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ACCESSIBLE DRUM-REEL FRAME FOR PIPE INSPECTION CAMERA SYSTEM

Abstract

A pipe inspection system includes a cable storage drum and a housing configured to removably receive and rotatably support the cable storage drum. A push-cable with multiple conductors is stored in the drum. An inspection camera may be attached to a distal end of the push-cable. The housing includes an accessible frame outer shell which can be opened to allow access to, and/or replacement of the cable storage drum. The frame has a hinged or otherwise transformably coupled portion that can be opened and closed. At least one latching/locking mechanism is provided to allow the frame to be opened, or closed and latched/locked. The frame accepts different size drum-reels. The frame may be configured to accept a removable bearing ring which mates with the cable storage drum. The frame may include a handle, as well as one or more wheels to allow the cable storage drum to be relocated.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS [0001] This application claims priority under 35 U.S.C. § 119(e) to U.S. Provisional Patent Application Ser. No. 63/625,259, entitled ACCESSIBLE DRUM-REEL FRAME FOR PIPE INSPECTION CAMERA SYSTEM, filed Jan. 25, 2024, and Ser. No. 62/552,522,entitled ACCESSIBLE DRUM-REEL FRAME FOR PIPE INSPECTION CAMERA SYSTEM, filed Feb. 12, 2024, the content of which is incorporated by reference herein in its entirety for all purposes.

FIELD
[0002] This disclosure relates generally to pipe inspection systems employing a camera head connected to the end of a push-cable payed out from a rotatable cable drum. More specifically, but not exclusively, this disclosure relates to a cable storage drum with a removable module for housing electronics and other components, including a battery module interface. The cable storage drum does not require any slip-rings to maintain connectivity between the battery module interface and the electronics. Additionally, an accessible drum-reel frame is provided which allows the cable drum to be easily removed for maintenance, and/or replacement. The drum-reel frame may be configured to accept cable drums of various sizes and shapes.
BACKGROUND
[0003] FIG. **1** illustrates a pipe inspection system including a cable storage drum and a housing configured to removably receive and rotatably support the cable storage drum, as known in the prior art. The cable storage drum typically includes an outer drum-reel for deploying or retracting a push-cable or hose into, or out of, a pipe or conduit to be inspected. A camera head or other inspection equipment may be operatively connected to a distal end of the push-cable.
[0004] The drum-reel is typically free to rotate bidirectionally around an inner hub which is stationary. The hub may be secured to a frame. The hub may be configured to house a power source such as a battery module, and other components, either electrical or mechanical. Electrical connectivity between the cable and the hub components is accomplished via one or more slip-rings which allow connectivity to be maintained even while the cable drum is rotating. Slip-rings do not always provide perfect electrical connectivity, require maintenance, and may be subject to failure.
[0005] Cable storage drums typically have a cable-reel (also known as a drum-reel) and are positioned partially or completely within a protective enclosure or housing. The housing is supported by a frame. The drum-reel is free to spin bidirectionally around a hub which is secured to the frame. Current frame designs do not allow fast and easy access to the cable storage drum, nor are they configured to allow the use of a large range of different cable-drum sizes and shapes.
[0006] Accordingly, the present invention is directed towards addressing the above-described problems and other problems associated with quickly and accurately obtaining and processing accurate utility location data.
SUMMARY
[0007] This disclosure relates generally to pipe inspection systems employing a camera head connected to the end of a push-cable payed out from a rotatable cable drum. More specifically, but not exclusively, this disclosure relates to a cable storage drum with a removable module for housing electronics and other components, including a battery module interface. The cable storage

drum does not require any slip-rings to maintain connectivity between the battery module interface and the electronics.

[0008] In one aspect, the present disclosure relates to a modular drum assembly with an inner core module which mates with a substantially hollow core outer cone removably attachable to a cable storage drum. The inner core module provides a housing for various component interfaces. With multiple component interfaces it provides the ability to quickly swap out batteries, add or remove different electrical and mechanical components, e.g. wireless and satellite positioning components, cable reel counters, sensor components, etc., greatly reduces inspection downtime, and improves the type and quality of captured inspection images and other data.

[0009] In another aspect, a modular drum assembly includes an inner core module which is removably attachable to an outer cone. The inner core module and the outer cone which are shaped to mate and lock together. The outer cone is removably attachable to a cable storage drum. Once attached, the modular drum assembly and the cable storage drum remain stationary relative to each other, thereby allowing both the modular drum assembly and the cable storage drum to rotate bidirectionally around a common hub. Since the cable storage drum and the modular drum assembly move in unison, the electrical and mechanical components inside the inner hub also move at the same time. Since connectivity to any inner hub components is constant, and independent from any rotation of the cable storage drum, the need for any slip-rings to maintain connectivity between components that do not move together is eliminated. This provides more reliable communication of captured images and data, and therefore, a more robust and reliable utility pipe or conduit inspection system. The outer cone may include an aperture for providing front-side access to the inner core module.

[0010] In another aspect, the hollow inner core is configured as a cartridge that can be plugged into the outer cone. When connected together, the inner core mates (makes contact) with a contact plate that is sealed inside the outside cone. The cartridge is hollow with multiple interfaces for connecting to various electrical and mechanical components, including one or both of wireless or satellite positioning modules or components (e.g. WiFi, GPS, GNSS, antennas, receivers, transmitter, transceivers, reel counters, sensors, battery modules and components, etc.).

[0011] On the opposite side of the inner core, the contact plate can be attached to a push-cable. The push-cable includes electrical contacts which may be attached to a camera at the distal end of the push-cable. The camera may be a digital self-leveling camera. Examples of a push-cable and video push cable system configurations are described in the following incorporated United States Patents and Patent applications which may be used in conjunction with the disclosure herein in various embodiments.

[0012] Details of example methods and devices that may be used in or combined with the devices and methods described herein, are disclosed in co-assigned patents and patent applications including: U.S. Pat. No. 5,939,679, issued Aug. 17, 1999, entitled VIDEO PUSH CABLE; U.S. Pat. No. 6,545,704, issued Apr. 8, 1999, entitled VIDEO PIPE INSPECTION DISTANCE MEASURING SYSTEM; U.S. Pat. No. 6,831,679, issued Dec. 14, 2004, entitled VIDEO CAMERA HEAD WITH THERMAL FEEDBACK LIGHTING CONTROL; U.S. Pat. No. 6,862,945, issued Mar. 8, 2005, entitled CAMERA GUIDE FOR VIDEO PIPE INSPECTION SYSTEM; U.S. Pat. No. 6,958,767, issued Oct. 25, 2005, entitled VIDEO PIPE INSPECTION SYSTEM EMPLOYING NON-ROTATING CABLE STORAGE DRUM; U.S. patent application Ser. No. 12/704,808, filed Feb. 13, 2009, entitled PIPE INSPECTION SYSTEM WITH REPLACEABLE CABLE STORAGE DRUM; U.S. patent application Ser. No. 13/647,310, filed Feb. 13, 2009, entitled PIPE INSPECTION SYSTEM APPARATUS AND METHOD; U.S. patent application Ser. No. 13/346,668, filed Jan. 9, 2012, entitled PORTABLE CAMERA CONTROLLER PLATFORM FOR USE WITH PIPE INSPECTION SYSTEM; U.S. patent application Ser. No. 14/749,545, filed Jan. 30, 2012, entitled ADJUSTABLE VARIABLE RESOLUTION

[0013] INSPECTION SYSTEMS AND METHODS; U.S. Pat. No. 8,289,385, issued Oct. 16, 2012, entitled PUSH-CABLE FOR PIPE INSPECTION SYSTEM; U.S. Pat. No. 8,395,661, issued Mar. 12, 2013, entitled PIPE INSPECTION SYSTEM WITH SELECTIVE IMAGE CAPTURE; U.S. patent application Ser. No. 13/826,112, filed March 14 2013, entitled SYSTEMS AND METHODS INVOLVING A SMART CABLE STORAGE DRUM AND NETWORK NODE FOR TRANSMISSION OF DATA; U.S. patent application Ser. No. 14/033,349, filed Sep. 20, 2013, entitled PIPE INSPECTION SYSTEM WITH SNAP-ON PIPE GUIDES; U.S. Pat. No. 8,540,429, issued Sep. 24, 2013, entitled SNAP ON PIPE GUIDE; U.S. Pat. No. 8,587,648, issued Nov. 19, 2013, entitled SELF-LEVELING CAMERA HEAD; U.S. patent application Ser. No. 14/136,104, filed Dec. 20, 2013, entitled ROTATING CONTACT ASSEMBLIES FOR SELF-LEVELING CAMERA HEADS; U.S. patent application Ser. No. 14/203,485, filed Mar. 10, 2014, entitled PIPE INSPECTION CABLE COUNTER AND OVERLAY MANAGEMENT SYSTEM; U.S. patent application Ser. No. 14/207,527, filed Mar. 12, 2014, entitled ROTATING CONTACT ASSEMBLIES FOR SELF-LEVELING CAMERA HEADS; U.S. patent application Ser. No. 14/216,358, filed Mar. 17, 2014, entitled SMART CABLE STORAGE DRUM AND NETWORK NODE SYSTEM AND METHODS; U.S. patent application Ser. No. 14/557,163, filed Dec. 1, 2014, entitled ASYMMETRIC DRAG FORCE BEARINGS; U.S. Pat. No. 8,908,027, issued Dec. 9, 2014, entitled ASYMMETRIC DRAG FORCE BEARING FOR USE WITH PUSH-CABLE STORAGE DRUM; U.S. Pat. No. 8,970,211, issued Mar. 3, 2015, entitled PIPE INSPECTION CABLE COUNTER AND OVERLAY MANAGEMENT SYSTEM; U.S. patent application Ser. No. 14/642,596, filed Mar. 9, 2015, entitled PIPE CLEARING CABLES AND APPARATUS; U.S. Pat. No. 8,984,698, issued Mar. 24, 2015, entitled LIGHT WEIGHT SEWER CABLE; U.S. patent application Ser. No. 14/746,590, filed Jun. 22, 2015, entitled THERMAL EXTRACTION ARCHITECTURES FOR CAMERA AND LIGHTING DEVICES; U.S. Pat. No. 9,066,446, issued Jun. 23, 2015, entitled THERMAL EXTRACTION ARCHITECTURE FOR CAMERA HEADS, INSPECTION SYSTEMS, AND OTHER DEVICES AND SYSTEMS; U.S. Pat. No. 9,080,992, issued Jul. 14, 2015, entitled ADJUSTABLE VARIABLE RESOLUTION INSPECTION SYSTEMS AND METHODS; U.S. Pat. No. 9,134,255, issued Sep. 15, 2015, entitled PIPE INSPECTION SYSTEM WITH SELECTIVE CAPTURE; U.S. patent application Ser. No. 14/935,878, filed Nov. 9, 2015, entitled INSPECTION CAMERA DEVICES AND METHODS WITH SELECTIVELY ILLUMINATED MULTISENSOR IMAGING; U.S. patent application Ser. No. 14/970,362, filed Dec. 15, 2014, entitled COAXIAL VIDEO PUSH-CABLES FOR USE IN INSPECTION SYSTEMS; U.S. Pat. No. 9,222,809, issued Dec. 29, 2015, entitled PORTABLE PIPE INSPECTION SYSTEMS AND APPARATUS; U.S. patent application Ser. No. 15/050,267, filed Feb. 22, 2016, entitled SELF-LEVELING CAMERA HEADS; U.S. Pat. No. 9,277,105, issued Mar. 1, 2016, entitled SELF-LEVELING CAMERA HEADS; U.S. patent application Ser. No. 15/264,355, filed Sep. 13, 2016, entitled HIGH BANDWIDTH VIDEO PUSH-CABLES FOR PIPE INSPECTION SYSTEMS; U.S. Pat. No. 9,448,376, issued Sep. 20, 2016, entitled HIGH BANDWIDTH PUSH-CABLES FOR VIDEO PIPE INSPECTION SYSTEMS; U.S. Pat. No. 9,468,954, issued Oct. 18, 2016, entitled PIPE INSPECTION SYSTEM WITH JETTER PUSH-CABLE; U.S. Pat. No. 9,477,147, issued Oct. 25, 2016, entitled SPRING ASSEMBLIES WITH VARIABLE FLEXIBILITY FOR USE WITH PUSH-CABLES AND PIPE INSPECTION SYSTEMS; U.S. patent application Ser. No. 15/369,693, filed Dec. 5, 2016, entitled CABLE STORAGE DRUM WITH MOVEABLE CCU DOCKING APPARATUS; U.S. Pat. No. 9,521,303, issued Dec. 13, 2016, entitled CABLE STORAGE DRUM MOVABLE CCU DOCKING APPARATUS; U.S. patent application Ser. No. 15/425,785, filed Feb. 6, 2017, entitled METHOD AND APPARATUS FOR HIGH-SPEED DATA TRANSFER EMPLOYING SELF-SYNCHRONIZING QUADRATURE AMPLITUDE MODULATION; U.S. Pat. No. 9,571,326, issued Feb. 14, 2017, entitled METHOD AND APPARATUS FOR HIGH-SPEED DATA TRANSFER EMPLOYING SELF-SYNCHRONIZING QUADRATURE AMPLITUDE

MODULATION; U.S. patent application Ser. No. 15/483,924, filed Apr. 10, 2017, entitled SYSTEMS AND METHODS FOR DATA TRANSFER USING SELF-SYNCHRONIZING QUADRATURE AMPLITUDE MODULATION; U.S. Pat. No. 9,625,602, issued Apr. 18, 2017, entitled SMART PERSONAL COMMUNICATION DEVICES AS USER INTERFACES; U.S. Pat. No. 9,634,878, issued Apr. 25, 2017, entitled SYSTEMS AND METHODS FOR DATA TRANSFER USING SELF-SYNCHRONIZING QUADRATURE AMPLITUDE MODULATION; U.S. patent application Ser. No. 15/590,964, filed May 9, 2017, entitled BORING INSPECTION SYSTEMS AND METHODS; U.S. Pat. No. 9,651,711, issued May 16, 2017, entitled HORIZONTAL BORING INSPECTION DEVICE AND METHODS; U.S. patent application Ser. No. 15/670,845, filed Aug. 7, 2017, entitled HIGH FREQUENCY AC-POWERED DRAIN CLEANING AND INSPECTION APPARATUS AND METHODS; U.S. patent application Ser. No. 15/701,247, filed Sep. 11, 2017, entitled PIPE INSPECTION SYSTEMS WITH SELF-GROUNDING PORTABLE CAMERA CONTROLLERS; U.S. Pat. No. 9,769,366, issued Sep. 19, 2017, entitled ELF-GROUNDING TRANSMITTING PORTABLE CAMERA CONTROLLER FOR USE WITH PIPE INSPECTION SYSTEMS; U.S. Pat. No. 9,791,382, issued Oct. 17, 2017, entitled PIPE INSPECTION SYSTEM WITH JETTER PUSH-CABLE; U.S. patent application Ser. No. 15/728,410, filed Oct. 9, 2017, entitled PIPE INSPECTION SYSTEM WITH JETTER PUSH-CABLE; U.S. patent application Ser. No. 15/805,007, filed Nov. 6, 2017, entitled PIPE INSPECTION SYSTEM CAMERA HEADS; U.S. patent application Ser. No. 15/806,219, filed Nov. 7, 2017, entitled MULTI-CAMERA PIPE INSPECTION APPARATUS, SYSTEMS AND METHODS; U.S. patent application Ser. No. 15/811,264, filed Nov. 13, 2017, entitled SPRING ASSEMBLIES WITH VARIABLE FLEXIBILITY FOR USE WITH PUSH-CABLES AND PIPE INSPECTION SYSTEMS; U.S. Pat. No. 9,824,433, issued Nov. 21, 2017, entitled PIPE INSPECTION SYSTEM CAMERA HEADS; U.S. Pat. No. 9,829,783, issued Nov. 28, 2017, entitled SPRING ASSEMBLIES WITH VARIABLE FLEXIBILITY FOR USE WITH PUSH-CABLES AND PIPE INSPECTION SYSTEMS; U.S. Pat. No. 9,835,564, issued Dec. 5, 2017, entitled MULTI-CAMERA PIPE INSPECTION APPARATUS, SYSTEMS, AND METHODS; U.S. patent application Ser. No. 15/919,077, filed Mar. 27, 2018, entitled PORTABLE PIPE INSPECTION SYSTEMS AND METHODS; U.S. Pat. No. 9,914,157, issued Mar. 13, 2018, entitled METHODS AND APPARATUS FOR CLEARING OBSTRUCTIONS WITH A JETTER PUSH-CABLE APPARATUS; U.S. patent application Ser. No. 15/922,703, filed Mar. 15, 2018, entitled SELF-LEVELING INSPECTION SYSTEMS AND METHODS; U.S. Pat. No. 9,924,139, issued Mar. 20, 2018, entitled PORTABLE PIPE INSPECTION SYSTEMS AND APPARATUS; U.S. Pat. No. 9,927,368, issued Mar. 27, 2018, entitled SELF-LEVELING INSPECTION SYSTEMS AND METHODS; U.S. Provisional Patent Application 62/686,589, filed Jun. 18, 2018, entitled MULTI-DIELECTRIC COAXIAL PUSH-CABLES; U.S. Provisional Patent Application 62/726,500, filed Sep. 4, 2018, entitled VIDEO PIPE INSPECTION SYSTEMS, DEVICES, AND METHODS INTEGRATED WITH NON-VIDEO DATA RECORDING AND COMMUNICATION FUNCTIONALITY; U.S. Provisional Patent Application 62/756,538, filed Nov. 6, 2018, entitled ROBUST AND LOW COST IMPEDANCE CONTROLLED SLIP RINGS; U.S. Provisional Patent Application 62/768,760, filed Nov. 16, 2018, entitled PIPE INSPECTION AND/OR MAPPING CAMERA HEADS, SYSTEMS, AND METHODS; U.S. Provisional Patent Application 62/794,863, filed Jan. 21, 2019, entitled HEAT EXTRACTION ARCHITECTURE FOR COMPACT VIDEO HEADS; U.S. patent application Ser. No. 16/443,789, filed Jun. 17, 2019, entitled MULTI-DIELECTRIC COAXIAL PUSH-CABLES AND ASSOCIATED APPARATUS; U.S. Pat. No. 10,356,360, issued Jul. 16, 2019, entitled HIGH BANDWIDTH VIDEO PUSH-CABLE FOR PIPE INSPECTION SYSTEMS; U.S. Pat. No. 10,359,368, issued Jul. 23, 2019, entitled PIPE INSPECTION SYSTEM WITH JETTER PUSH-CABLE; U.S. Pat. No. 10,379,436, issued Aug. 13, 2019, entitled SPRING ASSEMBLIES WITH VARIABLE FLEXIBILIY FOR USE WITH PUSH-CABLES AND PIPE INSPECTION SYSTEMS; U.S. Pat.

No. 10,440,332, issued Oct. 8, 2019, entitled INSPECTION CAMERA DEVICES AND METHODS WITH SELECTIVELY ILLUMINATED MULTISENSOR IMAGINING; U.S. Pat. No. 10,527,402, issued Jan. 7, 2020, entitled PIPE INSPECTION SYSTEM CABLE COUNTER AND OVERLAY MANAGEMENT SYSTEM; U.S. Pat. No. 10,585,012, issued Mar. 10, 2020, entitled PORTABLE CAMERA CONTROLLER FOR USE WITH PIPE INSPECTION SYSTEMS; U.S. Pat. No. 10,613,034, issued Apr. 7, 2020, entitled SELF-LEVELING INSPECTION SYSTEMS AND METHODS; U.S. Pat. No. 10,715,703, issued Jul. 14, 2020, entitled SELF-LEVELING CAMERA HEADS; U.S. Pat. No. 10,761,233, issued Sep. 1, 2020, entitled SONDES AND METHODS FOR USE WITH BURIED LINE LOCATOR SYSTEMS; U.S. Pat. No. 10,764,541, issued Sep. 1, 2020, entitled COAXIAL VIDEO PUSH-CABLES FOR USE IN INSPECTION SYSTEMS; U.S. patent application Ser. No. 17/087,554, filed Nov. 2, 2020, entitled PORTABLE PIPE INSPECTION SYSTEMS AND METHODS; U.S. Pat. No. 10,834,364, issued Nov. 10, 2020, entitled PORTABLE PIPE INSPECTION SYSTEMS AND METHODS; U.S. Pat. No. 10,841,144, issued Nov. 17, 2020, entitled SYSTEM AND METHODS FOR DATA TRANSFER USING SELF-SYNCHRONIZING QUADRATURE AMPLITUFE MODULATION (QAM); U.S. Pat. No. 10,855,950, issued Dec. 1, 2020, entitled HIGH BANDWIDTH VIDEO PUSH-CABLES FOR PIPE INSPECTION SYSTEMS; U.S. Pat. No. 10,863,064, issued Dec. 8, 2020, entitled CABLE STORAGE DRUM WITH MOVEABLE CCU DOCKING APPARATUS; U.S. Pat. No. 10,907,690, issued Feb. 2, 2021, entitled PIPE INSPECTION SYSTEMS WITH ASSYMETRIC DRAG FORCE BEARINGS; U.S. Pat. No. 10,921,263, issued Feb. 16, 2021, entitled PIPE INSPECTION SYSTEM WITH JETTER PUSH-CABLE; U.S. patent application Ser. No. 17/182,113, filed Feb. 22, 2021, entitled VIDEO PIPE INSPECTION SYSTEMS; U.S. patent application Ser. No. 17/202,128, filed Mar. 15, 2021, entitled BORING INSPECTION SYSTEMS AND METHODS; U.S. Pat. No. 10,955,583, issued Mar. 23, 2021, entitled BORING INSPECTION SYSTEMS AND METHODS; U.S. Pat. No. 10,976,462, issued Apr. 13, 2021, entitled VIDEO INSPECTION SYSTEMS WITH PERSONAL COMMUNICATION DEVICE USER INTERFACES; U.S. Pat. No. 10,992,849, issued Apr. 27, 2021, entitled PIPE INSPECTION SYSTEMS WITH SELF-GROUNDING PORTABLE CAMERA CONTROLLERS; U.S. Pat. No. 11,016,381, issued May 25, 2021, entitled SPRING ASSEMBLIES WITH VARIABLE FLEXIBLE FOR USE WITH PUSH-CABLES AND PIPE INSPECTION SYSTEMS; U.S. patent application Ser. No. 17/397,940, filed Aug. 9, 2021, entitled INSPECTION SYSTEM PUSH-CABLE GUIDE APPARATUS; U.S. Pat. No. 11,088,890, issued Aug. 10, 2021, entitled VIDEO INSPECTION SYSTEMS AND METHODS USING SELF-SYNCHRONIZING QAM; U.S. Pat. No. 11,132,781, issued Sep. 28, 2021, entitled PIPE INSPECTION SYSTEM CAMERA HEADS; U.S. patent application Ser. No. 17/528,155, filed Nov. 16, 2021, entitled PORTABLE CAMERA CONTROLLER PLATFORM FPR USE WITH PIPE INSPECTION SYSTEMS; U.S. Pat. No. 11,178,317, issued Nov. 16, 2021, entitled HEAT EXTRACTION APPARATUS; U.S. patent application Ser. No. 17/528,956, filed Nov. 17, 2021, entitled VIDEO INSPECTION SYSTEM APPARATUS AND METHODS WITH RELAY MODULES AND CONNECTION PORTS; U.S. patent application Ser. No. 17/531,533, filed Nov. 19, 2021, entitled INPUT MULTIPLEXED SIGNAL PROCESSING APPARATUS AND METHODS; U.S. patent application Ser. No. 17/532,938, filed Nov. 22, 2021, entitled PIPE INSPECTION AND/OR MAPPING CAMERA HEADS, SYSTEMS, AND METHODS; U.S. Pat. No. 11,187,822, issued Nov. 30, 2021, entitled SONDE DEVICES INCLUDING SECTIONAL FERRITE CORE STRUCTURE; U.S. Pat. No. 11,187,971, issued Nov. 30, 2021, entitled ROTATING CONTACT ASSEMBLIES FOR SELF-LEVELING CAMERA HEADS; U.S. Pat. No. 11,199,510, issued Dec. 14, 2021, entitled PIPE INSPECTION AND CLEANING APPARATUS AND SYSTEMS; U.S. Pat. No. 11,209,115, issued Dec. 28, 2021, entitled PIPE INSPECTION AND/OR MAPPING CAMERA HEADS, SYSTEMS, AND METHODS; U.S. Pat. No. 11,209,334, issued Dec. 28, 2021, entitled PORTABLE CAMERA CONTROLLER

PLATFORM FOR USE WITH PIPE INSPECTION SYSTEMS; U.S. Pat. No. 11,300,700, issued Apr. 12, 2022, entitled SYSTEM AND METHODS OF USING A SONDE DEVICE WITH A SECTIONAL FERRITE CORE STRUCTURE; U.S. patent application Ser. No. 17/868,709, filed Jul. 19, 2022, entitled INSPECTION CAMERA DEVICES AND METHODS; U.S. patent application Ser. No. 17/815,387, filed Jul. 27, 2022, entitled INWARD SLOPED DRUM FACE FOR PIPE INSPECTION CAMERA SYSTEM; U.S. Pat. No. 11,402,337, issued Aug. 2, 2022, entitled VIDEO PIPE INSPECTION SYSTEMS WITH VIDEO INTEGRATED WITH ADDITIONAL SENSOR DATA; U.S. Pat. No. 11,418,761, issued Aug. 16, 2022, entitled INSPECTION CAMERA DEVICES AND METHODS WITH SELECTIVELY ILLUMINATED MULTISENSOR IMAGING; U.S. Pat. No. 11,448,600, issued Sep. 20, 2022, entitled MULTI-CAMERA PIPE INSPECTION APPARATUS, SYSTEMS, AND METHODS; U.S. patent application Ser. No. 17/993,784, filed Nov. 23, 2022, entitled VIDEO PIPE INSPECTION SYSTEMS; U.S. Pat. No. 11,528,401, issued Dec. 13, 2022, entitled PIPE INSPECTION SYSTEMS WITH SELF-GROUNDING PORTABLE CAMERA CONTROLLERS; U.S. patent application Ser. No. 18/091,079, filed Dec. 29, 2022, entitled VIDEO INSPECTION SYSTEMS WITH WIRELESS ENABLED DRUM; U.S. patent application Ser. No. 18/148,850, filed Dec. 30, 2022, entitled SPRING ASSEMBLIES WITH VARIABLE FLEXIBILITY FOR USE WITH PUSH-CABLES AND PIPE INSPECTION SYSTEMS; U.S. Pat. No. 11,550,214, issued Jan. 10, 2023, entitled SPRING ASSEMBLIES WITH VARIABLE FLEXIBLE FOR USE WITH PUSH-CABLES AND PIPE INSPECTION SYSTEMS; U.S. Pat. No. 11,558,537, issued Jan. 17, 2023, entitled VIDEO INSPECTION SYSTEM WITH WIRELESS ENABLED CABLE STORAGE DRUM; U.S. patent application Ser. No. 18/121,547, filed Mar. 14, 2023, entitled DOCKABLE CAMERA REEL AND CAMERA CONTROL UNIT (CCU) SYSTEM; U.S. patent application Ser. No. 18/121,562, filed Mar. 14, 2023, entitled PIPE INSPECTION AND CLEANING APPARATUS AND SYSTEMS; U.S. Provisional Patent Application 63/492,473, filed Mar. 27, 2023, entitled VIDEO INSPECTION AND CAMERA HEAD TRACKING SYSTEMS AND METHODS; U.S. Pat. No. 11,614,412, issued Mar. 28, 2023, entitled PIPE INSPECTION SYSTEMS WITH JETTER PUSH-CABLE; U.S. Pat. No. 11,614,613, issued Mar. 28, 2023, entitled DOCKABLE CAMERA REEL AND CCU SYSTEM; U.S. patent application Ser. No. 18/130,341, filed Apr. 3, 2023, entitled VIDEO PUSH-CABLES FOR PIPE INSPECTION SYSTEMS; U.S. Pat. No. 11,621,099, issued Apr. 4, 2023, entitled COAXIAL VIDEO PUSH-CABLES FOR USE IN INSPECTION SYSTEMS; U.S. patent application Ser. No. 18/135,661, filed Apr. 17, 2023, entitled VIDEO PIPE INSPECTION SYSTEMS AND METHODS WITH SENSOR DATA; U.S. patent application Ser. No. 18/140,488, filed Apr. 27, 2023, entitled INTEGRATED FLEX-SHAFT CAMERA SYSTEM; U.S. Pat. No. 11,639,990, issued May 2, 2023, entitled VIDEO PIPE INSPECTION SYSTEMS WITH VIDEO INTEGRATED WITH ADDITIONAL SENSOR DATA; U.S. Pat. No. 11,649,917, issued May 16, 2023, entitled INTEGRATED FLEX-SHAFT CAMERA SYSTEM WITH HAND CONTROL; U.S. patent application Ser. No. 18/203,029, filed May 29, 2023, entitled SELF-LEVELING INSPECTION SYSTEMS AND METHODS; U.S. Pat. No. 11,665,321, issued May 30, 2023, entitled PIPE INSPECTION SYSTEM WITH REPLACEABLE CABLE STORAGE DRUM; U.S. patent application Ser. No. 18/207,898, filed Jun. 9, 2023, entitled SONDE DEVICES WITH A SECTIONAL CORE; U.S. Pat. No. 11,674,906, issued Jun. 13, 2023, entitled SELF-LEVELING INSPECTION SYSTEMS AND METHODS; U.S. Provisional Patent Application 63/510,014, filed Jun. 23, 2023, entitled INNER DRUM MODULE WITH PUSH-CABLE INTERFACE FOR PIPE INSPECTION; U.S. Pat. No. 11,709,289, issued Jul. 25, 2023, entitled SONDE DEVICES WITH A SECTIONAL FERRITE CORE; U.S. patent application Ser. No. 18/365,225, filed Aug. 3, 2023, entitled SYSTEMS AND METHODS FOR INSPECTION ANIMATION; U.S. Pat. No. 11,719,376, issued Aug. 8, 2023, entitled DOCKABLE TRIPODAL CAMERA CONTROL UNIT; U.S. patent application Ser. No. 18/490,763, filed Oct. 20, 2023, entitled LINKED CABLE-

HANDLING AND CABLE-STORAGE DRUM DEVICES AND SYSTEMS FOR THE COORDINATED MOVEMENT OF A PUSH-CABLE; U.S. Provisional Patent Application 63/599,890, filed Nov. 16, 2023, entitled VIDEO INSPECTION AND CAMERA HEAD TRACKING SYSTEMS AND METHODS; U.S. patent application Ser. No. 18/528,773, filed Dec. 4, 2023, entitled PIPE INSPECTION SYSTEM CAMERA HEAD; U.S. Pat. No. 11,842,474, issued Dec. 12, 2023, entitled PIPE INSPECTION SYSTEM CAMERA HEADS; U.S. patent application Ser. No. 18/539,265, filed Dec. 14, 2023, entitled INTEGRAL DUAL CLEANER DRUM SYSTEMS AND METHODS; U.S. patent application Ser. No. 18/539,268, filed Dec. 14, 2023, entitled HIGH FREQUENCY AC-POWERED DRAIN CLEANING AND INSPECTION APPARATUS AND METHODS; U.S. Pat. No. 11,846,095, issued Dec. 19, 2023, entitled HIGH FREQUENCY AC-POWERED DRAIN CLEANING AND INSPECTION APPARATUS & METHODS; U.S. Pat. No. 11,859,755, issued Jan. 2, 2024, entitled INTEGRAL DUAL CLEANER CAMERA DRUM SYSTEMS AND METHODS; U.S. patent application Ser. No. 18/412,452, filed Jan. 12, 2024, entitled MULTI-CAMERA APPARATUS FOR WIDE ANGLE PIPE INTERNAL INSPECTION; U.S. patent application Ser. No. 18/414,785, filed Jan. 17, 2024, entitled SONDE DEVICES; U.S. Pat. No. 11,879,852, issued Jan. 23, 2024, entitled MULTI-CAMERA APPARATUS FOR WIDE ANGLE PIPE INTERNAL INSPECTION; and U.S. Pat. No. 11,880,005, issued Jan. 23, 2024, entitled SONDE DEVICES INCLUDING A SECTIONAL FERRITE CORE STRUCTURE. The content of each of these applications is incorporated by reference herein in its entirety.

[0014] In one aspect, the inner core module includes a plurality of component interfaces for electrical or mechanical components, or both. A battery module interface provides connectivity for multiple battery types and brands. The battery module interface may be replaced with other battery module interfaces to provide additional connectivity to additional battery sizes and types.

[0015] In another aspect, the interface between the cable storage drum and the outer cone is a rotation module. The rotation module may include various bearing configurations. As an example, the rotation module may include a set of front bearings, and a set of rear bearings. The rear bearings may be physically larger that the set of front bearings in order to provide removable access of the battery interface module. The set of front bearings and set of rear bearings may be partially enclosed by a clamshell assembly housing including a first half clamshell enclosure and a second half clamshell enclosure which are removably attachable to each other.

[0016] In another aspect, the inner core module may include a wireless transmit antenna positioned relatively front and center along the rotation axis of the cable storage drum all the way forward to roughly the lane of the small bearing set front side where the camera exits.

[0017] In another aspect, the cable storage drum may include various accessories. For instance, one or more cable guides, including a cable locking mechanism, may be provided. The cable guides may include wheels removed.

[0018] In another aspect, the inner core hub may be cone shaped. The inner core hub may include space, as well as interface connections for various electronics including but not limited to wireless communication electronics, cable counters, GNSS and other types of satellite positioning electronics (e.g. transmitters, receivers, transceivers, antennas, etc.), power electronics including a battery module interface, and image processing electronics including various types of processors, and memory. One skilled in the art would recognize that other electrical and mechanical systems and components related to utility camera inspection and/or communications could also be located inside the inner core hub.

[0019] In another aspect, a frame is provided for supporting a cable storage drum. The frame is configured to open and close quickly and efficiently thereby allowing the cable drum to be easily accessed for maintenance or replacement. The frame connects to the drum-reel hub, thereby, allowing the drum-reel to bidirectionally rotate around the hub.

[0020] In another aspect, the frame includes a latching system to facilitate opening and closing of

the frame, and to secure (latch or lock) the cable storage drum within the frame.
[0021] In another aspect, the frame is configured to accept cable drums of various sizes and shapes. The frame may include a bearing system to facilitate rotation of the hub within the frame. The bearing system may include a removable bearing ring positioned within a bearing holder which is attached to the frame.
[0022] In another aspect, one or more cable guides may me provided. The cable guides may be attached to the frame, the drum-reel, or both. The cable guides may be stationary, or configured to be removable.
[0023] In another aspect, one or more handles may be provided. For instance, a push/pull handle may be provided, and may include a locking mechanism to allow the push/pull handle to be placed in multiple positions, and locked in place for conveniently pushing or pulling the drum-reel frame assembly via one or more wheels which may be provided, with or without a cable storage drum installed in the frame assembly.
[0024] In another aspect, a hinged or otherwise transformably coupled front frame portion may be provided to allow access to the inside of the frame for installing or removing a cable storage drum. Wheels may be provided for easily moving the frame with or without a cable storage drum installed, and may be positioned on the opposite side of a frame hinge or hinge point.
[0025] In another aspect, a latch or locking mechanism may be provided to allow the frame to be easily opened and closed. The latching or locking mechanism may be positioned on either side of the frame with respect to the hinge point.
[0026] In another aspect, a lift/carry handle may be provided for conveniently lifting and/or carrying the frame assembly, with or without a cable storage drum installed in the frame assembly. The lift/carry handle may include a handle locking mechanism which allows the lift/carry handle to be locked into a substantially upright position when in use, or folded down, and locked into place for storage when not needed.
[0027] Various additional aspects, features, and functions are described below in conjunction with the Drawings.
[0028] Details of example devices, systems, and methods that may be combined with the embodiments disclosed herein, as well as additional components, methods, and configurations that may be used in conjunction with the embodiments described herein, are disclosed in co-assigned patents and patent applications including: U.S. Pat. No. 5,939,679, issued Aug. 17, 1999, entitled VIDEO PUSH CABLE; U.S. Pat. No. 6,545,704, issued Apr. 8, 1999, entitled VIDEO PIPE INSPECTION DISTANCE MEASURING SYSTEM; U.S. Pat. No. 6,831,679, issued Dec. 14, 2004, entitled VIDEO CAMERA HEAD WITH THERMAL FEEDBACK LIGHTING CONTROL; U.S. Pat. No. 6,862,945, issued Mar. 8, 2005, entitled CAMERA GUIDE FOR VIDEO PIPE INSPECTION SYSTEM; U.S. Pat. No. 6,958,767, issued Oct. 25, 2005, entitled VIDEO PIPE INSPECTION SYSTEM EMPLOYING NON-ROTATING CABLE STORAGE DRUM; U.S. patent application Ser. No. 12/704,808, filed Feb. 13, 2009, entitled PIPE INSPECTION SYSTEM WITH REPLACEABLE CABLE STORAGE DRUM; U.S. patent application Ser. No. 13/647,310, filed Feb. 13, 2009, entitled PIPE INSPECTION SYSTEM APPARATUS AND METHOD; U.S. patent application Ser. No. 13/346,668, filed Jan. 9, 2012, entitled PORTABLE CAMERA CONTROLLER PLATFORM FOR USE WITH PIPE INSPECTION SYSTEM; U.S. patent application Ser. No. 14/749,545, filed Jan. 30, 2012, entitled ADJUSTABLE VARIABLE RESOLUTION INSPECTION SYSTEMS AND METHODS; U.S. Pat. No. 8,289,385, issued Oct. 16, 2012, entitled PUSH-CABLE FOR PIPE INSPECTION SYSTEM; U.S. Pat. No. 8,395,661, issued Mar. 12, 2013, entitled PIPE INSPECTION SYSTEM WITH SELECTIVE IMAGE CAPTURE; U.S. patent application Ser. No. 13/826,112, filed Mar. 14, 2013, entitled SYSTEMS AND METHODS INVOLVING A SMART CABLE STORAGE DRUM AND NETWORK NODE FOR TRANSMISSION OF DATA; U.S. patent application Ser. No. 14/033,349, filed Sep. 20, 2013, entitled PIPE INSPECTION SYSTEM WITH SNAP-ON

PIPE GUIDES; U.S. Pat. No. 8,540,429, issued Sep. 24, 2013, entitled SNAP ON PIPE GUIDE; U.S. Pat. No. 8,587,648, issued Nov. 19, 2013, entitled SELF-LEVELING CAMERA HEAD; U.S. patent application Ser. No. 14/136,104, filed Dec. 20, 2013, entitled ROTATING CONTACT ASSEMBLIES FOR SELF-LEVELING CAMERA HEADS; U.S. patent application Ser. No. 14/203,485, filed Mar. 10, 2014, entitled PIPE INSPECTION CABLE COUNTER AND OVERLAY MANAGEMENT SYSTEM; U.S. patent application Ser. No. 14/207,527, filed Mar. 12, 2014, entitled ROTATING CONTACT ASSEMBLIES FOR SELF-LEVELING CAMERA HEADS; U.S. patent application Ser. No. 14/216,358, filed Mar. 17, 2014, entitled SMART CABLE STORAGE DRUM AND NETWORK NODE SYSTEM AND METHODS; U.S. patent application Ser. No. 14/557,163, filed Dec. 1, 2014, entitled ASYMMETRIC DRAG FORCE BEARINGS; U.S. Pat. No. 8,908,027, issued Dec. 9, 2014, entitled ASYMMETRIC DRAG FORCE BEARING FOR USE WITH PUSH-CABLE STORAGE DRUM; U.S. Pat. No. 8,970,211, issued Mar. 3, 2015, entitled PIPE INSPECTION CABLE COUNTER AND OVERLAY MANAGEMENT SYSTEM; U.S. patent application Ser. No. 14/642,596, filed Mar. 9, 2015, entitled PIPE CLEARING CABLES AND APPARATUS; U.S. Pat. No. 8,984,698, issued Mar. 24, 2015, entitled LIGHT WEIGHT SEWER CABLE; U.S. patent application Ser. No. 14/746,590, filed Jun. 22, 2015, entitled THERMAL EXTRACTION ARCHITECTURES FOR CAMERA AND LIGHTING DEVICES; U.S. Pat. No. 9,066,446, issued Jun. 23, 2015, entitled THERMAL EXTRACTION ARCHITECTURE FOR CAMERA HEADS, INSPECTION SYSTEMS, AND OTHER DEVICES AND SYSTEMS; U.S. Pat. No. 9,080,992, issued Jul. 14, 2015, entitled ADJUSTABLE VARIABLE RESOLUTION INSPECTION SYSTEMS AND METHODS; U.S. Pat. No. 9,134,255, issued Sep. 15, 2015, entitled PIPE INSPECTION SYSTEM WITH SELECTIVE CAPTURE; U.S. patent application Ser. No. 14/935,878, filed Nov. 9, 2015, entitled INSPECTION CAMERA DEVICES AND

[0029] METHODS WITH SELECTIVELY ILLUMINATED MULTISENSOR IMAGING; U.S. patent application Ser. No. 14/970,362, filed Dec. 15, 2014, entitled COAXIAL VIDEO PUSH-CABLES FOR USE IN INSPECTION SYSTEMS; U.S. Pat. No. 9,222,809, issued Dec. 29, 2015, entitled PORTABLE PIPE INSPECTION SYSTEMS AND APPARATUS; U.S. patent application Ser. No. 15/050,267, filed Feb. 22, 2016, entitled SELF-LEVELING CAMERA HEADS; U.S. Pat. No. 9,277,105, issued Mar. 1, 2016, entitled SELF-LEVELING CAMERA HEADS; U.S. patent application Ser. No. 15/264,355, filed Sep. 13, 2016, entitled HIGH BANDWIDTH VIDEO PUSH-CABLES FOR PIPE INSPECTION SYSTEMS; U.S. Pat. No. 9,448,376, issued Sep. 20, 2016, entitled HIGH BANDWIDTH PUSH-CABLES FOR VIDEO PIPE INSPECTION SYSTEMS; U.S. Pat. No. 9,468,954, issued Oct. 18, 2016, entitled PIPE INSPECTION SYSTEM WITH JETTER PUSH-CABLE; U.S. Pat. No. 9,477,147, issued Oct. 25, 2016, entitled SPRING ASSEMBLIES WITH VARIABLE FLEXIBILITY FOR USE WITH PUSH-CABLES AND PIPE INSPECTION SYSTEMS; U.S. patent application Ser. No. 15/369,693, filed Dec. 5, 2016, entitled CABLE STORAGE DRUM WITH MOVEABLE CCU DOCKING APPARATUS; U.S. Pat. No. 9,521,303, issued Dec. 13, 2016, entitled CABLE STORAGE DRUM MOVABLE CCU DOCKING APPARATUS; U.S. patent application Ser. No. 15/425,785, filed Feb. 6, 2017, entitled METHOD AND APPARATUS FOR HIGH-SPEED DATA TRANSFER EMPLOYING SELF-SYNCHRONIZING QUADRATURE AMPLITUDE MODULATION; U.S. Pat. No. 9,571,326, issued Feb. 14, 2017, entitled METHOD AND APPARATUS FOR HIGH-SPEED DATA TRANSFER EMPLOYING SELF-SYNCHRONIZING QUADRATURE AMPLITUDE MODULATION; U.S. patent application Ser. No. 15/483,924, filed Apr. 10, 2017, entitled SYSTEMS AND METHODS FOR DATA TRANSFER USING SELF-SYNCHRONIZING QUADRATURE AMPLITUDE MODULATION; U.S. Pat. No. 9,625,602, issued Apr. 18, 2017, entitled SMART PERSONAL COMMUNICATION DEVICES AS USER INTERFACES; U.S. Pat. No. 9,634,878, issued Apr. 25, 2017, entitled SYSTEMS AND METHODS FOR DATA TRANSFER USING SELF-SYNCHRONIZING QUADRATURE AMPLITUDE MODULATION;

U.S. patent application Ser. No. 15/590,964, filed May 9, 2017, entitled BORING INSPECTION SYSTEMS AND METHODS; U.S. Pat. No. 9,651,711, issued May 16, 2017, entitled HORIZONTAL BORING INSPECTION DEVICE AND METHODS; U.S. patent application Ser. No. 15/670,845, filed Aug. 7, 2017, entitled HIGH FREQUENCY AC-POWERED DRAIN CLEANING AND INSPECTION APPARATUS AND METHODS; U.S. patent application Ser. No. 15/701,247, filed Sep. 11, 2017, entitled PIPE INSPECTION SYSTEMS WITH SELF-GROUNDING PORTABLE CAMERA CONTROLLERS; U.S. Pat. No. 9,769,366, issued Sep. 19, 2017, entitled ELF-GROUNDING TRANSMITTING PORTABLE CAMERA CONTROLLER FOR USE WITH PIPE INSPECTION SYSTEMS; U.S. Pat. No. 9,791,382, issued Oct. 17, 2017, entitled PIPE INSPECTION SYSTEM WITH JETTER PUSH-CABLE; U.S. patent application Ser. No. 15/728,410, filed Oct. 9, 2017, entitled PIPE INSPECTION SYSTEM WITH JETTER PUSH-CABLE; U.S. patent application Ser. No. 15/805,007, filed Nov. 6, 2017, entitled PIPE INSPECTION SYSTEM CAMERA HEADS; U.S. patent application Ser. No. 15/806,219, filed Nov. 7, 2017, entitled MULTI-CAMERA PIPE INSPECTION APPARATUS, SYSTEMS AND METHODS; U.S. patent application Ser. No. 15/811,264, filed Nov. 13, 2017, entitled SPRING ASSEMBLIES WITH VARIABLE FLEXIBILITY FOR USE WITH PUSH-CABLES AND PIPE INSPECTION SYSTEMS; U.S. Pat. No. 9,824,433, issued Nov. 21, 2017, entitled PIPE INSPECTION SYSTEM CAMERA HEADS; U.S. Pat. No. 9,829,783, issued Nov. 28, 2017, entitled SPRING ASSEMBLIES WITH VARIABLE FLEXIBILITY FOR USE WITH PUSH-CABLES AND PIPE INSPECTION SYSTEMS; U.S. Pat. No. 9,835,564, issued Dec. 5, 2017, entitled MULTI-CAMERA PIPE INSPECTION APPARATUS, SYSTEMS, AND METHODS; U.S. patent application Ser. No. 15/919,077, filed Mar. 27, 2018, entitled PORTABLE PIPE INSPECTION SYSTEMS AND METHODS; U.S. Pat. No. 9,914,157, issued Mar. 13, 2018, entitled METHODS AND APPARATUS FOR CLEARING OBSTRUCTIONS WITH A JETTER PUSH-CABLE APPARATUS; U.S. patent application Ser. No. 15/922,703, filed Mar. 15, 2018, entitled SELF-LEVELING INSPECTION SYSTEMS AND METHODS; U.S. Pat. No. 9,924,139, issued Mar. 20, 2018, entitled PORTABLE PIPE INSPECTION SYSTEMS AND APPARATUS; U.S. Pat. No. 9,927,368, issued Mar. 27, 2018, entitled SELF-LEVELING INSPECTION SYSTEMS AND METHODS; U.S. Provisional Patent Application 62/686,589, filed Jun. 18, 2018, entitled MULTI-DIELECTRIC COAXIAL PUSH-CABLES; U.S. Provisional Patent Application 62/726,500, filed Sep. 4, 2018, entitled VIDEO PIPE INSPECTION SYSTEMS, DEVICES, AND METHODS INTEGRATED WITH NON-VIDEO DATA RECORDING AND COMMUNICATION FUNCTIONALITY; U.S. Provisional Patent Application 62/756,538, filed Nov. 6, 2018, entitled ROBUST AND LOW COST IMPEDANCE CONTROLLED SLIP RINGS; U.S. Provisional Patent Application 62/768,760, filed Nov. 16, 2018, entitled PIPE INSPECTION AND/OR MAPPING CAMERA HEADS, SYSTEMS, AND METHODS; U.S. Provisional Patent Application 62/794,863, filed Jan. 21, 2019, entitled HEAT EXTRACTION ARCHITECTURE FOR COMPACT VIDEO HEADS; U.S. patent application Ser. No. 16/443,789, filed Jun. 17, 2019, entitled MULTI-DIELECTRIC COAXIAL PUSH-CABLES AND ASSOCIATED APPARATUS; U.S. Pat. No. 10,356,360, issued Jul. 16, 2019, entitled HIGH BANDWIDTH VIDEO PUSH-CABLE FOR PIPE INSPECTION SYSTEMS; U.S. Pat. No. 10,359,368, issued Jul. 23, 2019, entitled PIPE INSPECTION SYSTEM WITH JETTER PUSH-CABLE; U.S. Pat. No. 10,379,436, issued Aug. 13, 2019, entitled SPRING ASSEMBLIES WITH VARIABLE FLEXIBILIY FOR USE WITH PUSH-CABLES AND PIPE INSPECTION SYSTEMS; U.S. Pat. No. 10,440,332, issued Oct. 8, 2019, entitled INSPECTION CAMERA DEVICES AND METHODS WITH SELECTIVELY ILLUMINATED MULTISENSOR IMAGINING; U.S. Pat. No. 10,527,402, issued Jan. 7, 2020, entitled PIPE INSPECTION SYSTEM CABLE COUNTER AND OVERLAY MANAGEMENT SYSTEM; U.S. Pat. No. 10,585,012, issued Mar. 10, 2020, entitled PORTABLE CAMERA CONTROLLER FOR USE WITH PIPE INSPECTION SYSTEMS; U.S. Pat. No. 10,613,034, issued Apr. 7, 2020, entitled SELF-LEVELING

INSPECTION SYSTEMS AND METHODS; U.S. Pat. No. 10,715,703, issued Jul. 14, 2020, entitled SELF-LEVELING CAMERA HEADS; U.S. Pat. No. 10,761,233, issued Sep. 1, 2020, entitled SONDES AND METHODS FOR USE WITH BURIED LINE LOCATOR SYSTEMS; U.S. Pat. No. 10,764,541, issued Sep. 1, 2020, entitled COAXIAL VIDEO PUSH-CABLES FOR USE IN INSPECTION SYSTEMS; U.S. patent application Ser. No. 17/087,554, filed Nov. 2, 2020, entitled PORTABLE PIPE INSPECTION SYSTEMS AND METHODS; U.S. Pat. No. 10,834,364, issued Nov. 10, 2020, entitled PORTABLE PIPE INSPECTION SYSTEMS AND METHODS; U.S. Pat. No. 10,841,144, issued Nov. 17, 2020, entitled SYSTEM AND METHODS FOR DATA TRANSFER USING SELF-SYNCHRONIZING QUADRATURE AMPLITUFE MODULATION (QAM); U.S. Pat. No. 10,855,950, issued Dec. 1, 2020, entitled HIGH BANDWIDTH VIDEO PUSH-CABLES FOR PIPE INSPECTION SYSTEMS; U.S. Pat. No. 10,863,064, issued Dec. 8, 2020, entitled CABLE STORAGE DRUM WITH MOVEABLE CCU DOCKING APPARATUS; U.S. Pat. No. 10,907,690, issued Feb. 2, 2021, entitled PIPE INSPECTION SYSTEMS WITH ASSYMETRIC DRAG FORCE BEARINGS; U.S. Pat. No. 10,921,263, issued Feb. 16, 2021, entitled PIPE INSPECTION SYSTEM WITH JETTER PUSH-CABLE; U.S. patent application Ser. No. 17/182,113, filed Feb. 22, 2021, entitled VIDEO PIPE INSPECTION SYSTEMS; U.S. patent application Ser. No. 17/202,128, filed Mar. 15, 2021, entitled BORING INSPECTION SYSTEMS AND METHODS; U.S. Pat. No. 10,955,583, issued Mar. 23, 2021, entitled BORING INSPECTION SYSTEMS AND METHODS; U.S. Pat. No. 10,976,462, issued Apr. 13, 2021, entitled VIDEO INSPECTION SYSTEMS WITH PERSONAL COMMUNICATION DEVICE USER INTERFACES; U.S. Pat. No. 10,992,849, issued Apr. 27, 2021, entitled PIPE INSPECTION SYSTEMS WITH SELF-GROUNDING PORTABLE CAMERA CONTROLLERS; U.S. Pat. No. 11,016,381, issued May 25, 2021, entitled SPRING ASSEMBLIES WITH VARIABLE FLEXIBLE FOR USE WITH PUSH-CABLES AND PIPE INSPECTION SYSTEMS; U.S. patent application Ser. No. 17/397,940, filed Aug. 9, 2021, entitled INSPECTION SYSTEM PUSH-CABLE GUIDE APPARATUS; U.S. Pat. No. 11,088,890, issued Aug. 10, 2021, entitled VIDEO INSPECTION SYSTEMS AND METHODS USING SELF-SYNCHRONIZING QAM; U.S. Pat. No. 11,132,781, issued Sep. 28, 2021, entitled PIPE INSPECTION SYSTEM CAMERA HEADS; U.S. patent application Ser. No. 17/528,155, filed Nov. 16, 2021, entitled PORTABLE CAMERA CONTROLLER PLATFORM FPR USE WITH PIPE INSPECTION SYSTEMS; U.S. Pat. No. 11,178,317, issued Nov. 16, 2021, entitled HEAT EXTRACTION APPARATUS; U.S. patent application Ser. No. 17/528,956, filed Nov. 17, 2021, entitled VIDEO INSPECTION SYSTEM APPARATUS AND METHODS WITH RELAY MODULES AND CONNECTION PORTS; U.S. patent application Ser. No. 17/531,533, filed Nov. 19, 2021, entitled INPUT MULTIPLEXED SIGNAL PROCESSING APPARATUS AND METHODS; U.S. patent application Ser. No. 17/532,938, filed Nov. 22, 2021, entitled PIPE INSPECTION AND/OR MAPPING CAMERA HEADS, SYSTEMS, AND METHODS; U.S. Pat. No. 11,187,822, issued Nov. 30, 2021, entitled SONDE DEVICES INCLUDING SECTIONAL FERRITE CORE STRUCTURE; U.S. Pat. No. 11,187,971, issued Nov. 30, 2021, entitled ROTATING CONTACT ASSEMBLIES FOR SELF-LEVELING CAMERA HEADS; U.S. Pat. No. 11,199,510, issued Dec. 14, 2021, entitled PIPE INSPECTION AND CLEANING APPARATUS AND SYSTEMS; U.S. Pat. No. 11,209,115, issued Dec. 28, 2021, entitled PIPE INSPECTION AND/OR MAPPING CAMERA HEADS, SYSTEMS, AND METHODS; U.S. Pat. No. 11,209,334, issued Dec. 28, 2021, entitled PORTABLE CAMERA CONTROLLER PLATFORM FOR USE WITH PIPE INSPECTION SYSTEMS; U.S. Pat. No. 11,300,700, issued Apr. 12, 2022, entitled SYSTEM AND METHODS OF USING A SONDE DEVICE WITH A SECTIONAL FERRITE CORE STRUCTURE; U.S. patent application Ser. No. 17/868,709, filed Jul. 19, 2022, entitled INSPECTION CAMERA DEVICES AND METHODS; U.S. patent application Ser. No. 17/815,387, filed Jul. 27, 2022, entitled INWARD SLOPED DRUM FACE FOR PIPE INSPECTION CAMERA SYSTEM; U.S. Pat. No. 11,402,337, issued Aug. 2, 2022,

entitled VIDEO PIPE INSPECTION SYSTEMS WITH VIDEO INTEGRATED WITH ADDITIONAL SENSOR DATA; U.S. Pat. No. 11,418,761, issued Aug. 16, 2022, entitled INSPECTION CAMERA DEVICES AND METHODS WITH SELECTIVELY ILLUMINATED MULTISENSOR IMAGING; U.S. Pat. No. 11,448,600, issued Sep. 20, 2022, entitled MULTI-CAMERA PIPE INSPECTION APPARATUS, SYSTEMS, AND METHODS; U.S. patent application Ser. No. 17/993,784, filed Nov. 23, 2022, entitled VIDEO PIPE INSPECTION SYSTEMS; U.S. Pat. No. 11,528,401, issued Dec. 13, 2022, entitled PIPE INSPECTION SYSTEMS WITH SELF-GROUNDING PORTABLE CAMERA CONTROLLERS; U.S. patent application Ser. No. 18/091,079, filed Dec. 29, 2022, entitled VIDEO INSPECTION SYSTEMS WITH WIRELESS ENABLED DRUM; U.S. patent application Ser. No. 18/148,850, filed Dec. 30, 2022, entitled SPRING ASSEMBLIES WITH VARIABLE FLEXIBILITY FOR USE WITH PUSH-CABLES AND PIPE INSPECTION SYSTEMS; U.S. Pat. No. 11,550,214, issued Jan. 10, 2023, entitled SPRING ASSEMBLIES WITH VARIABLE FLEXIBLE FOR USE WITH PUSH-CABLES AND PIPE INSPECTION SYSTEMS; U.S. Pat. No. 11,558,537, issued Jan. 17, 2023, entitled VIDEO INSPECTION SYSTEM WITH WIRELESS ENABLED CABLE STORAGE DRUM; U.S. patent application Ser. No. 18/121,547, filed Mar. 14, 2023, entitled DOCKABLE CAMERA REEL AND CAMERA CONTROL UNIT (CCU) SYSTEM; U.S. patent application Ser. No. 18/121,562, filed Mar. 14, 2023, entitled PIPE INSPECTION AND CLEANING APPARATUS AND SYSTEMS; U.S. Provisional Patent Application 63/492,473, filed Mar. 27, 2023, entitled VIDEO INSPECTION AND CAMERA HEAD TRACKING SYSTEMS AND METHODS; U.S. Pat. No. 11,614,412, issued Mar. 28, 2023, entitled PIPE INSPECTION SYSTEMS WITH JETTER PUSH-CABLE; U.S. Pat. No. 11,614,613, issued Mar. 28, 2023, entitled DOCKABLE CAMERA REEL AND CCU SYSTEM; U.S. patent application Ser. No. 18/130,341, filed Apr. 3, 2023, entitled VIDEO PUSH-CABLES FOR PIPE INSPECTION SYSTEMS; U.S. Pat. No. 11,621,099, issued Apr. 4, 2023, entitled COAXIAL VIDEO PUSH-CABLES FOR USE IN INSPECTION SYSTEMS; U.S. patent application Ser. No. 18/135,661, filed Apr. 17, 2023, entitled VIDEO PIPE INSPECTION SYSTEMS AND METHODS WITH SENSOR DATA; U.S. patent application Ser. No. 18/140,488, filed Apr. 27, 2023, entitled INTEGRATED FLEX-SHAFT CAMERA SYSTEM; U.S. Pat. No. 11,639,990, issued May 2, 2023, entitled VIDEO PIPE INSPECTION SYSTEMS WITH VIDEO INTEGRATED WITH ADDITIONAL SENSOR DATA; U.S. Pat. No. 11,649,917, issued May 16, 2023, entitled INTEGRATED FLEX-SHAFT CAMERA SYSTEM WITH HAND CONTROL; U.S. patent application Ser. No. 18/203,029, filed May 29, 2023, entitled SELF-LEVELING INSPECTION SYSTEMS AND METHODS; U.S. Pat. No. 11,665,321, issued May 30, 2023, entitled PIPE INSPECTION SYSTEM WITH REPLACEABLE CABLE STORAGE DRUM; U.S. patent application Ser. No. 18/207,898, filed Jun. 9, 2023, entitled SONDE DEVICES WITH A SECTIONAL CORE; U.S. Pat. No. 11,674,906, issued Jun. 13, 2023, entitled SELF-LEVELING INSPECTION SYSTEMS AND METHODS; U.S. Provisional Patent Application 63/510,014, filed Jun. 23, 2023, entitled INNER DRUM MODULE WITH PUSH-CABLE INTERFACE FOR PIPE INSPECTION; U.S. Pat. No. 11,709,289, issued Jul. 25, 2023, entitled SONDE DEVICES WITH A SECTIONAL FERRITE CORE; U.S. patent application Ser. No. 18/365,225, filed Aug. 3, 2023, entitled SYSTEMS AND METHODS FOR INSPECTION ANIMATION; U.S. Pat. No. 11,719,376, issued Aug. 8, 2023, entitled DOCKABLE TRIPODAL CAMERA CONTROL UNIT; U.S. patent application Ser. No. 18/490,763, filed Oct. 20, 2023, entitled LINKED CABLE-HANDLING AND CABLE-STORAGE DRUM DEVICES AND SYSTEMS FOR THE COORDINATED MOVEMENT OF A PUSH-CABLE; U.S. Provisional Patent Application 63/599,890, filed Nov. 16, 2023, entitled VIDEO INSPECTION AND CAMERA HEAD TRACKING SYSTEMS AND METHODS; U.S. patent application Ser. No. 18/528,773, filed Dec. 4, 2023, entitled PIPE INSPECTION SYSTEM CAMERA HEAD; U.S. Pat. No. 11,842,474, issued Dec. 12, 2023, entitled PIPE INSPECTION SYSTEM CAMERA HEADS; U.S. patent

application Ser. No. 18/539,265, filed Dec. 14, 2023, entitled INTEGRAL DUAL CLEANER DRUM SYSTEMS AND METHODS; U.S. patent application Ser. No. 18/539,268, filed Dec. 14, 2023, entitled HIGH FREQUENCY AC-POWERED DRAIN CLEANING AND INSPECTION APPARATUS AND METHODS; U.S. Pat. No. 11,846,095, issued Dec. 19, 2023, entitled HIGH FREQUENCY AC-POWERED DRAIN CLEANING AND INSPECTION APPARATUS & METHODS; U.S. Pat. No. 11,859,755, issued Jan. 2, 2024, entitled INTEGRAL DUAL CLEANER CAMERA DRUM SYSTEMS AND METHODS; U.S. patent application Ser. No. 18/412,452, filed Jan. 12, 2024, entitled MULTI-CAMERA APPARATUS FOR WIDE ANGLE PIPE INTERNAL INSPECTION; U.S. patent application Ser. No. 18/414,785, filed Jan. 17, 2024, entitled SONDE DEVICES; U.S. Pat. No. 11,879,852, issued Jan. 23, 2024, entitled MULTI-CAMERA APPARATUS FOR WIDE ANGLE PIPE INTERNAL INSPECTION; U.S. Pat. No. 11,880,005, issued Jan. 23, 2024, entitled SONDE DEVICES INCLUDING A SECTIONAL FERRITE CORE STRUCTURE; U.S. Provisional Patent Application 63/625,259, filed Jan. 25, 2024, entitled ACCESSIBLE DRUM-REEL FRAME FOR PIPE INSPECTION CAMERA SYSTEM; U.S. Provisional Patent Application 63/552,522, filed Feb. 12, 2024, entitled ACCESSIBLE DRUM-REEL FRAME FOR PIPE INSPECTION CAMERA SYSTEM; U.S. Pat. No. 11,909,150, issued Feb. 20, 2024, entitled ROBUST IMPEDANCE CONTROLLED SLIP RINGS; U.S. patent application Ser. No. 18/611,449, issued Mar. 20, 2024, entitled VIDEO INSPECTION AND CAMERA HEAD TRACKING SYSTEMS AND METHODS; U.S. Pat. No. 11,962,943, issued Apr. 16, 2024, entitled INSPECTION CAMERA DEVICES AND METHODS; U.S. Pat. No. 11,988,951, issued May 21, 2024, entitled MULTI-DIELECTRIC COAXIAL PUSH-CABLES AND ASSOCIATED APPARATUS; U.S. patent application Ser. No. 18/747,912, filed Jun. 19, 2024, entitled INNER DRUM MODULE WITH PUSH-CABLE INTERFACE FOR PIPE INSPECTION; U.S. Provisional Patent Application 63/719,026, filed Nov. 11, 2024, entitled PUSH-CABLE WITH OFFSET JACKET EXTRUSION; and U.S. Provisional Patent Application 63/726,858, filed Dec. 2, 2024, entitled DIGITAL SELF-LEVELING PIPE INSPECTION CAMERA SYSTEMS AND METHODS WITH AUTOMATIC MAGNIFICATION. The content of each of the above-described patents and applications is incorporated by reference herein in its entirety. The above applications may be collectively denoted herein as the “co-assigned applications” or “incorporated applications.”

Description

BRIEF DESCRIPTION OF THE DRAWINGS

[0030] FIG. **1**A is an illustration of an embodiment of a cable storage drum for a pipe inspection system, as known in the prior art.

[0031] FIG. **1**B is an illustration of an embodiment showing an inside view of a cable storage drum for a pipe inspection system, as known in the prior art.

[0032] FIG. **2**A is an illustration of an embodiment of a cable storage drum with an inner drum module with a push-cable interface, in accordance with certain aspects of the present invention.

[0033] FIG. **2**B is an enlarged partial view of an illustration of an embodiment of a cable storage drum with an inner drum module with a push-cable interface, in accordance with certain aspects of the present invention.

[0034] FIG. **2**C is an illustration of an alternate view of an embodiment of a cable storage drum with an inner drum module with a push-cable interface, in accordance with certain aspects of the present invention.

[0035] FIG. **3** is an illustration of an embodiment of a cable storage drum **300** configured for an inner core module, in accordance with certain aspects of the present invention.

[0036] FIGS. **4**A-C are illustrations of an embodiment of an inner core module, in accordance with

certain aspects of the present invention.
[0037] FIG. **5** is an illustration of an an embodiment of an inner core module aligned for insertion into an outer cone of a cable storage drum, in accordance with certain aspects of the present invention.
[0038] FIG. **6** an illustration of an illustration of a cut-away view of an embodiment of a cable storage drum with an inner drum module, in accordance with certain aspects of the present invention.
[0039] FIG. **7**A illustrates details of an inner core module with a battery module interface, in accordance with certain aspects of the present invention.
[0040] FIG. **7**B illustrates details of an inner core module with a battery module interface populated with a battery, in accordance with certain aspects of the present invention.
[0041] FIG. **8** is an illustration of an embodiment of a front view (open) of a cable storage drum with an installed battery module, in accordance with certain aspects of the present invention.
[0042] FIG. **9** is an illustration of an embodiment of a cable storage drum with cable guides for a push-cable, in accordance with certain aspects of the present invention.
[0043] FIG. **10**A is an illustration of an embodiment of a front view of an accessible drum-reel frame enclosing a cable storage drum, in accordance with certain aspects of the present invention.
[0044] FIG. **10**B is an illustration of an embodiment of a side view of an accessible drum-reel frame enclosing a cable storage drum, in accordance with certain aspects of the present invention.
[0045] FIG. **10**C is an illustration of an embodiment of a rear view of an accessible drum-reel frame enclosing a cable storage drum, in accordance with certain aspects of the present invention.
[0046] FIG. **10**D is an illustration of an embodiment of a front view of an accessible drum-reel frame without a cable storage drum, in accordance with certain aspects of the present invention.
[0047] FIG. **10**E is an illustration of an embodiment of a side view of an accessible drum-reel frame without a cable storage drum, in accordance with certain aspects of the present invention.
[0048] FIG. **10**F is an illustration of an embodiment of an accessible drum-reel frame in an open position, in accordance with certain aspects of the present invention.
[0049] FIG. **11** is an illustration of an embodiment of a front interface of an accessible frame and a drum, in accordance with certain aspects of the present invention.
[0050] FIG. **12** is an illustration of an embodiment of a rear interface of an accessible frame and a drum, in accordance with certain aspects of the present invention.
[0051] FIGS. **13**A-D are illustrations of embodiments of a lift/carry handle with a handle locking mechanism.

DETAILED DESCRIPTION OF EMBODIMENTS

[0052] It is noted that as used herein, the term “exemplary” means “serving as an example, instance, or illustration.” Any aspect, detail, function, implementation, and/or embodiment described herein as “exemplary” is not necessarily to be construed as preferred or advantageous over other aspects and/or embodiments.

Example Embodiments

[0053] FIG. **1**A illustrates details of an exemplary prior art embodiment of a cable storage drum **100** for a pipe inspection system. Cable storage drum **100** includes an outer enclosure **110** to provide a housing, as well as environmental protection for a stored push-cable (not shown).
[0054] FIG. **1**B illustrates details of an exemplary prior art embodiment showing an inside view of a cable storage drum **100** for a pipe inspection system. A push-cable **120** is contained within enclosure **110**. Enclosure **110** may include a first half housing **130** and a second half housing **140**. The housing halves may be hinged **150** to allow access to the inside of enclosure **110**. Push-cable **130** is typically attached to a rotating hub **160** via a cable attachment mechanism **170**. A camera head **180** may be attached at the distal end of push-cable **130** through a flexible guiding coil **190**. Hub **170** may include interfaces for one or more electrical components. Electrical connectivity is typically maintained with the rotating hub **150** through a slip-ring (not shown). One or more cable

guides (not shown) may be provided to direct push-cable **120** into and out of enclosure **110**.
[0055] FIG. **2**A illustrates details of an exemplary cable storage drum **200** with an inner drum module **210** with a push-cable **220** interface. Cable storage drum **200** includes a housing or enclosure **230** to protect inner drum module **210** and other internal components. Inner drum module **210** is capable of rotating bidirectionally around a stationary axis **240**. Various sized and shaped viewing holes, slots, or windows **250** may be provided on inner drum module **210** to provide viewing of push-cable **220**. Additional venting holes or slots **260** may be provided on enclosure **230** to provide venting, and to reduce the overall weight of cable storage drum **200**.
[0056] Push-cable **220** may be connected to inner drum module **210** via a cable attachment mechanism **270**. A camera head **280** may be attached at the distal end of push-cable **220** through a flexible guiding coil **290**. One or more pipe guides **295** may be attached to camera head **280** to help guide and protect camera head **280** as it is being inserted into and out of a utility pipe or or conduit for inspection.
[0057] Cable storage drum **200** may include various accessories or components such as none or more handles **215**, non-slip feet **225**, and/or foldable legs **235** for allowing cable storage drum **200** to be set in multiple non-upright positions. One or more cable guides **245** and **255** may be provided to facility the movement of push-cable **220** into and out of cable storage drum **200**.
[0058] FIG. **2**B illustrates details of an enlarged partial view **200** of an illustration of an embodiment of a cable storage drum **200** with an inner drum module **210** with a push-cable **220** interface, in accordance with certain aspects of the present invention. Viewing holes, slots, or windows **250** allow viewing of push-cable **220** inside the cable storage drum **200**. This may be useful to determine how much of the push-cable **220** is being stored in cable storage drum **200** vs how much cable is being deployed into a utility pipe or conduit, as well as providing feedback as to the general condition of the push-cable **220** (e.g. good condition vs bad condition, i.e. dirty, greasy, frayed, etc.).
[0059] FIG. **2**C illustrates details of an alternate view **200** of an illustration of an embodiment of a cable storage drum **200** with an inner drum module **210** with a push-cable **220** interface, in accordance with certain aspects of the present invention. Non-slip feet **225** and foldable legs **235** allow the cable storage drum **200** to be leaned back towards the ground or other surface **265** at multiple angles which may better facilitate use of cable storage drum **200** and push-cable **220** during the inspection of a utility pipe or conduit.
[0060] FIG. **3** illustrates details of an illustration of an embodiment of a cable storage drum **300** configured for an inner core drum module. A hollow core outer cone **310** is configured to rotate bidirectionally around a stationary axis or hub **320**. An enclosure **330** provides a housing, as well as environmental protection for a stored push-cable (not shown). Enclosure **330** at least partially covers both the outer cone **310** and the stationary axis **320**. Outer cone **310** is configured to rotate bidirectionally (i.e. clockwise or counter clockwise) around a stationary axis of cable storage drum **300**.
[0061] Outer cone **310** is also configured to accept and mate with an inner core module (not shown) which contains various interfaces for one or more electrical and/or mechanical components, including a power source. Various shaped and sized tabs or edges **340** and grooves or indentations **350** may be provided to line up and mate with tabs and grooves on the inner core drum module (not shown). An electrical connector **360** is provided to mate with an electrical connector on inner core module **400** to provide connectivity to any electrical components connected inside inner core module **400**. Once mated, outer cone **310** and the inner core module **400** are locked together relative to each other, thereby allowing both outer cone **310** and the inner core drum to move together simultaneously.
[0062] FIGS. **4**A-**4**C illustrate details of an embodiment of an inner core module **400** for a cable storage drum. A baseplate **410** is provided to line up relatively flush with the outer cone edge **315** of outer cone **310** when the two parts are mated together. Various shaped and sized tabs or edges

420 and grooves or indentations **430** may be provided to line up and mate with tabs and grooves on the inner core drum module (not shown). An electrical connector **440** is provided to mate with an electrical connector on outer cone **310** to provide connectivity to any electrical components connected inside inner core module **400**. A top down view of inner core module **400** is shown in FIG. **4**C.

[0063] FIG. **5** illustrates details of an illustration of an embodiment **500** of an inner core module **400** aligned for insertion into an outer cone **310** of a cable storage drum. The shape of outer cone **310** is such that, when inserted, inner core module **400** will line up, and form a tight fit with outer core **310**. Baseplate **410** will come in contact outer cone edge **315** of outer cone **310** when the two parts are mated together. Electrical connectors **360** and **440** will also mate when outer cone **310** and inner core module **400** are aligned and mated. Various tabs and edges **420**, as well as grooves and indentations **430**, of inner core module **400** may also line up with counter part tabs or edges **340** as well as grooves and indentations **350**, of outer cone **310**, thereby providing a more secure fit.

[0064] FIG. **6** is an illustration of a cut-away view of an embodiment of a cable storage drum **600** with an inner drum module, in accordance with certain aspects of the present invention. An enclosure (not shown) is provided to cover and protect all drum components. The cable storage drum **600** is attached to a ridged or semi-ridged structure or frame (not shown) via front drum hub **610**. An outer cone **620** is configured to accept and mate with inner core module **630** which contains various electronic interfaces **635** (e.g. connectors, tabs, slots, and the like). When outer cone **620** and inner core module **630** are mated, they become fixed together so that when outer cone **620** rotates in one direction, inner core module **630** will rotate in the same direction.

[0065] Rear bearings **640**, and front bearings **645** allow outer cone **620** and inner core module **630** to rotate bidirectionally (i.e. clockwise or counter clockwise) relative to the cable storage drum frame. Rear bearing **640** may also be referred to as small bearing because they are smaller in circumference and/or surface area to front bearings **645** which may also be referred to as large bearings. Rear bearings **640** are attached between front drum hub **610** and outer cone **620**, and front bearings **645** are connected between outer cone **620** and rear drum hub **642**.

[0066] A universal battery plate **650** is configured to accept, and made with various size modular battery packs **660**. Various antennas **670**, e.g. WiFi, GPS, GNSS, etc., as well wireless communication equipment, receivers, transmitter, transceivers, etc., may be provided. In some embodiments, interfaces may be provided to allow different types of wireless communication equipment to be added or removed. One or more magnetic sensors **680** capable of detecting one or more magnets **685** may be provided to count drum rotations relative to the frame. One or more inner core handles **690** may be provided to facility insertion and/or removal of inner core module **630** into and/or out of outer cone **620**.

[0067] FIG. **7**A illustrates details of an inner core module **700** with a battery module interface **705**. The battery module interface **705** includes a replaceable battery tray **710** which is configured to accept various battery modules (not shown) of different types, electrical characteristics, and manufacturers. Battery tray **710** can be easily replaced with a different size or shape of tray to accept additional types and styles of battery modules by removing fasteners **720**. Battery tray **710** includes grooves **730** for securing the battery module which may include tabs or rails which interface with the grooves **730**. One or more contact tabs **740** are designed to make electrical contact with contacts provided on the battery module. A heatsink **750** is provided to help dissipate heat which may be generated by the battery module or other electrical components which may be located in the inner core module **700**. Locking mechanisms **760** lock inner core module **700** into the outer cone (See FIG. **3**). Handles **770** are provided to help insert and remove inner core module **700** into or out of the outer cone.

[0068] FIG. **7**B illustrates details of an inner core module **700** with a battery module interface **705**. Battery **780** is shown installed into battery tray **710**.

[0069] FIG. **8** illustrates details an embodiment **800** of a front view (open) of a cable storage drum

810 with an inner core module **820** installed, in accordance with certain aspects of the present invention. A battery module **780** is shown attached to inner core module **820** via battery module interface **705**. One or more locking mechanisms **830** may be provided to secure the inner core module **820** to outer cone **840** which is located inside cable storage drum **810**. One or more handles **850** may be provided to facilitate insertion and removal of the inner core module **820** into and out of outer cone **840**. A removably attachable clamshell assembly housing including first and second half clamshell enclosures (not shown) may be provided to at least partially cover both the back and front of the cable storage drum **810**, thereby providing protection to both cable storage drum components, as well as personnel.

[0070] FIG. **9** illustrates details of a cable storage drum **900** with cable guides **910** for guiding a push-cable **920** into and out of cable storage drum **900**. A camera head **930** may be attached to the distal end of push-cable **920**. A coil **940** may be provided to help facilitate movement of push-cable **920** and a camera head **930** as it moves through a utility pipe or conduit during inspection. The push-cable **920** may be terminated at a proximal end of coil **940**, and a flexmitter-flex connector (**922**) may then connect camera head **930** at a distal end of coil **940** to push-cable **920** through coil **940**. The coil **940** will help both the push-cable **920** and camera head **930** negotiate bends and turns. A push-cable lock latch or lock **950** may be used to keep push-cable **1020** from moving during storage and transportation. A pipe guide **960** may also be attached to push-cable **920** and camera head **930** to help protect the camera head **930** as it is moving in and out of a utility or pipe during inspection.

[0071] FIGS. **10**A and **10**B illustrate details of a drum-reel frame assembly **1000** enclosing a cable storage drum **300**. The accessible drum-reel frame assembly **1000** may be a supporting frame structure with tubular elements, and may include a front frame assembly **1010**, a base frame assembly **1020**, a rear frame assembly **1030**, and a top frame assembly **1040**. All of the frame assemblies together form a substantially rigid framing system configured to secure, and partially or completely enclose a cable storage drum **300**, or another size or shape storage drum (not shown). The front **1010**, base **1020**, rear **1030**, and top frame assemblies **1040** each comprise one or more substantially rigid members. One or more hinges **1050** may be provided to allow front frame assembly **1010** to open and close allowing access to cable storage drum **300** for maintenance and/or replacement. A front frame cross member **1060** may be provided to reinforce front frame assembly **1010**. Front frame cross member **1060** may include a front bearing ring holder **1070** configured to hold a front bearing ring **1072** (See FIG. **10**F).

[0072] FIGS. **10**A-**10**D show that front frame assembly **1020** rotates with respect to hinges **1050**, also known as hinge points, to allow the installation or removal of a cable storage drum. It is, however, foreseeable that the hinges **1050** may be located elsewhere, thereby creating a different hinge point. For instance, the hinge point could be located closer to the wheels **1085** similar to the way existing clamshell cable storage drum enclosures are configured. In FIGS. **10**A-**10**D a base frame cross member **1025** is provided, which separates the front frame assembly **1010** the rear frame assembly **1030**. However, base frame member **1025** can be lengthened, shortened, or even removed in order to provide a different hinge point for front frame assembly **1012** via hinges **1050**, or other well known assembly or method for creating a hinge point.

[0073] One or more cable guides **1075** may be provided for guiding a push-cable **120** (not shown) into or out of cable storage drum **300** as the push-cable is being wound onto or off of rotating hub **160** (not shown) which is located inside of cable storage drum **300**. Cable guides **1075** are shown attached to rear frame assembly **1030**, however, it would be understood by one of ordinary skill in the art that they could be provided elsewhere on the accessible drum-reel frame assembly **1000**.

[0074] A frame locking mechanism **1080** may be provided for allowing front frame assembly **1010** to be closed, thereby securing it to top frame assembly **1040**, or to be opened, thereby allowing front frame assembly **1010** and top frame assembly **1040** to be separated. Frame locking mechanism **1080** may interface with frame locking mechanism latches **1082** in order to facilitate

quick latching and unlatching of locking mechanism **1080**.
[0075] A push/pull handle **1090** which may be positioned via push/pull handle position lock **1095** may be provided. The push/pull handle may be used for carrying the accessible drum-reel frame assembly **1000** with or without drum **300**, or may be used to push accessible drum-reel frame assembly **1000** with or without drum **300** via wheels **1085**. A carry/lift handle **1097** may be provided as well for carrying or repositioning the accessible drum-reel frame assembly **1000**. The carry/lift handle **1097** may be stationary, or may be configured to change positions by rotating around a pivot point, and may lock, latch, snap, or otherwise be secured in various positions. The carry/lift handle **1097** may be slidably positionable in a forward or backward direction to allow better balance and frame access to a user.
[0076] FIG. **10**C illustrates details of an accessible drum-reel frame **1000** from a rear view. A rear frame cross member **1063** is attached to rear frame assembly **1030**
[0077] FIGS. **10**D (front view) and **10**E (side view) illustrate details of an accessible drum-reel frame **1000** without a cable storage drum attached.
[0078] FIG. **10**F illustrated details an accessible drum-reel frame **1000**, shown in an open position. See FIGS. **10**A and **10**B above for detailed component description.
[0079] FIG. **11** illustrates details of a front interface **1100** of an accessible frame and cable storage drum **300**. The front bearing ring **1072** mates on a first side with the front bearing ring holder **1070** which is attached to, or part of, the front frame cross member **1060**. The front bearing ring **1072** mates on a second side with cable storage drum **300** via a drum front bearing interface **1110**.
[0080] FIG. **12** illustrates details of a rear interface **1200** of an accessible frame and cable storage drum **300**. The rear bearing ring **1067** mates on a first side with the rear bearing ring holder **1065** which is attached to, or part of, the rear frame cross member **1063**. The rear bearing ring **1067** mates on a second side with cable storage drum **300** via a drum rear bearing interface **1210**.
[0081] FIGS. **13**A-**13**D illustrate details of a lift/carry handle with a handle locking mechanism **1300**. As shown in FIG. **13**A, lift/carry handle **1097** includes handle tabs **1310** which slide into rotating elements **1320** via rotating element slots **1325**. A spring **1130** may be provided to interface between handle tabs **1310** and rotating elements **1320** inside rotating element slots **1325**. In FIG. **13**A springs **1130** are shown in a non-compressed position. When handle **1097** has a downward force applied to it handle tabs **1310** compress springs **1130** into rotating element slots **1325**, as shown in FIG. **13**B.
[0082] As shown in FIG. **13**B, handle tabs **1310** and rotating elements **1320** are positioned inside a handle receiving element **1340** which may configured as part of top frame assembly **1040** as shown, or attached to top frame assembly **1040** (not shown). Rotating elements **1320** are substantially circular in shape with an opening on one end so that when handle tabs **1310**, which are curved on one end, are fully inserted into rotating slots **1325**, a full substantially circular shape is completed, as shown in FIG. **13**C. There may be a groove, slot, or other indentation (not shown) for the spring to fit into at the bottom inside of rotating element **1320** so that when compressed, spring **1130** interfere with handle tab **1310** resting flush against the inside bottom of handle receiving element **1340**.
[0083] FIG. **13**C shows tab **1310** without a downward force applied to lift/carry handle **1097** (not shown) which allows spring **1330** to force tab **1310** up into the top slot of handle receiving element **1340** preventing the handle **1097** from rotating. Also, when the lift/carry handle **1097** is pulled, the weight of the accessible drum-reel frame **1000**, as well as a cable storage drum **300**, if installed, pulls in the opposite direction of the handle **1097** further securing the handle **1097** by preventing rotation.
[0084] FIG. **13**D shows that when a downward force is applied to lift/carry handle **1097** (not shown) tab **1310** forces spring **1330** (not shown) to compress allowing tab **1310** to be inserted into rotating element slot **1325** which allows rotating element **1320** to be rotated clockwise or counter clockwise inside handle receiving element **1340**. This rotation allows lift/carry handle **1097** to be

stored when not needed.
[0085] Handle receiving element **1340** may include one or more divots or spaces **1345** for allowing the handle tab **1310** to be secured in place inside handle receiving element **1340** for storage. Moving lift/carry handle **1097** from a substantially upright position in either a clockwise or counter clockwise direction, forces the handle tabs **1310** to be pushed into the divots or spaces, thereby providing an audible and/or tactile “click”.
[0086] The scope of the invention is not intended to be limited to the aspects shown herein but are to be accorded the full scope consistent with the disclosures herein and their equivalents, wherein reference to an element in the singular is not intended to mean “one and only one” unless specifically so stated, but rather “one or more.” Unless specifically stated otherwise, the term “some” refers to one or more. A phrase referring to “at least one of” a list of items refers to any combination of those items, including single members. As an example, “at least one of: a, b, or c” is intended to cover: a; b; c; a and b; a and c; b and c; and a, b and c.
[0087] The previous description of the disclosed aspects is provided to enable any person skilled in the art to make or use embodiments of the present invention. Various modifications to these aspects will be readily apparent to those skilled in the art, and the generic principles defined herein may be applied to other aspects without departing from the spirit or scope of the disclosure. Thus, the disclosure is not intended to be limited to the aspects shown herein but is to be accorded the widest scope consistent with the disclosures herein and in the appended drawings.

Claims

1. An accessible drum-reel frame for a pipe inspection camera system, the drum-reel frame comprising: a frame assembly configured for attaching to, and supporting a cable storage drum, the frame assembly comprising: a base frame portion connected with one or more frame members which form a back frame portion; a top frame assembly connected at a first end to the back frame portion; a hinged or otherwise transformably coupled front frame portion which attaches at a proximal end to the base frame portion, and at distal end to a second end of the top frame assembly; at least one latching or locking mechanism for securing the distal end of the front frame portion to the second end of the top frame assembly, a front bearing ring holder removably attachable to the front frame portion, wherein the front bearing ring holder interfaces with a front bearing ring; and a rear bearing ring holder removably attachable to the back frame portion, wherein the rear bearing ring holder interfaces with a rear bearing ring, wherein the cable storage drum is configured to rotate bidirectionally between the front bearing ring and the rear bearing ring.
2. The drum-reel frame of claim 1, further comprising at least one handle removably attachable to the back frame portion.
3. The drum-reel frame of claim 1, further comprising a handle locking mechanism which allows at least one of the one or more handles to be placed and locked into at least two different positions.
4. The drum-reel frame of claim 1, further comprising one or more wheels attached to the base frame portion.
5. The drum-reel frame of claim 1, further comprising one or more cable guides attached to the frame assembly.
6. The drum-reel frame of claim 1, further comprising at least one handle removably attachable to the top frame assembly.
7. The drum-reel frame of claim 1, further comprising a substantially round-shaped cable storage drum.
8. The drum-reel frame of claim 7, further comprising a push-cable with a plurality of conductors, the push-cable being stored in the cable storage drum in a plurality of coils.
9. The drum-reel frame of claim 8, further comprising a drum front bearing interface for mating with the front bearing ring, and a drum rear bearing interface for mating with the rear bearing ring.

10. The drum-reel frame of claim 1, wherein the latching or locking mechanism may be opened or closed to allow the cable storage drum to be inserted or removed from the drum-reel frame.
11. The drum-reel frame of claim 9, wherein the cable storage drum further comprises: a substantially round-shaped housing, the housing comprising: an inner hub around which the push-cable is wound and unwound; a substantially frame hollow core outer cone removably attachable to the cable storage drum, the hollow core outer cone including a removable inner core module, wherein the inner core module includes a plurality of component interfaces for electrical or mechanical components, or both; and a battery module interface attached inside the inner core module, wherein the outer cone and the inner core module including the battery module interface and the plurality of component interfaces rotate simultaneously with the cable storage drum.
12. An accessible frame assembly configured for a cable storage drum in a pipe inspection camera system, the frame assembly comprising: a base frame portion connected with one or more frame members which form a back frame portion; a top frame assembly connected at a first end to the back frame portion; a hinged or otherwise transformably coupled front frame portion which attaches at a proximal end to the base frame portion, and at distal end to a second end of the top frame assembly; at least one latching or locking mechanism for securing the distal end of the front frame portion to the second end of the top frame assembly, a front bearing ring holder removably attachable to the front frame portion, wherein the front bearing ring holder interfaces with a front bearing ring; and a rear bearing ring holder removably attachable to the back frame portion, wherein the rear bearing ring holder interfaces with a rear bearing ring, wherein the frame assembly is configured to mate with, and secure a cable-storage drum, and wherein the frame assembly is further configured so for the cable storage drum to rotate bidirectionally between the front bearing ring and the rear bearing ring.
13. The frame assembly of claim 12, further comprising a cable storage drum.
14. The frame assembly of claim 13, wherein the cable storage drum comprises: a substantially round-shaped housing, the housing comprising: an inner hub around which a push-cable is wound and unwound; a substantially frame hollow core outer cone removably attachable to the cable storage drum, the hollow core outer cone including a removable inner core module, wherein the inner core module includes a plurality of component interfaces for electrical or mechanical components, or both; and a battery module interface attached inside the inner core module, wherein the outer cone and the inner core module including the battery module interface and the plurality of component interfaces rotate simultaneously with the cable storage drum.
15. The frame assembly of claim 14, wherein the housing includes a drum front bearing interface configured to mate with the front bearing ring of the frame assembly, and the inner hub includes a drum rear bearing interface configured to mate with the rear bearing ring of the frame assembly.
16. The frame assembly of claim 15, wherein the latching or locking mechanism may be opened or closed to allow the cable storage drum to be inserted or removed from the drum-reel frame.
17. The frame assembly of claim 12, further comprising at least one handle removably attachable to the back frame portion.
18. The frame assembly of claim 12, further comprising a handle locking mechanism which allows at least one of the one or more handles to be placed and locked into at least two different positions.
19. The frame assembly of claim 12, further comprising one or more wheels attached to the base frame portion.
20. The frame assembly of claim 12, further comprising one or more cable guides attached to the frame assembly.
21. The frame assembly of claim 12, further comprising at least one handle removably attachable to the top frame assembly.
22. The frame assembly of claim 14, wherein the plurality of component interfaces include one or more of electrical interfaces, mechanical interface, reel-counters, wireless communication equipment, and satellite positioning equipment.

23. The frame assembly of claim 22, wherein satellite positioning equipment includes GNSS equipment.
24. The frame assembly of claim 14, wherein the battery module interface provides connectivity for multiple battery types and brands.
25. The frame assembly of claim 14, wherein the battery module interface mates with a contact plate sealed inside the inner cone.
26. The frame assembly of claim 14, further comprising a camera head operatively connected to a distal end of the push-cable.
27. The frame assembly of claim 14, wherein the outer cone includes an aperture for providing front-side access to the inner cone.
28. The frame assembly of claim 14, wherein the inner cone includes a battery mounting pocket including an exposed heatsink comprising an exposed thermally conductive surface for dissipating heat away from the battery module.
29. The frame assembly of claim 22, wherein the wireless communication equipment and the satellite positioning equipment include antennas, and wherein the antennas are positioned in a front side of the inner core module near a central axis of rotation of the cable storage drum.
30. The frame assembly of claim 20, wherein the one or more cable guides comprise a split, two point cable exit guide including two feed-in/feed-out support apertures, wherein the support apertures are separated from each other by a distance of at least **4** times an inside aperture diameter.
31. The frame assembly of claim 14, the cable storage drum further comprising a plurality of electrical contacts between the inner core module and the outer cone which mate when the inner core module is installed into the outer cone, and wherein the plurality of electrical contacts provide connections for one or more of power, data, or electrical signals between the component interfaces and the camera.
32. The frame assembly of claim 14, further comprising at least one latch for securing the inner core module to the outer cone.
33. The frame assembly of claim 14, further comprising one or more operator controls exposed on an outside face of the inner core module.
34. The frame assembly of claim 14, further comprising one or more interface indicators visible on an outside face of the inner core module.
35. The frame assembly of claim 34, wherein one or more of the interface indicators is a wireless connection status LED.
36. The frame assembly of claim 34, wherein one or more of the interface indicators is a power on status LED.
37. The frame assembly of claim 20, wherein at least one of the one or more cable guides includes a camera spring locking mechanism.
38. The frame assembly of claim 14, further comprising a variable drag drum brake for slowing down or stopping rotation of the cable storage drum.
39. The frame assembly of claim 14, further comprising an internally powered drum drive module.
40. The frame assembly of claim 23, wherein the GNSS equipment includes a GNSS receiver.
41. The frame assembly of claim 22, wherein the wireless communication equipment includes a orientation sensing module.
42. The frame assembly of claim 41, wherein the orientation sensing module comprises at least one of a compass and an Inertial Navigation System (INS) sensor.
43. The frame assembly of claim 22, wherein the wireless communication equipment includes a rotation sensor for sensing rotations between the cable storage drum and the clamshell assembly.
44. The frame assembly of claim 14, further wherein the push-cable is a camera cable including a spring-loaded removable electrical interface which is mechanically secured to the cable storage drum and the outer cone assembly.
45. The frame assembly of claim 31, wherein the removable electrical interface is a three part stack

assembly with a middle component connect via spring loaded contacts to an inside of the inner core module and the camera cable on an outside of the inner core module.

46. The frame assembly of claim 14, wherein the inner core module includes one or more handles.

47. The frame assembly of claim 14, wherein a NFT (Near Field Tag) is permanently or removably attached to a front exposed face of the inner core module.

48. The frame assembly of claim 14, further comprising a dry cable termination cable capture attached on an inside of the cable storage drum, and a spring contact interface attached on a reverse side of the cable storage drum that contacts at least one electronic interface inside the inner core module.

49. The drum-reel frame of claim 1, wherein the front bearing ring is removably attachable to the front bearing ring holder.

50. The drum-reel frame of claim 1, wherein the rear bearing ring is removably attachable to rear bearing ring holder.

51. The frame assembly of claim 12, wherein the front bearing ring is removably attachable to the front bearing ring holder.

52. The frame assembly of claim 12, wherein the rear bearing ring is removably attachable to rear bearing ring holder.

53. The drum-reel frame of claim 1, further comprising: a handle with two opposing end handle tabs; and a pair of rotating elements, wherein each rotating element includes a slot, wherein each of the two opposing handle tabs is connected to a spring, and the tabs and the springs are free to slide into and out the slots in the rotating elements, wherein when the springs are compressed between the handle tabs and the slots, the tabs and the rotating elements form a substantially circular shape thereby allowing the pair of rotating elements and the tabs to rotate freely within a pair of handle receiving elements which are configured as part of, or attached to the top frame assembly so that the handle may be placed for storage to either one of two sides, and when the springs are not compressed, the handle is locked in a substantially upright position for moving or carrying the frame.

54. The drum-reel frame of claim 53, wherein the handle receiving element includes one or more divots for locking the handle in a secured position when not in use.

55. The drum-reel frame of claim 54, wherein at least one of the one or more divots are configured to provide a tactile and audible snap when making contact with at least one of the handle tabs.