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12-16-75 OR 3,926,047

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Duke et al.

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[54] **WELL PRODUCTION SIGNAL MEANS**

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[73] Assignee: **Atlantic Richfield Company**, Los Angeles, Calif.

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[52] **U.S. Cl.** **73/151**

[51] **Int. Cl.**[2] **E21B 47/00**

[58] **Field of Search** ..... 73/151, 133 R

[56] **References Cited**

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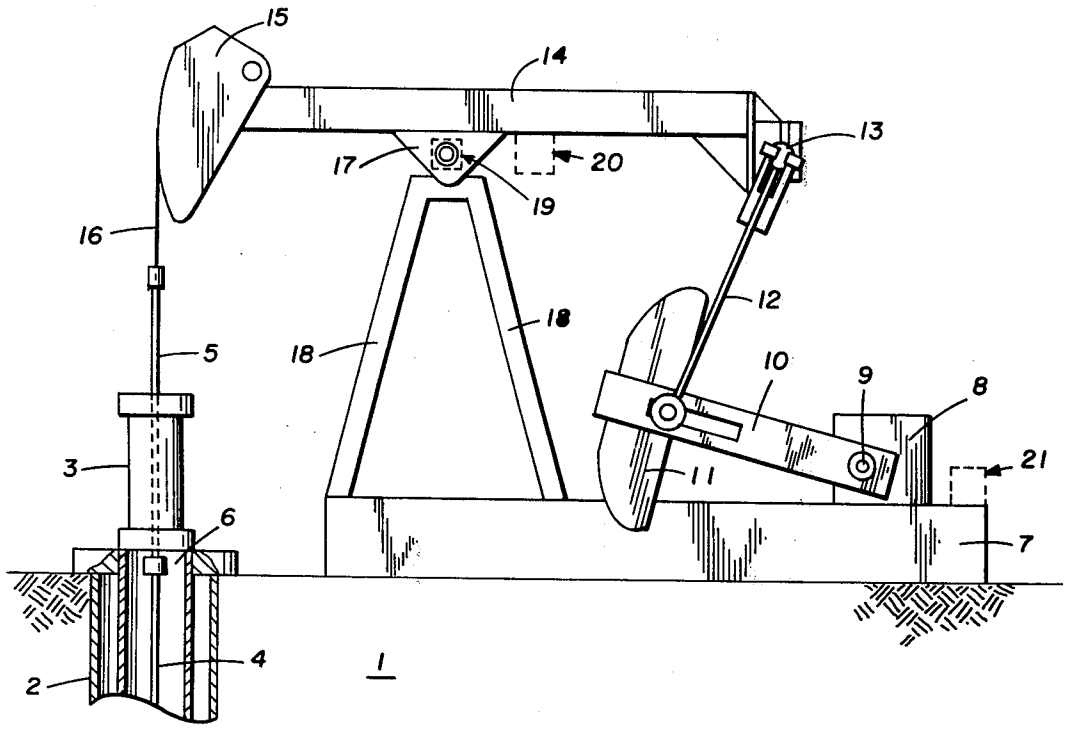
Primary Examiner—Jerry W. Myracle

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[57] **ABSTRACT**

A well pumping unit which employs a walking beam carried on a saddle bearing which in turn is supported by a sampson post wherein a signal means which produces a signal on movement of a member of the signal means is connected to at least one of the walking beam, saddle bearing, and the main shaft of the gear box which drives the pumping unit. Operation of the pumping unit gives an indication by way of the signal means as to the position of the polished rod which is connected to the pumping unit.

1 Claim, 6 Drawing Figures



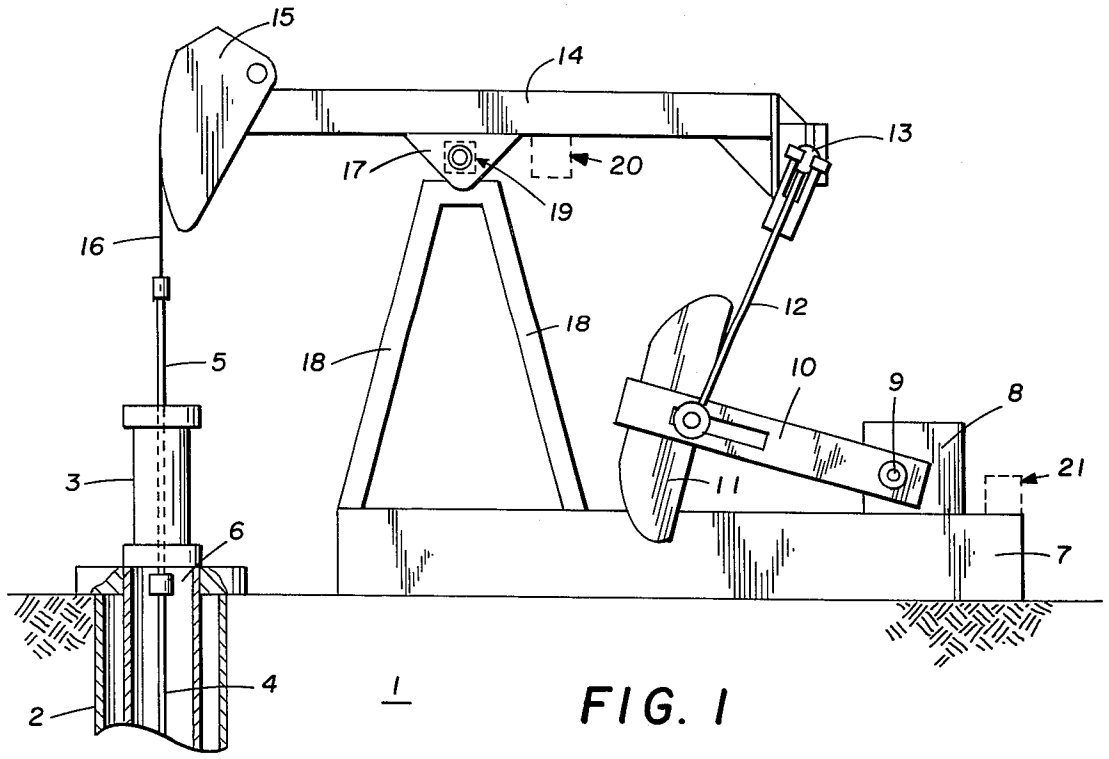


FIG. 1

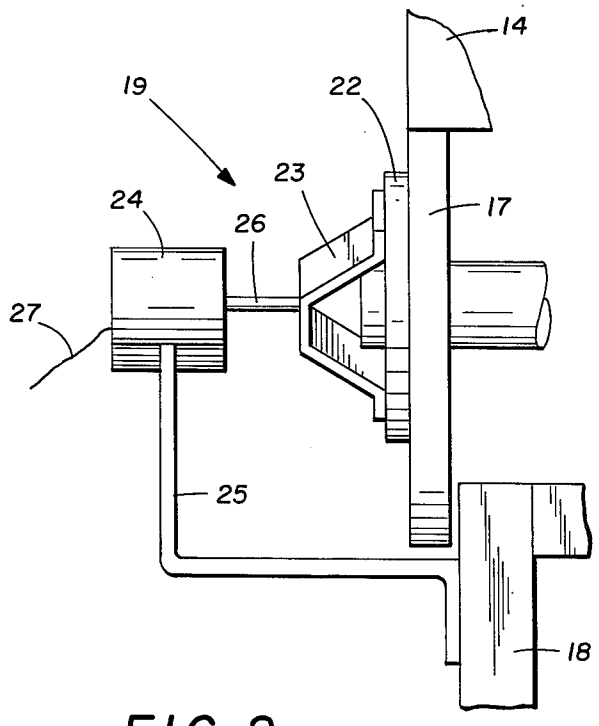


FIG. 2

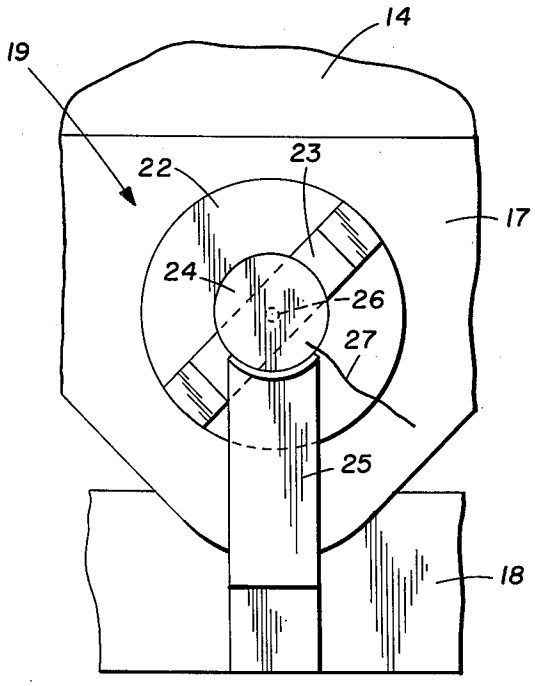


FIG. 3

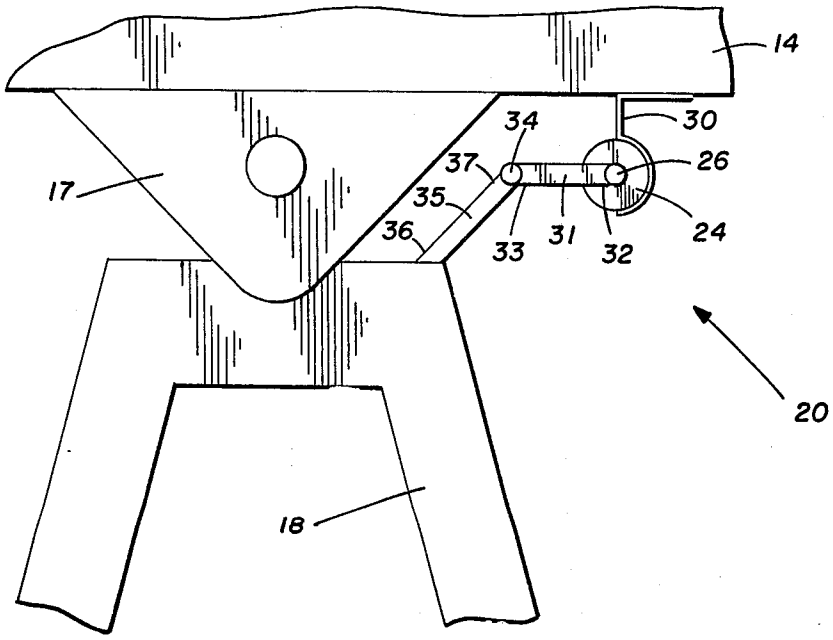


FIG. 4

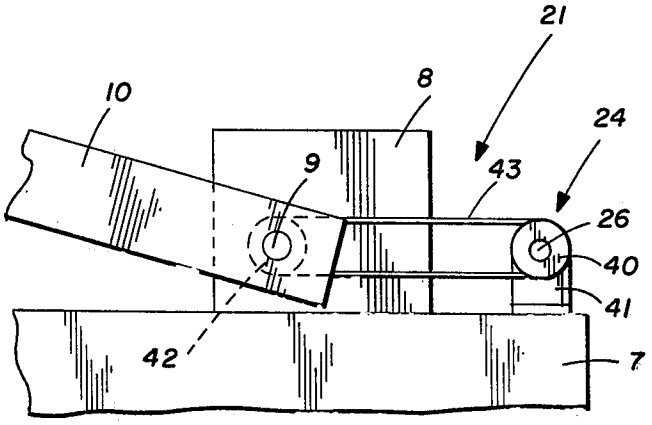


FIG. 5

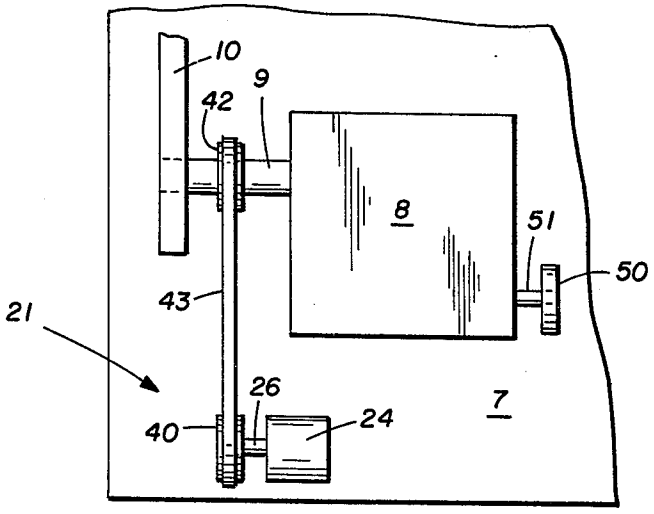


FIG. 6

WELL PRODUCTION SIGNAL MEANS

BACKGROUND OF THE INVENTION

Numerous onshore wells are produced by utilizing a pumping unit which is connected to a polished rod. The polished rod carries a string of sucker rods at the bottom of which is a downhole pump. The pumping unit moves the polished rod, sucker rods, and downhole pump up and down in the wellbore to pump oil to the surface of the earth. Literally, thousands of these pumping units are spread across the country, some of which are located in very remote places. Being a mechanical device which is exposed to the elements and which has a number of working parts on the surface of the earth as well as in the downhole pump itself, parts of the device wear thereby causing inefficient operation of the pumping unit. Some parts ultimately break thereby causing an involuntary shutdown of the unit.

Oftentimes, a pumping unit is simply run to failure after which it is fixed and then run until failure again. Many times a unit will, before failure, run for extended periods of time at very low efficiency. Therefore, it is desirable to be able to determine when a pumping unit is not running at peak efficiency thereby indicating wear in the pumping unit itself or in the downhole pump which needs attention even though the unit is still operating.

Accordingly, apparatus has been devised which, by way of one or more strain gauges, measures the load on the sucker rod string during the pumping cycle. The readout from this type of measurement is known as a load trace which shows the load on the sucker rod string in relation to time during each pumping cycle (i.e., one complete trip of the downhole pump, sucker rod string, polished rod, and associated surface pump apparatus from a given position of the pump to the opposite position of the pump and then back again). These strain gauge transducers can be placed at many places on the surface pumping unit such as on the walking beam or on the polished rod as fully and completely disclosed in U.S. Pat. No. 3,343,409, the disclosure of which is hereby incorporated herein by reference.

The load trace by itself is not as useful as it might be unless the position of the polished rod is known at the time the load is measured so that it is desirable to make a determination of the position of the polished rod in relation to time and this is known as a displacement trace.

When the load trace and displacement trace are matched as to a particular point in time, it can be determined what the load on the sucker rod string was and at what point in the pumping cycle that load occurred. From this type of information numerous data can be obtained which are quite valuable in determining whether a pumping unit is working efficiently. For example, mathematical models have been developed which can operate on this type of data to give an indication of the torque on the gear box of the pumping unit, the maximum and minimum stresses experienced by the polished rod during the pumping cycle, the horsepower used to produce a particular volume of fluid, the overall pumping efficiency, the friction in the sucker rods, tubing movement, the operating fluid level, and so on.

As indicated in the above-cited U.S. Pat. No. 3,343,409, a displacement trace has normally been obtained by hooking a displacement transducer to the polished rod by way of a cable, the displacement transducer being a cable-and-reel driven device with a constant tension rewind assembly so that as the polished rod moves up and down, the displacement transducer is activated by the cable moving up and down with the polished rod thereby activating the reel which normally drives a potentiometer to produce a varying voltage signal.

Since a strain gauge transducer or load cell can be mounted elsewhere on the surface pumping unit than the polished rod, and since it is desirable for a long-term operation not to have apparatus sitting around the wellhead and connected to the polished rod, particularly by a cable which moves up and down with the polished rod, it is highly desirable from both a safety and a permanency of installation point of view to obtain the displacement trace from a part of the surface pumping unit other than the polished rod. This way the polished rod is freed from all associated transducer equipment. This allows all transducer equipment to be placed in more innocuous places than by the wellhead and minimizes the likelihood of damage thereto by normal operations being carried on around the wellhead. Also, a permanent installation can be set up in a manner which requires a minimum of maintenance.

SUMMARY OF THE INVENTION

According to this invention, displacement trace equipment is located at one or more points on the surface pump unit. These points are physically removed from the polished rod and wellhead. More specifically, displacement trace signal means apparatus is employed in association with the walking beam, saddle bearing, or main gear box shaft so that when a strain gauge load cell is, for example, employed on the walking beam, all transducer apparatus is removed from the vicinity of the polished rod and wellhead.

Accordingly, it is an object of this invention to provide a new and improved apparatus for monitoring the operation of a pumping unit. It is another object to provide a new and improved apparatus for automating the production of an oil field. It is another object to provide a new and improved apparatus for permanently monitoring a surface pumping unit's operation.

Other aspects, objects and advantages of this invention will be apparent to those skilled in the art from this disclosure and the appended claims.

DETAILED DESCRIPTION OF THE INVENTION

FIG. 1 shows a plan view of a conventional surface pumping unit.

FIG. 2 shows a partial section of the pumping unit of FIG. 1 with a displacement trace signal means mounted in accordance with this invention.

FIG. 3 is a plan view of the apparatus of FIG. 2.

FIG. 4 is a cross-section of other apparatus according to this invention.

FIG. 5 shows yet other apparatus according to this invention.

FIG. 6 shows a top view of the apparatus of FIG. 5.

More specifically, FIG. 1 shows the earth 1 having a well bore 2 drilled therein and on the surface of which is wellhead 3 of well bore 2. A sucker rod string 4 extends into well bore 2 and is connected to polished rod 5 by way of coupling 6.

Sitting on the earth's surface is platform 7 which carries a gear box 8 that has a main shaft 9 extending therefrom. Gear box 8 is driven by a power means (not

shown) which operates the entire pumping unit. Member **10** is connected to main shaft **9** and carries counter balance **11.** Counter balance **11** is connected by way of Pittmans **12** to tail bearing **13.** Tail bearing **13** is fixed to walking beam **14,** the opposite end of which carries horsehead **15.** A wire cable **16** is connected between horsehead **15** and the upper end of polished rod **5.**

Walking beam **14** rests on saddle bearing **17** which in turn is supported by sampson post **18.**

The apparatus according to this invention can be fixed to the surface pumping unit of FIG. **1** in a plurality of locations. A preferred location is represented by dotted line box **19** and is associated with the saddle bearing **17.** Another suitable location is represented by dotted line box **20** which is attached to the underside of walking beam **14.** Yet another location is represented by dotted line box **21** which rests on platform **7** in the vicinity of main shaft **9.**

FIG. **2** shows a part of saddle bearing **17** to which is fitted a conventional bearing dust cover **22.** Dust cover **22** rotates with saddle bearing **17** as horsehead **15** reciprocates up and down. Therefore, dust cover **22** rotates through a finite arc such as 30° as horsehead **15** reciprocates, for example, from its lowest point to its highest point.

Bracket **23** is fixed to dust cover **22** and thereby rotates with saddle bearing **17.** A displacement signal means **24** which produces a signal upon movement of a member of the signal means is carried by way of support **25** which is fixed to sampson post **18.** In this particular embodiment of the invention, the member of signal means **24** which is movable is shaft **26.** Shaft **26** is fixed to bracket **23** so that operation of the pumping unit causes movement of walking beam **14** and saddle bearing **17** which in turn rotates shaft **26** and generates a signal. The signal is transmitted by way of conduit **27** to conventional readout and/or control equipment such as a computer, recorder, and the like. The signal produced by signal means **24** is of a character which varies with the extent of movement of shaft **26** so that the position of the polished rod **5** can be determined at a given point in time by the character of the signal.

Signal means **24** can be any electric, sonic, mechanical, or magnetic device known in the art which will produce a signal whose character, e.g., magnitude, will vary with the extent of movement of shaft **26.** Thus, a displacement trace can be obtained in relation to time and the particular position of the sucker rod at a given point in time can be determined and matched with the same point in time on the load trace. This gives the load on the polished rod in relation to the position of the polished rod at that specific point in time.

Signal means **24** can be any device which produces a signal of varying characteristics depending upon the extent of movement of shaft **26.** The device need not employ a rotatable shaft. For example, the device could employ a movable member which slides into and out of the device or is moved laterally within the device rather than rotated. Numerous devices, be they electrical, sonic, magnetic, or the like, are available in commerce and known to those skilled in the art. One suitable device is known as an absolute position encoder of the 5V80 series, manufactured by "BALDWIN" Electronics Inc. of Little Rock, Arkansas. This encoder is an electrically operated device which can be made to count upwards as its shaft is rotated either clockwise or counterclockwise so that a varying output signal is obtained as the shaft of the encoder is rotated. Put another way, as the encoder input shaft is rotated, there will appear at the encoder output a sequence of unique binary words that absolutely define every shaft position. Suitable other devices can utilize a rotating plate with a plurality of varying sized apertures around the periphery thereof so that rotation of the plate admits greater amounts of light to a receiving device. This principle can also be employed sonically and magnetically. In the sonic case sound of a different pitch is obtained as a plate is rotated because of air passing through different sized apertures in the periphery of the plate. In the magnetic case magnets placed around the periphery of the rotating plate can be employed.

FIG. **3** is an end view of the apparatus of FIG. **2,** and shows circular dust cover **22** carrying rectangular bracket **23.**

FIG. **4** shows a portion of the pumping unit of FIG. **1** wherein the signal means **24** is located on the walking beam **14** instead of on saddle bearing **17.**

Signal means **24** is fixed to walking beam **14** by way of support **30.** Shaft **26** of signal means **24** is connected to a first elongate member **31,** which can be a pipe, rod, or other suitable device, and which has opposing first and second ends **32** and **33,** respectively. The first end **32** is fixed to shaft **26** while second end **33** extends toward the sampson post **18** — saddle bearing **17** combination but terminates at a point intermediate signal means **24** and the combination **17–18.** Second end **33** carries a swivel means **34.** A second elongate means **35** having opposing first and second ends **36** and **37,** respectively, is connected between swivel **34** and sampson post **18** with first end **36** being fixed rigidly to sampson post **18.** As walking beam **14** oscillates up and down, signal means **24** moves therewith and shaft **26** is rotated slightly by the restraint placed thereon by elongate means **31** and **35.** In this way, when the surface pumping unit is operated shaft **26** is rotated to cause a signal to be produced as described hereinabove with respect to FIG. **2.**

FIG. **5** shows gear box **8** with its main shaft **9** and member **10.** In this embodiment a signal means **24** is located in position **21** of FIG. **1** but behind a pulley means **40.** The signal means **24** and pulley means **40** are supported on platform **7** by way of support **41.** In the space between member **10** and gear box **8** is employed another pulley means **42** which is fixed to main shaft **9.** A belt means **43** interconnects pulley means **40** and **42** so that operation of main shaft **9** causes rotation of shaft **26** of signal means **24** to generate a signal as explained hereinabove with respect to FIG. **2.** In the situation of FIG. **5** wherein shaft **26** is rotated 360° rather than through a finite arc of less than 360° (embodiments of FIGS. **2** through **4**) a conventional signal point must be put into signal means **24** so that the displacement trace will show when each 360° revolution is completed. This is known in the art and therefore will not be described in further detail.

FIG. **6** shows a top view of FIG. **5** and includes a main drive pulley **50** connected to gear box **8** by way of shaft **51.** Main pulley **50** is connected to the main power source (not shown) for operating the surface pumping unit.

Reasonable variations and modifications are possible within the scope of this disclosure without departing from the spirit and scope of this invention.

We claim:

1. In a well pumping unit containing a walking beam carried by a saddle bearing which in turn is supported

by a sampson post, said walking beam being driven by a main shaft from a gear box, the improvement comprising a displacement trace signal means which produces a signal upon movement of a member of said signal means and without a cable-and-reel driven device, the character of said signal varying with the extent of movement of said member, said signal means is carried by said walking beam so that movement of said walking beam can cause movement of said movable member, a first elongate member having opposing first and second ends and fixed at its first end to said movable member, said first elongate member extending generally toward said sampson post-saddle bearing combination, said first elongate member terminates at its opposing second end intermediate said signal means and said combination, said second end of said first elongate means carries a swivel means, a second elongate means having opposing first and second ends and fixed at its first end to said sampson post, said opposing second end of said second elongate means being connected to said swivel means so that as said walking beam reciprocates up and down the movable member is moved by the restraint placed thereon by said first and second elongate means, and means for conducting said signal from said signal means to a receiving means.

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