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J. E. BOWDEN
WELL-LOGGING CONTROL SYSTEM FOR REGULATING
THE TENSION IN A DRILL LINE

3,076,635

Filed Aug. 25, 1959

3 Sheets-Sheet 1

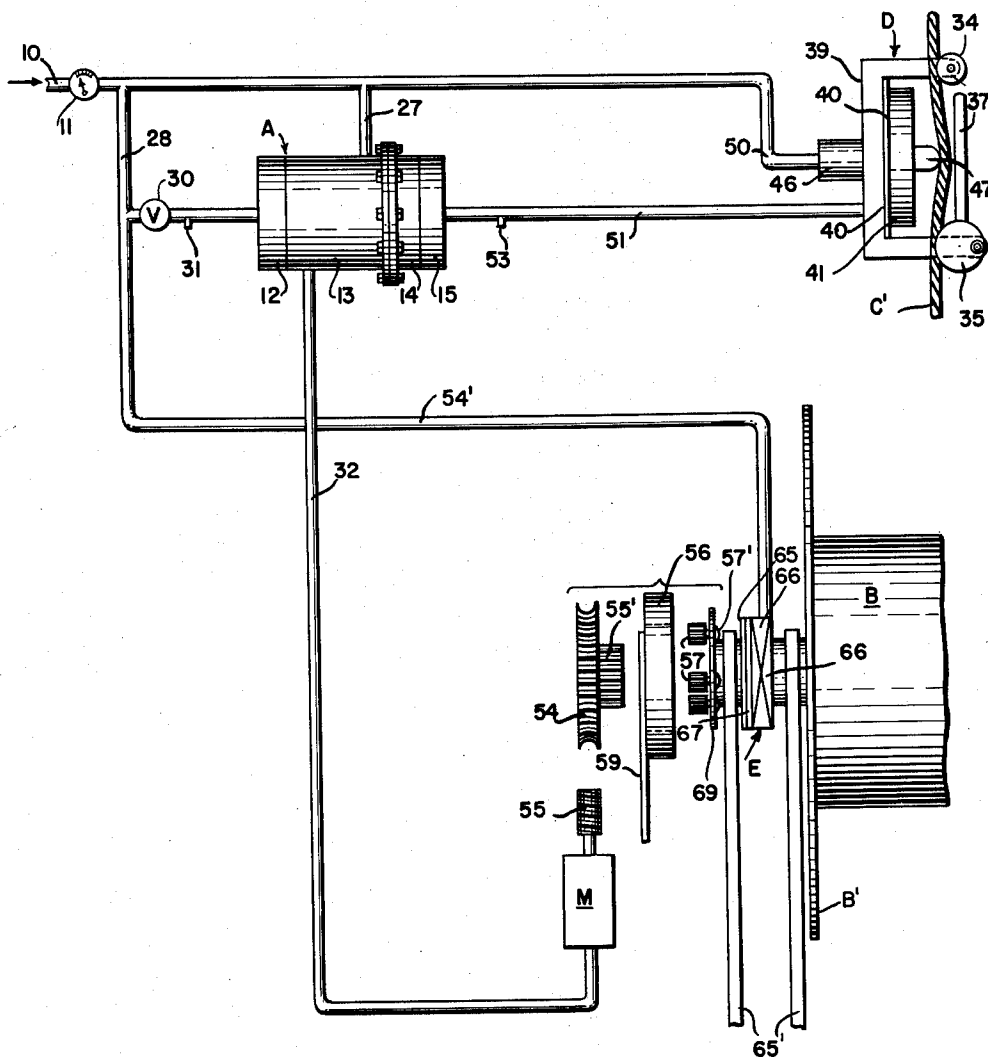


FIG. 1.

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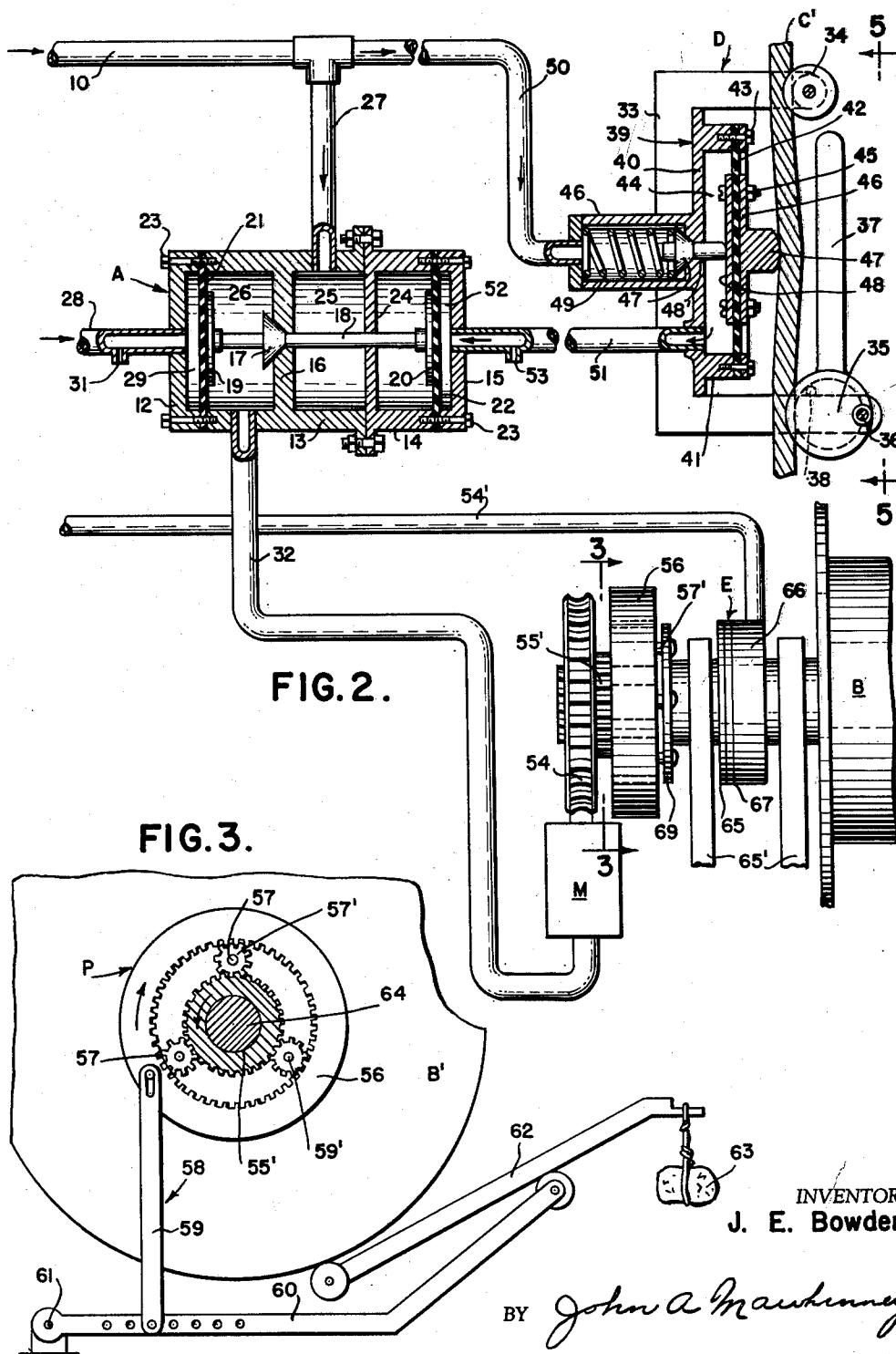
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3 Sheets-Sheet 3

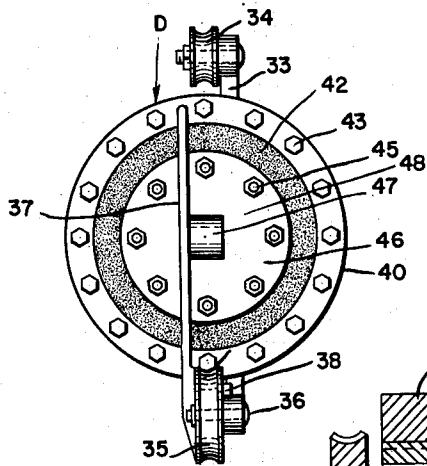


FIG. 5.

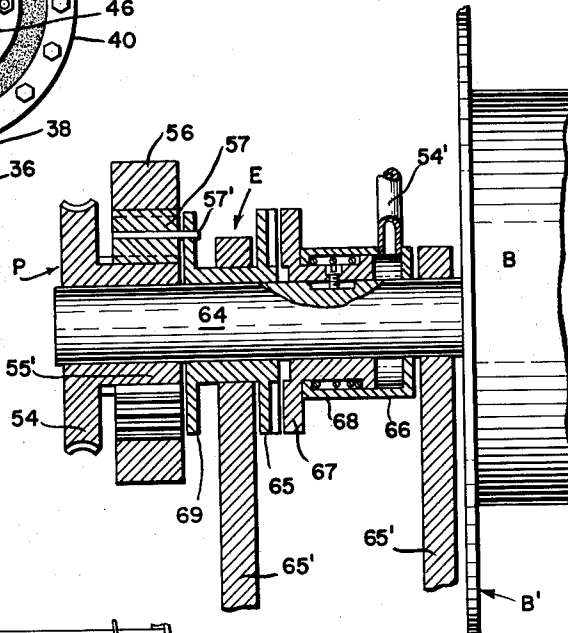


FIG. 4.

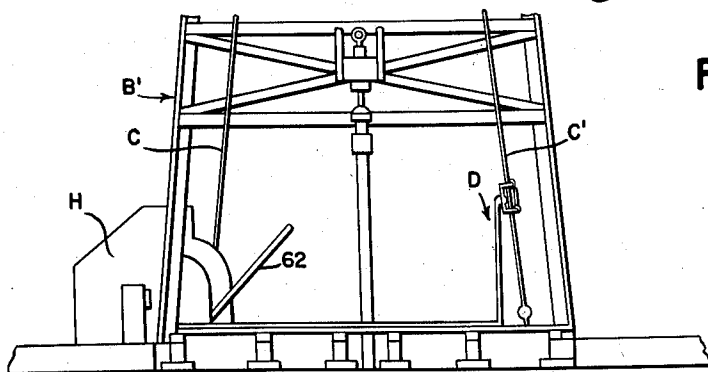


FIG. 6.

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WELL-LOGGING CONTROL SYSTEM FOR REGULATING THE TENSION IN A DRILL LINE

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6 Claims. (Cl. 254-173)

This invention relates to the automatic regulation of tension in the drill line of an oil well drilling control system as successively deeper subsurface formations are penetrated.

Certain subject matter disclosed herein is shown and described in my co-pending application for patent Serial No. 668,230, filed June 26, 1957.

It is primarily aimed to provide a novel automatic system which is readily attachable to the conventional rotary oil rig for continuously controlling the tension in the drill line and especially one whose operation may be exclusively pneumatic.

Another important object is to provide a novel diaphragm sensor unit directly associated with the dead line.

A further object is to provide a novel system having a supply valve controlling the driving fluid to the hoist drum gearing, which is reciprocable according to the pressure against opposite sides thereof, the pressure against one side being governed by the sensor unit.

Still another object is to provide the sensor unit with a supply valve which is variably opened according to the drill line tension to permit passage of pressure through the unit to one side of said valve.

Further objects are to provide in such system, novel means for automatically maintaining constant drilling weight on the drilling bit to increase the efficiency of the bit; novel means for generating a mechanical signal proportional to the hoist drum shaft movement and effect resetting of friction brake mechanism in response thereto, and to provide a novel planetary-type gearing transmission for controlling said friction brake mechanism.

The more specific objects and advantages will be pointed out or otherwise become apparent as the description is considered in connection with accompanying drawings.

In said drawings:

FIG. 1 is a representative plan or layout of the improved pneumatic system and apparatus with parts of the employed planetary gearing exploded;

FIG. 2 is a plan or layout of most of the parts of FIG. 1, on a larger scale with the planetary gearing enmeshed and with the main valve assembly and sensor cross-sectioned;

FIG. 3 is a view taken substantially on line 3-3 of FIG. 2 looking in the direction of the arrows;

FIG. 4 is an elevation of one end portion of the rig drum, with the associated planetary gearing and clutch shown in cross-section;

FIG. 5 is a side elevation of the sensor looking to the left in FIGS. 1 and 2, and

FIG. 6 is a fragmentary elevation of a conventional rig with the sensor and brake mechanism diagrammatically included.

Referring specifically to the drawings showing by way of example one operative embodiment and wherein like or corresponding reference characters designate corresponding parts throughout the different views, an operating fluid is supplied through conduit 10 under control of a suitable valve 11 therein. The instant invention is so designed that its operation may be exclusively pneumatic to attain simplicity in manufacture and maintain operating costs at a minimum.

Briefly, a divided stream of the air under pressure biases a control valve assembly A to closed position. Said assembly is associated with the motor M of the driving and braking mechanism of a drum or spool B of a

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conventional drilling rig B', fragmentarily shown in FIG. 1, and its associated drilling line or string of cable C of which C' represents the deadline. The tension of said line regulates the admission of another divided pneumatic stream through a sensor unit D to the control valve assembly A to function in opposition to the first divided stream to variably position the valve per se thereof and thus control the pneumatic input to motor M. Practically all of the elements and combinations comprising the instant invention may substantially occupy a single main housing H of the rig or derrick B' but of course all of them may be variously located and positioned as seems most advantageous.

With more specific reference to control valve assembly A it comprises a casing made for example in separable sections as at 12, 13, 14 and 15, section 13 having a partition wall 16 across the same affording a port and valve seat therethrough for frusto-conical valve head 17 of a slidably reciprocable valve rod 18, portions of which project on opposite sides of that head. The rod 18 at opposite ends carries plates 19 and 20 which contact or have flexible diaphragms 21 and 22 fastened thereto, which diaphragms are marginally secured in place by the bolts 23 or other means joining the adjacent casing sections. The valve rod 18 is mounted by said partition wall 16 and a partition wall 24.

Said control valve assembly A thus has a main input chamber 25 and an output chamber 26. A branch conduit 27 leads from supply conduit 10 to chamber 25 and another branch conduit 28 leads from said supply conduit to a chamber 29 of the valve assembly A, the pressure against the free face of diaphragm 21 biasing same to the right and the valve head 17 to closed position, since the pressures thru branch conduits 27 and 28 balance. A conventional filter-valve regulating unit 30 and a continuously open drain nozzle or opening 31 are provided in branch conduit 28. A conduit 32 leads from chamber 26 to motor M.

As hereinbefore intimated the position of valve head 17 is regulated by the tension of the dead end C' of the drilling line or cable at sensor D. More in detail, a conventional mounting frame 33 has an upper spool 34 pivotally mounted at its top and a spool cam 35 pivotally mounted at 36 adjacent its lower end. An elongated handle 37 extends upwardly from spool cam 35 and the latter in combination with a dowel 38, removably positioned within a mating axial recess within the cam, assists in maintaining the handle 37 and cam 35 in the desired position with the dead end portion C' bowed or deflected outwardly from the vertical.

Said frame 33 carries a chamber of casing 39 having for example a base wall 40 and an annular marginal wall 41, against the outer edge of which a flexible diaphragm 42 is suitably fastened as at 43, in spaced parallelism to wall 40 and enclosing a space 44. Bolted or otherwise fastened to the diaphragm at 45 and movable therewith is a plate 46 having a central stud or projection 47 in contact with the bow or deflection of said dead end portion C'. If desired a plate 48 may be fastened against the diaphragm by said bolts 45 for further reinforcement.

Projecting centrally from wall 40 is a small housing 46 for a valve 47 slidably mounted in a port 48' in wall 40 which is urged by an expansive coil spring 49 against its seat at said port. A section of the supply conduit 10 at 50 leads to housing 46. A conduit 51 establishes communication between sensor space 44 and a space or chamber 52 of the casing of valve assembly A and one of the main walls of which space 52 is the diaphragm 22 whose free face is subject to the pressure therein for sliding to the left to correspondingly slide and open valve

head 17 for flow of air from chamber 25 through the port of valve 17 to chamber 26, conduit 32 and motor M. A continuously open nozzle or drain opening 53 is provided in conduit 51.

A branch conduit 54' diverts air from supply conduit 10 to operate a spring-biased normally open clutch generally indicated at E which functions to drivingly engage the hoist drum or spool B with a planetary gear assembly P which is in turn driven by motor M. This planetary gear assembly P includes a gear 54 which receives torque from a worm 55 driven directly by motor M. A sun pinion gear 55' is keyed or otherwise securely affixed to the gear 54 for concurrent rotation therewith. A ring gear 56 meshes with a plurality of small planetary gears 57 enmeshed with the peripheral teeth of the sun pinion 55'.

The numeral 53 indicates generally a lever system which is actuated by means of the planetary gear assembly P. A slotted lever 59 is pivotally secured at one end to the radial end surface of the internal ring gear 56. The opposite end of the lever 59 is pivotally secured to a lever 60 which is adapted to oscillate about a fixed pivot pin 61. The lever 60 is mounted to actuate a hoist drum brake lever 62 provided with a suitable counterweight 63 suspended from the outermost extremity thereof to assist the brake system in restraining the hoist drum from the tendency to rotate which is caused by the pull of the drill line.

Further, concerning said pneumatically operable clutch E it will be seen that the gear 54 with associated pinion 55' is mounted for concentric rotation with the drum spool B and its shaft 64. The drum shaft 64 is journaled between suitable support members 65'. Each of the planetary gears is rotatably journaled upon a spindle 57' secured at one end to a flange 69 with a clutch plate 65.

The clutch E includes an airtight casing 66 disposed to permit rotation of the drum shaft 64 therein. Casing 66 carries an axially movable clutch plate 67 which is biased to its indicated position by means of the coiled compression spring 68. The plate 67 is keyed to shaft 64 for concentric rotation therewith. The clutch plates 66 and 67 are each provided with suitable serrations or the like for positive locking engagement therebetween so that in operation, the application of compressed air to the clutch through conduit 54' causes the spring biased clutch plate 67 to move axially into engagement with the clutch plate 65.

It will be realized that as the drill bit penetrates successively deeper formations, the tension on the drill line increases. Since pneumatic pressure supplied via control valve 11 and conduit 10 has engaged the normally open clutch E, the diaphragm sensor D samples the increasing tension in the dead line and progressively increases the extent of opening at valve port 48.

The application of torque to the gear 54 and sun pinion 55' causes them to turn freely on the drum shaft 64. This in turn causes the associated planetary gears each to revolve about its individual spindle 57'. However, since the planetary spindles 57' are held almost motionless by the engagement of the clutch P, the rotation of the planetaries on such relatively stationary spindles causes the ring gear 56 to rotate slightly in the clockwise direction. As a result, the lever 60 is raised slightly, effecting a corresponding elevation in the hoist drum brake lever 62 which reduces the tension in the hoist drum friction brake bands, and allows the hoist drum to rotate slightly. The inherent tension in the drilling cable then turns the hoist drum through a given arc, and pulls a quantity of line from the drum spool causing the spool to rotate in an opposite direction. This allows the drill pipe string to lower and transfers some of the suspended weight supported by the derrick to the drill bit.

When the drum rotates oppositely, in this manner, the planetary spindles 57' are each caused to rotate counter-

clockwise. During this interval, the sun pinion or gear 55' is either practically stationary or moving much more slowly than the individual planetary gears. This causes the ring gear 56 to rotate counterclockwise and relieve the upward force previously exerted upon the lever 60. The release of lever 60 then causes the friction brake bands to re-engage. Thus, in combination with a diaphragm sensor unit, the tension of the drilling line is automatically adjusted during continuous drilling operations.

Presuming operation a stream of air under pressure from a portable tank, compressor or any suitable source is supplied from the left (FIG. 1) through conduit 10, branching through conduit 28 to valve chamber 29 and also through conduit 27 to the main supply chamber 25 of the valve assembly A, balancing and closing valve 17. Said air stream further branches through conduit 54' (FIG. 1) into chamber 66 and slides clutch plate 67 to the left into engagement with clutch plate 65 which drivingly connects hoist line drum B, its braking mechanism and planetary gearing P all as hereinbefore specifically described. As well, the air branches through conduit 50 into housing 46 and together with spring 49 biases valve 47 to closed position. Such valve 47 and valve 17 remain closed when the tension in cable C is insufficient to open or move the stud 47 and diaphragm sensor at 42 to the left and opens only when the tension on the cable in the operation of the drill string becomes sufficient to so move such sensor to open valve 47. This opening and closing of such valve depends upon the decreasing and increasing of the deflection of the dead end C'. When valve 47 is so opened the air under pressure passes through the port 48, chamber 44, conduit 51 and into chamber 52, unbalancing the pressures biasing closing of valve 17 and sliding that valve to the left and thus opening its port so that the air passes from chamber 25 into chamber 26 and conduit 32 to motor M. It will be realized that the extent of opening of valve 47 is variable and proportional to the tension to which cable C is subjected and that the extent of opening of main valve 17 and speed of rotation of motor M are correspondingly proportional; hence the degree of restraint imposed upon the drum means is automatically variable.

The remainder of the operation of the planetary gearing P and the drum mechanism B has hereinbefore been specifically traced.

Various changes may be resorted to within the spirit and scope of the invention.

What is claimed is:

1. In a system for regulating drill line tension as successively deeper formations are penetrated, drum means rotatable in response to tension in the drill line mounted to support a supply of said drill line and provided with braking means thereon for release through tension in the drill line and reapplication through rotation of the drum, means for exerting a variable force on said braking means including a planetary gear assembly, a clutch means for said drum means and planetary gear assembly having a first clutch member and a co-acting clutch member, said planetary gear assembly including a first gear means and a brake-operating part rotatable in the same direction but in a direction opposite to the direction of drum rotation and being rotatable in opposite directions relative to each other, a fluid operable motor mounted to supply input torque to said first gear means, a planetary gear element of said assembly carried by the first clutch member geared to said part, a fluid pressure circuit, a control valve mechanism in said circuit, a first branch supply conduit in said circuit whereby pressure in said conduit will urge said control valve means toward closed position, a second branch supply conduit in said circuit including a diaphragm sensor responsive to tension in said drill line operable to initiate flow of fluid pressure to said motor, said circuit having a first branch conduit portion from said sensor to said control valve means for passage

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of fluid pressure to said control valve means to overbalance and variably open it, and a second branch conduit portion in said circuit for passage of fluid pressure to thereby engage said clutch members.

2. A system according to claim 1 wherein said first gear means and first clutch member are journaled on the same axis as said drum, and said coacting clutch member is slidably mounted on said axis.

3. A system according to claim 1 wherein said drum means includes a shaft having a portion extending laterally beyond the drum means, said first gear means and first clutch member are journaled on said extending portion, and said coacting clutch member is slidably mounted on said extending portion.

4. A system according to claim 1, wherein said control valve mechanism has a valve element, a rod slidably mounting said valve element, and diaphragm means on opposite sides of said valve element to move said rod according to application of fluid pressure thereagainst from said first branch supply conduit and said first branch conduit portion, respectively.

5. A system according to claim 1 wherein said sensor

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has a chamber to receive fluid pressure via said second branch supply conduit, and from which chamber said first branch conduit portion leads.

6. A system according to claim 1 wherein said sensor has a housing to which said second branch supply conduit directly leads, a chamber in said sensor, valve means in said housing operable by deflection of the drill line to control passage of pressure fluid to said chamber, said first branch conduit portion leading from said chamber and including a bleeder.

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