COMMONWEALTH OF AUSTRALIA
PATENTS ACT 1952-1973
APPLICATION FOR A PATENT

We COAL INDUSTRY (PATENTS) LIMITED

of Hobart House, Grosvenor Place, LONDON SW1X 7AE, ENGLAND

hereby apply for the grant of a Patent for an invention entitled:

"TELEMETRY SYSTEM FOR BOREHOLE DRILLING"

which is described in the accompanying complete specification. This Application is a Convention Application and is based on the Application(s) numbered: 86/12008 for a Patent or similar protection made in Great Britain on 16th May, 1986.

Our address for service is:

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AUSTRALIA

DATED this 1st day of May, 1987.

COAL INDUSTRY (PATENTS) LIMITED

By their Patent Attorneys

GRIFFITH HASSEL & FRAZER

TO: THE COMMISSIONER OF PATENTS
COMMONWEALTH OF AUSTRALIA

6549A
Declaration in support of an Application for a Patent

In support of the application made by Coal Industry (Patents) Limited for a patent for an invention entitled:

"TELEMETRY SYSTEM FOR BOREHOLE DRILLING"

I, John Irwin Wood, of the Applicant's address, do solemnly and sincerely declare as follows:

1. I am authorised by the Applicant for the patent to make this Declaration on its behalf.

2. Alan MEADOWS
   of 16 Dove Cliff Road, Stretton, Burton-on-Trent, Staffordshire, England

   and

   and

   is the actual inventor(ers) of the invention and the Applicant is the Assignee of the said inventor(ers).

3. The basic application, as defined by Section 141 of the Act, was made in the United Kingdom on: 16 May, 1986 by Coal Industry (Patents) Limited.

4. The basic application referred to in Paragraph 3 of this Declaration was the first application made in a Convention country in respect of the invention, the subject of the application.


COAL INDUSTRY (PATENTS) LIMITED

J.Y. Wood, Director
1. A telemetry system for borehole drilling comprising an effectively continuous length of hardwire which in use extends along a drill string located in a borehole, the hardwire extending between electrical signal control, equipment situated outside the borehole and probe means situated within the borehole, the effectively continuous length of hardwire including a store of hardwire constituted by a bonded wound hollow coil of hardwire situated adjacent to the probe means.
COMMONWEALTH OF AUSTRALIA

PATENTS ACT 1952

COMPLETE SPECIFICATION

FOR OFFICE USE

Short Title:  
Int. Cl: 

Application Number: 72477/67 
Lodged:

Complete Specification-Lodged:  
Accepted: 
Lapsed: 
Published:

Priority:

Related Art:

TO BE COMPLETED BY APPLICANT

Name of Applicant: COAL INDUSTRY (PATENTS) LIMITED 
Address of Applicant: Hobart House, Grosvenor Place, LONDON SW1X 7AE, ENGLAND 
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Complete Specification for the invention entitled:

"TELEMETRY SYSTEM FOR BOREHOLE DRILLING"

The following statement is a full description of this invention, including the best method of performing it known to us:

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This invention relates to a telemetry system for borehole drilling, the telemetry system being used to convey electrical signals along the borehole between probe means located in the borehole and signal control equipment situated outside the borehole. In addition or alternatively, instruction signals may be fed from the signal control equipment situated outside the borehole to receiving equipment in the probe means located within the borehole.

In this specification the nature of the signals transmitted between the probe means and the signal control equipment may have a variety of functions including control and monitoring functions.

It is known from prior telemetry systems to feed a continuous hardwire for transmitting electrical signals from a store situated at the mouth of the borehole, or within a drill pipe section adjacent the mouth of the borehole, along the central aperture defined by a series of hollow drill pipe sections to equipment at or in the borehole. Although such a system tends to give efficient signal transmission it suffers from the disadvantage that the
hardwire store has to be threaded through new drill pipe sections added to the drill string as the borehole is extended. Also, the hardwire has to be unthreaded from each drill pipe section when the drill string is removed from the borehole. In an attempt to avoid the need repeatedly to thread and unthread the store of hardwire as the drill string is extended or withdrawn from the borehole, it is known initially to thread the hardwire through all the drill pipe sections stacked at the mouth of the borehole ready for use. Unfortunately, this proposal receives an involved operational procedure to ensure the drill pipe sections are fed onto the drill string in the correct order and that the loose lengths of hardwire extending between the sections do not become trapped or damaged.

A further known proposal involves the use of a sheave of stored hardwire located axially within a section of the drill string installed within the borehole. Although this proposal substantially overcomes the problems associated with the need to thread or unthread the hardwire through the drill pipe sections it introduces a further problem in that the axially located sheath tended to restrict the flow of drilling fluid along the drill string and therefore interferes with the drilling operations.

An object of the present invention is to provide an improved hardwire telemetry system for borehole drilling which enables information signal means to be transmitted efficiently along the drill string and which tends to overcome or reduce the above mentioned problems.

According to the present invention a telemetry system for borehole drilling comprises an effectively continuous length of hardwire which in use extends along a drill string located in a
borehole, the hardwire extending between electrical signal control
equipment situated outside the borehole and probe means situated
within the borehole, the effectively continuous length of hardwire
including a store of hardwire constituted by a bonded wound hollow
coil of hardwire situated adjacent to the probe means.

Advantageously, the store of hardwire comprises a wound hollow
coil having a plurality of layers.

Advantageously, the hardwire comprises a twin core cable.

Preferably, each turn of cable within the wound hollow coil is
lightly bonded only to adjacent turns in the same layer.

Preferably, the bond is achieved by using an adhesive which is
a solvent for the outer insulation of the cable and which thereby,
tends to weld together adjacent turns.

Preferably, adhesion between layers is prevented by using a
coating, such as a silicone oil, provided between the layers.

Advantageously, the wound hollow coil is bonded to the inside
wall of the drill pipe section.

Conveniently, the store of hardwire may comprise a plurality
of wound hollow coils spliced end to end. The splicing may be by
means of a connection including a hollow sealed tube enclosing the
joined ends of coils and filled with an electrically insulating
grease.

By way of example, only, one embodiment of the present
invention now will be described with reference to the accompanying
drawings, in which:-

Figure 1 is a diagrammatic longitudinal sectional view taken
through a drill pipe section provided with a store of hardwire in
the form of a wound, hollow coil;
Figure 2 is a diagrammatic longitudinal sectional view taken through one embodiment of borehole probe means;

Figure 3 is a diagrammatic longitudinal sectional view taken through a slip ring unit for mounting on a drill string adjacent to the mouth of a borehole; and

Figure 4 is a diagrammatic longitudinal sectional view taken through a connector for splicing together lengths of hardwire.

The accompanying figures show details of a telemetry system for borehole drilling which enables electrical signals to be transmitted from borehole probe means 1 along a hardwire 2 constituted by an insulated twin wire and via a slip ring unit 3 to signal control equipment (not shown) located outside the mouth of the borehole. The borehole probe means 1, comprises, in this example, a crystal-photomultiplier assembly 4, an inclination sensor 5 and various electronic circuit means 6, is housed within a tubular housing 7 which in turn is housed within a drill pipe section (not shown). A metal shield 8 is proximally partially to enclose the crystal-photomultiplier assembly 4 to define window means opposite the shield and provide a directional view facility. The assembly 4, inclinometer means 5 and circuit means 6 are enclosed in protective coats of a foam plastic material to provide shock protection. A bellows arrangement 9 retains the various component linearly. The electrical signals derived by the probe means 1 are fed back along the borehole by the hardwire telemetry system.

A head of the probe means 1 is a down-the-hole motor (not shown) arranged to drive a drill bit head (not shown). Behind the probe means 1 the hardwire 2 is fed to a tensioning means 10 which ensures the length of hardwire 2 between the probe means and the
tensioning means is always maintained tight. The tensioning means include a spring biassed pulley arrangement 11 which permits an extra length of hardwire to be fed out when the drill pipe section provided with the tensioning means is disconnected from the drill pipe section including the probe means. Moreover, the tensioning means ensures the hardwire is maintained taught during the connection of two drill pipe sections thereby ensuring the hardwire does not become trapped in the screw joint between the sections during the connecting operation.

Figure 1 shows how the hardwire is fed from a store of hardwire constituted by a wound hollow coil 12 and, via a collar arrangement 13 having radial arms 14 supporting the tensioning means, to the tensioning means 10, the tensioning means includes a central cylindrical slideway 15 housing a tension spring 16 and a piston 17 carrying a pulley 18 of the aforementioned pulley arrangement 11. The hardwire leaving the coil 12 extends to a radially outer collar of the collar arrangement 13 and then is passed along one of the radial arms 14 to the tensioning means where it is looped over the forward end of the cylindrical slideway 15 and around the pulley 18 to provide a take up loop.

The wound hollow coil 12 providing the store of hardwire is situated adjacent to the probe means and comprises a double layer of wound turns. The double layers are wound in opposite directions to minimise inductance and the hardwire comprises a twin core insulated cable. Each turn of cable of the wound hollow coil is lightly bonded to adjacent turns in the same layer, the bond being achieved by using an adhesive which is a solvent for the outer insulation of the cable and which thereby tends to weld together adjacent turns.
Adhesion between turns in different layers is prevented by coating the wound layer with, for example, silicone oil. The hollow coil 12 is bonded inside the drill pipe section. If a larger capacity store of cable is required then more than one hollow coil can be used.

The lengths of hardwire in the plurality of coils are spliced together by a connector 100 as shown in Figure 4. Each connector comprises a plastic tube 101 having its ends sealed by resilient grommets 102 secured in position by lock nuts 103. The cores of twin hardwire are connected by crimping or twisting their free ends and located in an electrically insulating sleeve 105. A connecting chamber 106 is then filled with silicone grease through a grease nipple 107 which is removed after filling and replaced by a plug. The connector 100 provides a sealed water proof splice connecting together two lengths of hardwire 2.

From Figure 1 it can be seen that the wound hollow coil of cable leaves the centre of the drill pipe open and the coil thereby tends not to lock the pipe and does not tend to restrict flow of drilling fluid along the pipe.

The cable from the hollow coil 12 passes along the drill string towards the mouth of borehole where it is disconnectably connected to a connector 20 (shown in Figure 3 disconnected) provided on the forward end of a shaft 21 supported by the aforementioned slip ring unit 3 including a slip ring device 22 and a drilling fluid inlet adaptor 23 sealably mounted on a cylindrical housing 24. A further shaft 25 extending from the slip ring device 22 is provided with a further connector 26 enabling a further length of cable (not shown) to feed electrical signal means to signal control equipment (not shown) situated outside the borehole.
When the drill string has to be extended the slip ring unit 3 is disconnected from the last installed drill pipe section and the cable disconnected from the connector 20. After removal of the slip ring unit 3 a new drill pipe section is fed towards the mouth of the borehole and the end of the cable previously connected to the connector 20 is threaded through the pipe section before the section is connected to the drill string. The cable then is reconnected to the connector 20 and the slip ring unit 3 remounted on the end of the extended drill string. Drilling then can continue until a further drill pipe section is required. The above extention procedure then is repeated. A similar disconnection and reconnection procedure is followed when the drill string is withdrawn from the borehole to facilitate threading, a semi-stiff rod (not shown) is used which can be pushed up inside the new pipe section of the drill string. This is fitted with a dummy connector at the end which mates with the connector terminating the telemetry cable. When the new rod is mounted on the machine prior to assembly into the string the telemetry cable can then be conveniently pulled through.

It will be appreciated that throughout the drilling operation the efficient, effective continuous hardwire telemetry system is maintained so that signals can be transmitted from the probe means to signal control, monitory and or indication equipment mounted outside the borehole. Also control signals may be efficiently transmitted along the hardwire from control equipment situated outside the borehole to controlled equipment located within the borehole. Such controlled equipment may comprise, for example, steering equipment for the bit of the drill string.
In other installations a flat 'figure of eight' cross-section twin core cable may be replaced by a single core cable, the pipes of the drill string being used as an electrical signal return path. Alternatively, cables with more than two cores can be used. As a further alternative optical fibre cables may be used.

When feeding power supply to power a probe it may be preferred to maintain the total electrical resistance of the circuit substantially constant, when a plurality of coils are used a set of switched resistances might be included in the telemetry circuit.
The claims defining the invention are as follows:--

1. A telemetry system for borehole drilling comprising an effectively continuous length of hardwire which in use extends along a drill string located in a borehole, the hardwire extending between electrical signal control, equipment situated outside the borehole and probe means situated within the borehole, the effectively continuous length of hardwire including a store of hardwire constituted by a bonded wound hollow coil of hardwire situated adjacent to the probe means.

2. A telemetry system as claimed in claim 1 in which the hardwire comprises a twin core cable.

3. A telemetry system as claimed in any one of the preceding claims, in which each turn of hardwire within the wound hollow coil is lightly bonded only to adjacent turns in the same layer.

4. A telemetry system as claimed in claim 3, in which the bond is achieved by using an adhesive which is a solvent for the outer insulation of the cable and which thereby, tends to weld together adjacent turns.

5. A telemetry system as claimed in any preceding claim in which the store of hardwire comprises a wound hollow coil having a plurality of layers.

6. A telemetry system as claimed in claim 5 in which adhesion between layers is prevented by using a coating provided between the layers.

7. A telemetry system as claimed in claim 6 in which the coating is a silicone oil.

8. A telemetry system as claimed in any one of the preceding
claims, in which the wound hollow coil is retained inside a drill pipe section.

9. A telemetry system as claimed in claim 8 in which the coil is bonded to the inside wall of the drill pipe section.

10. A telemetry system as claimed in any one of the preceding claims, in which the store of hardwire comprises a plurality of wound hollow coils spliced end to end.

11. A telemetry system as claimed in claim 10 in which the coils are spliced by a connector including a hollow sealed tube enclosing the joined ends of the coils and filled with an electrically insulating grease.

12. A telemetry system for a borehole drilling, substantially as described herein and substantially as shown in the accompanying drawings.

DATED this 4th day of MAY, 1987
COAL INDUSTRY (PATENTS) LIMITED
By their Patent Attorneys
GRIFFITH HASSEL & FRAZER
FIG. 4