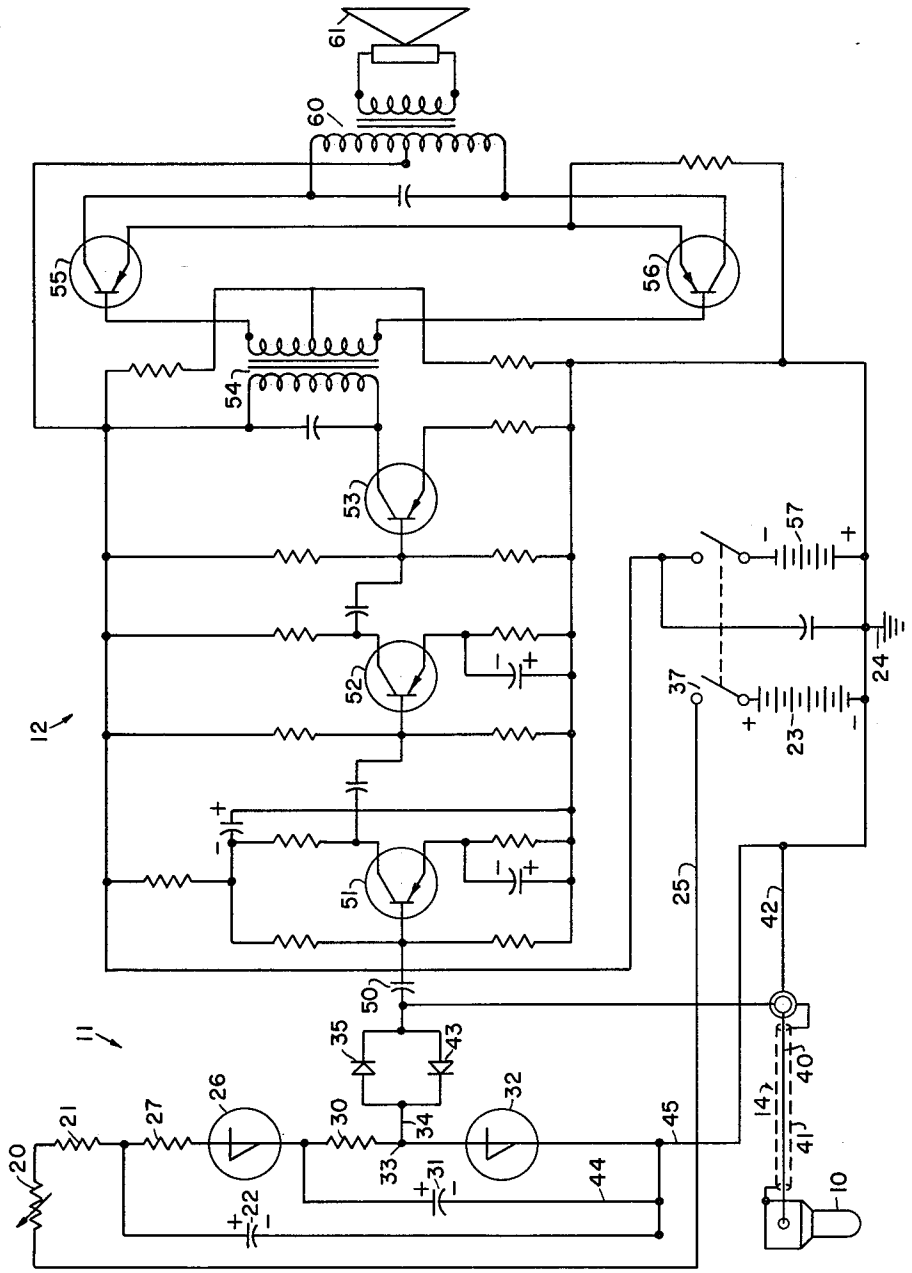
June 9, 1964 R. H. KOLB 3,136,975

MONITORING CIRCUIT FOR LOGGING INSTRUMENTS

Filed July 20, 1959




INVENTOR:
ROBERT H. KOLB
BY: Theodore E. Biber
HIS ATTORNEY

United States Patent Office

3,136,975
Patented June 9, 1964



# 3,136,975
# MONITORING CIRCUIT FOR LOGGING INSTRUMENTS

Robert H. Kolb, Houston, Tex., assignor to Shell Oil Company, a corporation of Delaware

Filed July 20, 1959, Ser. No. 828,208
3 Claims. (Cl. 340—18)

This invention pertains to a monitoring system and more particularly to a system which is designed to monitor a device and its associated circuit as it is being installed in an oil well or the like.

Many devices are semi-permanently installed in the bottom of oil wells and the like for determining various physical properties. For example, pressure and temperature transmitters are installed in the bottom of oil wells and connected to surface recording equipment by a connecting cable. As these devices are being installed in oil wells they receive considerable mechanical shock and thus often times either the device or its associated cable is damaged. In some installations the downhole instrument is connected to the surface equipment by a single insulated cable strapped to the side of the production tubing string. Normally the damage is not discovered until after installation is completed and an attempt is made to obtain information such as downhole pressure or downhole temperature from the device which has been installed. Since the damage is not discovered until after the installation is completed and the rig has been removed from the well considerable expense is involved in retrieving the device, correcting the trouble and reinstalling it. The cost involved is readily apparent when it is remembered that the average oil well in the United States is on the order of 7,000 to 10,000 feet deep and heavy equipment is required to retrieve the production tubing string.

Accordingly, the principal object of this invention is to provide an automatic monitoring system which will continuously monitor the installation of a downhole device and its associated circuit and periodically indicate the condition of the device and its circuit as the downhole instrument is being installed.

A further object of this invention is to provide a small compact automatic monitoring system which audibly indicates the condition of the downhole device and its associated circuit during its installation in the wellbore without requiring either manual attention or observation.

The above objects and advantages of this invention are obtained by providing a device which will periodically interrogate the downhole device and its associated circuit and receive a return response indicating the condition of the downhole device and its circuit. The response of the device to the interrogation is amplified and passed through an audio speaker so that an audible sound or ringing will be obtained. Thus, if the device is interrogated at set time intervals an associated audible sound will be produced. The people associated with the installation will only be required to listen for the audible sound and not required to check or initiate any tests in order to determine whether the device and its associated circuit is in a satisfactory operating condition.

The above objects and advantages will be more easily understood from the following detailed description of a preferred embodiment when taken in conjunction with



the attached drawing showing a schematic diagram of this invention as applied to a downhole pressure transmitter.

Referring to the attached drawing, there is shown a downhole pressure transmitter **10**, a pulsing circuit **11** and an amplifying circuit **12**. The downhole pressure transmitter may be of any design such as the one illustrated and described in the applicant's copending application, Serial No. 731,328, filed April 28, 1958 and now Patent Number 3,062,052. This type of transmitter utilizes a vibrating string whose frequency varies with pressure. It is interrogated by drawing the string to one side by means of a coil and armature and then releasing the string, the vibrations of the string inducing an alternating signal in the coil. This invention is designed to periodically test the operation of the downhole pressure transmitter **10** and the cable **14** in order to ascertain that it is in a satisfactory operating condition during its installation in a well. The surface equipment generates a periodic pulse which is transmitted down the cable **14** to interrogate the transmitter **10** and then audibly reproduces the transmitter response. The surface equipment also audibly reproduces the interrogating pulse thus indicating that the surface equipment is operating satisfactorily and has actually transmitted a pulse to the transmitter **10**.

As shown on the drawing, the pulsing circuit **11** utilizes a variable resistor **20** in series with a fixed resistor **21** and a capacitor **22** as a resistance capacitor circuit for determining the period between individual pulses. The variable resistor **20** and fixed resistor **21** are in series with a second fixed resistor **27** which forms part of a second resistance capacitance circuit. The resistance capacitor circuit is coupled by means of a lead **25** to the positive side of a battery **23** whose negative side is grounded at **24**. Thus, the capacitor **22** will be charged exponentially to a final voltage which is determined by the breakdown voltage of the diode **26**. More particularly, the diodes **26** and **32** are four-layer, two terminal semiconductor devices. The diodes **26** and **32** have the particular quality of acting as a switch in that they remain open and exhibit a relatively high resistance until a predetermined voltage level is exceeded at which level they break down and exhibit a relatively low resistance thus acting as a switch. In a particular circuit the resistances **20** and **21** have a value of approximately 50,000 ohms and the capacitor **22** a value of 100 microfarads, the resistance **27** having a value of approximately 80 ohms, and the diode **26** having a breakdown voltage of 30 volts. Thus, the capacitor **22** will be charged until it reaches a voltage level of 30 volts at which point the diode **26** will break down and the capacitor discharge through the remainder of the circuit to the ground **24**. If the resistance **20** is provided with a suitable range one may obtain a charging time for the capacitor **22** on the order of 10–15 seconds and thus the period of the pulse may be varied between these limits.

After the diode **26** breaks down and permits the capacitor **22** to discharge through the remainder of the circuit, the capacitor **31** will be charged to the breakdown voltage of the diode **32**. The capacitor **31** is in series with the resistance **27** and thus forms a second resistance capacitance circuit. The capacitance **31** is connected to the ground **24** by means of leads **44** and **45**. The diode **32** is selected so as to have a lower break-

down voltage than the diode **26**; 20 volts being a reasonable value for the example described above. Also, the resistance **27** and capacitor **31** should be chosen to give a reasonably short charging time for the circuit; 5–10 milliseconds being a suitable value. As the capacitor **31** charges the exponentially increasing voltage will appear as a pulse at the point **33** having a 5–10 millisecond duration. This pulse is coupled to the center conductor **40** of the logging cable **14** by means of a current limiting resistor **30**, the lead **34**, diode **35** and lead **36**. The diode **35** should be selected to have a certain threshold voltage on the order of one volt or the like.

The shield or outer conductor **41** of the logging cable **14** is connected to the ground **44** by means of lead **42**. A second diode **43** is disposed in the opposite direction to and parallel with diode **35** in order to provide a path to ground for the decreasing portion of the pulse as will be explained below.

When the above-described pulsing circuit is operated by closing the switch **37** on the battery **23** the capacitor **22** will charge as described above until the breakdown voltage of the diode **26** is reached. This voltage level is approximately 30 volts for the example given above and is reached in approximately 10–15 seconds depending on the setting of the resistance **20**. This voltage of course will have an exponential form well known in the charging of a capacitor and a sharp decrease to zero when the diode **26** breaks down. When the diode **26** breaks down it permits the capacitor **22** to discharge through the remainder of the pulsing circuit to the ground **24**, thus charging the capacitor **31**. As capacitor **31** charges it will generate an exponentially increasing voltage pulse at the point **33** having a substantial instantaneous return to zero when the breakdown voltage level of the diode **32** is reached. This pulse will be transmitted through the diode **35** in a substantially unaltered form to the downhole pressure transmitter **10**. It is desirable to use a pulse which has an exponential wave form on its forward side and a steep wave form on its back side in contrast to a square wave pulse for actuating the downhole pressure transmitter **10**. This results from the fact that the pressure transmitter **10** utilizes a vibrating string and if the string was pulled sharply to one side through the use of a pulse having a square wave shape the string would vibrate in the displaced position and in case it was released by the square wave pulse on the inward half cycle of its vibration the subsequent signal would have a greatly diminished amplitude. This difficulty is avoided by using the exponentially increasing voltage pulse since the string is slowly pulled towards the magnet thus preventing its vibration until it is released by the breakdown of the voltage pulse.

The voltage pulse transmitted over the cable **14** rises to a maximum value and then falls to zero. The diode **35** blocks the path to ground for the falling pulse and thus the pulse tends to charge the cable **14** due to its capacitance. To prevent this buildup of a charge a path to ground is provided by inserting diode **43** in parallel with and in opposite direction to the diode **35**. This path through the diodes **43** and **32** will permit the falling signal from the cable **14** to be bypassed to the ground **24** and thus maintain the cable relatively free of any charge. Even though the diode **43** provides a path to ground it isolates this ground path for the low amplitude return signals from the transmitter because of its threshold voltage and, thus the two diodes **35** and **43** act as a switch to couple the pulsing circuit to the cable **14** during the pulsing period and disconnect it during the receiving period.

The signal from the transmitter **10** is coupled to the audio amplifier **12** through a blocking capacitor **50**. The audio amplifier **12** is provided with three single stages formed by transistors **51**, **52** and **53** and a push-pull output stage formed by transistors **55** and **56**. The output of transistor **53** is coupled to the push-pull output stage through a transformer **54** with the output from the push-pull stage being coupled to a speaker **61** through an output transformer **60**. As shown, the transistors of the audio amplifier may be supplied with power from a single battery **57** if so desired.



From the above description it can be appreciated that this invention has provided a simple pulsing circuit which utilizes all solid state elements to generate periodic pulses for interrogating the pressure transmitter **10** and for connecting cable **14**, as the pressure transmitter is installed in a well. The use of solid state elements results in a very reliable device which has relatively low power requirements. Furthermore, the period of the pulse may be varied over a relatively wide range through the use of the variable resistance **20**. Also the pulse supplied for interrogating the pressure transmitter **10** has an exponentially increasing forward side which insures that the audio signal generated by the vibrating string of the pressure transmitter will have a uniform amplitude. Finally, the audio amplifier **12** will audibly reproduce both the interrogating pulse supplied to the pressure transmitter as well as the audio signal from the pressure transmitter. Thus, the person installing the pressure transmitter will first hear the interrogating pulse and an instant later the pulse of the pressure transmitter. If the interrogating pulse is not heard it indicates that the pulsing circuit is malfunctioning, while if the interrogating pulse is heard but not the audible signal from the pressure transmitter, it would indicate that the cable circuit **14** or the pressure transmitter **10** is malfunctioning. Therefore, the invention audibly indicates both the functioning of the pulsing circuit and the pressure transmitter and associated circuit.

While but a single embodiment of this invention has been shown and described in detail it should not be limited to the details described but only to its broad spirit and scope.

I claim as my invention:

1. A system for monitoring the installation in a wellbore of a vibrating string device capable of measuring a physical characteristic, said system comprising: a cable coupling the device to the surface of the well, a pulsing circuit located at the surface and having a first capacitance resistance circuit having an adjustable time constant, said capacitance resistance circuit being coupled to a second capacitance resistance circuit through a first static device having a predetermined breakdown voltage; said second capacitance resistance circuit having a relatively short time constant and coupled to ground through a second static device having a predetermined breakdown voltage; said second capacitance resistance circuit being coupled to said cable through a diode to transmit the pulse produced by said second capacitance resistance circuit; to energize the device said cable in addition being coupled to an amplifier and audio reproducing means located at the surface to reproduce both said pulse and the response of the device.

2. A system for monitoring the installation in a wellbore of a vibrating string device capable of measuring a physical quantity, said system comprising: a cable coupling the device to the surface of the well, a pulsing circuit located at the surface and having a first capacitance resistance circuit having an adjustable time constant, said capacitance resistance circuit being coupled to a second capacitance resistance circuit through a first static device having a predetermined breakdown voltage; said second capacitance resistance circuit having a relative short time constant and coupled to ground through a second static device having a predetermined breakdown voltage; said second capacitance resistance circuit being coupled to said cable through a first diode to transmit the pulse produced by said second capacitance resistance circuit to energize its device; said cable in addition being coupled to an audio amplifier and speaker system located at the surface to reproduce both said pulse and the response of the device and a second diode

disposed in parallel with but opposite to said first diode to provide a path to ground.

3. A system for monitoring the installation of a device in a wellbore comprising: a cable coupling the device to the surface of the well, said device supplying an audio frequency signal when interrogated by a pulse of sufficient magnitude; a pulsing circuit including a first means for generating a periodic pulse having a preset repetition rate, a second means energized by the pulse of said first means for generating a second pulse capable of interrogating the device; unidirectional circuit means for coupling the second pulse to said cable and another circuit means coupling the response of the device to an amplifier means whereby the device is interrogated and both the second pulse and audio frequency signal from the device are audibly reproduced.



**References Cited** in the file of this patent

UNITED STATES PATENTS

| | | |
|---|---|---|
| 1,654,819 | Kinley | Jan. 3, 1928 |
| 2,421,081 | O'Brien | May 27, 1947 |
| 2,454,219 | Schultz | Nov. 16, 1948 |
| 2,530,308 | Martin | Nov. 14, 1950 |
| 2,686,849 | Thomas | Aug. 17, 1954 |
| 2,695,991 | Atkinson | Nov. 30, 1954 |
| 2,730,632 | Curtis | Jan. 10, 1956 |
| 2,737,639 | Summers | Mar. 6, 1956 |
| 2,843,765 | Aigrain | July 15, 1958 |
| 2,915,739 | Rumble | Dec. 1, 1959 |
| 2,980,898 | Mason | Apr. 18, 1961 |
| 2,999,208 | Ruehlemann | Sept. 5, 1961 |