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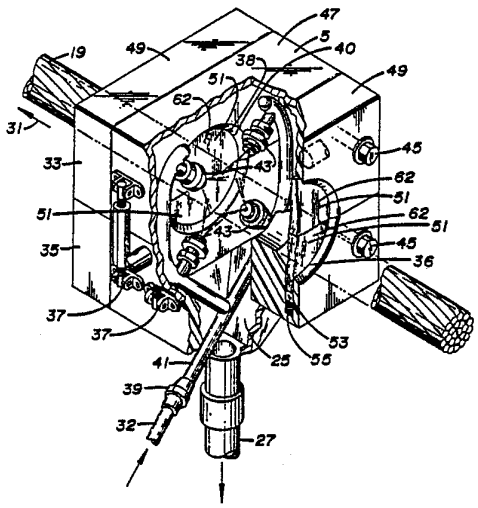
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(54) Title: SERVICE LUBRICATING OF METAL HAULAGE CABLES



(57) Abstract

An apparatus to lubricate metal haulage cables having a recirculating system and an enclosure. The enclosure (5) generally comprises: a funnel or beveled shaped entrance (34) urging irregularities on the surface of the cable (19) radially inward towards the entrance opening (36); brushes (51) or curtain means cleaning the surface of the entering cable, an interior load-bearing surface (60) supporting the enclosure; a plurality of high pressure spray nozzles (43) applying heated lubricant to the cable as the cable traverses the enclosure; brushes (51) or curtain means removing excess lubricant from the cable as the cable exits the enclosure; and a funnel-shaped bottom (25) gathering the excess lubricant for recirculation. The spray nozzles spray heated lubricant onto the cable whenever the cable is worked or reeled onto a cable drum (21). The recirculating system recovers, filters, reheats and recycles the excess lubricant. A cleaning cycle enables circulation of a cleaning solvent solution through the system.

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SERVICE LUBRICATING OF METAL HAULAGE CABLES

Cross Reference to Related Applications

This is a continuation-in-part of application Serial No. 872,521 filed in the United States Patent and Trademark Office on June 10, 1986.

TECHNICAL FIELD

This invention relates to cable lubricating systems and in particular to systems which periodically lubricate metal cables used for haulage.

BACKGROUND ART

Metal cables are used for a variety of purposes. Generally, metal cables may be classified according to their uses. Support cables are used where strength and not flexibility is important, such as cables used on

suspension bridges, tower supports, etc. Haulage cables are used where both strength and flexibility are important, such as cables used for winches, elevators, tug boat lines and fishing lines. Metal cables are generally constructed with a center core composed of a plurality of metallic wires surrounded by bundles of metal wires called strands. The strands are tightly twisted around the center core. The core is the heart of the cable since it furnishes support for the surrounding strands and wires. The diameter of the core wires is generally larger than the surrounding strand wires.

Usually, a haulage cable is stored by using a rewinding assembly to wrap the cable through a pair of laterally moving uprights or fairleads onto a reel or cable drum. During the reeling process, the lateral movement of the fairleads aligns the cable onto the cable drum in an orderly fashion. The cable is reeled by machinery linked to engines dedicated for the purpose of powering the cable-reeling assembly or it is linked to a power plant used for other purposes, such as for powering the ship. The linkage may be mechanical or hydraulic.

When the cable is worked or bent, as happens in the reeling process, the wires, strands and core within sections of the cable work against each other and become slightly separated to accommodate a curvature of the cable.

It is recognized that lubricating the metal cables substantially increases the useful life of the cable. This is true particularly when the individual wires must move with respect to each other as happens when the cable is worked. Coating the individual wires within the cable with lubricant facilitates the movement of the wires and reduces friction between them. The lubrication assists the wires to follow the lines of stress and facilitates

the transfer of forces between the wires within the cable, thereby avoiding breakage due to a concentration of stresses along certain portions of the cable. The lubrication facilitates the averaging of the stresses along the diameter of the cable and within the center core.

Most cable lubricants are petroleum based liquids or semi-liquids which are highly viscous substances blended with a combination of materials. These include solvents which enhance penetration, and/or viscosity extenders and additives which improve the lubricating qualities of the lubricant. The particular blend of materials best suited is determined by the intended use of the lubricant.

Present methods to lubricate haulage cables usually depend upon the particular haulage application. A common method now used to lubricate haulage cables is to hand apply a low viscosity lubricant with mops or rags which are periodically dipped in a supply of lubricant and applied directly to the cable as the cable is reeled. A simplification of this method employs a hand held spraying machine, such as a pressure pump insecticide applicator commonly used in gardening applications. The applicator is first filled with a low viscosity lubricant. The applicator is pressurized, and then the lubricant is sprayed from the applicator through a hand held nozzle on the cable as it is reeled.

An automatic drip type oil applicator for servicing haulage cables has been described by the American Society of Lubrication Engineers in its standard Handbook of Lubrication Engineering (O'Conner and Boyd, 1968, page 21-11). Lubricating oil is pumped from an oil tank to a dripping nozzle located above the cable where the cable turns over a pulley wheel. The oil pump is mechanically linked to a pulley wheel. The rate of application is

adjusted to meter out oil in proportion to the speed of the pulley wheel. This handbook teaches the most effective way to lubricate a cable is to spray a specially heated petroleum component onto the cable during the manufacturing process. Depending upon the available means of application and temperature, the service lubrication may require a deviation from the described most effective method. The handbook suggests the lubricant be first diluted with a suitable volatile solvent to decrease the viscosity of the lubricant and then sprayed onto the cable. This method depends upon the evaporation of the volatile solvents to leave a uniform film of the residual lubricant. In practice, this system is quite inefficient since much of the lubricant is airborne during the spraying process and the low viscosity lubricant-solvent mixture tends to migrate through and exit the cable. It is very difficult to control the evaporation of the volatile solvents of the lubricant. The penetrating qualities of the lubricant mixture permit the lubricant to flow out of the cable through the many layers of coiled cable strands and pool under the cable reel. The volatile solvents then evaporate to leave a hazardous residual lubricant coating surrounding the reeling and winching area.

Bentley, et al. (U.S. Patent No. 4,414,917) discloses a large and extremely complex recirculating device used to lubricate cables. Bentley teaches that the cable should traverse multiply aligned cylinders which are supported on the cable by load-bearing exterior horizontal rollers located adjacent to the entrance and exit of the device and by a pair of horizontal rollers located between the second and third cylinders. Exterior vertical rollers located adjacent to the entrance and exit assist the horizontal rollers to ride upon the cable. Within the

three cylinders, the cable is sequentially cleaned with a spray of water, dried with a jet of air, and sprayed with lubricant.

Although Bentley teaches that the cable would dry more quickly if the temperature of the jet of air was elevated to about 100 degrees Fahrenheit, Bentley does not provide a means to elevate the temperature of the lubricant to decrease lubricant's viscosity. Nor does Bentley teach that a heated lubricant, having a decreased viscosity which assists the lubricant's penetration into the cable, should be sprayed onto or into the cable wherein the lubricant remains when the temperature of the lubricant decreases. Absent a means of heating the lubricant and thereby decreasing the lubricant's viscosity, a device constructed according to Bentley may effectively be inoperative if a lubricant is used which has a high viscosity at atmospheric temperatures.

Bentley teaches "the oil is applied to the nozzles of the lubricating cylinder 16 at pressures up to 5,000 psi" (col. 9, lines 59-62) suggesting a maximum or upper limit to the lubricant pressure of 5,000 pounds per square inch.

The Bentley patent fails to disclose the use of brushes to remove contaminants at the entrance of the device and to remove excess lubricant at the exit of the enclosure. Bentley teaches away from using a sleeve means of wiping the contaminants from the cable on entering and leaving the device. Even before entering the Bentley device, contaminants may impact and accumulate against the leading load-bearing rollers or be compressed into the cable as the contaminants pass between the cable and rollers. Nor does Bentley teach that filters should be used to filter the lubricant as it enters or exits the lubricant storage tank.

Bentley does not disclose a device which has a means to allow the device to follow the angular, vertical, and lateral displacement of the cable as the cable travels between the fairleads and drum, such as the gimballed frame assembly upon which a device as taught by the Applicant may be mounted. If constructed as taught by Bentley, the entire device would be subject to the unrestricted violent and adverse whipping conditions of the cable.

Bell (U.S. Patent No. 2,429,915) discloses a cable painting or liquid coating machine which may be used to coat vertically oriented cables. Bell teaches that a coil spring should force a supply of liquid to a brush. The brush applies "the liquid to the surface of the cable" (col. 3, line 45). Bell teaches that a felt gasket ring be used to clean the surface of the cable as the painting progresses, and that soft, rubber, lower gasket rings be used to prevent the excess paint from dripping below the device. These gasket rings are projected inwardly to lightly contact the surface of the cable. Bell teaches that the load-bearing surfaces of the device are interiorly located concave rollers. The paint is applied as the device is being pulled up the vertically oriented cable.

Bell does not teach that the liquid should be sprayed or injected into the cable at a high pressure or temperature. Nor does Bell teach that the entrance, and other portions of the device which lead to the gasket rings, should have a funnel-shaped bevel. Irregularities on the cable such as broken strands are not funneled toward the gasket rings but rather would impact directly against and cause significant damage to the gasket rings. Bell makes no provision for the draining or removal of the contaminants swept from the cable by the felt gasket ring. Bell does not teach that the liquid should be

recirculated, nor does Bell incorporate the use of a funneled shaped bottom, gimballed supporting frame assembly, pump, cleaning system or filters as shown and claimed herein.

Böcher (U.S. Patent No. 1,575,526) discloses a method and apparatus for conserving cables by cleaning the cable, drying it, applying a conserving preparation such as varnish to the cable, and drying the preparation. Böcher teaches that compressed and highly heated air should be sprayed through a first set of nozzles onto a cable to mechanically clean the surface and outside crevices of the cable, and to dry and heat the cable. A second set of nozzles spray a mixture of heated preparation and heated compressed air onto the cable. Thereafter, a third set of nozzles spray cold or heated compressed air onto the cable to dry it. Böcher teaches that the device should be provided with a means to permit a slight lateral displacement of the apparatus so that it may adapt itself to the "whipping" of the cable.

Böcher does not disclose the use of brushes to wipe contaminants off the surface of the cable or to contain the excess lubricant within the device. Böcher does not teach that the entrance of the device should have a funnel-shaped bevel to urge broken strands and other irregularities on the cable surface to enter the device without jamming against the leading face of the entrance. Böcher does not teach that the lubricant should be recirculated and therefore does not incorporate a funneled shaped bottom, a circulating pump or filters. Böcher also does not teach the use of a gimballed supporting frame assembly or cleaning system.

Andersen (U.S. Patent No. 1,471,583) discloses a cable lubricating device wherein a pair of castings are coupled together about a segment of cable. The interior

compartment of the castings is filled with a lubricating agent which coats the surface of the cable as the cable traverses across the interior of the castings. Excess grease is wiped from the cable during its passage through the compartment by contacting a gland assembly which presses packing waste about the cable. The device is suspended upon a frame which is positioned below and in alignment with the drum.

Andersen does not disclose a recirculating system where the lubricant is sprayed at a high pressure and temperature upon the cable. Rather, the device as taught by Andersen only coats the surfaces of the cable. Instead of using brushes to wipe contaminants off the surface of the cable, Andersen teaches that packing waste should be used to make load-bearing gaskets which contain the excess lubricant within the device. The entrance of the device does not have a funnel-shaped bevel to urge broken strands and other irregularities on the cable surface into the device. Nor does Andersen teach that the lubricant should pass through a pump, be filtered, and then be recirculated. The suspension of the Andersen device does not allow as much freedom of movement as is allowed by the Applicant's gimballed supporting frame assembly.

Other related but less pertinent patents include: Crump (U.S. Patent No. Re.29,493; Grant (U.S. Patent No. 3,306,310); Landry, Jr. (U.S. Patent No. 3,851,623); Thomson et al. (U.S. Patent No. 4,089,295); Blanton, Jr. (U.S. Patent No. 4,336,866); Shenk (U.S. Patent No. 4,063,617); Bendaham (U.S. Patent No. 4,498,558); Johansen (U.S. Patent No. 4,422,529); and Hallikas et al. (U.S. Patent No. 4,592,521). In addition, Biewer (U.S. Patent No. 3,815,846) discloses a self-level winding apparatus which may be used to orderly wind a cable onto a cable drum.

DISCLOSURE OF THE INVENTION

The ideal cable lubricating system would cause the lubrication to penetrate between the cable strands wherein the lubricant would remain to provide a formidable barrier against the corrosive effects of foreign material. The lubrication process should incorporate the flexing or working operation of the cable, since the cable wires and strands open slightly and move with respect to each other during the flexing or working operation of the cable, the lubrication should be applied at that time. This facilitates the penetration of the heated lubricant into the cable. Under these conditions, capillary action will enhance the penetration of the heated lubricant between the wires and strands. The lubricant will cool, increase its viscosity, and become trapped between the cable strands. The system should minimize lubricant loss and prevent misapplication or migration of the lubricant to surrounding areas. The application should be routine or automatic whenever the cable is reeled.

Accordingly, it is the general objective of the present invention to provide an improved method and apparatus to lubricate metal haulage cables.

More specifically, it is an objective of the present invention to provide an automatic means to spray continuous segments of a moving haulage cable within an enclosure with heated lubricant in conjunction with the winding operation of the cable onto a cable drum.

It is also an objective to provide a means to enclose the area of lubricant application and collect and filter the unused lubricant so that it may be reheated and made available for reapplication to the moving cable.

It is another objective to elevate the temperature of the lubricant, to decrease its viscosity, and thereby facilitate the penetration of the lubricant into the cable when the lubricant is applied during the working of the strands. The lubricant enters the cable in a heated condition and becomes more viscous as it cools within the cable thereby decreasing its tendency to leave the cable.

It is another objective to provide a means of automatically lubricating metal haulage cables whenever the cable is reeled.

It is a further objective to provide a means of automatically orienting a means of spraying heated lubricant onto segments of a moving cable within an enclosure by pivotally attaching the enclosure to a sliding and pivotal assembly which moves with a pair of fairleads. The position of the enclosure and spraying operation is adjusted according to the changing position and angle of the cable during the reeling operation.

Another objective is to provide an apparatus wherein a brush or curtain means wipes contaminants off of the cable before that portion of the cable enters the enclosure.

Another objective is to provide an apparatus having an enclosure entrance which has a funnel-shaped bevel wherein the broken strands of the cable and other irregularities on the surface of the cable are directed radially inward towards the entrance.

Another objective is to provide an apparatus having a load-bearing surface located interiorly from the brushes at the entrance.

Another objective is to provide an apparatus having a brush or curtain means which wipes excess lubricant from the cable before that portion of the cable exits the enclosure.

Another objective is to provide an apparatus having a load-bearing surface located exteriorly from the brushes positioned nearest the exit.

Another objective is to provide an apparatus wherein the load-bearing surfaces are easily removed and replaced.

Another objective is to provide an apparatus wherein the load-bearing surfaces may be sized and replaced to properly encompass cables of varying diameters.

These objectives are met by the apparatus hereafter described and claimed.

This invention comprises four main areas: an enclosure; a gimballed rectangular frame assembly; a circulation system; and an optional cleaning system. The enclosure has an upper part and a lower part which, when coupled together, fit comfortably around the diameter of the cable with a portion of the cable traversing the enclosure's interior compartment from an entrance to an exit. The upper part and the lower part are held together with suitable fastener means.

The upper part and lower part each have three distinct portions, a center portion and two outer portions. The center portion contains a series of lubricant spray means or spray nozzles directed radially inward toward the traversing cable, a means for supplying lubricant to the spray nozzles, and a means for draining the excess lubricant from the enclosure. In the center portion, the spray nozzles impinge hot lubricant at a very high

velocity upon and between the strands of the traversing cable. The heated lubricant displaces the contaminants and water lodged between the cable strands to effectively protect the cable from adverse conditions. The elevated temperatures greatly reduce the lubricant's viscosity. By spraying heated lubricant directly onto the cable there is no need to use lubricant additives or rely upon the evaporation of mixed or diluted solvents to assist the lubrication's penetration and placement within the cable. A funnel-shaped bottom pools and drains the excess lubricant from within the enclosure.

The outer portions comprise the load-bearing surfaces, means for funneling irregularities on the surface of the cable towards the entrance and exit, means for wiping contaminants from the surface of the cable as the cable enters the enclosure, and means for restricting the excess lubricant from passing through the entrance and exit. The outer portions are designed with an orifice which approximates the diameter of the cable. The outer portions may be quickly and easily replaced. Due to the diameter of the orifice of the outer portions, the outward flow of excess lubricant through the entrance or exit is dramatically restricted. The orifice surfaces act as the load-bearing surfaces of the enclosure. The little amount of excess lubricant which does escape the enclosure self-lubricates the load-bearing surfaces.

The outer side of the outer portion defining the entrance is formed with a funnel-shaped bevel. The largest diameter of the funnel-shaped bevel is outward from the entrance. Irregularities on the surface of the cable, such as broken wires or strands which emerge from the cable, are directed towards the entrance orifice. Located near the entrance of the enclosure, a spring loaded second wiping means, such as a brush or curtain means, removes dirt and contaminants from the cable. The funnel-shaped

bevel assists in removing the contaminants from the brush or curtain means.

The inner side of the outer portion defining the exit of the enclosure is also formed with a funnel-shaped bevel to direct cable surface irregularities toward the exit orifice and to help drain the excess lubricant from the cable into the enclosure. Located near this inner side of the outer portion are spring loaded wiping means, brush or curtain means which wipe excess lubricant from the surface of the cable into the enclosure. As the brush or curtain means flex about the surface of the cable they also provide a barrier to contain lubricant within the enclosure and condense airborne lubricant particles.

The gimballed rectangular frame assembly enables the enclosure to be pivotally and slidably mounted to a piece of equipment such as the reel side of a winching system's fairleads. The fairleads restrict cable whipping and move laterally to place the cable in a generally uniform fashion upon the cable drum. The gimballed frame assembly permits the angular, vertical and lateral movement of the enclosure to follow the position and orientation of the cable, as the cable is reeled through the fairleads and is passed through the enclosure. The load-bearing surfaces of the enclosure ride upon the cable, automatically adjusting the direction of the spray towards the moving cable.

The circulating system involves the flow of lubricant from a lubricant storage tank to the low pressure or suction side of a circulating pump. The storage tank is subjected to an external heater which elevates the temperature of the lubricant inside. The heater may be comprised of electrical resistive elements, heat obtained from piping hot exhaust gas or diesel injector return lines from power plant driving or reeling systems, or any other accessible

source of heat. The heat source should contact, or be in close proximity to, the exterior surfaces of the storage tank, thereby heating the lubricant stored inside. The elevated temperature of the lubricant within the storage tank should be maintained during the lubricating operation of the spray nozzles.

The hot lubricant passes through the circulating pump which dramatically increases its pressure to force the lubricant through a second filter and be ejected from spray nozzles located near the center of the enclosure. The high pressure pump may be powered by electricity or by linking the pump to the cable reeling assembly. The pump should circulate the lubricant whenever the cable is reeled in.

Exiting the spray nozzles, the hot lubricant impinges upon the traversing cable. Much of the lubricant becomes overspray or becomes airborne within the interior portion of the enclosure. After contacting the brushes or inner walls of the enclosure, the excess lubricant condenses and/or drains down through a collecting funnel-shaped bottom to an awaiting first filter. The first filter removes contaminants from the excess lubricant before the excess lubricant is returned to the storage container where the lubricant is reheated and recirculated.

The storage tank, external heater, circulating pump, second filter, first filter, and their connecting lines may be located wherever space permits. Preferably, these elements are located near the enclosure. If the excess lubricant fails to drain properly from the enclosure, or the hydrostatic pressure is insufficient to drain the excess lubricant into the first filter and on to the storage tank, then it may be necessary to install a second circulating pump to assure complete circulation.

The invention also contemplates an optional cleaning cycle or circulating means to advantageously use the high-pressure pump as a means to pump cleaning solution and solvents through the circulating system and enable the exterior of the equipment to be cleaned. The storage tank is drained of the lubricant by opening a drain located in the bottom of the storage tank. Cleaning solvent may be poured into the enclosure. The cleaning solvent passes through the first filter and is stored in the storage tank. Alternatively, a separate cleaning solution storage vessel containing cleaning solvent may be connected by a first valve to the circulating system between the second filter and the circulating pump. The circulating pump is operated to circulate the cleaning solvent throughout the circulation system. During the cleaning cycle, the operation of the circulating pump should not be dependent upon the movement of the cable.

A three-position second valve may be connected between the circulating pump and the spray nozzles. Use of the first position of the second valve allows the cleaning solvent to travel towards the spray nozzles. Use of the second position of the second valve allows the cleaning solvent to be piped to a cleaning solution spray means, such as a wide-angle spray nozzle, located within the storage tank, and thereby pressure clean the interior surfaces of the storage tank. Use of the third position of the second valve allows the cleaning solvent to be piped to an exteriorly positioned cleaning solution spray means, such as a hand-held spray nozzle. The hand-held spray nozzle may be positioned on a wand and is used to spray other parts of the equipment and the surrounding area. The storage tank is then drained of the cleaning solvent or solution and the system is recharged with lubricant.

BRIEF DESCRIPTION OF DRAWINGS

Figure 1 is a perspective view of the invention mounted on fairleads in the aft of a vessel.

Figure 2 is an enlarged perspective view of the details of the enclosure.

Figure 3 is a side elevation view of the enclosure.

Figure 4 is a schematic view of the lubrication cycle and cleaning solution cycle.

BEST MODE FOR CARRYING OUT THE INVENTION

Referring now to the drawings, it will be seen that Figure 1 demonstrates an enclosure 5, pivotally mounted on a rectangular frame assembly 6. The rectangular frame assembly 6 is able to pivot and slide on lateral tracks 7 which are mounted to the reel side of a fairlead assembly 9. The various mounting methods of lateral tracts 7 to the fairlead assembly 9 are well known and are not shown here. The lateral tracks 7 may be mounted by attaching standoffs (not shown) from the reel side of the fairlead assembly 9 or by having the ends of the lateral tracks 7 bent to form a wide "U" shape and attaching the ends of the lateral tracks 7 to the fairlead assembly 9. While the mounting method of the lateral tracks 7 will depend upon the particular configuration of the fairlead assembly 9, it is important that the enclosure 5 be permitted to float about and follow the action of the cable 19. Enclosure 5 is attached at approximately the midpoint of its sides to lateral pins 8 which form a part of the vertical slide mounts 10. The vertical slide mounts 10 allow the assembly to move vertically along the vertical tracks 11 portion of the rectangular frame assembly 6. The enclosure 5 is allowed to pivot about the lateral pins 8. The mounting frame assembly 6 is attached at approximately the midpoint of horizontal tracks 13 to

vertical pins 14 which form a part of the lateral slide mounts 15. The lateral slide mounts 15 allow the assembly to move laterally along the lateral tracks 7. The enclosure 5 is allowed to pivot about the vertical pins 14. This arrangement gives the enclosure 5 freedom to move up and down, side-to-side and to pivot according to the position of the cable 19 as the cable 19 is pulled between the fairlead rollers 17 in the fairlead assembly 9 onto the cable drum 21. The fairlead assembly 9 moves back and forth laterally placing the cable 19 onto the cable drum 21 in an orderly fashion.

Wheel machinery (not shown) powers the cable drum 21 to pull the cable 19 through the fairlead rollers 17 and enclosure 5. A power transfer unit located beneath cover 23 enables the fairlead assembly 9 to act jointly with the wheel machinery. The enclosure 5 remains aligned with the taut cable 19 between the fairlead rollers 17 and the cable drum 21.

In Figure 1, the cable drum 21, fairlead assembly 9 and enclosure 5 are shown mounted generally near the aft portion 29 of a vessel. Arrows 30 and 31 indicate the direction the cable 19 is moving with respect to the vessel when the cable 19 is being reeled in.

Figures 2 and 3 illustrate the details of the enclosure 5. The enclosure 5 generally has a cubical shape. However, other configurations such as a donut shape may also be used. The enclosure 5 is assembled by securing together an upper part 33 and a lower part 35 with a first side latch 37 and a second side latch (not shown). The first side latch 37 and the second side latch are located on alternate sides of the enclosure 5. The upper part 33 can be removed from the lower part 35 in order for the

enclosure 5 to be placed around or removed from the cable 19. The enclosure 5 has an entrance 36 opening and an exit 38 opening.

The upper part 33 and the lower part 35 comprise a center portion 47 and two outer portions 49. In the preferred embodiment, the center portion 47 is constructed of stainless steel and the outer portions 49 are constructed of ultra high molecular weight polyethylene 49. Other materials may also be used. The outer portions 49 and center portion 47 of the upper part 33 and the lower part 35 are held together with bolts 45 and nuts 46. The bolts 45 and nuts 46 provide an effective means to replace damaged or worn center portions 47 or outer portions 49. The outer portions 49 are easily replaced so that the diameter of the entrance 36 and exit 38 openings of the enclosure 5 are approximately the same as the diameter of the cable 19. The load bearing surfaces 60 of the outer portions 49 rest or ride upon the cable 19. The rectangular frame assembly 6 prevents excessive abrasion between the enclosure 5 and the cable 19. When the enclosure 5 contacts the cable 19, the contact is generally restricted to the light touching of the brushes 51 and the riding of the load-bearing surfaces 60. The brushes 51 do not pressure seal the interior of the enclosure 5, nor are the brushes primary load-bearing surfaces. Rather, the brushes 51 only brush contaminants off of the cable 19 and contain airborne and excess lubricant within the enclosure. The load-bearing surfaces 60 are easily replaced by replacing the outer portions 49.

Heated and filtered lubricant is pumped through a high pressure flexible line 32 and a quick disconnect coupling 39 to feeder line 41. The high pressure flexible line 32, coupling 39 and feeder line 41 are tolerant to high

pressure and high temperature and are made to withstand pressure in the order of at least 6,000 psi and 150 degrees Fahrenheit.

Feeder line 41 connects to four spray nozzles 43 which are oriented toward the normal surface of the cable 19 from four equally spaced spray locations. Preferably, the spray nozzles 43 are diametrically directed at 90 degree intervals about the cable 19. The feeder line 41 is suitably connected to the spray nozzles 43 and is secured to the lower part 35 of the enclosure 5 so that the cable 19 can be placed through an upper opening of the feeder line 41 into the center of the area sprayed by the spray nozzles 43. Spray nozzles 43 which have been proved suitable for this purpose are tungsten carbide spray nozzles ARO#TC725 which have an approximate spray angle of 45 degrees towards the cross section of the cable and an approximate spray angle of 60 degrees along the length of the cable. The angle of spray enables the lubricant to impinge upon the cable 19 as the cable 19 traverses through the enclosure 5 from the entrance 36 to the exit 38 in the direction shown by the arrow 31.

Brushes 51 are located within the recesses 53 of the outer portions 49. The brushes 51 are urged toward the cable 19 by springs 55. The brushes 51 sweep the cable 19 as it enters and exits the enclosure 5. The brushes 51 at the entrance 36 remove water, seaweed, dust, dirt and other contaminants from the surface of the cable 19 as the cable 19 enters the enclosure 5. The brushes 51 at the exit 38 remove excess lubricant from the cable 19 as the cable 19 exits the enclosure 5. The brushes 51 also act as barriers to contain airborne lubricant within the enclosure 5. The brushes 51 are preferably made of stiff filaments which are sufficiently stiff to remove the contaminants and contain the excess lubricant while still being sufficiently pliable to conform to the uneven

surface of the cable. The filaments may be made of metal, nylon or any other suitable abrasion resistant material unaffected by the lubricant and the elevated temperature of the lubricant.

Alternatively, the brushes 51 may take the form of multiply overlapping curtains which form an iris. The curtains define the entrance 36 and exit 38 to the enclosure 5. The curtains may be made out of one half-inch to one inch (1/2" - 1") rubber sheeting. The curtains are not primary load-bearing surfaces but rather are only slightly urged against the cable 19 to contain the airborne and excessive lubricant within the enclosure 5 and brush contaminants off the cable 19 at the entrance 36.

The entrance 36 is sloped with a first funnel-shaped bevel 34 to gather irregularities on the surface of the cable 19 and to facilitate the removal of the contaminants from the entrance 36 as the contaminants are brushed from the surface of the cable 19. The first funnel-shaped bevel 34 is shaped with the wider diameter of the opening towards the outer side of the entrance 36 and the narrower diameter of the opening towards the inner side of the entrance 36.

The inner side of the exit 38 has a second funnel-shaped bevel 40 to gather irregularities on the surface of the cable and to facilitate the removal of the excess lubricant as it is brushed from the surface of the cable 19. Excess lubricant drains down along the brushes 51 of the exit 38 towards the funnel-shaped bottom 25 to drain through the first flexible drain line 27.

Referring to Figure 4, the schematic diagram of the circulating system shows the spray nozzles 43 spraying lubricant upon a centrally located cross section of cable

19 within the enclosure 5. The funnel-shaped bottom 25 of enclosure 5 communicates through a first flexible drain line 27 to a first filter 65. The first filter 65 communicates through a second flexible drain line 28 to a storage tank 67. In the preferred embodiment, the first flexible drain line 27 and second flexible drain line 28 are made from nylon hose having a one inch (1 in.) diameter. The excess lubricant drains downwardly through the funnel-shaped bottom 25 and to the first filter 65 through the first flexible drain line 27. The first filter 65 removes water and contaminants from the drained lubricant which may interfere with the quality of the lubricant in the storage tank. The drained lubricant at this point has first viscosity and a first temperature. The drained lubricant then travels from the first filter 65 through the second flexible drain line 28 to the storage tank 67.

An external heater 69 elevates the temperature of the lubricant within the storage tank 67 from the first temperature and the first viscosity to a second temperature and second viscosity. The first temperature is cooler than the second temperature and the first viscosity is more viscous than the second viscosity. The second temperature of the lubricant should be at least 150 degrees Fahrenheit (150° F.). The external heater 69 may be electrically powered such as with resistive elements strapped onto the surface of the storage tank 67. The lubricant may alternatively be heated by advantageously conducting engine cooling lines or diesel injection lines external to the lubricant storage tank to use waste heat from these sources to elevate the temperature of the lubricant.

The lubricant travels from the storage tank 67 through a second flexible line 57 to a second filter 71. The second filter 71 further removes water and contaminants from the

lubricant. The purpose of this second filter 71 is to assure that particles and other contaminants will not damage the pump 73 nor clog the spray nozzles 43. A double stage filter, where the first filter stage removes large contaminants and the second filter stage removes fine contaminants is preferred.

The lubricant travels from the second filter 71 through a third flexible line 58 to the suction end or supply side of a circulating pump 73. The circulating pump 73 increases the pressure of the hot lubricant. As is illustrated in Figure 4, the circulating pump 73 may be mounted near or upon the fairleads assembly 9. The lubricant having said second temperature, said second viscosity, and said elevated pressure travels from the circulating pump 73 through the high pressure flexible line 32 and quick disconnect coupling 39 into the feeder line 41. Both the high pressure flexible line 32 and the feeder line 41 are made from high pressure and high temperature tolerant materials. The lubricant is then injected or impinged at a very high velocity into the cable 19.

This invention also incorporates an optional cleaning cycle to facilitate the periodic maintenance of this device and the surrounding area. During the cleaning cycle an electrical switching system or power switching system may be engaged so that the circulating pump 73 may operate at times other than when the cable is being reeled in. The cleaning cycle comprises the connection of a first valve 75 to the third flexible line 58 and the connection of a second valve 77 to the high pressure flexible line 32. By engaging the first valve 75, the supply of lubricant may be terminated and a cleaning solution, obtained from a cleaning solution storage vessel 79, may be introduced to the system. The three-position second valve 77 located on the high pressure side of the

circulating pump 73 may be engaged to circulate the cleaning solution to either the spray nozzles 43, to an exterior hand-held spray nozzle 81, or to a wide angle spray nozzle 83 which is located within the lubricant storage tank 67.

Once the lubricant is drained from the storage tank 67 through the drain 68, the first valve 75 is set to disconnect the suction end of the circulating pump 73 from the second filter 71 and connect the suction or supply end of the circulating pump 73 to the cleaning solution storage vessel 79. By selecting a first position on the second valve 77, the cleaning solution can be pumped to the spray nozzles 43 located within the enclosure 5 and thereby clean the interior of the enclosure 5, the funnel-shaped bottom 25, the first flexible drain line, the first filter and the second flexible drain line. By selecting a second position on the second valve 77, the interior surfaces of the storage tank 67 can be high pressure sprayed by the cleaning solution through a wide angle nozzle 83. By selecting a third position on the second valve 77, other nearby equipment or cables may be sprayed with the exterior hand-held spray nozzle 81. After draining the storage tank 67 of the cleaning solution, the system may be recharged with new lubricant by pouring it into the lower part 35 of the enclosure 5.

The foregoing detailed description has been given for clearness of understanding. Since modifications will be obvious to those skilled in the art, it should be understood that this invention includes variations thereof and is not subject to unnecessary limitations.

In operation, the enclosure 5 is attached to the cable 19 by disengaging the upper part 33 from the lower part 35 by unconnecting the first side latch 37 and second side latch. The lower part 33 is placed against the cable 19

so a portion of the cable 19 spans the enclosure 5 from the entrance 36 to the exit 38 between the entrance and exit brushes 51. The feeder line 41 fits around the cable 19 so that the cable 19 is centrally located between the spray nozzles 43. The upper part 33 is placed upon the lower part 35. The upper part 33 and lower part 35 are then locked together by engaging the first side latch 37 and the second side latch, located on each side of the enclosure 5.

On a typical winch, the fairlead assembly 9 is coupled to move back and forth laterally during the reeling operation. This permits the orderly laying of the cable 19 onto the cable drum 21. The enclosure 5 is mounted on a gimballed, slidable rectangular frame assembly 6. The rectangular frame assembly 6 is then mounted to the fairlead assembly in such a manner as to allow the free pivotal, lateral and vertical movement of the enclosure 5 about the cable 19 during the reeling procedure.

The first flexible drain line 27 and the feeder line 41 interconnect the enclosure 5 and the rest of the assembly. The storage tank 67, external heater 69, the first filter 65, the second filter 71, the circulating pump 73, the first valve 75, and the second valve 77 are all conveniently placed at a position near the fairlead assembly 9, usually below the enclosure 5. In this way, excess lubricant drains by gravity through the funnel-shaped bottom 25 and the first flexible drain line 27 to the first filter 65. Although the placement of the storage tank 67 is generally below the enclosure 5 so that the excess lubricant can drain through the first filter 65 to the storage tank by gravity, it may be necessary to incorporate the use of a second pump to deliver the lubricant or cleaning solution from the first filter 65 to the storage tank 67. This is particularly necessary where the storage tank 67 is placed far away from the enclosure

5 or when the storage tank 67 is placed at about the same elevation or above the enclosure 5.

The lubricant in the storage tank 67 is heated to a temperature above 150 degrees Fahrenheit (150° F.). The circulating pump 73 operates whenever the cable drum 21 reels in the cable 19. As the cable 19 is being reeled, the brushes 51 at the entrance 36 of enclosure 5 remove the contaminants on the surface of the cable 19.

Under the suction of the circulating pump, the lubricant is filtered through the second filter 71 and fed into the suction or supply side of the circulating pump 73. The lubricant is then pumped under a pressure through the high pressure flexible line 32, the quick disconnect coupling 39 and the feeder line 41 to the spray nozzles 43. The heated lubricant is sprayed under a high pressure and with great velocity onto the cable 19 as the cable passes through the enclosure 5 while the cable 19 is being reeled onto the cable drum 21. The high temperature, reduced viscosity, and high pressure of the lubricant assures the penetration of the heated lubricant between the strands of the cable 19. The working and movement of the cable 19 moves and opens spaces between the cable 19 strands. This movement assists the penetration of the lubricant between the strands. After application, the lubricant eventually cools within the cable 19 becoming more viscous and relatively immobile.

The brushes 51 act to contain the excess and airborne lubricant within the enclosure 5. The brushes 51 at the exit 38 of the enclosure remove the excess lubricant from the cable 19. The excess lubricant within the enclosure 5 drains into the funnel-shaped bottom 25, through the first flexible drain line 27 and into the first filter 65. The excess lubricant is transferred from the first filter 65

through the second flexible drain line 28 into the storage tank 67 where the lubricant is reheated and recycled.

INDUSTRIAL APPLICABILITY

The invention may be used wherever service lubricating of metal haulage cables is required. The use of this invention is particularly advantageous in situations where space is limited such as in winch assemblies on tug boats and fishing vessels. Cables used with boat winches often undergo long periods of severe tension in salt water, where corrosion of the cable is accelerated unless the cables are properly maintained and lubricated.

With this invention, cables can be automatically lubricated with a high velocity, heated lubricant whenever the cable is reeled. The penetration of the lubricant between the cable strands is enhanced the decreased viscosity of the heated lubricant and by the working of the strands during the reeling operation. The enclosure may be pivotally attached to a sliding and pivotal assembly which permits the angular, vertical, and lateral movement of the enclosure and the proper orientation of the cable while the cable is being reeled. The enclosure may also be positioned to surround a portion of the haulage cable as the cable is pulled between stationary guides or pulley wheels. The lubricant is applied to the cable as the cable passes through the enclosure. The excess lubricant pools within the enclosure and is returned through multiple filters to a nearby heated lubricant storage tank where the lubricant may be reused.

CLAIMS

I Claim:

1. An apparatus for lubricating a cable with a lubricant comprising:

(a) an enclosure, said enclosure having an entrance and an exit, said cable traversing said enclosure between said entrance and said exit;

(b) a load-bearing surface located within said enclosure, said load-bearing surface supporting said enclosure on said cable;

(c) a lubricant spray means located inside said enclosure, said lubricant spray means spraying said lubricant towards said cable; and

(d) a wiping means located between said exit and said lubricant spray means, said wiping means providing an overspray collection curtain to restrict the passage of the excess of said lubricant from said exit.

2. The apparatus of Claim 1, further comprising a second wiping means located near said entrance, said second wiping means wiping said cable as said cable enters said enclosure;

3. The apparatus of Claim 1, wherein said load-bearing surface approximates the diameter of said cable.

4. The apparatus of Claim 1, wherein said load-bearing surface defines said entrance.

5. The apparatus of Claim 1, wherein said load-bearing surface defines said exit.

6. The apparatus of Claim 1, wherein said entrance is configured with a funnel-shaped bevel, said funnel-shaped bevel having a wider diameter located towards the outer side of said entrance and a narrower diameter located towards the inner side of said entrance.

7. The apparatus of Claim 1, wherein said exit is configured with a funnel-shaped bevel, said funnel-shaped bevel having a wider diameter located towards the inner side of said exit and a narrower diameter located towards the outer side of said exit.

8. The apparatus of Claim 1, wherein said enclosure further comprises a funnel-shaped bottom, said funnel-shaped bottom pooling the excess of said lubricant.

9. The apparatus of Claim 1, further comprising a frame assembly, said frame assembly comprising:

(a) a lateral pin pivotally connected to said enclosure;

(b) a lateral slide mount pivotally connected to said lateral pin;

(c) a vertical track slidably connected to said lateral slide mount;

(d) a horizontal track securely attached at approximately right angles to said vertical track;

(e) a vertical pin pivotally connected to said horizontal track; and

(f) a vertical slide mount pivotally connected to said vertical pin.

10. The apparatus of Claim 1, further comprising a circulation system, said circulation system comprising:

(a) a storage tank communicating to said enclosure, said storage tank storing said lubricant; and

(b) a circulating pump communicating from said storage tank to said lubricant spray means within said enclosure, said circulating pump circulating said lubricant to said lubricant spray means from said storage tank at an elevated pressure.

11. The apparatus of Claim 10, further comprising a second filter communicating between said storage tank and said circulating pump, said second filter filtering said lubricant as it travels from said storage tank to said circulating pump.

12. The apparatus of Claim 10, further comprising a return means for returning the excess of said lubricant to said storage tank after said lubricant has been sprayed on said cable.

13. The apparatus of Claim 12, wherein said return means comprises a first filter communicating between said enclosure and said storage tank, said first filter filtering said lubricant as it travels from said enclosure to said storage tank.

14. The apparatus of Claim 10, further comprising a heat means, said heat means heating said lubricant within said storage tank to an elevated temperature.

15. The apparatus of Claim 1, further comprising a circulating means for circulating a cleaning solution through said apparatus, said circulating means comprising a drain on said storage tank, said lubricant being replaced with said cleaning solution, said circulating pump circulating said cleaning solution through said apparatus.

16. The apparatus of Claim 15, wherein said circulating means further comprises:

(a) a cleaning solution spray means located within said storage tank; and

(b) a second valve communicating between said circulating pump and said cleaning solution spray means within said storage tank, said second valve directing said cleaning solution from said circulating pump to said cleaning solution spray means within said storage tank, said cleaning solution spray means within said storage tank spraying the interior surfaces of said storage tank.

17. The apparatus of Claim 15, wherein said circulating means further comprises:

(a) an exteriorly positioned cleaning solution spray means for spraying cleaning solution on and about the exterior of said apparatus; and

(b) a second valve communicating between said circulating pump and said exteriorly positioned cleaning solution spray means, said second valve directing said cleaning solution from said circulating pump to said exteriorly positioned cleaning solution spray means.

18. The apparatus of Claim 17, wherein said exteriorly positioned cleaning solution spray means is hand-held.

19. An recirculating apparatus using a lubricant to lubricate a cable comprising:

(a) a storage tank, said storage tank storing said lubricant, said lubricant comprising a first viscosity at a first temperature and a second viscosity at a second temperature, said first temperature being cooler than said second temperature, said first viscosity being more viscous than said second viscosity;

(b) a heater connected to said storage means, said heater changing said lubricant from said first temperature and said first viscosity to said second temperature and said second viscosity;

(c) a pump connected to said storage tank, said pump pumping said lubricant at said second temperature and said second viscosity from said storage tank to a spray nozzle, said spray nozzle directing said lubricant radially inward toward a portion of said cable, said lubricant leaving said spray nozzle at a high velocity and impinging upon said portion of said cable, said cable comprising multiple strands, said lubricant covering and penetrating between said strands of said portion of said cable; and

(d) an enclosure enclosing said spray nozzle and said portion of said cable, said enclosure comprising an entrance, an exit and a bottom, said portion of said cable entering said enclosure at said entrance, traversing said enclosure and exiting said enclosure at said exit, said entrance comprising a first brush to remove contaminants from the surface of said portion of said cable as said portion of said cable enters said enclosure, said exit comprising a second brush to remove excess lubricant from said cable as said portion of said cable exits said enclosure, said first brush, said second brush, and said enclosure generally enclosing the airborne and excess lubricant, said bottom being configured to pool said excess lubricant, said excess lubricant being pooled at said bottom of said enclosure, said pump returning said pooled excess lubricant from said bottom of said enclosure to said storage tank.

20. The apparatus of Claim 14, wherein said heat means comprises an electrical resistive element suitably connected to an electrical power source.

21. The apparatus of Claim 14, wherein said heat means employs waste heat derived from machinery associated with the haulage of said cables.

22. The apparatus of Claim 1, wherein said wiping means comprises a brush arranged to surround said cable as said cable enters said exit.

23. The apparatus of Claim 1, wherein said second wiping means comprises a brush arranged to surround said cable as said cable enters said entrance.

24. The apparatus of Claim 22, further comprising a spring means to bias said wiping means against the surface of said cable as said cable enters said exit.

25. The apparatus of Claim 23, further comprising a spring means to bias said second wiping means against the surface of said cable as said cable enters said entrance.

26. The apparatus of Claim 1, wherein said load-bearing surface is made of ultra high molecular weight polyethylene having the properties of being inert to said elevated temperature of said lubricant.

27. The apparatus of Claim 13, further comprising a second circulating pump returning said lubricant from said first filter to said storage tank.

28. The apparatus of Claim 10, wherein said circulating pump operates whenever said cable is being reeled.

AMENDED CLAIMS

[received by the International Bureau on 12 October 1987 (12.10.87);
original claims 1, 2 and 19 amended; other claims unchanged
(5 pages)]

1. An apparatus for lubricating a cable with a lubricant comprising:

(a) an enclosure, said enclosure having an entrance and an exit, said cable traversing said enclosure between said entrance and said exit;

(b) a load-bearing surface located within said enclosure, said load-bearing surface supporting said enclosure on said cable;

(c) one or more lubricant spray means located inside said enclosure, each of said lubricant spray means projecting lubricant in a conical spray directly toward said cable, such that the axis of said conical spray lies in a plane defined by a perpendicular cross section of said cable taken at the point at which the axis of said spray cone impinges upon said cable; and; and

(d) a wiping means located between said exit and said lubricant spray means, said wiping means providing an overspray collection curtain to restrict the passage of the excess of said lubricant from said exit.

2. The apparatus of Claim 1, further comprising a second wiping means located near said entrance, said second wiping means wiping said cable as said cable enters said enclosure.

3. The apparatus of Claim 1, wherein said load-bearing surface is a hollow cylinder having a diameter approximately equal to said cable.

4. The apparatus of Claim 1, wherein said load-bearing surface defines said entrance.

5. The apparatus of Claim 1, wherein said load-bearing surface defines said exit.

6. The apparatus of Claim 1, wherein said entrance is configured with a funnel-shaped bevel, said funnel-shaped bevel having a wider diameter located towards the outer side of said entrance and a narrower diameter located towards the inner side of said entrance.

7. The apparatus of Claim 1, wherein said exit is configured with a funnel-shaped bevel, said funnel-shaped bevel having a wider diameter located towards the inner side of said exit and a narrower diameter located towards the outer side of said exit.

8. The apparatus of Claim 1, wherein said enclosure further comprises a funnel-shaped bottom, said funnel-shaped bottom pooling the excess of said lubricant.

9. The apparatus of Claim 1, further comprising a supporting frame assembly, said frame assembly comprising:

(a) a lateral pin pivotally connected to said enclosure;

(b) a lateral slide mount pivotally connected to said lateral pin;

(c) a vertical track slidably connected to said lateral slide mount;

(d) a horizontal track securely attached at approximately right angles to said vertical track;

(e) a vertical pin pivotally connected to said horizontal track; and

(f) a vertical slide mount pivotally connected to said vertical pin.

10. The apparatus of Claim 1, further comprising a circulation system, said circulation system comprising:

(a) a storage tank communicating to said enclosure, said storage tank storing said lubricant; and

(b) a circulating pump communicating from said storage tank to said lubricant spray means within said enclosure, said circulating pump circulating said lubricant to said lubricant spray means from said storage tank at an elevated pressure.

11. The apparatus of Claim 10, further comprising a second filter communicating between said storage tank and said circulating pump, said second filter filtering said lubricant as it travels from said storage tank to said circulating pump.

12. The apparatus of Claim 10, further comprising a return means for returning the excess of said lubricant to said storage tank after said lubricant has been sprayed on said cable.

13. The apparatus of Claim 12, wherein said return means comprises a first filter communicating between said enclosure and said storage tank, said first filter filtering said lubricant as it travels from said enclosure to said storage tank.

14. The apparatus of Claim 10, further comprising a heat means, said heat means heating said lubricant within said storage tank to an elevated temperature.

15. The apparatus of Claim 1, further comprising a circulating means for circulating a cleaning solution through said apparatus, said circulating means

comprising a drain on said storage tank, said lubricant being replaced with said cleaning solution, said circulating pump circulating said cleaning solution through said apparatus.

16. The apparatus of Claim 15, wherein said circulating means further comprises:

(a) a cleaning solution spray means located within said storage tank; and

(b) a second valve communicating between said circulating pump and said cleaning solution spray means within said storage tank, said second valve directing said cleaning solution from said circulating pump to said cleaning solution spray means within said storage tank, said cleaning solution spray means within said storage tank spraying the interior surfaces of said storage tank.

17. The apparatus of Claim 15, wherein said circulating means further comprises:

(a) an exteriorly positioned cleaning solution spray means for spraying cleaning solution on and about the exterior of said apparatus; and

(b) a second valve communicating between said circulating pump and said exteriorly positioned cleaning solution spray means, said second valve directing said cleaning solution from said circulating pump to said exteriorly positioned cleaning solution spray means.

18. The apparatus of Claim 17, wherein said exteriorly positioned cleaning solution spray means is hand-held.

19. A recirculating apparatus using a lubricant to lubricate a cable comprising:

(a) a storage tank, said storage tank storing said lubricant, said lubricant comprising a first

viscosity at a first temperature and a second viscosity at a second temperature, said first temperature being cooler than said second temperature, said first viscosity being more viscous than said second viscosity;

(b) a heater connected to said storage means, said heater changing said lubricant from said first temperature and said first viscosity to said second temperature and said second viscosity;

(c) a pump connected to said storage tank, said pump pumping said lubricant at said second temperature and said second viscosity from said storage tank to a spray nozzle, said spray nozzle directing said lubricant radially inward toward a portion of said cable, said lubricant leaving said spray nozzle at a high velocity and impinging upon said portion of said cable, said cable comprising multiple strands, said lubricant covering and penetrating between said strands of said portion of said cable; and

(d) an enclosure enclosing said spray nozzle and said portion of said cable, said enclosure comprising an entrance, an exit and a bottom, said portion of said cable entering said enclosure at said entrance, traversing said enclosure and exiting said enclosure at said exit, said entrance comprising a first brush to remove contaminants from the surface of said portion of said cable as said portion of said cable enters said enclosure, said exit comprising a second brush to remove excess lubricant from said cable as said portion of said cable exits said enclosure, said first brush, said second brush, and said enclosure generally enclosing the airborne and excess lubricant, said bottom being configured to pool said excess lubricant, said excess lubricant being pooled at said bottom of said enclosure, said pump returning said pooled excess lubricant from said bottom of said enclosure to said storage tank.

STATEMENT UNDER ARTICLE 19

Amendments have been made to the above-referenced international application following receipt of the International Search Report. The amendments introduce no new matter, but serve to further restrict the scope of the claimed subject matter as originally disclosed in this application.

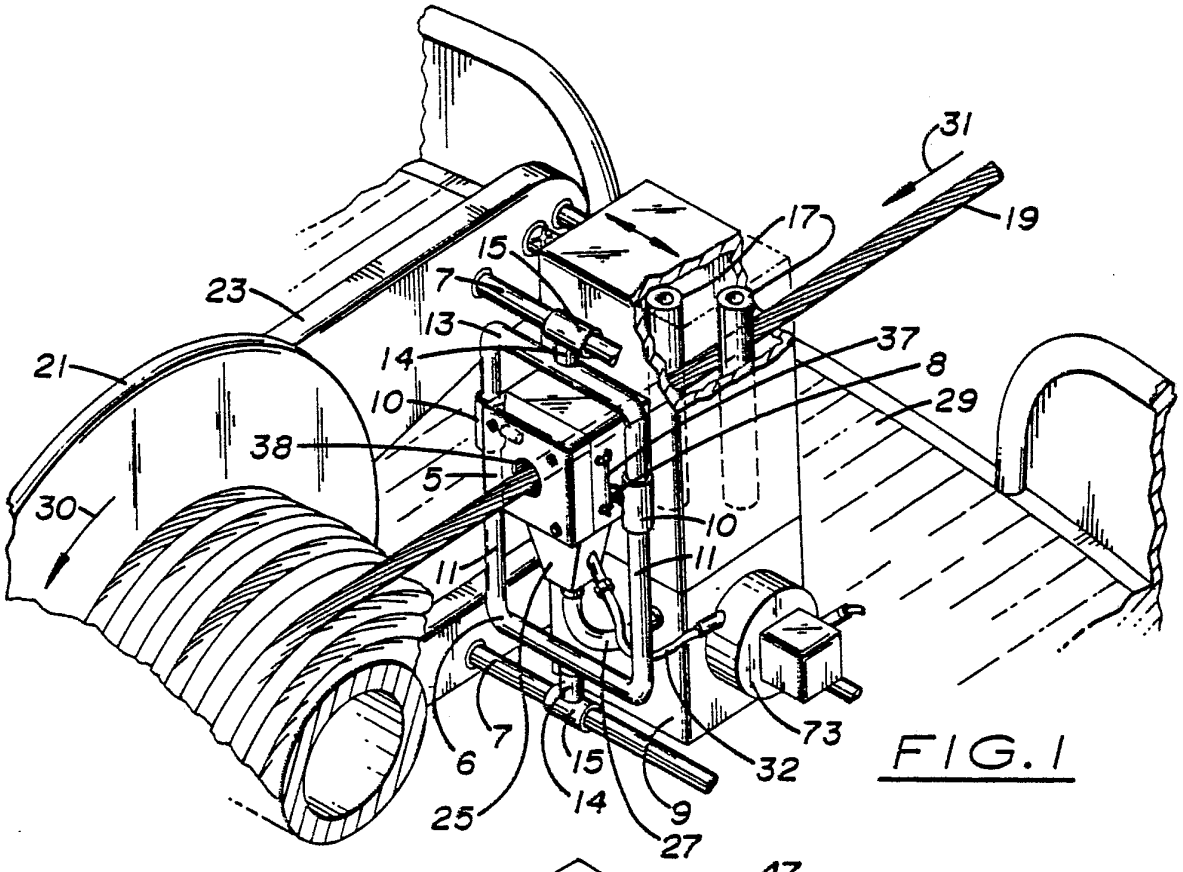

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FIG. 1

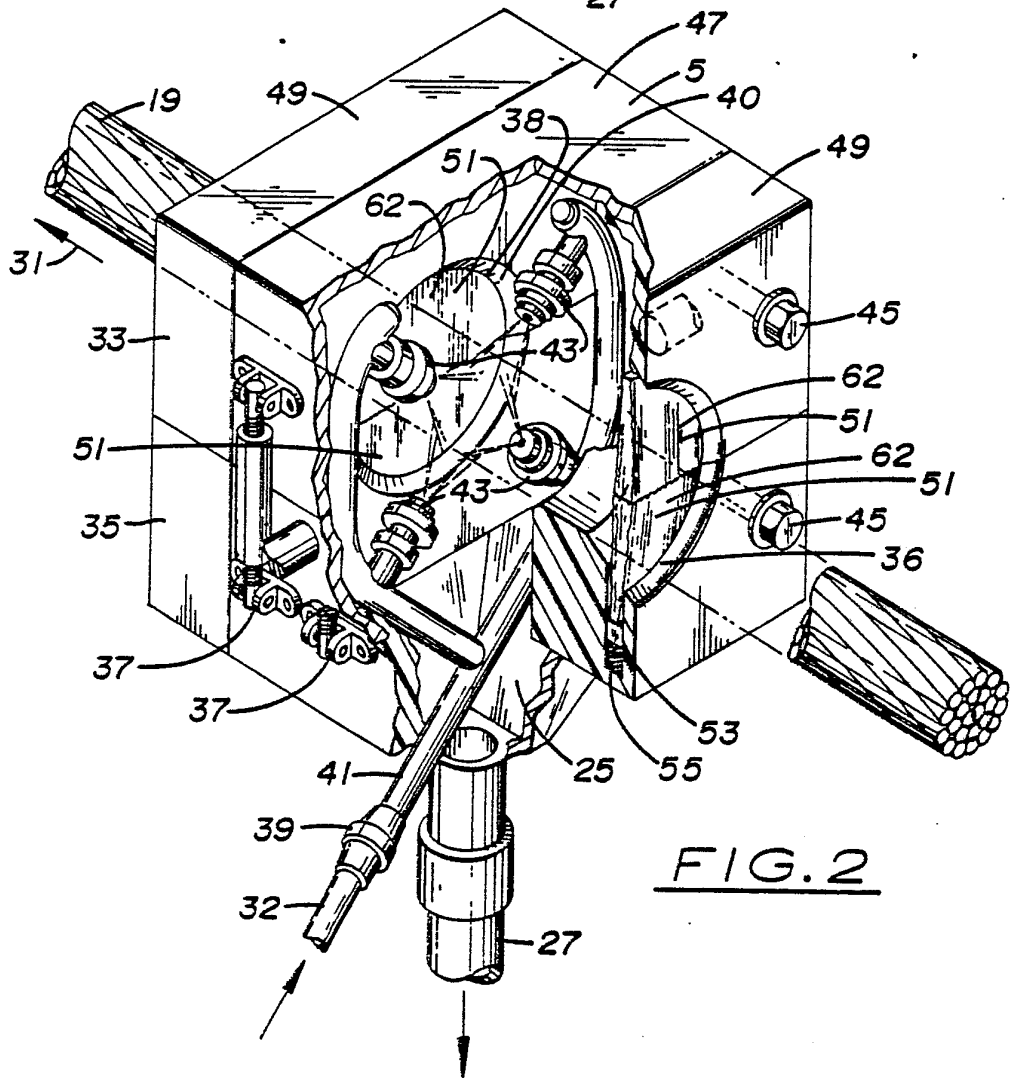

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FIG. 2

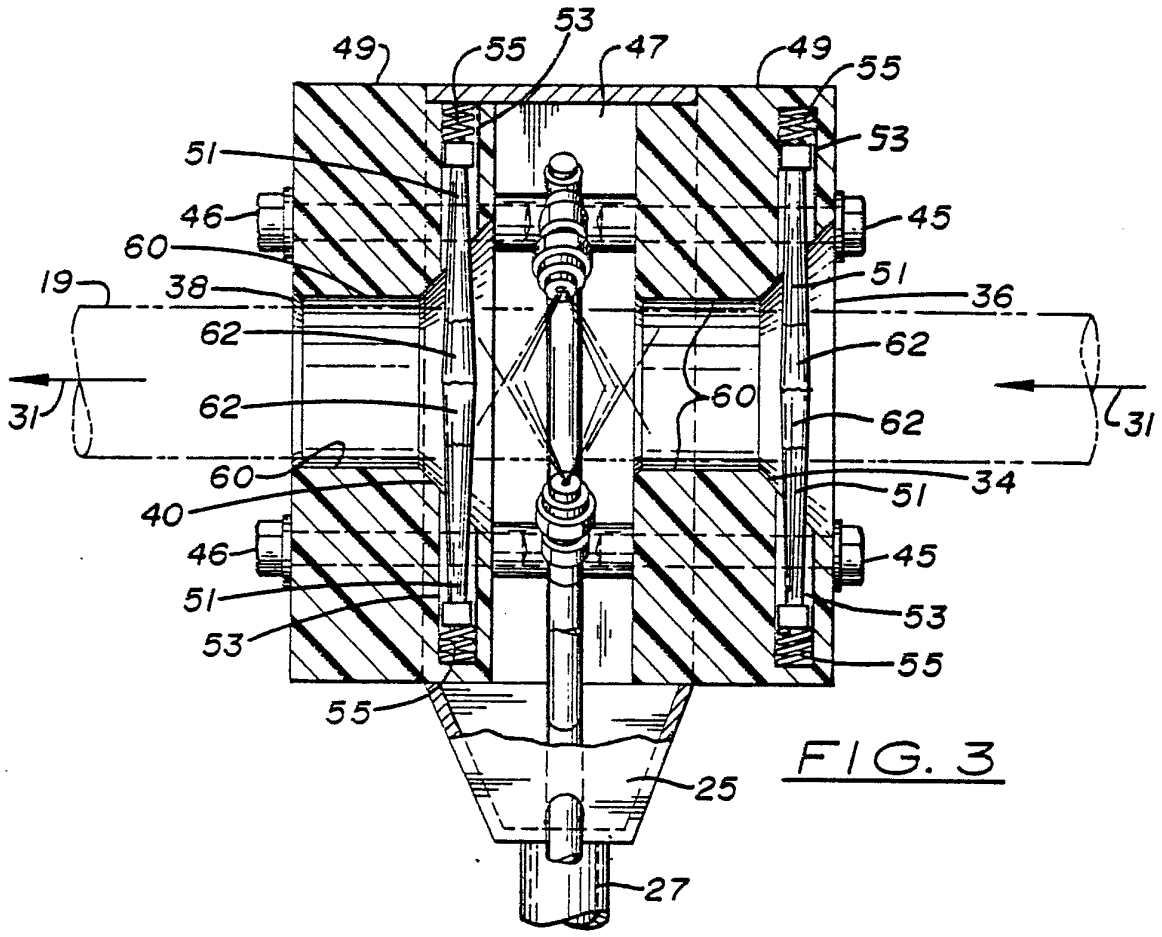

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FIG. 3

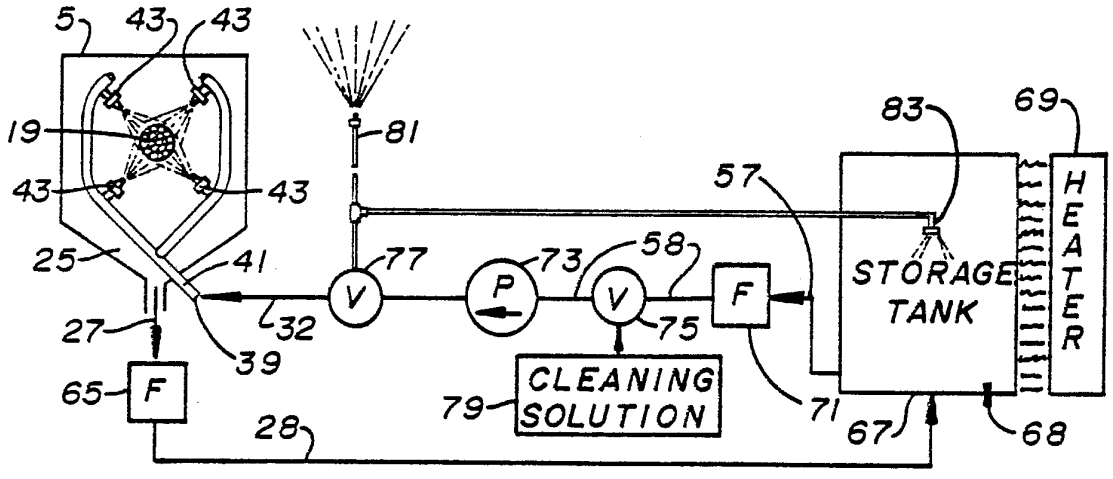

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HEATER
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STORAGE TANK
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CLEANING SOLUTION
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FIG. 4

INTERNATIONAL SEARCH REPORT

International Application No PCT/US87/01431

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [3]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC 4 B05B 13/02

U.S. CL. 118/324, 325

II. FIELDS SEARCHED

Minimum Documentation Searched [4]

Classification System	Classification Symbols
U.S.	15/256.6; 118/72,109,125,302,307,316,326,603; 184/15.1,15.2,15.3,16;242/157.1,158.R; 524/382, 389,390,413

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [5]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [14]

Category *	Citation of Document, [16] with indication, where appropriate, of the relevant passages [17]	Relevant to Claim No. [18]
X Y	US, A, 296,440 PUBLISHED 08 APRIL 1884 (OLIVER)	6-7
A	US, A, 348,535 PUBLISHED 31 AUGUST 1886 (ROSENBLATT)	
X Y	US, A, 1,471,583 PUBLISHED 23 AUGUST 1923 (ANDERSEN)	9
A	US, A, 1,509,906 PUBLISHED 30 SEPTEMBER 1924 (SAWTELLE)	
X Y	US, A, 1,575,526 PUBLISHED 02 MARCH 1926 (BOCHER)	14, 19-21
X Y	US, A, 1,649,184 PUBLISHED 15 NOVEMBER 1927 (POSEY)	9
X Y	US, A, 1,829,831 PUBLISHED 03 NOVEMBER 1931 (HISKEY)	18

* Special categories of cited documents: [15]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search [2]	Date of Mailing of this International Search Report [2]
21 JULY 1987	06 AUG 1987
International Searching Authority [1]	Signature of Authorized Officer [20]
ISA/US	ALAIN L. BASHORE

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category *	Citation of Document, [16] with indication, where appropriate, of the relevant passages [17]	Relevant to Claim No [18]
A	US, A, 2,140,426 PUBLISHED 13 DECEMBER 1938 (HODSON)	
X/Y	US, A, 2,429,915 PUBLISHED 28 OCTOBER 1947 (BELL)	22-23
A	US, A, 2,660,382 PUBLISHED 24 NOVEMBER 1953 (WILSON)	
A	US, A, 2,858,555 PUBLISHED 04 NOVEMBER 1958 (MEDOVICK)	
A	US, A, 3,306,310 PUBLISHED 28 FEBRUARY 1967 (GRANT)	
X/Y	US, A, 3,815,846 PUBLISHED 11 JUNE 1974 (BIEWER)	9
X/Y	US, A, 3,851,623 PUBLISHED 03 DECEMBER 1974 (LANDRY, JR.)	13
A	US, A, RE. 29,493 PUBLISHED 13 DECEMBER 1977 (CRUMP)	
X/Y	US, A, 4,063,617 PUBLISHED 20 DECEMBER 1977 (SHENK)	6-7
X/Y	US, A, 4,089,295 PUBLISHED 16 MAY 1978 (THOMSON ET AL)	13
A	US, A, 4,169,427 PUBLISHED 02 OCTOBER 1979 (CRUMP ET AL)	
X/Y	US, A, 4,174,678 PUBLISHED 20 NOVEMBER 1979 (VAN DEN BERGH)	1-5
A	US, A, 4,336,866, PUBLISHED 29 JUNE 1982 (BLANTON, JR.)	

FURTHER INFORMATION CONTINUED FROM THE SECOND SHEET

X Y	US, A, 4,414,917 PUBLISHED 15 NOVEMBER 1983 (BENTLEY ET AL)	1-2, 8,10-12, 15-17, 26-28
A	US, A, 4,422,529 PUBLISHED 27 DECEMBER 1983 (JOHANSEN)	
A	US, A, 4,498,558 PUBLISHED 12 FEBRUARY 1985 (BENDAHAN)	
X Y	US, A, 4,570,285 PUBLISHED 18 FEBRUARY 1986 (SKELTON)	24-25
A	US, A, 4,592,521 PUBLISHED 03 JUNE 1986 (HALLIKAS ET AL)	

V. ☐ OBSERVATIONS WHERE CERTAIN CLAIMS WERE FOUND UNSEARCHABLE [10]

This international search report has not been established in respect of certain claims under Article 17(2) (a) for the following reasons:

1. ☐ Claim numbers . because they relate to subject matter [12] not required to be searched by this Authority, namely:

2. ☐ Claim numbers . because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out [13], specifically:

VI. ☐ OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING [11]

This International Searching Authority found multiple inventions in this international application as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims of the international application.

2. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims of the international application for which fees were paid, specifically claims:

3. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claim numbers:

4. ☐ As all searchable claims could be searched without effort justifying an additional fee, the International Searching Authority did not invite payment of any additional fee.

Remark on Protest

☐ The additional search fees were accompanied by applicant's protest.

☐ No protest accompanied the payment of additional search fees.