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Kostelnicek

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[54] **WELLBORE TELEMETRY APPARATUS**

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[52] **U.S. Cl.** .... **191/12 R**; 174/69

[51] **Int. Cl.**[2] **H02G 11/00**

[58] **Field of Search** .... 174/69, 47, 35, 135; 175/104, 105, 40, 320; 191/12 R; 137/355.16, 355.2, 355.21, 355.23, 355.28

[56] **References Cited**

UNITED STATES PATENTS

3,285,629	11/1966	Cullen	175/104
3,608,125	9/1971	Nelson	191/12 R
3,746,832	7/1973	Bernard	174/69
3,809,800	5/1974	Fletcher	174/69

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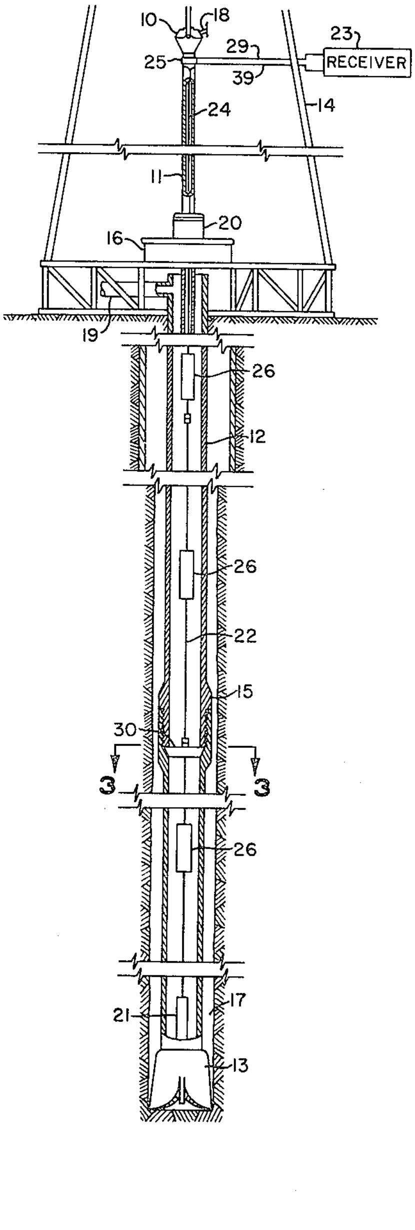
[57] **ABSTRACT**

An apparatus having coiled conductor stored therein is used in a wellbore telemetry system. The telemetry system permits the monitoring of a subsurface condition as drilling proceeds. The apparatus includes a tubular container, an insulated electric conductor mounted in the container in a configuration which includes left-hand and right-hand coils, and means for dispensing conductor from opposite ends of the container. The apparatus permits the conductor string to be lengthened as the drill string is lengthened.

8 Claims, 8 Drawing Figures



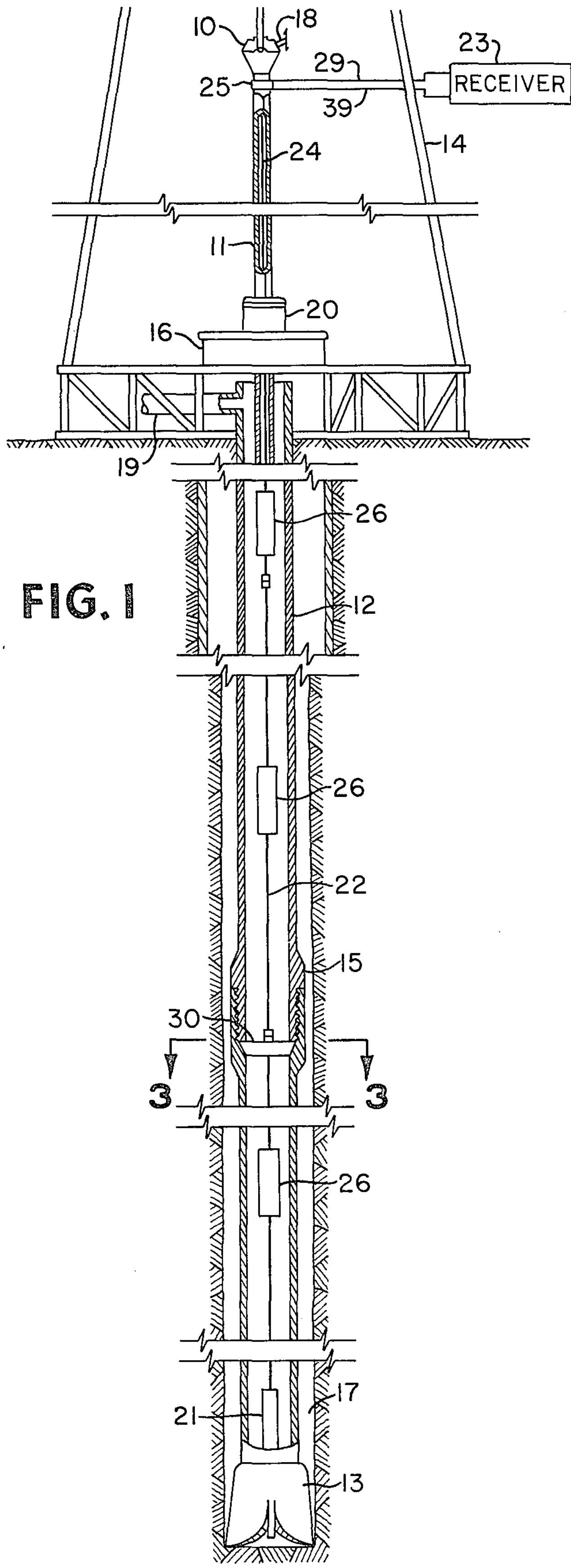

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FIG. 1

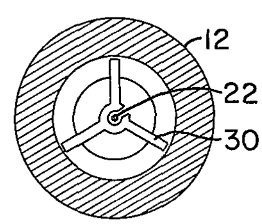
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FIG. 3

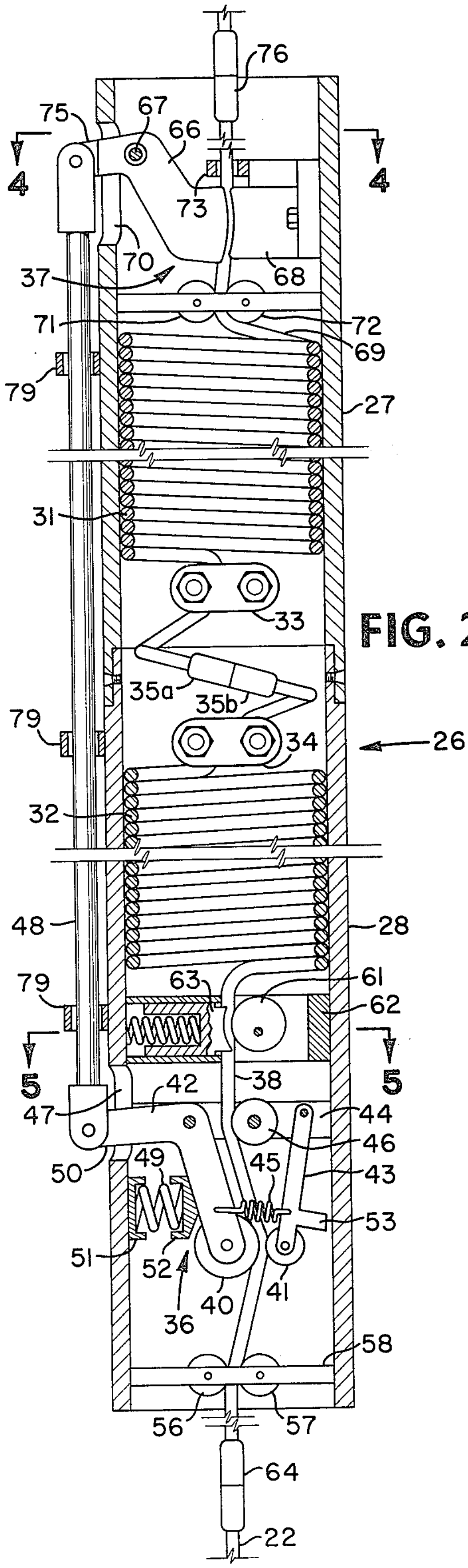

FIG. 2

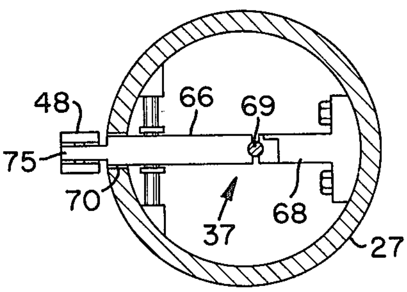

FIG. 4

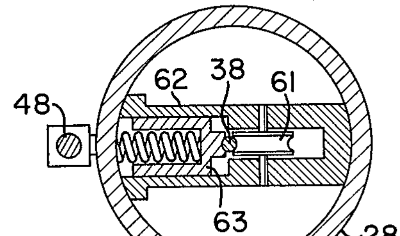

FIG. 5

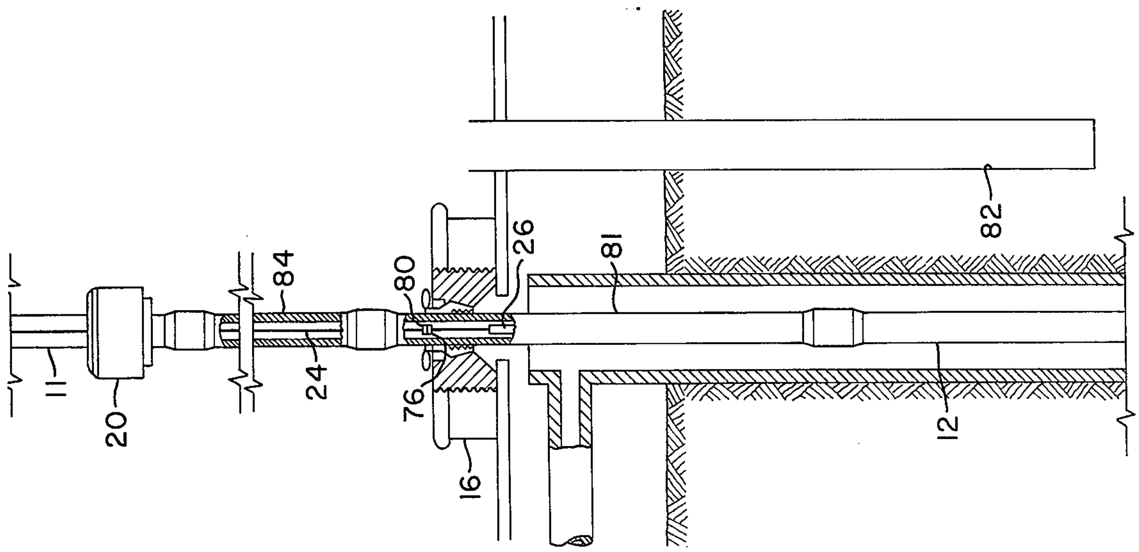

FIG. 8

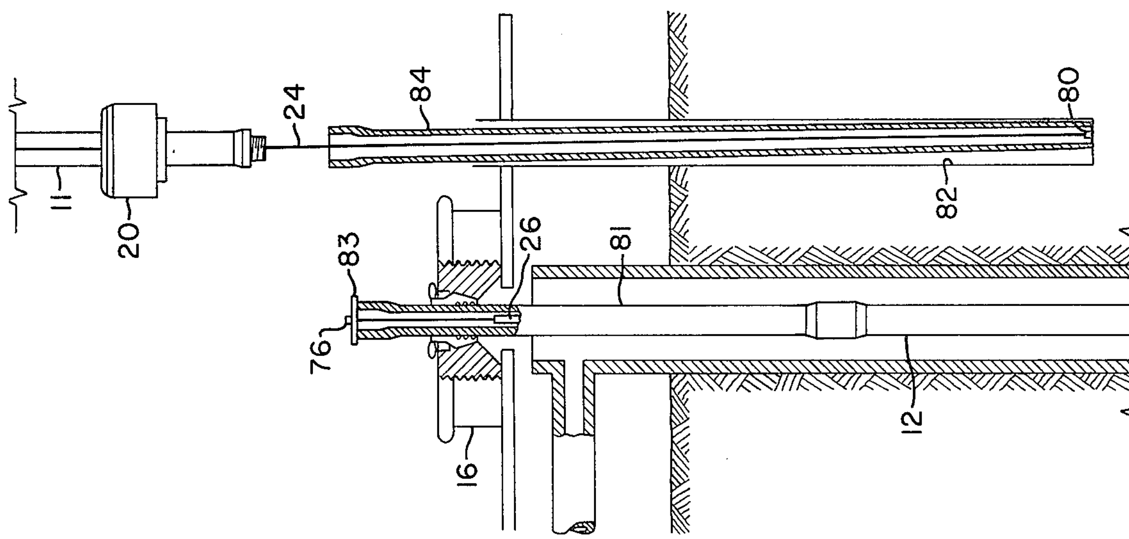

FIG. 7

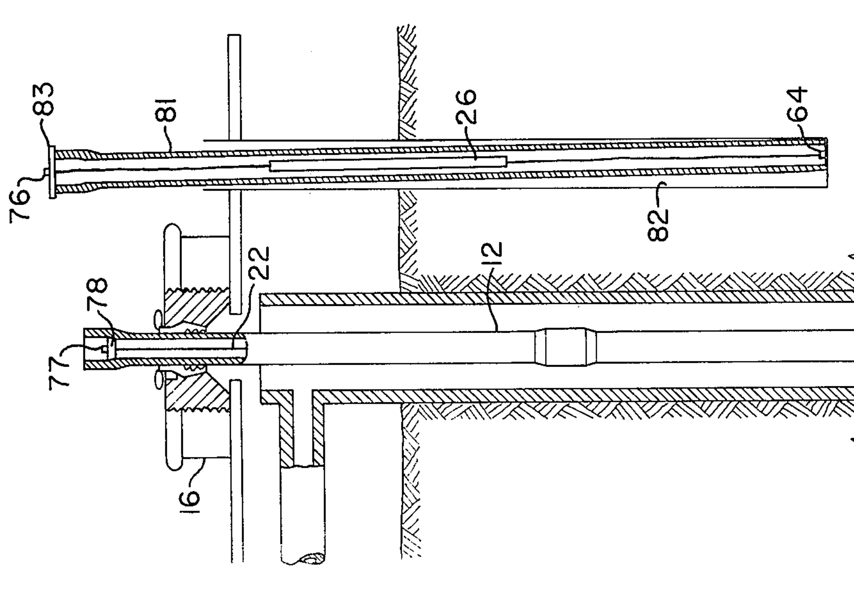

FIG. 6

WELLBORE TELEMETRY APPARATUS

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to an improved apparatus for use in well-bore telemetry operations. In one aspect, it relates to an improved cable system for maintaining electric continuity between surface and subsurface locations in a drill string.

2. Description of the Prior Art

In the drilling of oil wells, gas wells, and similar boreholes, it frequently is desirable to transmit electric energy between subsurface and surface locations. One application where electrical transmission has received considerable attention in recent years is found in wellbore telemetry systems designed to sense, transmit, and receive information indicative of a subsurface condition. This operation has become known in the art as "logging while drilling." A major problem associated with wellbore telemetry systems proposed in the past has been that of providing reliable means for transmitting an electric signal between the subsurface and surface locations. This problem can best be appreciated by considering the manner in which rotary drilling operations are normally performed. In rotary drilling, a borehole is advanced by rotating a drill string provided with a bit. Sections of drill pipe, approximately 30 feet in length, are added individually to the drill string as the borehole is advanced. In adapting an electrical telemetry system to rotary drilling equipment, it will thus be appreciated that the means for transmitting an electric signal between subsurface and surface locations must be such as to permit the addition of individual pipe sections to the drill string. An early approach to the problem involved the use of a continuous electrical cable which was adapted to be lowered inside the drill string and to make contact with a subsurface instrument. This technique, however, required withdrawing the cable each time a pipe section was added to the drill string. A more recent approach involves the use of special drill pipe equipped with an electric conductor. Each pipe section is provided with connectors that mate with connectors of an adjacent pipe section and thereby provide an electrical circuit across the joint (U.S. Nos. 3,518,608 and 3,518,609). Disadvantages of this system include the need for special pipe sections and the difficulty of maintaining insulation of the electrical connectors at the pipe section joints.

SUMMARY OF THE INVENTION

The apparatus of the present invention is adapted for use in well drilling operations wherein an electric conductor disposed in a pipe string is employed to transmit electric energy between a subsurface and surface location.

A novel feature of the invention involves the configuration of a conductor within a drill string which permits storage of excess conductor. The invention contemplates the use of a tubular container for maintaining the electric conductor within the drill string in a coiled configuration and for uncoiling the conductor as additional conductor is needed. Thus, as the drill string is lengthened, the electric circuit between the subsurface and surface can be maintained merely by dispensing the coiled portions of the conductor until the excess conductor stored in the container is used up. The coiled conductor is maintained in the container in coiled portions wound in opposite hands, i.e. one portion is provided with left-hand coils and a second with right-hand coils. Means are provided for paying out the conductor from the top and bottom of the container in such a manner that the individual left-hand and right-hand coils are unwound at about the same time or alternatively, thereby preventing twists from forming in the conductor string.

In a preferred embodiment of the invention, the apparatus comprises an elongated open-ended tube capable of being lowered into a pipe string used to drill a well, an electric conductor or cable mounted in the tube having a first portion wound in left-hand coils and a second portion wound in right-hand coils, and means for dispensing the coiled portions from opposite ends of the tube. A preferred form of the dispensing means includes cable brake or clutch which in response to the tension in the conductor string operates to reduce gripping force on the conductor. In one embodiment a cable clutch is provided at each end of the tube for separately gripping cable dispensed from the left-hand coils and from the right-hand coils. One clutch operates in response to movement of the other clutch to enable dispensing of cable from opposite ends at about the same rate. This may be achieved by unwinding the coils at about the same rate or unwinding left-hand and right-hand coils alternatively.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1. is a schematic view of well drilling equipment provided with a telemetry system for monitoring a subsurface condition

FIG. 2 is an enlarged longitudinal sectional view of a container employed in the telemetry system shown in FIG. 1 illustrating the coiled configuration of the conductor stored in the container.

FIG. 3 is a cross-sectional view of the drill pipe shown in FIG. 1, the cutting plane taken along the line 3—3 thereof.

FIG. 4 is a cross-sectional view of the apparatus shown in FIG. 2, with the cutting plane taken along the line 4—4 thereof.

FIG. 5 is a cross-sectional view of the apparatus shown in FIG. 2, the cutting plane taken along line 5—5 thereof.

FIGS. 6, 7, and 8 are schematic views, illustrating sequential steps for adding a section of drill pipe to the drill string.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Conventional rotary drilling equipment, as schematically illustrated in FIG. 1, includes swivel 10, kelly 11, tubular drill string 12, and bit 13. These components, connected in the manner illustrated, are suspended from the drilling derrick 14 by means of rig hoisting equipment. The kelly 11 passes through rotary table 16 and connects to the upper end of the drill string 12. The term "drill string" as used herein refers to the column of tubular pipe 12 between the bit 13 and the kelly 11; and the term "pipe string" refers to the complete pipe column including kelly 11. The major portion of the drill string normally is composed of drill pipe with a lower portion being composed of drill collars. The drill string 12 consists of individual pipe sections connected together in end-ro-end relation by threaded connections. One connection is illustrated at 15 in FIG. 1. In the lower four sections of FIG. **1**, the diameters of the borehole and the drill string **12** have been expanded in relation to the upper section to reveal further details.

The borehole **17** is advanced by rotating the drill string **12** and bit **13** while at the same time drilling fluid is pumped through the drill string **12** and up the borehole annulus. The drilling fluid is delivered to swivel **10** through a hose attached to connection **18** and is returned to the surface fluid system through pipe **19.** A kelly bushing **20** couples the rotary table **16** to the kelly **11** and provides means for transmitting power from the rotary table **16** to the drill string **12** and bit **13.** (The use of a power swivel eliminates the need for the kelly and rotary table. The present invention may be used with either system; for purposes of illustration, however, it will be described in connection with the kelly and rotary table system.)

As mentioned previously, it frequently is desirable to monitor a subsurface drilling condition during drilling operations. This requires measuring a physical condition at the subsurface location, transmitting this data as an electrical signal to the surface, and reducing the signal to useful form. Typical situations where telemetry is applicable in drilling operations include drilling through abnormal pressure zones, drilling through zones where hole deviation is likely to be a problem, directional drilling, exploratory drilling, and the like.

Although the present invention may be employed in most any drilling operation wherein an electric conductor is used in tubular pipe to transmit electric energy between subsurface and surface locations, it finds particularly advantageous application in a wellbore telemetry system such as that illustrated in FIG. **1** comprising an instrument **21**, electric conductor **22**, and receiver **23.**

The instrument **21** capable of measuring a subsurface condition and generating an electric signal indicative of that condition is provided within the drill string **12.** A variety of devices capable of sensing a physical condition are available. These include transducers for measuring pressure, temperature, strain and the like; surveying instruments for measuring hole deviation; and logging instruments for measuring resistivity or other properties of subsurface formations. The instrument **21** may be powered by batteries or by energy transmitted through conductor **22.** Alternatively, a subsurface generator driven by fluid flowing through the drill string **12** may be used to power instrument **21.**

The present invention is concerned primarily with the apparatus for storing portions of the electric conductor **22** is a coiled configuration within the drill string **12.** The energy transmitted through the conductor **22** may be a signal generated by the subsurface instrument **21** and transmitted to the receiver **23** at the surface. Alternatively, the energy may be electric power transmitted from the surface to actuate or drive a subsurface instrument or motor, Or, energy may be transmitted down the conductor **22** to power the instrument **21** and simultaneously intelligence may be transmitted up the same conductor.

As applied in telemetry operations, it is preferred that the energy being transmitted be in the form of a pulsating signal. Information can be transmitted by varying the number, amplitude, width or spacing of a train of amplitude of the pulsating signal. More than one transducer or other device may be employed in the instrument **21** if desired, in which case a multiplexer may be used for sending the various signals over a single pair of conductors.

The instrument **21** may be mounted directly in the drill string **12** or, as illustrated in FIG. **1**, it may be a separate tool that is lowered into the drill string **12** on the conductor **22.**

The conductor **22** extends from the subsurface instrument **21** substantially through the drill string **12,** and connects to a suitable conductor **24,** provided in the kelly **11** (see FIG. **8**). Conductor **24** may be embedded in the kelly **11,** in which case the conductor **22** will extend to the upper end of the drill string **12** and connect to conductor **24** at that point. In order to facilitate the addition of pipe sections to the drill string **12,** however, it is preferred that conductor **24** be disposed within kelly **11** and extend slightly more than the length of one pipe section below kelly **11.** If telemetry operations are to be performed while the kelly **11** and drill string **12** are rotating, the upper end of conductor **24** will be connected to a device **25** capable of transmitting electric energy from a rotating member to a stationary member. Device **25** may be a rotary transformer having a rotor secured to the kelly **11** and a stator secured to the stationary portion of the swivel **10,** or it may be a slip ring and brush assembly. Electric conductor **29** interconnects the stationary portion of device **25** and receiver **23** and conductor **39** may be grounded to the pipe string providing a return path for the circuit. If telemetry operations are to be performed at times when the drill string **12** and kelly **11** are stationary, the conductors **29** and **39** may be connected directly to conductor **24** and the pipe string through a suitable connector. In this situation, conductors will be disconnected when the kelly **11** and drill string **12** are rotated. Other means for transmitting the signal to the receiver **23** include a wireless transmitter connected to conductor **22** and located on a rotating member, e.g. kelly **11.**

The receiver **23** is an instrument capable of receiving the signal generated by instrument **21** and reducing it to useful form.

In accordance with the present invention, the conductor **22** is arranged within the drill string **12** in a configuration such that the total length of the conductor **22** is substantially longer than the distance between the subsurface instrument **21** and the surface. As described in detail below, the excess length of conductor **22** stored in the drill string **12** permits the conductor **22** to be extended as the drill string **12** is lengthened.

In one aspect, the present invention contemplates storing the excess cable in the form of coils within the drill string **12** in canisters or tubular containers shown generally as **26** in FIG. **1.** The containers **26** may be constructed of metal or plastic and have a diameter sufficiently small to permit them to pass internally of the drill string **12.** In the preferred form of the invention, several of the containers **26** will be used in the conductor string **22** and each will provide sufficient length of excess cable stored therein to permit the addition of several sections of drill pipe before another container with stored conductor will be required. By coiling the conductor within the tube, substantial lengths of excess cable can be stored therein. For standard A.P.I. drill pipe having an inside diameter of 2.64 inches, a 2.5 inch O.D. container is capable of storing 50 feet of ⅛ inch unarmored cable per foot of container. A 10 ft. container thus is capable of storing approximately 500 feet of conductor. Thus one ten foot container provides sufficient cable to span about 16 sections of 30 foot drill pipe. FIG. 1 illustrates the conductor string 22 as having three containers 26. The lower two containers, as illustrated, have dispensed their stored cable for lengthening the conductor 22 at the point of operations illustrated in FIG. 1.

It should be realized, of course, that the container 26 may be longer than that illustrated in the drawings but for convenience it is preferred that relatively short containers be used. If high strength cable, such as armored cable, is used as the conductor string 22, the containers 26, conductor 22 and connectors can be constructed in a self-supporting fashion. However, if the conductor 22 does not include a reinforcing steel sheath or tension wire, the system may include reinforcing spiders for supporting each container and its conductor section at spaced intervals within the drill string. One spider 30 is illustrated in FIGS. 1 and 3 as being mounted at a joint 15 in the drill string 12 and serving to support the bottom container 26 and its associated cable.

As illustrated in FIG. 2, the container 26 is constructed in two tubular sections 27 and 28 adapted to be joined in end-to-end relation by means of a suitable fastener such as screws. Upper section 27 contains a first portion of coiled cable illustrated as 31 and lower section 28 contains a second portion of coiled cable 32. Coiled cable portions 31 and 32 are wound in opposite hands; that is, portion 31 is arranged in right-hand spiral and portion 32 in a left-hand spiral. The inner ends of coiled portions 31 and 32 are each secured to the inner wall of their respective sections 27 and 28 by bolt and clamp assemblies 33 and 34. The purpose of the clamp assemblies is merely to retain the cable 22 securely to the container 26 after the coiled portions have been paid out. The portions 31 and 32 arranged in opposite hands may be one continuous cable, but in order to facilitate loading the container, it is preferred that they be separate cable sections joined by connectors 35*a* and 35*b*. The coiled portions 31 and 32 being wound in opposite hands, upon being dispensed at about the same rate or alternately from their respective compartments, will prevent twists from forming in the conductor string 22.

Means are provided for controlling the dispensing of the coiled portions 31 and 32 of the cable from the container 26. A first cable clutch assembly 36 at the lower end of the container 26 is adapted to grip a straight portion 38 of the cable to retain the coiled portion 32 within lower section 28. Upon being actuated, assembly 36 permits stored cable to be fed out or dispensed from the lower end of container 26. As it unwinds, the cable passes through the clutch assembly 36 and thereby lengthens the conductor string 22.

A second cable clutch assembly 37, positioned in the upper end of container 26 retains coiled cable within section 27. Upon being actuated to a release position, assembly 37 permits cable to unwind and feed out the upper end of container 26. Thus, it is seen that the telemetry conductor is lengthened by cable being unwound from both coiled portions 31 and 32 and being fed out opposite ends of container 26. As noted previously, the portions 31 and 32, being wound in opposite hands, prevent the cable from twisting as individual coils are unwound at the same time or alternately.

As described in more detail below, the upper clutch assembly 37 is movable to its released position in response to actuation of the lower clutch assembly 36. In this embodiment, the lower clutch assembly is actuably responsive to tension in conductor 22. By pulling the conductor 22 upwardly at the surface, clutch assembly 36 releases which in turn causes the upper clutch assembly 37 to release.

As best seen in FIGS. 2 and 5, the lower clutch assembly 36 comprises gripping rollers 40 and 41 arranged within the lower end of container 26 such that the nip of the rollers engages straight portion 38 of the cable. Roller 40 serves as the main clutch and is mounted on bell crank 42. Roller 41 serves as a backup for roller 40 and is mounted on arm 43. Bell crank 42 and arm 43 are pivotally mounted to support member 44 which also supports guide roller 46.

A downwardly extending arm of the bell crank supports, in free-wheeling relationship, roller 40 while the other arm extends outwardly through opening 47 formed in the wall of container 26 and has an outer exposed end 50. The exposed end 50 is connected to rod 48 which interconnects the lower and upper clutch assemblies 36 and 37.

The bell crank 42 is urged inwardly forcing roller 40 to its normal cable engaging position by spring 49. Spring 49 is maintained in position by retainers 51 and 52 which are fastened respectively to the inner wall of container 26 and bell crank 42. Arm 43 supports roller 41 in free-wheeling relationship and is provided with stop 53 which determines the backup position of roller 41. Spring 45 maintains rollers 40 and 41 close together thereby maintaining the cable section properly at the nip thereof. Guide rollers 56 and 57 mounted on support member 58 are provided below the clutch assembly 36.

A brake assembly which forms part of the lower clutch assembly 36 is provided immediately below the coiled cable 32 in section 28 to prevent the coils from unwinding. This assembly comprises a back-up roller 61 eccentrically mounted on support member 62 which in turn is secured to the container 26. A spring loaded, cable engaging member 63 is urged toward the eccentric roller 61 and is also supported by member 62. The cable from coiled portion 32 thus passes downwardly between member 63 and eccentric roller 61, around guide 46, through the nip of rollers 40 and 41, between guide rollers 56, 57 and downwardly out the lower end of container 26. The lower terminal end of the cable is provided with a connector 64 which is adapted to mate with a connector provided in the conductor string 22.

As shown in FIGS. 2 and 4, the upper clutch assembly 37 comprises a cable gripping member 66 pivotally mounted to the upper section 27 as at 67. Member 66 extends through opening 70 of section 27 and has an outer end 75 disposed externally of container 26. Member 66 is adapted to grip an upper straight portion 69 of cable above coils 31 and is adapted to cooperate with back-up member 68 which is secured to the interior of section 27. As illustrated, members 66 and 68 are each provided with a grooved end for gripping cable portion 69. Cable unwound from coiled portion 31 passes through the nip of guide rollers 71 and 72, through the brake assembly 37, through an upper guide 73 which is secured to member 68. The upper end of cable portion 69 terminates in connector 76 which is adapted to mate with a connector of an adjacent cable section.

As mentioned previously, the upper clutch assembly **37** is actuated by the lower clutch assembly **36** through rod **48.** Thus, tension in the conductor string above the container **26** caused by the weight of the cable and container or by pulling forces will not release coiled cable from section **27.** Rod **48** is secured to the outer exposed ends **50** and **75** of members **42** and **66** and in effect forms a linkage between the two clutch assemblies. Rod guides **79** spaced along the exterior of container **26** maintains the rod in proper position.

In this embodiment the actuation of the lower clutch assembly **36** is by cable tension. In the relaxed position of the conductor string **22,** the lower clutch assembly **36** is in the position generally as shown in FIG. **2.** In the relaxed position the spring **49** forces roller **40** into gripping engagement with cable portion **38** forcing the cable and back-up assembly to the right stop position as viewed in FIG. **2.** This prevents the cable from being pulled from the lower coiled section of the container **26.** With roller **40** positioned in its normal gripping position, the brake member **66** of the upper clutch assembly **37** will also occupy the braking position through the linkage comprising bell crank **42** and rod **48.** Spring **49** thus not only forces roller **40** into engagement with the cable between the nip of rollers **40** and **41** but also forces member **66** into forceful engagement with conductor portion **69.**

An upward pulling force on conductor **22** imparts tension on the cable string which tends to straighten cable portion **38** between guide rollers **56, 57,** and guide roller **46.** This forces rollers **40** and **41** to the released position. Movement of roller **40** also moves clutch member **66** away from cable portion **69** releasing the upper clutch assembly. Releasing of the upper and lower clutch assemblies **36** and **37,** permits cable to be dispensed from opposite ends of the container **26.** For each loop of left-hand and right-hand coils dispensed, the container revolves one revolution thereby preventing twists from forming in the cable. The cable is dispensed by coiled portions being unwound and being fed through their respective clutch assemblies. As the cable is dispensed from opposite ends, for every left-handed wound coil a right-handed wound coil is released. Because of the eccentric roller **61,** cable is dispensed intermittenly from the lower end. When the lobe of the eccentric roller **61** engages the cable portion **38,** the braking forces increase so that the rate of cable being dispensed is reduced. However, once the lobe is forced past the engagement position on the cable, the cable passes through the brake with less resistance thereby increasing the rate at which it can be dispensed. The intermittent action of the brake on cable **38** causes the left-hand and right-hand coils to be unwound and dispensed from the container alternatively.

There are a number of commercially available cables that are sufficiently flexible to permit such cable to be coiled in the manner illustrated in FIG. **2.** A particularly suitable cable is a single conductor 12 AWG neoprene jacket conductor sold by Vector Cable Company as B-5025.

In order to facilitate the insertion of the coil conductor within the container **26,** it is preferred that the container **26** be constructed in two sections as described previously. The conductor may be installed within each tube section **27** and **28** by winding conductor on a suitable mandrel. The mandrel with the conductor wound thereon is inserted into a tube section as for example through the lower end of section **27.** An upper portion of the conductor provided with connector **76** is threaded through the guide rollers **71** and **72,** the clutch assembly **37,** the guide **73,** and finally out the upper end of section **27.** A relatively long lead may be provided at this end. With the conductor properly positioned in section **27,** the mandrel is turned in the opposite direction of the coils to release the grip of the coiled conductor, permitting the mandrel to be removed from the coils and section **27.** The lower end of the coiled cable **31** is clamped to the wall of section **27** leaving connector **35**a exposed. The same procedure is used in mounting cable portion **32** within lower section **28** except the coils in this section are wound in opposite hand relative to the coils in section **27.** The lower lead extending from coiled portion **32** is threaded through the lower brake and clutch assemblies and may be provided with a relatively long lead extending below the lower end of section **28.** As mentioned previously, the lower end of the cable terminates in connector **64.** The upper end of the cable within tube section **28** is clamped to the interior wall thereof and the upper connector **35***b* is mated with the lower connector **35***a* of cable portion **32.** The two tubular sections **27** and **28** are then fastened together and the rod **48** connected to the clutch assemblies **36** and **37.**

It should be noted that each cable container is constructed such that there will be very little resistance to the flow of fluids therethrough. During the drilling operations, drilling fluid will be pumped down the drill pipe and will pass around and through the containers **26.**

In describing operation of the present invention, it will be assumed that the borehole **17** has been drilled to a certain depth using conventional techniques and at this depth it is desired to commence drilling-while-logging operations. The drill string **12** and bit **13** attached thereto is lowered into the borhole **17** in the usual manner. The instrument **21** is lowered on cable **22** and located at the proper depth within the drill string **12.** The upper end of the conductor **22** is provided with a cable clamp and connector **77.** The clamp and connector **77** may be located in a spider **78** similar to spider **30** shown in FIG. **3** for supporting the upper end of the cable on the drill string. Since this initial section of cable may extend several thousand feet, it is preferably constructed of armored cable such as a single conductor 3/16-inch armored cable manufactured by the Vector Cable Company and sold as Type I-18P.

With the conductor **22** properly located in the drill string **12,** a pipe section **81** provided with a cable container **26** may be added into the system. This may be achieved by the following procedure described with reference to FIGS. **6, 7** and **8.**

Pipe section **81** with the cable container **26** therein is elevated by the rig hoisting equipment. The lower connector **64** is mated with connector **77** and pipe section **81** is then screwed into the top section of the drill string **12.** The drill string and cable therein is lowered the length of pipe section **81** and again suspended in the rotary table **16** (see FIG. **7**). The kelly **11** is then connected to the next pipe section **84** placed in the mouse hole **82** by threading the tail **24** of the kelly conductor into the pipe section **84** and screwing the kelly into the box end of pipe section **84.**

This assembly is then elevated above the drill string **12** and the kelly cable **80** is mated with connector **76.**

The support plate **83** is then removed and the pipe section **84** is screwed into the box end of pipe section **81.** It should be noted that because of the excess length of the conductor and the kelly, there will be some slack in the conductor within pipe joint **81.** However, this slack will be removed by the addition of the next pipe joint to the drill string **12.**

With the drill string **12** and conductor **22** lengthened, drilling may proceed for another length of pipe permitting the monitoring of drilling conditions as desired. The individual sections of drill pipe can be added in the same manner that pipe section **84** was added for each incremental advance of the borehole **17.** During the addition of second and subsequent pipe sections, surplus cable is pulled from the coiled portions stored in container **26** permitting the lengthening of the conductor string **22** as the drill pipe **12** is lengthened. Each container **26** will be provided with sufficient amounts of surplus cable in the coiled configuration to accommodate several pipe joints. When the surplus cable is used up, a second container may be inserted into the conductor string **22.** If the cable used in the containers does not have sufficient strength to support large loads, a spider may be provided at the upper end of the conductor. This spider may be inserted immediately prior to the addition of the next container and conductor section. The spider may be of the same construction as that illustrated in FIG. **3.**

Drilling operations may proceed as described previously using a plurality of the containers **26** in the conductor string **22.**

When it becomes necessary to interrupt drilling operations as for example to change bit **13,** the conductor **22** which by this time may include several containers **26,** may be removed by disconnecting the kelly **11** and kelly conductor **24** in the manner described previously. The cable sections and associated container may be individually retrieved. Each cable section is thus withdrawn from the drill string permitting the removal of the same length of drill pipe before the next cable section is withdrawn.

Although the present invention has been described with reference to specific types of equipment and cable, it should be realized that numerous modifications may be made without departing from the spirit of the invention. For example, the cable within each container **26** may be provided with internal tension members which increase the tensile strength of the material. In this type of construction, the spiders at the upper end of each cable section may not be required.

It should also be mentioned that the present invention may be used with drilling equipment other than that described herein. For example, it may be used in connection with turbodrills in positive displacement hydraulic motors. These devices normally include motor or turbine mounted on the lower end of the drill string and adapted to connect to the drive or bit. The motor or turbine powered by the drilling fluid drives the drill bit while the drill string remains stationary. When this type of subsurface drilling equipment is used in directional drilling operations, the present invention provides a highly useful means for transmitting directional data to the surface.

I claim:

1. Apparatus for use in an electric system employed in a pipe string to conduct electric signal between a subsurface location and a surface location, which comprises a container adapted to be inserted in said pipe string; an insulated electric conductor mounted in said container and having a first portion wound in left-hand coils and a second portion wound in right-hand coils, said conductor being adapted for connection into the electric system; first conductor gripping means for dispensing conductor from the lower end of said container; and second conductor gripping means for dispensing conductor from the upper end of said container, said first and second conductor gripping means being interconnected so that conductor is dispensed from opposite ends of said container at about the same rate.

2. Apparatus as defined in claim **1** wherein said first conductor gripping means includes a member urged into engagement with said conductor at a point below the coiled portions and wherein said second gripping means includes a member urged into engagement with said conductor at a point above the coiled portions, a linkage interconnecting said members whereby actuation of one member to its released position moves the other member to its released position.

3. Apparatus as defined in claim **2** wherein said member of said first gripping means is moved to the released position by tension in said conductor.

4. Apparatus as defined in claim **1** wherein one of said conductor gripping means is operatively responsive to tension in the conductor dispensed from said container.

5. Apparatus for maintaining electric circuit from a subsurface location to the surface which comprises: a container capable of being lowered into the pipe string, an electric conductor section having two coiled portions wound in opposite hands; one of said coiled portions being mounted in an upper section of said container and the other of said coiled portions being mounted in a lower section of said container; means for electrically connecting the upper coiled portion to a terminal above said container; means for connecting the lower coiled portion to a terminal below said container; a lower conductor brake normally positioned to engage said conductor at a point below said coiled portions and being movable to release said conductor; and an upper conductor brake normally positioned to engage said conductor at a point above said coiled portions and being movable to release said conductor, said upper conductor brake being movable to the release position in response to movement of said lower conductor brake.

6. Apparatus as defined in claim **5** and further comprising means for supporting said container on said pipe string.

7. Apparatus for insertion into a pipe string which comprises: a container having upper and lower coiled portions mounted therein, said coiled portions being wound in opposite hands and having upper and lower means for dispensing portions of conductor from opposite ends of said container, said upper and lower dispensing means being interconnected such that conductor is dispensed from opposite ends of said container at about the same rate.

8. Apparatus as defined in claim **5** wherein said container is free to revolve within said pipe string such that as coiled conductor is dispensed from its opposite ends, said container revolves preventing twists from forming in said conductor.

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