March 1, 1955 A. L. SELJOS ET AL 2,703,008

WEIGHT ON BIT INDICATING AND DRILLING CONTROL SIGNALING APPARATUS

Filed Aug. 17, 1951 2 Sheets-Sheet 1

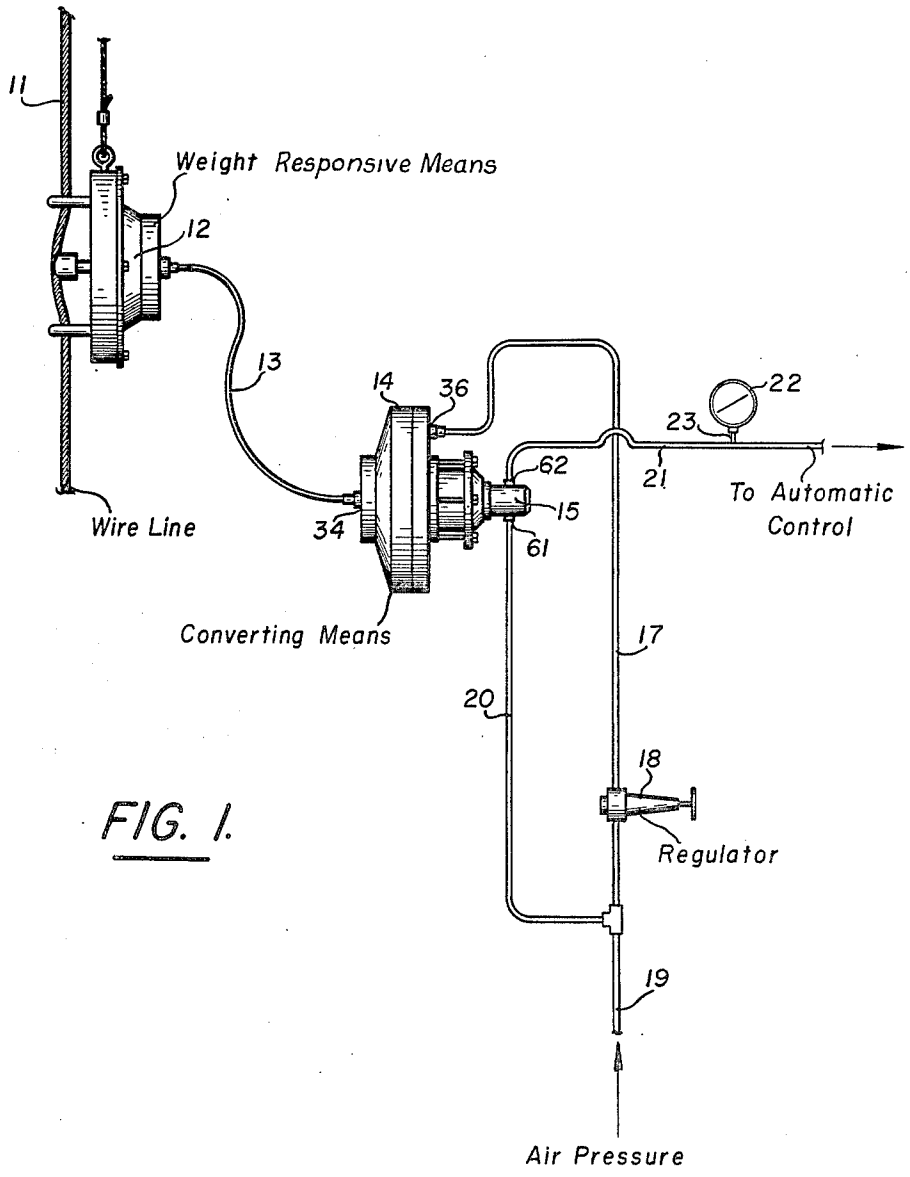


FIG. 1.

INVENTOR.
Algernon S. Badger,
BY Arthur L. Seljos,
Thomas B. McCulloch
AGENT.

March 1, 1955 A. L. SELJOS ET AL 2,703,008

WEIGHT ON BIT INDICATING AND DRILLING CONTROL SIGNALING APPARATUS

Filed Aug. 17, 1951

2 Sheets-Sheet 2

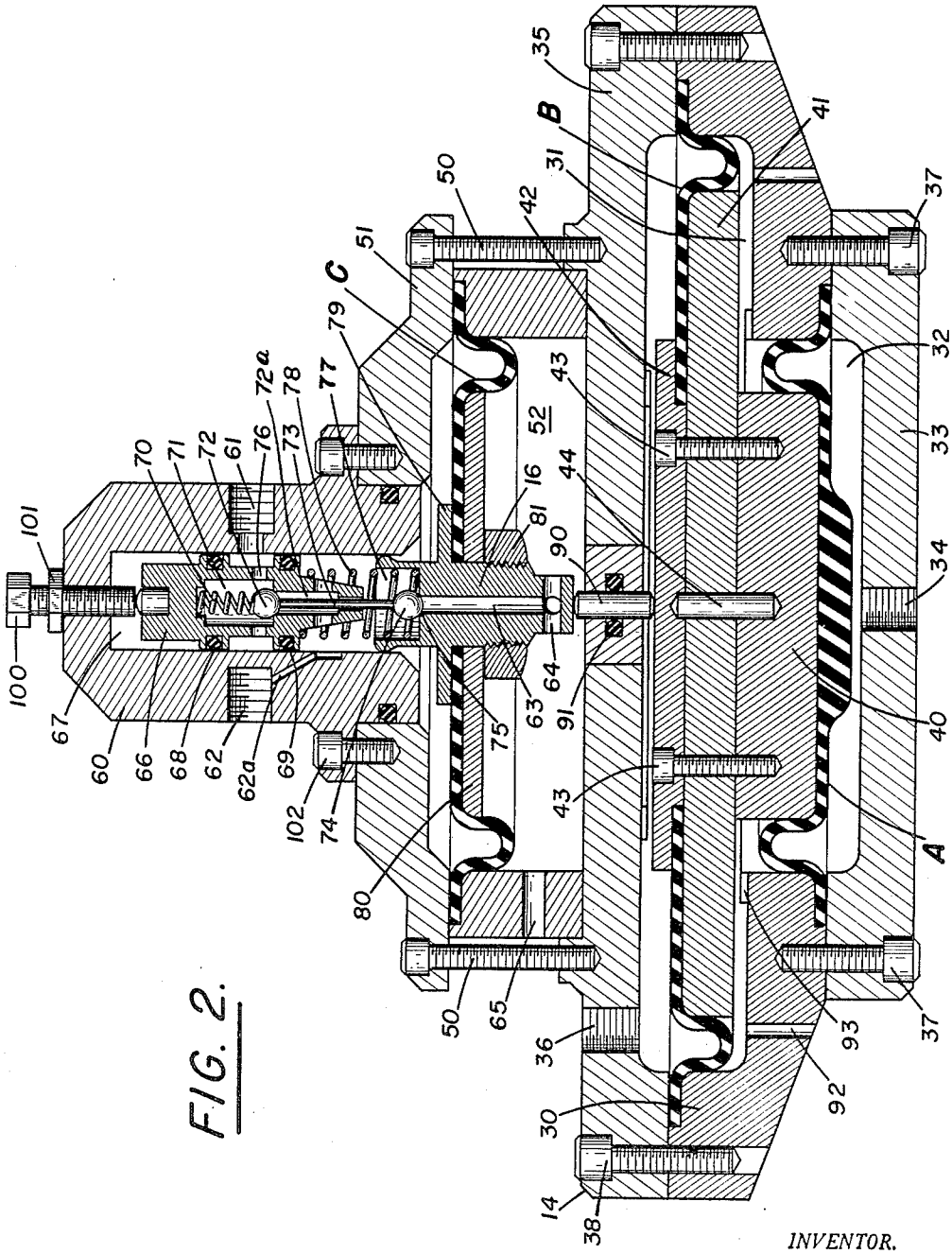


FIG. 2.

INVENTOR.
Algernon S. Badger.
BY Arthur L. Seljos,

AGENT.

United States Patent Office 2,703,008 Patented Mar. 1, 1955

2,703,008

WEIGHT ON BIT INDICATING AND DRILLING CONTROL SIGNALING APPARATUS

Arthur L. Seljos and Algernon S. Badger, Houston, Tex., assignors, by mesne assignments, to Standard Oil Development Company, Elizabeth, N. J., a corporation of Delaware

Application August 17, 1951, Serial No. 242,301

5 Claims. (Cl. 73—151)

The present invention is directed to a weight on bit indicating and a drilling control signalling apparatus. More particularly, the invention is directed to apparatus for indicating the weight on bit directly while delivering a signal to automatic control for drilling operations responsive to the weight on the bit.

The present invention may be briefly described as a device for indicating the weight on bit and drilling control signalling apparatus which comprises means adapted to be attached to a line of a well drilling rig and adapted to deliver a pressure signal responsive to tension exerted on said line. The pressure signal is delivered to a converting means which is operatively connected to the pressure signal means. The converting means includes first, second and third pressure responsive means and a valve operatively connected to the third pressure responsive means, the first pressure responsive means being responsive to the changes in the pressure signal delivered by the pressure signalling means while the second pressure responsive means is responsive to a pressure different from that delivered by the pressure signalling means. The third pressure responsive means is adapted to open and close the valve and to deliver fluid therethrough from a source of fluid pressure to a conduit connected to an outlet of the valve. A pressure indicating means is operatively connected to the pressure converting means for indicating the weight on a drilling bit attached to the line. The pressure indicating means may be connected to the conduit connected to the outlet of the pilot valve, the pressure signal from the device being directed through the conduit to automatic drilling control mechanism for actuation thereof.

The present invention will be further described and illustrated by reference to the drawing in which

Fig. 1 is a schematic illustration of the several elements of our invention, and

Fig. 2 is a sectional view of the pressure converting means making up an element of the combination.

Referring now to the drawing, Figs. 1 and 2, numeral **11** designates a wire line, such as a live or dead line, of a well drilling rig which is operatively connected to a drilling weight responsive device **12**. Drilling rig responsive device **12** may be a load or weight responsive means, such as described in the patent to Shimek, 2,013,810, issued September 10, 1935, or it may be a tension or responsive means, such as described in the patent to Martin, 1,872,087, dated August 16, 1932. Other equivalent devices, such as are well known to the prior art, may be used as the means to be attached to the line of a well drilling rig so long as it will deliver a pressure signal responsive to tension exerted on a wire line to which the pressure signalling means may be attached. The drilling weight responsive device, such as **12**, is operatively connected by a line or conduit **13** to a pressure converting means generally indicated by numeral **14**. Pressure converting means embodies first, second and third pressure responsive means and a valve. The first pressure responsive means is illustrated by a diaphragm A while the second pressure responsive means is indicated by a diaphragm B. A third pressure responsive means is designated as a diaphragm C for the purposes of this illustration. A valve such as a pilot valve **15** which is indicated schematically in Fig. 1 is operatively connected to diaphragm C by the element generally indicated as **16**. An adjusting pressure is delivered against the diaphragm B through a conduit **17** containing a pressure regulator valve **18** which is connected by conduit **19** to a source of fluid pressure such as air. A branch line **20** connects to line **19** and delivers air to valve **15** and thence, controlled by valve **15**, to conduit **21** and to pressure indicating means such as a pressure gauge **22** connected to line **21** by conduit **23**. The conduit **21** is adapted to be connected to an automatic drilling control mechanism and to deliver a pressure signal thereto.

Referring now specifically to Fig. 2, the pressure converting means **14** has arranged therein diaphragms A, B and C. The pressure converting means includes a housing **30** which encloses a first chamber **31** and a second chamber **32**. The housing **30** is provided with a first plate **33** which defines an inlet **34** which is adapted to be connected to conduit **13**. The housing **30** is provided with a second cover plate **35** which defines an inlet **36** which is adapted to be connected to line **17**. The cover plate **33** is bolted to housing **30** by threaded bolts **37** and the cover plate **35** is bolted to housing **30** by threaded bolts **38**. Arranged between the diaphragms A and B are plates **40** and **41**. Plate **40** is above diaphragm A and fits snugly thereagainst while plate **41** is below diaphragm B and fits snugly thereagainst and against plate **40**. Above the diaphragm B and the plate **41** is a third plate **42**. The three plates are connected to each other by inset threaded bolts **43** and by pin **44**.

Connected to the cover plate **35** by threaded bolts **50** is a housing **51** enclosing a third chamber **52** in which is arranged diaphragm C. Diaphragm C is connected by an actuating means **16** to a valve generally indicated by the numeral **60** which is provided with an inlet **61** which is connected to line **20** and an outlet **62** which is connected to line **21** and to pressure gauge **22**.

The element **16** is provided with a passageway **63** which terminates at the lower end of element **16** into ports **64** which communicate with chamber **52** and thence by port **65** with the atmosphere. The valve **60** includes a valve mechanism **66** arranged in a chamber **67** of valve **60**. The element **66** is sealed in the chamber **67** by O-rings **68** and **69** and encloses a compression member, such as spring **70** arranged in the internal chamber **71** of valve mechanism **66**. The spring **70** bears against a spherical seating member **72** which is connected by a longitudinal member **73** to a second seating member **74**. The first spherical seating member **72** fits on the lower part of the member **66** while the seating member **74** fits on the seating member **75** defined by element **16**. The element **72** serves to open and close a vertical passage **72***a* in valve mechanism **66** and allows communication between inlet **61** and outlet **62** through passage **72***a* and **62***a* while the spherical seating member **74** serves to open and close the passageway **63** of element **16** bearing against the lower end of seating member **74**; fitting into a recess **77** of element **16** is a compression means such as a coil spring **78** which bears against the mechanism **66** and the element **16**. Outlet **62** is fluidly connected to the lower portion of chamber **67** below valve mechanism **66** by a passageway **62***a*.

The diaphragm C is snugly held in chamber **52** by a shoulder **79** of element **16** and a plate **80** held in place by nut **81**, which is threadably attached to element **16**. The element **16** bears against a pin **90** which is slidably fitted into the cover plate **35** of the housing **30**. This pin is sealed with an O-ring **91**. It will be noted that the chamber **31** between the diaphragms A and B is vented to the atmosphere by a port **92**. It will be further noted that the chamber **31** is provided with a stop **93** to limit the travel of plate **41**.

The valve **60** is provided with an adjusting screw **100** which bears against the valve mechanism **66**. The adjusting bolt **100** is held in place by the lock-nut **101**. The valve **60** is attached to the housing **51** by threaded bolts **102**.

The apparatus of the present invention functions in the following manner:

Assuming that the converting means **14** has no pressure exerted on either diaphragms A, B, or C, at the beginning, the apparatus is adjusted for use by admitting a pressure, proportional to the total weight exerted on line **11**, against diaphragm A through inlet **34**. This

causes movement of diaphragm A which serves to open the pilot valve **15** admitting air through port **61**, port **76**, and passageway **72***a* against diaphragm C and delivering air through port **62***a* and **62**. In this example the areas of diaphragms A and B are equal. The signal pressure from weight responsive means **12**, as shown in the example which follows, is several times greater than the pressure of the air admitted from the supply air through line **20** to port **61**. Therefore, the weight on bit gauge **22** may be considered as a vernier gauge for the total weight, including weight on bit, exerted on line **11**. The maximum forces exerted on diaphragm A by the signal pressure are greater than the maximum forces exerted on diaphragm C. To balance the converting means **14**, pressure is then admitted to diaphragm B through inlet **36** from conduit **17** and regulator **18** until the forces on B and C are equal to the forces exerted on A. Then the weight on bit gauge **22** reads zero but actually is 95 pounds per square inch. Any change then reflects weight on bit.

The weight on bit gauge is calibrated so that a decrease in pressure on the gauge indicates an increase in bit weight. With the converting means **14** in a balanced state, the inlet and outlet valves are both closed. When the total weight on line **11** decreases, the pressure transmitted through conduit **13** decreases. Then the force exerted by diaphragm A is less than the force exerted by diaphragms B and C, causing the pilot valve **15** to exhaust air pressure from above diaphragm C and from conduit **21** through port **62** until the assembly is again in balance. The lower pressure on diaphragm C is then read on gauge **22** as the actual weight on bit.

If the weight on bit should decrease, an increase in pressure from conduit **13** to diaphragm A would result with the force on A being greater than diaphragms B and C; the pilot valve **15** would then admit air through port **61** until enough pressure was admitted to diaphragm C to put it back in a balanced state with neither air being admitted nor exhuasted.

Thus, the converting means **14** serves to balance out the weight exerted on line **11** other than weight on bit and allows the weight on bit to be read directly on gauge **22**.

Thus a drilling weight pressure signal is exerted on diaphragm A from the drilling rig weight responsive means generally designated as **12**. A regulated air pressure is delivered to diaphragm B from regulator **18** by line **17**. Air pressure is delivered by conduit **20** to inlet **61** of the pressure converting means **14**. The diaphragms A, B and C are related so that the pressure on A times the area of the diaphragm A equals the pressure on diaphragm B times the area of diaphragm B plus the pressure on diaphragm C times the area of diaphragm C. The converting means **14** has the characteristic, by the selection of the areas of the three diaphragms and their relationship to each other to supply pressure which is delivered by conduit **21** which may range from 0 to the maximum pressure delivered by conduit **20**, the fluctuations being indicative of the weight on bit and responsive to the pressure signal delivered by line **13**.

Referring to Fig. 2 especially, it will be seen that a pressure signal is delivered through inlet **34** to diaphragm A which causes this diaphragm to flex upwardly. At the same time an adjusting pressure is delivered to diaphragm B through inlet **36** by line **17**. This causes the diaphragm B to flex downwardly. The net result of the signalling pressure operating against the adjusting pressure is that the plates **40**, **41** and **42** are caused to move in an upward or downward direction depending on whether the pressure signal through line **13** is increasing or decreasing. An increase in weight on bit results in a decrease of signalling pressure and a decrease in weight on bit results in an increase in signalling pressure in this device. Assuming that the pressure is such that the net effect is the flexing upward of the plates, **40**, **41** and **42**, this would cause the pin **90** to move upward against the valve operating element **16** connected to the diaphragm C. In the meanwhile, however, fluid pressure is being delivered by line **20** to inlet **61** and the spherical element **72** is moved off its seat on valve mechanism **66** and causes delivery of air through outlet **62** to conduit **21**. However, as the element **72** moves off its seat, this allows the air pressure introduced by inlet **61** to be exerted also against the diaphragm C which causes flexing of diaphragm C in a downward direction; thus a decrease in weight on bit results in an increase of signal pressure and will cause the pilot valve to admit air until the device is in balance allowing the direct weight on bit to remain constant on the pressure indicating means **22** and delivering a constant signal to the automatic drilling control mechanism, not shown. When the apparatus gets out of balance by a decrease in the signal pressure the diaphragm C will flex downward to the point where the spherical member **74** will be unseated by moving off seat **75** causing exhaustion of air from port **62** and the space above diaphragm C through to passageway **63** and then by way of port **64** to chamber **52** and to the atmosphere by port **65**.

The direct weight on bit gauge **22** has a maximum reading equal to the pressure source to which line **19** is connected. In order to be able to cover the desired total weight range with a lower supply of pressure, diaphragm B has an area larger than the area of diaphragm A. Diaphragms A and C have equal areas. Thus the pressure on diaphragm A times the area of diaphragm A equals the pressure of diaphragm B times the area of diaphragm B plus the area of diaphragm C times the area of diaphragm C.

In operating, the zero weight pressure is adjusted by regulator **18** to make the gauge **22** read zero weight, that is about 95 lbs./sq. in. when the bit is off the bottom. As the weight responsive pressure decreases with increasing weight on bit the weight on bit pressure at gauge **22** decreases in proportion. The gauge first is calibrated to read bit weight directly in pounds. It may be desirable to make the zero weight 90% of the whole scale so that the weight off bit may be read to indicate 10% full scale for tight hole indicating, fishing, etc.

It is to be understood that it is possible to vary the ratios of the three diaphragms to each other as may be desired to obtain most efficient utilization of our invention.

Example

In an actual commercial operation a signal from a load or weight responsive means of the type illustrated amounting to 440 lbs./sq. in. was transmitted to the equivalent of conduit **13** against the equivalent of diaphragm A in Figs. 1 and 2 with the bit off bottom. At the same time an adjusting pressure of 70 lbs./sq. in. was transmitted to the equivalent of diaphragm B, bringing the equivalent of gauge **22** to zero. Pressure in line **21** was then 90 pounds per square inch. The drill string was then lowered to place the bit on bottom and the load or weight responsive means then transmitted a signal of 400 pounds per square inch through conduit **13**, the adjusting pressure remaining unchanged at 70 pounds per square inch. The net effect of the signalling pressures against the adjusting pressure were transmitted through the equivalent of three plates **40**, **41** and **42** to the valve **15** through the equivalent of diaphragm C. During time of these signals air at 100 lbs./sq. in. pressure was introduced to the inlet of the equivalent of valve **15** by a conduit corresponding to line **20**. The decrease in the signal of 40 pounds per square inch caused by lowering the bit on bottom showed an increase in weight on bit on gauge **22**. Thus the effect of the adjustment pressure against the signalling pressure and the air introduced by line **20** caused air to be delivered through line **21** to the gauge **22** and to the automatic drilling control mechanism, not shown, at a pressure of 50 lbs./sq. in.; by suitably calibrating the gauge **22**, this pressure was made to show the direct weight on bit on gauge **22** at 20,000 pounds. The procedure is repeated when the weight on the drill string off bottom is changed and at such time the adjusting pressure may likewise be changed.

The nature and objects of the present invention having been completely described and illustrated, what we wish to claim as new and useful and to secure by Letters Patent is:

1. A weight on bit device which comprises, in combination, means adapted to be attached to a line of a well drilling rig and adapted to deliver a pressure signal responsive to tension exerted on said line, means for converting said pressure signal including first, second, and third pressure responsive means and a valve operatively connected to said third pressure responsive means, means operably connecting said first pressure responsive means

to said pressure signalling means, said first pressure responsive means being responsive to changes in the pressure signal delivered by said pressure signalling means, means operably connecting said second pressure responsive means to a source of pre-set pressure different from that delivered by the pressure signalling means, said second pressure responsive means being responsive to said pre-set pressure and said pre-set pressure opposing the signal pressure on said first pressure responsive means, means for delivering fluid under pressure to said valve and to said third pressure responsive means, and pressure indicating means operatively connected to said valve to receive said fluid for indicating the weight on a drilling bit attached to said line, said third pressure responsive means being adapted to open said valve and receive said fluid under pressure to oppose the signal pressure and to close said valve and exhaust said fluid from said third pressure responsive means and said pressure indicating means.

2. A weight on bit device which comprises, in combination, means adapted to be attached to a line of a well drilling rig and adapted to deliver a pressure signal responsive to tension exerted on said line, means for converting said pressure signal including first, second, and third diaphragms and a pilot valve operatively connected to said third diaphragm, means operatively connecting said first diaphragm to said pressure signalling means, said first diaphragm being responsive to changes in the pressure signal delivered by said pressure signalling means, means operatively connecting said second diaphragm to a source of pre-set pressure different from that delivered by the pressure signalling means, said second diaphragm being responsive to said pre-set pressure and said pre-set pressure opposing the signal pressure on said first diaphragm, means for delivering fluid under pressure to said valve and to said third diaphragm, and pressure indicating means operatively connected to said valve to receive said fluid for indicating the weight on a drilling bit attached to said line, said third diaphragm being adapted to open said valve and receive said fluid under pressure to oppose the signal pressure and to close said valve and exhaust said fluid from said third diaphragm and said pressure indicating means.

3. A weight on bit device which comprises, in combination, means adapted to be attached to a line of a well drilling rig and adapted to deliver a pressure signal responsive to tension exerted on said line, means for converting said pressure signal including first, second and third diaphragms, a first conduit operatively connecting said first diaphragm with said pressure signalling means, a pilot valve having an inlet and an outlet operatively connected to said third diaphragm, a second conduit connected to said outlet of said valve, said first diaphragm being responsive to changes in the pressure signal delivered by said pressure signalling means, a third conduit operably connecting said second diaphragm to a pre-set pressure different from that delivered by said pressure signalling means, said second diaphragm being responsive to said pre-set pressure and said pre-set pressure opposing the signal pressure on said first diaphragm, a fourth conduit for delivering fluid under pressure to the inlet of said valve and to said third diaphragm, and a pressure gauge connected to said second conduit to receive said fluid for indicating the weight on a drilling bit attached to said line, said third diaphragm being adapted to open said valve and receive said fluid under pressure to oppose the signal pressure and to close said valve and exhaust said fluid from said third diaphragm and said pressure gauge, said second conduit being adapted to be connected to a drilling control mechanism to deliver a pressure signal thereto.

4. A weight on bit device which comprises, in combination, means adapted to be attached to a line of a well drilling rig and adapted to deliver a pressure signal responsive to tension exerted on said line, means for converting said pressure signal including first, second and third pressure responsive means and a valve operably connected to said first pressure responsive means, means operably connecting said first pressure responsive means to said pressure signalling means, said first pressure responsive means being responsive to changes in the pressure signals delivered by said pressure signalling means, means operably connecting said second pressure responsive means to a source of pre-set pressure different from that delivered by the pressure signalling means, said second pressure responsive means being responsive to said pre-set pressure and said pre-set pressure opposing the signal pressure on said first pressure responsive means, means for delivering fluid under pressure to said valve and to said third pressure responsive means, said third pressure responsive means being adapted to receive said fluid pressure to oppose the signal pressure on said first pressure responsive means to open and close said valve and said valve being adapted to deliver fluid to actuate said third pressure responsive means, and means for exhausting fluid from said valve and said fluid pressure responsive means, said delivery and exhaustion of said fluid being an indication of the weight on a bit attached to said line.

5. A weight on bit device which comprises, in combination, means adapted to be attached to a line of a well drilling rig and adapted to deliver a pressure signal responsive to tension exerted on said line, means for converting said pressure signal including first, second and third diaphragms and a valve operably connected to said first diaphragm, means operably connecting said first diaphragm to said pressure signalling means, said first diaphragm being responsive to changes in the pressure signal delivered by said pressure signalling means, means operably connecting said second diaphragm to a source of pre-set pressure different from that delivered by the pressure signalling means, said second diaphragm being responsive to said pre-set pressure and said pre-set pressure opposing the signal pressure on said first diaphragm, means for delivering fluid under pressure to said valve and to said third diaphragm, said third diaphragm being adapted to receive said fluid pressure to oppose the signal pressure on said first diaphragm to open and close said valve, and said valve being adapted to deliver fluid to actuate said third diaphragm, and means for exhausting fluid from said valve and said third diaphragm, said delivery and exhaustion of said fluid being an indication of the weight on a bit attached to said line.

References Cited in the file of this patent

UNITED STATES PATENTS

2,099,955	Edwards	Nov. 23, 1937
2,304,782	Donaldson	Dec. 15, 1942
2,528,883	Hayward	Nov. 7, 1950
2,529,883	Otto	Nov. 14, 1950