilling line on a drawworks,

FIG. 3 is a front view illustrative of the appearance of a forward panel of an enclosure where the controls for the present invention are mounted on the panel,

FIG. 4 is an electrical schematic diagram of the system embodying the present invention, and

FIG. 5 is an electrical schematic diagram of a calibration system for the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The tripping of a pipe string relative to a well bore should be accomplished in the shortest possible time without causing damage to the well or creating hazardous conditions. With the known parameters of the well, safe maximum velocity values for moving the pipe can be defined. Minimum velocities, of course, do not of themselves create problems, but in the tripping of the well a certain rhythmical operation is developed between the various operators. The judgment of the hoist operator who controls speed of the pipe string is assisted if both the upper and lower velocity limits are defined so that he can maintain an established or defined rhythmical time operation relative to movement of the pipe.

Referring now to FIG. 1, there is shown a well that traverses earth formations 10. The well is illustrated as having surface casing 11 for the first few hundred feet and a protective liner 12 set in place in the next, lower

section. The drilling of the well is accomplished by means of a conventional rotary bit 13 attached to a drilling string 14. The drill string 14 extends to the earth's surface where it passes through conventional well head equipment 15 that includes blowout preventers and other well-known equipment. The drill string 14 is rotated by means of a rotary table 16 in a rig derrick 17. On the derrick 17 one threbbble section of pipe 18 is illustrated for purposes of explanation. When the pipe string 14 is being pulled from the well bore, slips 19 on the rotary table suspend and support the pipe string in the borehole while the pipe section 18, which is uncoupled from the string, is placed in the pipe rack. In making a trip, elevators 20 are used for latching onto or gripping the pipe string. The elevators 20 are attached to a traveling block 21 which is coupled by a drilling line 22 to a drawworks 23. The drilling line 22 is suspended in the center of the rig near the apex by a crown block 24.

The operation for removing a string of pipe from a wellbore starts by the driller releasing the drawworks 23 and lowering the elevators 20 to the derrick floor 17. There the crew (sometimes called roughnecks) latch the elevators 20 to the protruding stand of the string of pipe. The driller opens the throttle on the drawworks 23, releases the drawworks brakes, and the drill pipe is on its way up. The driller stops the upward movement of the traveling block 21 when the elevators 20 carry the pipe up to a derrickman positioned above the drilling rig floor and a joint connection is above the table 16. The slips 19 are then set by the crew on the derrick floor and the crew uses tongs to uncouple a pipe section. Upon disconnection of the pipe section, the bottom of the disconnected stand of pipe is placed on the rig floor while the derrickman swings the top of the stand of pipe into the derrick pipe rack. As soon as the derrickman has control of the upper end of the pipe stand, the elevators 20 are released from the pipe string so that the traveling block 21 and elevators 20 can be lowered at full speed to the rig floor. This operation is repeated until all of the pipe string is removed from the well bore.

For returning the pipe to the well bore, the foregoing described operations are simply reversed. That is, the elevators 20 pick up the upper end of a stand of pipe which is racked in the rig, and the crew couples the stand of pipe to the pipe string supported by the slips 19. The slips 19 are then released and the pipe string lowered into the borehole. When the upper end of the pipe string is just above the rotary table, the slips 19 are again set. The elevators 20 are next released and the traveling block raised to pick up the upper end of another stand of pipe and the operation is repeated.

In FIG. 2, which is a partial illustration of a drilling line drum of the drawworks 23, a roller 27 is disposed along a flange 26 of the drum and the roller 27 provides a mechanical drive to a transducer device 28. The rotational motion of the flange 26 through a friction drive rotates the roller 27 and, in turn, transducer 28 produces an electrical output signal as a function of the rotation of roller 27. The rotation of roller 27 and the output signal of transducer 28 are a function of velocity of the drilling line which is a function of the velocity of the traveling block which is, in turn, a function of the speed of the pipe. Transducer 28 is constructed and adapted to provide a direct current signal where the polarity is dependent upon the direction of rotation of roller

ler 27. The magnitude of the electrical signal from transducer 28, which varies as a function of speed, is affected by the location of the wheel 27 relative to the axis of the drum, the size of wheel 27 and a number of other factors. All of these factors can be electrically compensated for so that a signal proportional to the speed or velocity of the drilling line can be obtained. As will hereinafter be more fully disclosed in connection with the present invention, a unique system of calibrating the speed monitoring device of the present invention has been devised.

The front panel of a speed monitoring system is shown in FIG. 3. The front panel 29 includes a meter 30 which has a face and scale markers disposed along an arc on the face of the meter. A velocity indicator 33 is movable across the face to indicate velocity values in feet per minute, which range from low values on the left of the face to higher values on the right of the face. Scales in seconds per stand or dual scales on the face can easily be used, if desired. Adjustable limits are schematically illustrated by lines 31 and 32 which can be set relative to the scale marker and indicator 33. The limits respectively define lower and upper velocity values. The meter operation is such that indicator 33, upon reaching limit 31 or limit 32, will activate a low or high velocity alarm device. On-off switches 34, 35 and 36 respectively control the application of power to the system, the connection or disconnection of a horn 37, and whether the signal to the meter represents the velocity of pipe going into or out of the borehole. Visual light indicators 38 and 39 are respectively operable as low velocity or high velocity indicators in addition to the horn 37. An adjustment knob or screw adjustment 40 is used for calibration of the meter.

Referring now to FIG. 4, an electronic system schematically illustrative of the system includes an A.C. power source 41 which has a manual switch 34a and a low velocity drop-out switch 42 in series. Source 41 provides operating power for the various electronic components. Also, in the description to follow, the use of identification numbers common to those of FIG. 3, when followed by a letter designation, are correlative to the panel control elements illustrated in FIG. 3.

Input terminals A and B receive a direct current input signal from the direct current transducer 28 (FIG. 1). A potentiometer 40a connected across the input terminals permits adjustment for calibration purposes. The output from the potentiometer 40a is input to the reversing switch means 36. The reversing switch means includes a pair of switches respectively having switch arms 47 and 48 which input to an amplifier 54. A zener diode 46 is coupled between the switch arms to protect the system against excessive voltage inputs. Diodes 49 and 50 are reversely connected with respect to input line b and respectively connected to switch contacts 47a and 48b. The input line a is coupled via the potentiometer arm to the switch contacts 47b and 48a. In the described system, the input to the amplifier 54 can have the same polarity irrespective of the travel of the drilling line by operation of the switch 36.

The amplifier 54 provides an input to a first comparator circuit 55, to a second comparator circuit 56 and to the meter 30. The input to the meter produces the response in the indicator 33 for a visual indication of speed. The first comparator circuit 55 is also input from a "high-set" circuit 57 which is adjustable by means of a potentiometer 60 to provide a reference input signal to

the comparator circuit 55. The reference signal from circuit 57 is also supplied to the meter 30 to provide the upper velocity indicator 32. In the operation of the comparator circuit 55 whenever the signal from the amplifier 54 exceeds the reference signal from the set circuit 57 an output signal from the first comparator circuit 55 is converted by a relay driver circuit 58 to a signal for operating a relay 59. The relay 59 when operated couples the A.C. power to a light 39 and a horn 37 so that both visual and auditory physiological indications are produced. A switch 35a permits the disconnection of the horn 37 from the operation.

The second comparator 56 is input from a "lo-set" circuit 61 which is adjustable by means of a potentiometer 62 to provide a reference input signal to the comparator circuit 56. The reference signal from circuit 61 is also supplied to the meter 30 to provide the lower velocity indicator 31. In the operation of the comparator circuit 56 whenever the signal from the amplifier 54 drops below the reference signal from the set circuit 61, an output signal is produced. An output signal from the second comparator circuit 56 is converted by a relay driver circuit 63 to a signal for operating a relay 64. The relay 64 when operated couples the A.C. power to a light 38 and the horn 37 to provide the physiological indications whenever the lower velocity limits are transgressed.

In addition to the foregoing indicator and alarm system, a recorder 65 may also be profitably employed. The recorder 65 may be of the standard chart type with a time drive 66.

The inputs which are of particular interest are the high velocity value and the instantaneous velocity value. Thus, the output from the hi-set circuit 57 is also input to the recorder 65 to provide a line indication 67 of the high velocity limit as a function of time. The output from the amplifier 54 is also input to the recorder 65 to provide indications of velocity as it occurs. Thus, a record of the driller's operations is maintained.

It will be readily apparent also that whenever the traveling block is decelerating to a stopped position, this will usually cause the meter to traverse the low velocity limit 31. To eliminate the nuisance of receiving the physiological indications each time that this event occurs, a switch 42 is disposed in the actuation circuits for the horn 37 and light 38. The switch 42 operates to disconnect the light 38 and horn 37 whenever the input signal from the sensor reaches a predetermined lower value. This predetermined lower value will correspond to a slower average speed than any normally encountered speed used in actually handling the pipe. The switch 42 is operated by a solenoid actuator 51a which is moved by a solenoid coil 51 which is in series with a transistor 52. The transistor 52 is operated by the output from a comparator circuit 53 which receives a reference input signal and the input signal from the transducer 28. The reference input signal is set to a value so that when the signal input from transducer 28 drops to a level indicating a stop is approaching, the solenoid 51 is operated to drop out the switch 42.

The operation of the foregoing described system is believed self evident; however, it may be briefly summarized as follows: while coming out of the hole, the roller 27 on the drum generates an electrical signal proportional to the speed of the pipe being pulled from the borehole. The electrical signal is applied through the direction switch 36 to the meter 30 and to the recorder

65 in order to provide an indication of instantaneous velocity. Should the instantaneous velocity exceed or fall below predetermined velocity or speed limits, a horn and light are actuated. A drop out circuit is provided to disconnect the visual and audible indicators whenever the pipe string is slowed to the stop condition. The horn can be separately disconnected. For going into the hole, the same procedure applies. The direction switch is operated, however, so that the meter is operated by opposite rotation of the roller.

It can be appreciated that the signal from transducer 28 can be calibrated by a number of well known techniques. A further aspect of the present invention involves a calibration system as illustrated in FIG. 5.

The particular meter 30 shown in FIG. 3 ranges from zero to full scale for an input of 0 to 3 volts. Transducer 28 can generate 3 volts per thousand rpm and thus can generate up to 15 volts for 5000 rpm.

The difference in voltages is significant in that the wider range of voltage output of transducer 28 permits scaling down to full scale operation of meter 30 over a wide variety of conditions.

Calibration of the alarm system to each rig is, of course, necessary. It is not reliable, however, to attempt calibration of meter 30 at the time a velocity determination is being made. The reasons for this will become apparent from the discussion to follow.

In the process of calibration the transducer 28 produces a voltage output as a function of velocity. Using a generator 28 which generates 3 volts per 1000 rpm, a range of 0-15 volts is obtained for 0 to 5000 rpm (of the wheel). This corresponds to the maximum velocity which could typically be obtained. Initially, the driller picks up the drill pipe at a fixed throttle setting (constant rpm) and two events are measured, i.e., the time elapsed for the middle section of a 3 section stand of pipe to traverse a fixed point on the rig and the voltage output E_0 during this period of time. The length of a section of pipe can be measured and with the time measurement, the velocity V_0 is determinable.

As shown in FIG. 5, the output from transducer 28 is applied to a calibration meter 70 via the contacts of a reversing switch 71 and the contacts of an input-output switch 72. Meter 70 thus indicates for a determined velocity V_0 of the pipe what a corresponding output voltage E_0 is for transducer 28. Next, switch 72 is operated to change the contacts from the position shown to a position coupling the meter 70 to an input calibration voltage source and a series connected potentiometer 73. The calibration voltage is also coupled via contacts of a reversing switch 74 to the inputs A-B of FIG. 4. The potentiometer 73 is then adjusted so that the voltage E_0 for the determined speed V_0 appears on the meter 70. The potentiometer 40a (FIG. 4) is then operated to adjust meter 30 to the determined velocity value V_0 . Hence, the rig transducer is calibrated to indicate velocity on the meter 30. After the meter 30 is calibrated, the calibrator is removed from the system and the output of transducer 28 directly supplied to meter 30 as described heretofore.

While particular embodiments of the present invention have been shown and described, it is apparent that changes and modifications may be made without departing from this invention in its broader aspects; and, therefore, the aim in the appended claims is to cover all such changes and modifications as fall within the true spirit and scope of this invention.

What is claimed is:

1. For a drilling system, alarm means for providing an indication whenever predetermined velocity values for travel of a pipe string relative to a borehole are exceeded by actual velocity of pipe being moved relative to a borehole,

means adapted for coupling with a pipe string for generating electrical input signals representative of actual velocity of a pipe string,

said alarm means including selectively operable preset means for establishing a preset condition which is representative of a velocity limit,

means for receiving and correlating input signals to said preset means where such input signals are representative of actual velocity of a pipe being moved relative to a borehole, said correlating means being constructed and arranged for providing an output signal whenever such an input signal reaches a preset condition,

means for receiving said output signal and for producing a physiological indication in response thereto, and

means coupled to said receiving and correlating means for selectively applying only those input signals to said alarm means which represent travel of such pipe in one direction.

2. The alarm means of claim 1 wherein said input signals represent actual velocity of a pipe in one direction and said selectively applying means includes means for reversing the polarity of the input signals for deriving input signals representative of actual velocity of a pipe being moved relative to a borehole in an opposite direction.

3. The alarm means of claim 2 wherein said generating means produces said input signals as electrical current values and wherein said correlating means includes a current responsive meter.

4. For a drilling system, alarm means for providing an indication whenever predetermined velocity values for travel of a pipe string relative to a borehole are exceeded by actual velocity of pipe being moved relative to a borehole,

means adopted for coupling with a pipe string for generating electrical input signals representative of actual velocity of a pipe string moving in either direction,

said alarm means being adopted to receive an input electrical signal representative of actual velocity of pipe travel relative to a borehole and including selectively adjustable present means for providing an output control signal whenever said input signals reaches a predetermined magnitude,

means responsive to said output signal for producing a physiological indication, and

means for sensing input signals and for selectively supplying only those input signals to said alarm means which represent travel of such pipe in one of said directions.

5. The alarm means of claim 4 wherein preset means are provided for upper and lower velocity limits and wherein indication means are provided for each of said preset means, said indication means respectively including a light-emitting means.

6. The alarm means of claim 5 wherein said indication means further includes horn means.

7. In a drilling system, a system for use in monitoring the velocity of a pipe string while it is being run into or out of a well bore comprising,

means adapted for coupling with a pipe string for generating direct current electrical signals proportional to the velocity of travel of a pipe string, 5
direct current meter means for receiving a direct current electrical signal representative of the velocity of a pipe string being moved relative to a borehole, said meter means being responsive to the magnitude of said signal for producing a visual indication of the velocity value related to such input signal, 10
means for reversing the polarity of an electrical signal applied to said meter means,
means associated with said meter for establishing upper and lower predetermined velocity limits, 15
alarm means,
means responsive to an electrical signal causing said upper limit to be exceeded or said lower limit to be passed for actuating said alarm means, and 20
means coupled to said alarm means for disabling the alarm means whenever an electrical signal causes said lower limit to be passed to a certain minimum value below said lower limit. 25

8. For a drilling system, an alarm mean for use in monitoring the velocity of a pipe string while it is being run into or out of a well bore, comprising

means adapted for coupling with a pipe string for generating electrical input signals representative of the velocity of a pipe string being moved relative to a well bore, 30
meter means for receiving an electrical input signal representative of the velocity of a pipe string being moved relative to a borehole, said meter means being responsive to the magnitude of such signals for producing a visual indication of the velocity value related to such input signal, 35
means coupled to said meter means for establishing upper and lower predetermined limits of velocity values, 40
alarm indicator means, and
means responsive to an electrical signal causing said upper limit to be exceeded or said lower limit to be passed for actuating said alarm means. 45

9. In a drilling system using a string of pipe for drilling a well bore,

means for supporting and moving a string of pipe relative to a borehole, 50
means for detecting the velocity of such a string of pipe relative to a well bore and for developing electrical signals functionally related to the instantaneous velocity of such string of pipe, 55
means responsive to said electrical signals for producing an indication of said electrical signals,
selectively operable means for providing a reference signal to said indication producing means and for adjusting the indication of said indication producing means for obtaining a selected indication, 60
means responsive to said reference signal for producing an indication of velocity values, and
means for adjusting said last-mentioned means relative to reference signal for obtaining a selected velocity value. 65

10. A method of tripping pipe during an operation in a well bore comprising the steps of:

moving a string of pipe between first and second locations relative to a rig floor and crown block on a drilling rig,

producing electrical signals as a function of the instantaneous velocity of said string of pipe while moving between said first and second locations, selecting at least one velocity limit value as a function of said electrical signal, 5
producing a physiological indication at such time as an electrical signal traverses a velocity limit value. 10

11. A method of calibrating equipment used in tripping pipe during an operation on a well bore comprising the steps of:

moving a string of pipe between first and second locations relative to a rig floor and crown block on a drilling rig at a constant velocity, 15
producing a first electrical signal as a function of said constant velocity,
indicating said first electrical signal as a function of voltage, 20
timing the movement of said string of pipe for determining a velocity value correlatable to said first electrical signal,
producing a second electrical signal equal to said first electrical signal, 25
indicating said second electrical signal as a function of velocity,
providing and adjusting an electrical attenuation for said second electrical signal for adjusting the value of the velocity as indicated by said second electrical signal to the value determined for said first electrical signal whereby said first electrical signals are calibrated relative to velocity values. 30

12. For a drilling system, alarm means for providing an indication whenever predetermined velocity values for travel of a pipe string relative to a borehole are exceeded by actual velocity of pipe being moved relative to a borehole, 35

means adapted for coupling with a pipe string for generating electrical input signals representative of actual velocity of a pipe string, 40
said alarm means being adapted to receive an input electrical signal representative of actual velocity of pipe travel relative to a borehole and including selectively adjustable preset means for providing an output control signal whenever said input signal reaches a predetermined magnitude, 45
means responsive to said output signal for producing a physiological indication, and
means for disabling said physiological indication means at a predetermined magnitude of said input signal below the signal magnitude established for a lower velocity limit. 50

13. The alarm means of claim 12 wherein said input signal generating means obtains signals for movement of a pipe string in either direction, and further including means for sensing such input signals and for selectively applying only those input signals to said alarm means which represent travel of such pipe string in one of said directions. 55

14. For a drilling system, an alarm means for use in monitoring the velocity of a pipe string while it is being run into or out of a well bore, comprising

means adapted for coupling with a pipe string for generating electrical input signals representative of the velocity of a pipe string being moved relative to a well bore, 65

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meter means for receiving an electrical input signal
representative of the velocity of a pipe string being
moved relative to a borehole, said meter means
being responsive to the magnitude of such signals
for producing a visual indication of the velocity
value related to such input signal, 5
means associated with said meter means for estab-
lishing upper and lower predetermined limits of ve-
locity values,
alarm indicator means,

means responsive to an electrical signal causing said
upper limit to be exceeded or said lower limit to be
passed for actuating said alarm means, and
means for disabling said alarm means whenever said
lower limit is passed by a predetermined value.

15. The alarm means of claim 14 and further includ-
ing means for reversing the polarity of the electrical sig-
nal input to said meter means.

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