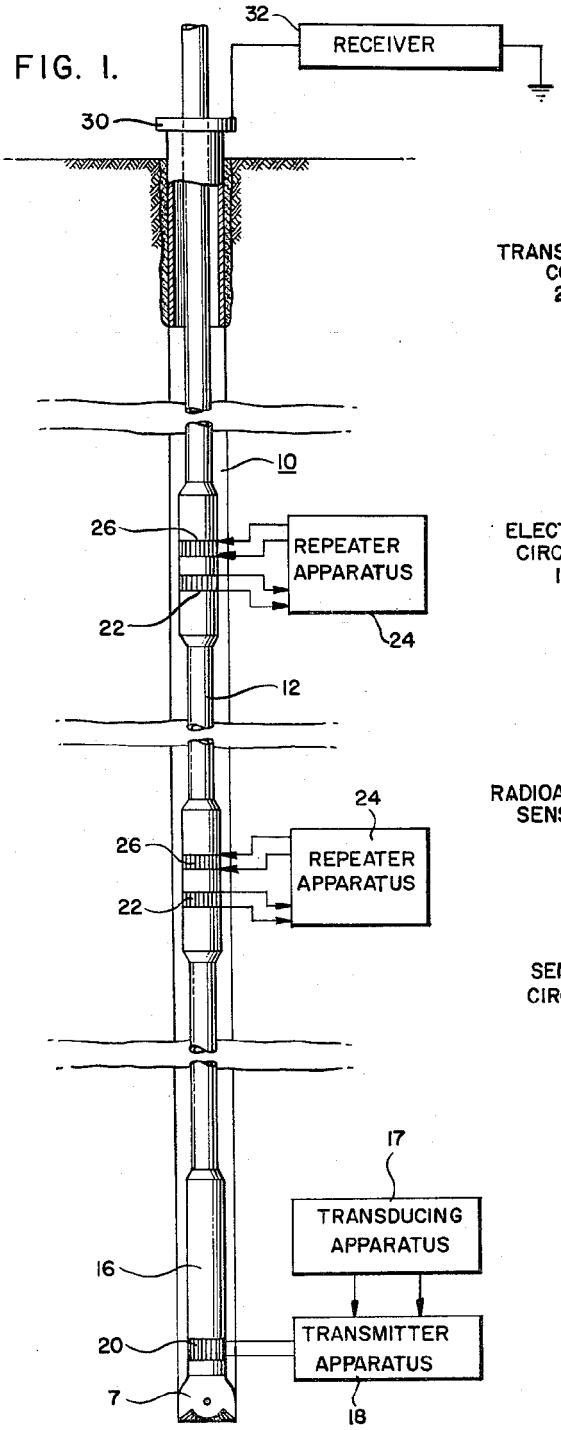
June 1, 1965 P. W. MARTIN 3,186,222

WELL SIGNALING SYSTEM

Filed July 28, 1960 4 Sheets-Sheet 1

FIG. 1.



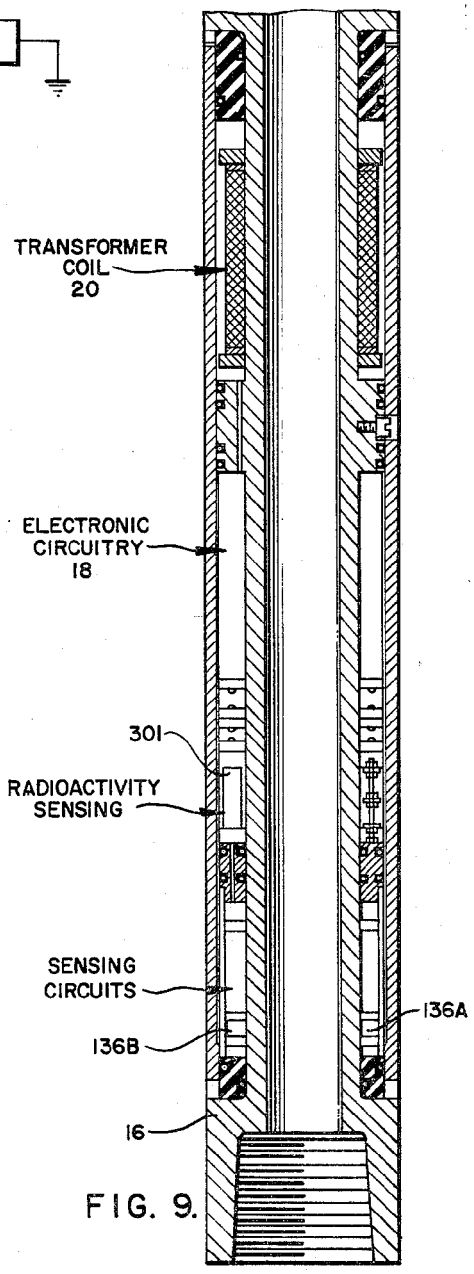


FIG. 9.

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June 1, 1965 P. W. MARTIN 3,186,222

WELL SIGNALING SYSTEM

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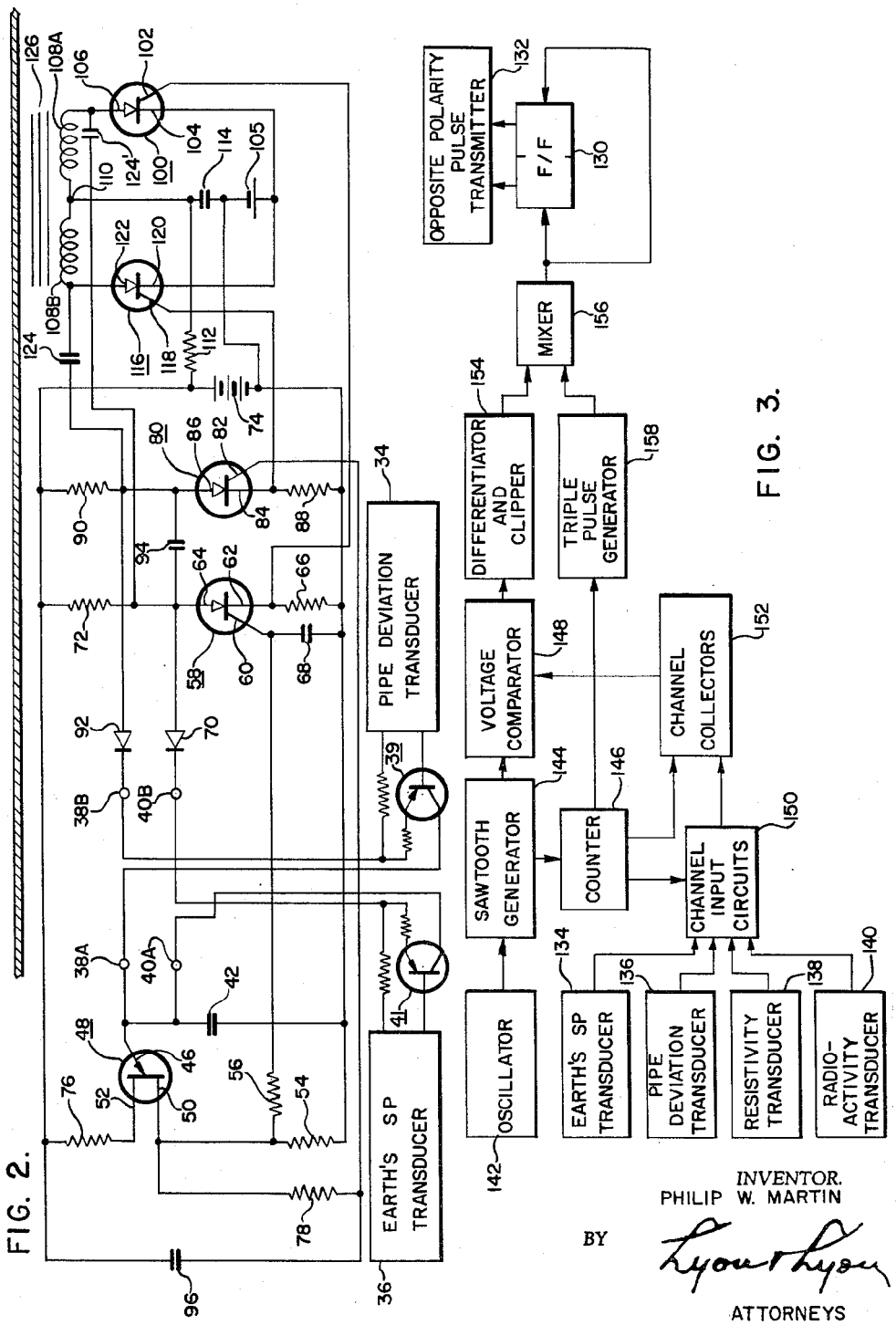

FIG. 2.

FIG. 3.

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June 1, 1965 P. W. MARTIN 3,186,222

WELL SIGNALING SYSTEM

Filed July 28, 1960 4 Sheets-Sheet 3

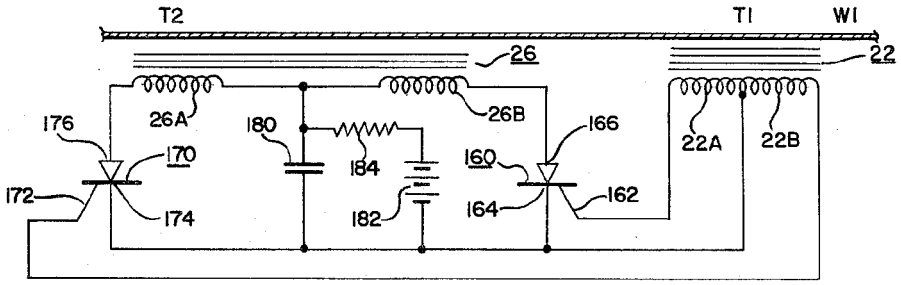

FIG. 4.

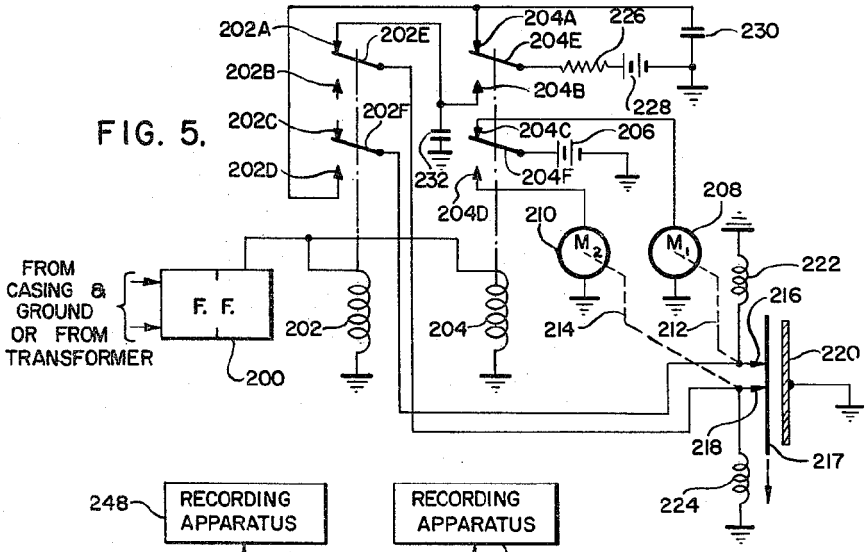

FIG. 5.

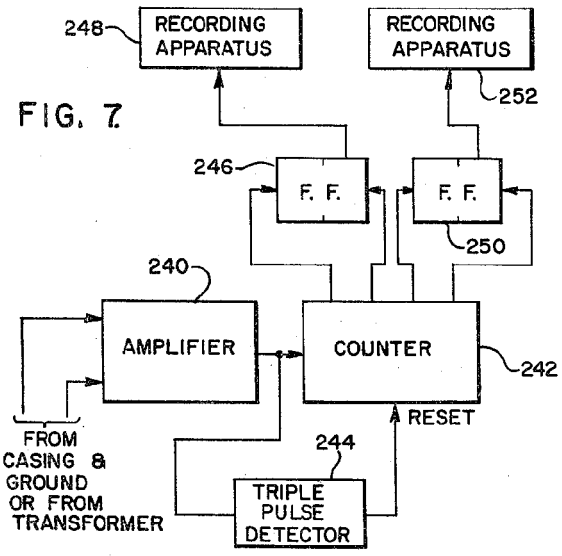

FIG. 7.

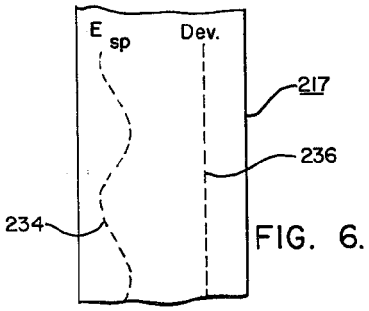

FIG. 6.

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June 1, 1965 P. W. MARTIN 3,186,222

WELL SIGNALING SYSTEM

Filed July 28, 1960 4 Sheets-Sheet 4

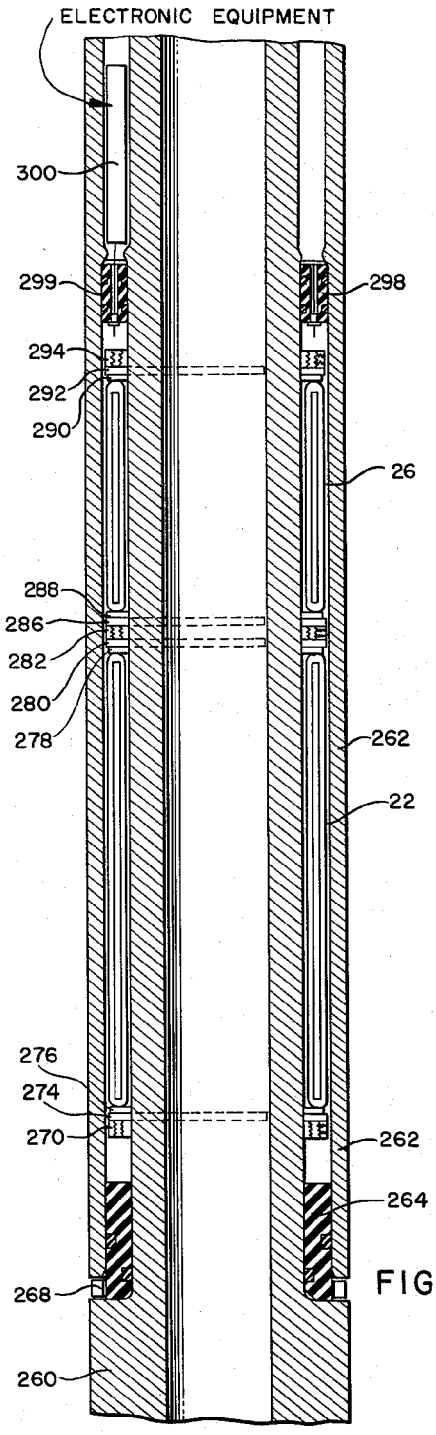

FIG. 8.

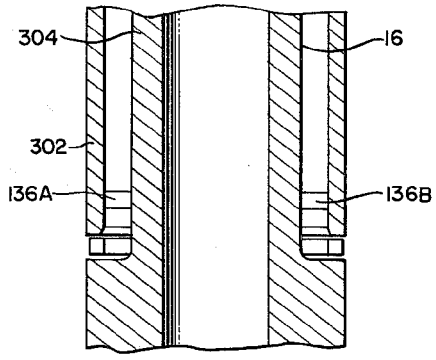

FIG. 10.

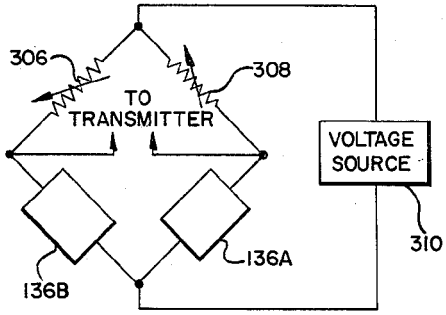

FIG. 11.

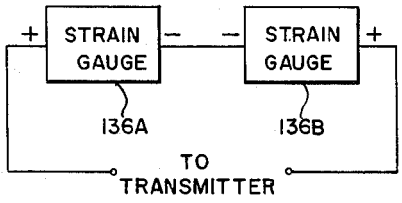

FIG. 12.

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United States Patent Office

3,186,222
Patented June 1, 1965

3,186,222

WELL SIGNALING SYSTEM

Philip W. Martin, Whittier, Calif. (% McCullough Tool Co., 5820 S. Alameda St., Los Angeles 58, Calif.)

Filed July 28, 1960, Ser. No. 45,857
12 Claims. (Cl. 73—151)

This invention relates to a well signaling system and, more particularly, to improvements therein.

The desirability of having available at the surface of a well, while it is being drilled, information concerning conditions at and in the vicinity of the drill at the bottom of the well has long been established. A considerable number of well signaling systems have been developed for the purpose of transmitting the information measured at the bottom of the well to the surface. The transmission of data from the bottom to the top of the well has not proved to be an easy task. The rotating metal drill string causes the generation of noise signals which adds to the problems attendant those of signal transmission. A considerable number of expedients have been tried. For example, cables have been lowered to the drilling string to contact the bit. The extremely rapid flow of fluid down the well with high mud pressures caused by mud pumps having on the order of hundreds of horsepower, cause terrific strain on such a line, cause stretch, and consequently slack in the line. The abrasive muds wear the line rapidly, and very high pressure differentials along the length of the drill pipe make this process quite impractical.

Another method which has been tried has been to signal, by pressure, pulses on the drill string set up by a pulsing device on the bottom. This has proven to be an economic failure and to be unreliable because of its extreme complexity and high noise level on a drilling rig.

Still another method has been to use a fixed conductor and a series of connections at each joint down the well. These have also not been successful. The trouble with using joints may be appreciated from the fact that in an average drilling string of 10,000 feet there are somewhere on the order of 250 joints, or connections, that must be made up. This means 250 places for shorts or open circuits; consequently, this, again, has not proven successful. Industry still very much desires a process of logging-while-drilling, because the most important time to obtain lithological information from the drilling well is while that formation is uncontaminated and fresh and immediate contact is made with the virgin formation, at which time one may withdraw the drill pipe and test that formation for productivity, or even spot oil in it immediately as it is open, to prevent water from reaching the clays in the oil sands and blocking all future production. This inability of the oil-drilling industry to realize what it is drilling through has probably cost the oil industry on the order of hundreds of millions of dollars a year, and it is entirely probable that the drilling rate per rig could double if a successful method of logging-while-drilling and deviation-determination-while-drilling entered the field. While the industry has spent millions of dollars trying to develop apparatus for logging-while-drilling and while large numbers of patents have been issued on logging-while-drilling over the last thirty years, not one commercially successful logging-while-drilling apparatus has been obtained.

An object of this invention is to provide a practical and operative well-logging system.

Another object of this invention is to provide a well signaling system wherein the effects of noise signals are obviated.

Yet another object of this invention is to provide a well signaling system which is simpler than those employed heretofore.

Still another object of the present invention is to provide a novel transmission system for well logging which is more economical to operate than any of those employed heretofore.

One important bit of data which is sought to be transmitted, from the bottom of the well to the top, is the weight applied by the drill string on the drill bit. The reason is that it has been found that excessive weight on the drill bit can cause the drill stem to flex, whereby drilling will take place at an angle to the vertical. A crooked well is extremely costly to the oil industry, since it produces serious wear on both the drilling and producing equipment, making it impractical to produce some otherwise productive wells, and sometimes causes the total loss of a valuable oil well. Often a hole already drilled is subsequently lost because the hole is so crooked that the drill string will not re-enter the hole.

Although it is desirable not to apply excessive weight to the drill bit because of the possibility of drilling a crooked hole, on the other hand, the drilling of the hole does require a sufficient weight to be applied for obtaining the maximum efficiency. All the devices which have been produced heretofore attempt, not very successfully, to solve the problem of preventing a crooked hole by measuring the weight on the drill bit.

Yet another object of this invention is the provision of an arrangement whereby an indication is achieved at the bottom of the well, which can be transmitted to the top of the well, as to when a drill bit is about to make a crooked hole whereby preventive measures may be taken.

Still another object of this invention is the provision of a simple and improved sensing arrangement which indicates when the drill bit deviates from a straight hole.

These and other objects of this invention may be achieved in a transmission system which transmits pulses wherein the time between successively transmitted pulses of opposite polarity is a measure of the quantity sought to be transmitted. Repeater stations for these pulses are provided along the drill string. Further, a sensing arrangement for determining when a crooked hole is about to occur is achieved by placing two sensing devices, such as strain gages, crystals, or electromagnetic transducers, on opposite sides of the pipe close above the drill bit to indicate the lateral stress on the pipe. The electrical outputs of these sensing elements may be balanced by opposing one against the other, whereby whenever the pipe begins to bend as the result of starting to travel in a path other than the vertical path there is a difference in compression which is measured by the sensing elements and which provides a resultant signal, indicating that a crooked hole is about to be drilled. This enables the drill operator to take the necessary steps to avoid the drilling of such crooked hole.

The novel features that are considered characteristic of this invention are set forth with particularity in the appended claims. The invention itself, both as to its organization and method of operation, as well as additional objects and advantages thereof, will best be understood from the following description when read in connection with the accompanying drawings, in which:

FIGURE 1 is a drawing illustrating an arrangement for transmitting data from the bottom of the well to the top in accordance with this invention;

FIGURE 2 is a schematic circuit diagram of a transmitter in accordance with this invention;

FIGURE 3 is a block diagram of another type of transmitter in accordance with this invention;

FIGURE 4 is a circuit diagram of a repeater station in accordance with this invention;

FIGURE 5 is a block schematic diagram of a receiver in accordance with this invention;

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