ELECTRICAL SIGNAL TRANSMISSION FOR WELL DRILLING

Harry Brandt, Davis, Calif., assignor to Chevron Research Corporation, San Francisco, Calif., a corporation of Delaware

2 Claims. (Cl. 339—16)

This application is a continuation of copending application Serial Number 162,421, filed December 27, 1961, and now abandoned.

This invention relates to an electrical signal transmission system for well drilling and more particularly, this invention relates to apparatus for electrically coupling drill pipes when said pipes are mechanically coupled together to form a drill string which provides an electrical transmission circuit between apparatus in the borehole on said drill string and apparatus on the earth's surface.

When drilling a borehole it is often desirable to send or receive electrical signals between the surface and downhole. For example, a force measuring device producing an electrical signal proportional to the force on a drill bit may be attached to the bit and an electrical signal transmitted to the surface to give force information to an operator. Devices producing signals proportional to temperature and resistivity are also frequently used. As is known in the art of well drilling, a borehole is advanced into the earth by the action of a drill bit against the drilling face. The drill bit is attached to a drill collar of a drill string and is supplied with rotational or reciprocating motion by the drill string and to some extent is weighted by a drill collar. The drill string is made up of drill stem sections comprising a number of drill pipes mechanically coupled together. The pipes are usually threaded together at the drilling rig as the bit progresses into the earth. Because of the number of drill pipes usually making up the drill string, and the extreme wear conditions inherent in drilling operations, transmission of electrical signals along the drill string has herefore been a difficult problem. Attempts have been made to utilize the drill string as one conductor and an insulated conductor carried in the drill string as a second conductor. These attempts have not met with great success due in part to failure of the electrical connectors between drill stem sections.

Briefly, the present invention provides a transmission system using the drill string as one conductor and an insulated conductor secured interiorly of said drill string as the second conductor, said insulated conductor having electrical connectors at the drill pipe joints. The electrical connectors provided for by the present invention electrically couple insulated conductors carried interiorly of said drill pipes when the drill pipes are mechanically coupled in a conventional manner by the drilling crew to form a drill string. A first electrical connector and a second electrical connector are provided in each end of a section of drill pipe. The electrical connectors in a drill pipe are adapted to make electrical contact when mated with corresponding connectors in other drill pipe when the pipes are mechanically coupled to make up a drill string.

When drill pipes are coupled, thus preventing current loss to the drill pipe or to ground. A special type connecting ring in one of the electrical connectors improves contact by removing dried mud from the connecting ring in the opposing electrical connector as the drill pipes are coupled.

It is one object of the present invention to provide an electrical transmission system for well drilling, said system comprising the drill pipes of the drill string as one conductor and an insulated conductor secured interiorly of the drill pipes as the second conductor, said insulated conductor having removably mounted electrical connectors in both ends of each drill pipe, which connectors electrically connect said insulated conductors in said drill pipes when said pipes are mechanically coupled to form a drill string.

Further objects and advantages of the present invention will become apparent from the following detailed description read in light of the accompanying drawings which are a part of this specification and in which:

FIG. 1 is a diagramatic view of two drill pipes, said pipes electrically coupled according to the present invention.

FIG. 2 is a sectional view of a preferred form of apparatus for providing an electrical connection between drill pipes.

FIG. 3 is a section at 3—3 of FIG. 2.

FIG. 4 is a supplemental view of the connecting ring shown in FIG. 3 as it would appear if it were removed from the electrical connector and unrolled.

FIG. 5 is a section at 5—5 of FIG. 2.

To obtain a better understanding of the invention, reference is now made to FIGS. 1 through 5, wherein a diagramatic view of an embryo drill string 30 comprising drill pipe 35 coupled to drill pipe 25 is shown. A drill pipe has male threads on one end commonly called the pin end, and female threads in the other end commonly called the box end. The pin end 21 of drill pipe 25 is screwed into the threads provided in box end 26 of drill pipe 25. If, for example, drill pipe 25 is the first drill stem section to be run in a borehole, a drill bit collar with a drill bit is connected at pin end 27. Additional drill pipe is added to the drill string by screwing the pin end of each drill pipe into the box end of the uppermost drill pipe of the drill string in a manner similar to the mechanical connection provided by pin end 21 and box end 26 of FIG. 1.

According to the preferred form of the invention a conduit 23 is secured interiorly of drill pipe 20. Conduit 23 extends substantially the length of drill pipe 20 from box end 22 to pin end 21. In a similar manner, a conduit 28 is secured interiorly of drill pipe 25. Conduits 23 and 28 are each adapted to receive an insulated electrical cable such as cable 12 in conduit 23 and cable 14 in conduit 28. The electric cable 12 in conduit 23 of drill pipe 20 is electrically connected to an electrical connector represented schematically by 32 in box end 22 and to an electrical connector 34 in pin end 21. In a similar manner the electrical cable 14 in conduit 28 of drill pipe 25 is electrically connected to an electrical connector 31 in box end 26 and to an electrical connector 33 in pin end 27. The connector 31 in the box end 26 of drill pipe 25 is adapted to make electrical contact with connector 32 in pin end 21 of drill pipe 20 when the drill pipes are mechanically coupled as shown in FIG. 1. For convenience in description the electrical connectors similar to connector 32 and connector 31 will be called male electrical connectors and electrical connectors similar to connector 34 and connector 33 will be called female electrical connectors.

The electrical connectors and the cable are insulated from the drill pipe to provide for an electrically insulated...
3,253,245

3 conductor for current flow along drill string 30. According to the present invention each drill pipe is provided with an insulated electric cable and mateable installed electrical connectors. Therefore, an electrical circuit is developed along the drill string as each new drill pipe is mechanically and electrically coupled into the drill string.

FIG. 2 is a detailed sectional view of a preferred form of apparatus for providing an electrical connection between insulated conduits secured interiorly of drill pipes according to the present invention. As there shown, pin end 21 of a drill pipe such as drill pipe section 25 is held in position by the coupling or joint between insulated cable 12 and insulated cable 14 is completed by the male electrical connector indicated generally by numeral 31 contacting the female electrical connector indicated generally by 34. The terms male and female are only relative. One skilled in the art will realize that the position of the connectors could be reversed so long as the two opposed electrical connectors mate when the drill pipes are mechanically coupled.

Referring now specifically to the connector represented generally by 31, a base ring 40 is provided with supporting shoulders 41. Base ring 40 is slidably received in the bore of a drill pipe as shown in FIG. 26 of a drill pipe 26 may be easily inserted and removed when desired by locking or unlocking setscrew 44. Thus, electrical connector 31 is removably secured in the box end of the drill pipe. The supporting shoulders 41 rest on a recess 42 located interiorly of box end 26. As shown in FIG. 5, which is section 5-5 of FIG. 2, base ring 40 is preferably supported interiorly of pin end 26 by three or four exteriorly located shoulders, such as shoulder 41. Base ring 40 is supported in this manner to drain paths 70 in the annulus formed by base ring 40 and box end 26. These openings provide a drain for drilling mud from the male connector when a drill pipe is removed from the borehole and stacked on the surface. As is known in the art, a drill pipe is usually wet with drilling mud when pulled from the hole. A hard durable cover results on surfaces where the mud dries. The dried mud functions as an undesirable insulator on a coated surface. It is important that the mud is not allowed to collect and dry on the electrical connectors. Drill pipes are usually stacked with the box end up and the pin end down. Therefore it is important to provide a drain in the electrical connector located in the box end of the drill pipe to insure that drilling mud will not collect there to dry and coat the connecting surfaces while the pipe is stacked.

Base ring 40 is provided with a passageway for receiving conduit 51 and insulated cable 14 when base ring 40 is inserted into box end 26. As discussed more fully below, the electrical connectors in each drill pipe may be rapidly and easily assembled in the field. Base ring 40 is held removably in place by setscrew 44 in well 45 of box end 26. The setscrew 47 in cable 14 is operably connected to a connecting ring 46. Connecting ring 46 is made of a conducting metal and is adapted to mate with a connecting ring 55 in the female electrical connector when mating ends of two drill pipes are coupled as shown in FIG. 2. Wire 47 is insulated from base ring 40 by means of insulating material 48. Connecting ring 46 is mounted on base ring 40 in connecting ring mounting 45. Connecting ring mounting 45 is made of a resilient material such as rubber. Connecting ring mounting 45 serves both as a mount for connecting ring 46 and as a mud sealing means for ring 46 and connecting ring 55 when the rings are coupled to drill pipe. The mud sealing function of mounting 45 is more fully described below.

Before describing the mud sealing means, the female connector located interiorly of pin end 21 and represented generally by 34 will be fully described. A hollow generally cylindrical core 51 having a piston-like flange 60 is adapted to be inserted and removed from pin end 21. The core 51 is supported by a support 50 secured interiorly of pin end 21. Flange 60 is provided with a hole 61. The hole 61 is adapted to receive insulated cable 12. Flange 60 is also provided with a setscrew 53 which is locked to prevent the core 51 from turning after it is positioned. The setscrew 53 holds the female connector removably secured in the pin end of the drill pipe. When core 51 is inserted into pin end 21 in the position shown in FIG. 2, two annular chambers are formed by the interior wall of pin end 21 and the exterior of core 51. The annular chambers are separated by flange 60 which extends around core 51.

A means for taking up an extra length of insulated cable is provided by the annular chamber designated by 62. Annular chamber 62 is adapted to contain insulated cable 12 wrapped on the exterior of core 51. Core 51 is rotated into position of pin end 21 to twist cable 12 around the core 51. This feature allows an extra length of cable 12 to be contained in the drill pipe. Thus, the drill pipe containing an insulated cable and electrical connectors of the present invention is easily assembled or repaired in the field. Assembly of a drill pipe containing electrical connectors is now described with reference to drill pipe section 20 of FIG. 1. The insulated electric cable 12 carried inside of conduit 23 is preferably about one foot long base ring 40 may be easily inserted and removed when desired by locking or unlocking setscrew 44. After the electrical connection between cable 12 and female connector 34 is made, the female connector is mounted interiorly of pin end 21 of drill pipe 20. The slack in the insulated cable is taken up by rotating female connector 34 as it is inserted into position in pin end 21. The female connector is then locked in position by suitable means. The locking means is preferably a setscrew or a similar device so that the connector is releasable from the pipe when the setscrew is unlocked.

Referring again to FIG. 2, the second annular chamber formed by core 51 and pin end 21 contains connecting ring 55 securely held in a nonconducting material 58. Suitable material for containing connecting ring 55 is, for example, Teflon or Bakelite. Connecting ring 55 is connected to electric cable 12 by a suitable means such as electric connection 56. Connecting ring 55 is castellated over part of its contacting surface. It has been discovered that greatly improved electrical connection with an opposing connecting ring in the resilient mounting is obtainable if the connecting ring mounted in the relatively nonresilient mounting, such as connecting ring 55 in female connector 34, is castellated over part of its contacting surface. One theory for this is that the castellations scrape or chill away mud which may be caked on the contacting surfaces of the opposing connecting ring as the drill pipe sections are screwed together. It is desirable that the castellated connecting ring be mounted in a manner to prevent the connecting ring from twisting when pipe sections are coupled in order that the ring better scrape clean the opposing connecting ring. The preferred form of the castellated connecting ring 55 is illustrated in FIG. 3 and FIG. 4. FIG. 3 is a sectional view at 3-3 of FIG. 2. FIG. 4 is a supplemental view of ring 55 as it would appear if it was removed from the female connector think unrolled to a flat position.

A major problem associated with electrical transmission through a drilling string is loss of current to ground at the connecting joints. The leakage problem is especially serious when the liquid in the borehole, which is usually drilling mud, is conductive. Since many drilling muds are conductive, leakage is a common problem. The present invention provides for establishing a metal-to-metal contact by mating connecting ring
removably secured interiorly of the pin end of said drill pipe, said second electrical connector including a second terminal insulated from electrical contact with said drill pipe, second locking means in said pin end removably securing said second electrical connector in said pin end and annular chamber means formed by said second electrical connector and said drill pipe for containing an extra length of cable therein.

2. Apparatus for use in a borehole electrical system comprising a drill pipe having a pin and a box end, said pipe adapted to be connected with other drill pipes to form a drill string, an insulated cable contained interiorly of said pipe, a first electrical connector connected to one end of said cable, said first electrical connector including a second annular connecting terminal insulated from electrical contact with said drill pipe, second locking means in the other end of said pipe removably securing said second electrical connector in the other end of said drill pipe and annular chamber means formed by one of said electrical connectors and said drill pipe for containing an extra length of said cable therein.

References Cited by the Examiner

UNITED STATES PATENTS

<table>
<thead>
<tr>
<th>Patent Number</th>
<th>Date</th>
<th>Inventor</th>
<th>Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>749,633</td>
<td>1/1904</td>
<td>Seeley</td>
<td>339—16</td>
</tr>
<tr>
<td>1,882,320</td>
<td>10/1932</td>
<td>Haggood</td>
<td>339—16</td>
</tr>
<tr>
<td>2,096,359</td>
<td>10/1937</td>
<td>Hawthorn</td>
<td>339—16 X</td>
</tr>
<tr>
<td>2,301,783</td>
<td>11/1942</td>
<td>Lee</td>
<td>339—16</td>
</tr>
<tr>
<td>2,531,120</td>
<td>11/1950</td>
<td>Feaster</td>
<td>339—16 X</td>
</tr>
<tr>
<td>2,694,800</td>
<td>11/1954</td>
<td>Sunderhaus</td>
<td>339—95 X</td>
</tr>
<tr>
<td>2,706,616</td>
<td>4/1955</td>
<td>Osmun</td>
<td>174—104 X</td>
</tr>
<tr>
<td>2,748,358</td>
<td>5/1956</td>
<td>Johnston</td>
<td>339—16</td>
</tr>
<tr>
<td>2,750,569</td>
<td>6/1956</td>
<td>Moon</td>
<td>339—16</td>
</tr>
<tr>
<td>3,041,875</td>
<td>7/1962</td>
<td>Reesby</td>
<td>339—16 X</td>
</tr>
</tbody>
</table>

JOSEPH D. SEERS, Primary Examiner.

PATRICK A. CLIFFORD, Examiner.