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1 "Apparatus and Method for Use in Handling a Load"

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3 This invention relates to apparatus for use in handling
4 a load which is capable of raising and lowering, or of
5 towing, a load and also handling service cables and/or
6 hoses connected to the load. The invention is
7 particularly, but not exclusively, applicable to the
8 handling of subsea equipment such as grabs.

9

10 Hitherto, providing services to underwater equipment
11 has required the provision of a specific bundle of
12 cable(s) and/or hose(s) dedicated to each application.
13 For some applications, it is known to incorporate the
14 service bundle within an armoured hoist rope. This
15 approach has a number of deficiencies. The resulting
16 rope is costly, gives inferior hoisting properties, and
17 by virtue of limitations on the diameter of rope which
18 can be handled the services which can be incorporated
19 are limited. Further, in practice it is impossible
20 with this arrangement to add to the length of the rope
21 or to join different types of materials, for example
22 wire ropes with fibre ropes.

1 It is also known from our previous application
2 PCT/GB96/00158 (WO-A-9622935) to wrap service cable
3 around a rope being paid out, and to unwrap the service
4 cable from the rope as the rope is recovered.

5

6 According to the present invention there is provided
7 apparatus according to claim 1.

8

9 The service cable holders can be drums.

10

11 Typically the wrapping device can recover the service
12 cables to their respective drums during recovery of the
13 rope and cables.

14

15 The term "service cable" is used herein to denote a
16 flexible elongate member used for conveying power or
17 data, such as an electrical cable, a fibre optic cable,
18 or a pneumatic or hydraulic hose.

19

20 Preferably, the service cables is wrapped helically
21 around the rope.

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1 Typically, the load-bearing rope will be a hoist rope
2 used for raising and lowering a load. Alternatively,
3 the load-bearing rope may be a towing rope used for
4 paying out, towing and recovering a load such as a
5 marine sensor array.

6
7 Preferably, the mechanism for paying out and recovering
8 the rope comprises a rope winch, from which the rope
9 passes over a rope sheave and thereafter extends to the
10 load along a substantially straight axis.

11
12 The wrapping device may comprise the or each service
13 cable drum being arranged for rotation about a drum
14 axis which coincides with said axis, the drum typically
15 having a central aperture through which the load-
16 bearing rope passes, said length of service cable
17 preferably passing over a service cable sheave which is
18 mounted for movement in a circular path around said
19 axis.

20
21 Alternatively, the or each service cable drum may be
22 rotatable on a structural member which is arranged for
23 movement in a circular path about said axis.

24
25 The hoist rope winch, the or each service cable drum,
26 and the wrapping device may conveniently each have a
27 respective driving motor; they could however be driven
28 by a single source through appropriate mechanical
29 linkages.

30
31 The first and second cables are typically wrapped
32 around the rope in different directions; for example,

1 the first cable can be wrapped onto the rope in an
2 anticlockwise direction and the second cable can be
3 wrapped around the rope in a clockwise direction so
4 that one cable overlays the other. This option is to
5 be preferred but the invention can also work well with
6 the service cables being wrapped in the same direction
7 but at different pitches of helix, so that one
8 overwraps the other.

9
10 The invention also provides apparatus according to
11 claim 19.

12
13 In a preferred embodiment the service cable is provided
14 on drum which is mounted on an arm which rotates around
15 the axis of the rope. The drum can be arranged to
16 rotate about a horizontal or a vertical axis.

17
18 The service cable holder is preferably mounted on an
19 arm that is preferably hinged to a frame and can be
20 provided with a lifting mechanism such as a hydraulic
21 ram to lift the arm with respect to the frame. Instead
22 of a hydraulic ram the lifting mechanism may be a

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1 screw-driven mechanism which can be electrically or
2 hydraulically powered.

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4 The invention also provides apparatus according to
5 claim 18.

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7 The invention also provides apparatus according to
8 claim 13.

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10 The invention also provides a method according to claim
11 20.

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1 Examples of apparatus and a method for use in handling
2 a load in accordance with the invention will now be
3 described with reference to the drawings, in which:-
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5 Fig. 1 is a schematic perspective view
6 illustrating the principle of operation of a first
7 winding device;

8 Fig. 2 is a more detailed side view, partly in
9 section, of an apparatus used in the example of
10 Fig. 1;

11 Fig. 3 is a view similar to Fig. 1 illustrating a
12 modification of the arrangement of Fig. 1;

13 Fig. 4 is a schematic perspective view
14 illustrating a second example;

15 Fig. 5 is a side view of an apparatus used in the
16 example of Fig. 4;

17 Fig. 6 is a schematic perspective view
18 illustrating a third example similar to that of
19 Fig. 1 but modified for towing rather than
20 lifting;

21 Fig. 7 illustrates a fourth example similar to
22 that of Fig. 4 but modified for towing rather than
23 lifting;

24 Fig. 8a is a schematic side view of a fifth
25 embodiment;

26 Fig. 8b is a close up view of the Fig. 8a
27 embodiment;

28 Fig. 8c shows in side sectional view some of the
29 components of the fifth embodiment;
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31
32

1 Fig. 9a shows a side sectional view of an arm
2 assembly of the fifth embodiment;
3 fig. 9b shows a side sectional view of a further
4 arm assembly of the fifth embodiment;
5 Figs. 10a and 10b show a side and top view
6 respectively of a sixth embodiment;
7 Fig. 11 shows a side view of a sleeve and bearing
8 of the sixth embodiment;
9 Fig. 12 shows a plan view of a main support plate
10 of the sixth embodiment;
11 Fig. 13 shows a plan view of bearings used in the
12 sixth embodiment;
13 Fig. 14 shows a plan view of gears used in the
14 sixth embodiment;
15 Fig. 15 shows a plan view of further gears used in
16 the sixth embodiment;
17 Fig. 16 shows an exploded side view of the drive
18 train in the sixth embodiment;
19 Fig. 17 shows a side view of a gearbox of the
20 sixth embodiment;
21 Fig 18 shows a seventh embodiment of a cable
22 winding device;
23 Fig 19 shows an eighth embodiment of a cable
24 winding device;
25 Fig 20 shows a ninth embodiment of a cable winding
26 device;
27 Fig. 21 shows a further embodiment of a winding
28 device;
29 Fig 22 shows a further device similar to the Fig.3
30 device; and
31 Fig.23 shows a further embodiment of a winding
32 device.

1 Reterring to Fig. 1, a prior art hoist rope 1 extends
2 from a hoist rope winch 13 over a hoist rope sheave 4
3 to support a load (not shown) for raising and lowering.
4 The hoist rope 1 may be any suitable form of hoist rope
5 such as flexible steel wire rope or synthetic fibre
6 rope, for example of "Kevlar". A service cable 2 is
7 reeled on a service cable drum 3 and extends to the
8 load via a service cable sheave 5.

9
10 The hoist rope 1 passes through a central aperture of
11 the service cable drum 3, and the service cable sheave
12 5 is arranged to be driven circumferentially around the
13 axis of the service cable 1. By coordinating the
14 movements of the hoist rope winch 13, the service cable
15 drum 3 and the service cable sheave 5, the service
16 cable 2 can be wrapped helically around the hoist rope
17 1 as the load is lowered, and unwrapped as the load is
18 raised. In this way, a hoist rope of any desired
19 properties can be used in combination with any required
20 service connection.

21
22 Further service cables on other drums can be added to
23 be rotated by the motor in different directions.

24
25 Fig. 2 shows the service cable drum 3 and associated
26 parts in greater detail. The hoist rope sheave 4 is
27 journaled to a fixed frame 20 which is secured to any
28 suitable supporting structure (not shown). The service
29 cable drum 3 is rotatably mounted on the lower part of
30 the frame 20 and driven in rotation by a motor 6.

31

1 The inner end of the service cable 2 is connected to
2 the appropriate service by a coupling assembly 8 which
3 comprises a slip ring arrangement in the case of
4 electrical or fibre optic services or a rotary coupling
5 in the case of pneumatic or hydraulic services; such
6 rotary couplings are well known per se.

7
8 The service cable sheave 5 is journaled on a mounting
9 frame 9 which is rotatable about the fixed frame 20 by
10 means of a motor 7.

11
12 The service cable 2 shown in this embodiment may be a
13 single cable or hose, or may be a specially made cable
14 comprising a plurality of cable(s)/hose(s).

15
16 The motors 6 and 7 are driven at speeds related to the
17 axial speed of the hoist rope 1. The speed correlation
18 may be fixed. Preferably, however, this correlation
19 will be controllable to alter both the length of twist
20 (pitch) of the lay of the service cable 2 on the hoist
21 rope 1, and the tension in the service cable 2.

22
23 Fig. 3 shows a modification in which a second service
24 cable 17 is wrapped on the hoist rope 1 along with the
25 service cable 2. In this modification, the service
26 cables 2, 17 are each provided with a respective
27 storage drum 15, 16 and a respective sheave 5, 14 which
28 may suitably be carried on a common supporting frame
29 for rotation in unison. The drum 14 revolves in an
30 opposite direction to the drum 5 around the rope's
31 axis, so that the second service cable 17 is wrapped

1 around the rope 1 in the opposite direction to that of
2 the first cable 2.

3

4 The apparatus may be further modified by adding further
5 drums and sheaves to handle more services. At least
6 one service cable is overwrapped on the others, and
7 this is preferably the last one to be applied so that
8 the overwrapping cable is at the outer surface of the
9 wrapped assembly.

10

11 Fig. 4 illustrates a second example in which the
12 service cable 2 is reeled on a drum 3 and the drum 3 is
13 itself rotated about the hoist rope 1 to achieve a
14 helical wrap and unwrap. As shown in more detail in
15 Fig. 5, the service cable drum 3 may be constituted by
16 a drum 12 removably mounted on a hub motor 11 which is
17 carried on the end of an arm 18 rotatably mounted on
18 the fixed frame 20 and driven by a motor 10.

19

20 As with the first example, the example shown in Figs. 4
21 and 5 could be modified by adding further service cable
22 drums to be rotated by the motor 10 in the opposite
23 direction to the first cable and drum so as to overwrap
24 the second cable on top of the first.

25

26 Fig. 6 illustrates the example of Fig. 1 modified for
27 use in a marine towing application, for example in
28 paying out, towing and recovering a sensor array such
29 as a sonar sensor or seismographic surveying sensor,
30 the sensor array being towed underwater or on the
31 surface. The service cable drum 3 is hinged to the
32 main structure of the towing vessel (not shown) and can

1 be tilted to a desired towing angle by hydraulic or
2 other mechanisms. Likewise, Fig. 7 illustrates the
3 modification of the example of Fig. 4 for the same use,
4 the frame carrying the mounting arm for the service
5 cable drum 3 being hinged to the vessel and tilted to
6 the desired angle by hydraulic or other mechanisms.

7
8 The invention may be applied to a system in which one
9 or more service cables is applied to a load-bearing
10 rope which itself carries a service channel in addition
11 to fulfilling its load-bearing function. For example,
12 the load-bearing rope could be a steel wire rope
13 carrying electrical signals, or a rope comprising
14 "Kevlar" load-bearing strands in combination with
15 optical fibre cable.

16
17 Fig. 8 discloses a further embodiment of the invention
18 having first and second drums 31 and 32 which are
19 arranged to rotate around a load-bearing rope 35 in
20 different directions and can wind different cables (for
21 example a fibre optic communications cable and a high
22 voltage power cable) in opposite directions around the
23 central load-bearing rope 35. This has been found by
24 the inventor to be useful particularly in applications
25 where the load-bearing rope 35 remains slack during
26 certain periods in the operation of the equipment. By
27 contra-rotating the cables around the load-bearing rope
28 they are less likely to move or become loose should the
29 load-bearing rope 35 slacken. In addition, a fragile
30 cable such as a fibre optic cable wound around the
31 load-bearing rope 35 in a first direction can be
32 overlaid by e.g. a high voltage power cable wound

1 around the load-bearing rope 35 and fibre optic cable
2 in the opposite direction, and this can also afford
3 some protection to fragile cables such as fibre optics
4 etc.

5
6 In the Fig. 8 apparatus, two different cables wound
7 onto respective drums 31 and 32 are paid out while the
8 drums are rotated around the load-bearing rope 35.

9
10 Drum 31 is mounted on an arm 40 connected to an arm
11 assembly 41 having a top hat structure with a top
12 surface, and an annular flange 41f provided at the
13 lower end of side walls 42s (shown in Fig. 9). The arm
14 assembly 41 has a central aperture 42 in its top
15 surface through which the load-bearing rope 35 passes,
16 and has an annular bevel gear 43 cut into the outer
17 edge of its top surface.

18
19 A second drum 32 is supported on a further arm 50 also
20 connected to an arm assembly 51 having a similar top
21 hat structure and shown in Fig. 9b. Arm assembly 51
22 comprises a lower annular flange 51f with a sleeve 51s
23 attached thereto and having a central bore 51b
24 extending through the sleeve 51s and through the
25 annular flange 51f. A bevel gear 53 (shown in Fig. 9a)
26 is manufactured separately but located over the sleeve
27 51s and fixed in place by any suitable means, for
28 example by welding or bolting or other fixing means
29 after the apparatus has been assembled.

30

31 The Fig. 8 apparatus is assembled by locating the arm
32 assembly 41 and a pair of bearing rings 44 over the

1 sleeve 51s, so that the arm assembly 41 is capable of
2 rotating on the bearings around the sleeve 51s. A slip
3 ring 55 for transmitting electric or hydraulic power
4 via the rotating arm assembly 41 and arm 40 to the drum
5 31 is then located over the ring 41 to rest on the
6 flange 41f. Slip rings suitable for this and other
7 purposes of the invention are known and suitable
8 electrical, fibre optic and fluid rotary union slip
9 rings are available e.g. from Focal Technologies Inc of
10 40 Thornhill Drive, Unit 7 Dartmouth, Nova Scotia,
11 Canada B3B 1S1. Such slip rings for electrical, fibre
12 optic and hydraulic power transmission are clearly
13 readily available and will not be described further
14 here.

15
16 Bevel ring 53 is then offered to the sleeve 51s and
17 attached thereto in opposite orientation to bevel gear
18 43. A further slip ring 56 is located on top of the
19 bevel ring 53 in order to transmit power from a
20 stationary source via the sleeve 51s, flange 51f and
21 arm 50 to the drum 32.

22
23 Bearing rings 45 are then located over the sleeve 51s
24 and a support bracket 58 is placed around them and
25 attached to the ship or other structure from which the
26 apparatus is to be used. The support bracket 58
27 likewise has an annular flange 58f and an aperture 58a
28 for the sleeve 51s. A top ring 60 having a central
29 aperture for the through passage of the rope 35 is then
30 bolted to the upper face of the sleeve 51s, and secures
31 the annular apparatus together around the central
32 sleeve 51s.

1
2 On flange 58f of the support bracket 58 a motor 62
3 drives a shaft 63 to a gearbox 64 disposed below the
4 bracket 58 but above the lower slip ring 55. The motor
5 62 and gearbox 64 transmit power via shaft 65 between
6 the slip rings to a bevel gear drivehead 66. Bevel
7 drivehead 66 engages bevel rings 53 and 43 and drives
8 them in opposite directions simultaneously. By a
9 single force exerted from the motor 62, the arms 40 and
10 50 and therefore the drums 31 and 32 can thus be driven
11 in opposite contra-rotating directions around the
12 central axis of the load-bearing rope 35 as it is payed
13 out (described previously).

14
15 The bearings 44, 45 support the arm assemblies 41 and
16 51 so that they can rotate within the main support
17 bracket 58 attached to the ship or other structure.

18
19 The winch drums 31 and 32 can hoist and lower cables by
20 use of electric or hydraulic power transmitted through
21 the slip rings 55, 56. Conventional power cables (or
22 hydraulic conduits if hydraulic motors are used) can be
23 passed through the drum support arms 40 and 50 from the
24 inner half of the slip ring adapters which will remain
25 stationary in relation to the arms 40, 50.

26
27 Although the embodiment shown in Figs. 8 & 9 is driven
28 through motor 62 and bevel gear 66, the apparatus could
29 also be driven from the sleeve 51s which could in
30 certain embodiments protrude out of the securing plate
31 and be rotated using belts, gears, chains or similar
32 mechanisms. The bevel gear arrangement shown in Figs.

1 8 & 9 would in that embodiment still remain to contra-
2 rotate the drums under the power applied to the sleeve
3 51s and therefore bevel gear 53.

4
5 The drums could also be driven independently using two
6 separate motors. One motor at the top of the sleeve
7 51s as mentioned above could drive the arm 50, and the
8 motor 62 could drive the arm assembly 41 through the
9 bevel gear 66. That embodiment would not require the
10 additional bevel ring 53, which could be removed.

11
12 A further improved variant of the invention is shown in
13 the remaining Figs. 10 to 17, Components of the
14 mechanism shown in these figures are slotted so that
15 the apparatus can be deployed or recovered without
16 first having to pass the load-bearing rope through the
17 centre of the mechanism. The load-bearing rope can
18 instead be removed or replaced within the mechanism
19 during any part of the operation. This is particularly
20 useful with heavy and oversized pieces of equipment.
21 The slots can be filled by removable segments which are
22 replaced after the load-bearing rope has been located
23 within the mechanism. This has the advantage of
24 allowing more traditional slip rings and the segment
25 could be located easily within a tapered notch. Single
26 gear driving would then be possible, but it is also
27 equally possible to drive a slotted mechanism by two or
28 more gears as shown in the drawings and described
29 below. The embodiment shown and described is not
30 affected by the notches, and these allow the load-
31 bearing rope to be removed or placed within the
32 mechanism as required without removal of the notch

1 filling segment. More than one drive shaft is
2 preferable to reduce the possibility of contact being
3 lost with the centre drive when the notch thereon
4 passes the driving wheel. In the embodiments shown,
5 all of the parts which rotate around the load-bearing
6 rope 35 are slotted.

7
8 Referring now to Figs. 10 to 17, a central rotating
9 notched sleeve 151, having an annular flange 151f on
10 its outer surface is provided. The sleeve 151 is
11 notched at 15 to allow radial passage of the rope 35
12 through the notch 15 into the axial bore. An annular
13 thrust bearing 170 separates the lower surface of the
14 flange 151f from a main support plate 175 through which
15 it passes via a central aperture 175a, also notched.
16 The main support plate 175 also has two side apertures
17 175b and c through which the drive shafts of motors 176
18 and 177 pass.

19
20 A main support bearing 179 surrounds the outer surface
21 of the sleeve 151 above the flange 151f.

22
23 Motor 176 drives winding gear 180 which is used to
24 drive the winding of the rope around the central load-
25 bearing rope 35. Winding gear 180 is a circular gear
26 driving two further gears 181, 182 in the same
27 direction. Gear train 180, 181, 182 drives a spur gear
28 185 also having a notch 15 coinciding with the notch 15
29 in the sleeve 151, and keyed to the sleeve 151 by means
30 of a keyway 185k. Rotation of gear train 180, 181, 182
31 therefore drives spur gear 185 and (by virtue of the
32 keyway) sleeve 151. Since the gears 181 and 182 are

1 spaced apart, the notching of the assembly of the spur
2 gear 185 and sleeve 151 does not affect power
3 transmission to the sleeve 151, since even if the notch
4 15 is adjacent one of the gears 181, 182, the other
5 will still be contacting the teeth and will transmit
6 power to the sleeve 151 for the time taken for the
7 notch 15 to pass the gear 181 or 182 as the case may
8 be.

9
10 A drum 190 is carried on a support arm 191 attached to
11 the lower end of the sleeve 151 and therefore rotation
12 of the drive train 180, 181, 182 by the motor 176
13 drives rotation of the arm 191 around the central axis
14 of the load-bearing rope, thereby winding the cable on
15 the drum 190 axially around the load-bearing rope 35 as
16 it is payed out as described previously.

17
18 Hoist and payout of the cable on the drum 190 is driven
19 by motor 177 through the drive train to be described
20 below. Motor 177 has a driveshaft 177d passing through
21 the aperture C in the main support plate 175. A spacer
22 178 spaces a gear 200 driven by shaft 177d from the
23 lower surface of the main support plate 175. Gear 200
24 is part of a drive train 200, 201, 202 similar to the
25 drive train 180, 181, 182 as previously described.
26 Drive train 200, 201, 202 drives the rotation of a
27 notched spur gear 205 having a slot 15 and located
28 around the sleeve 151 on a bearing 203. The spur gear
29 205 is able to rotate relative to the sleeve 151, and
30 is driven around the sleeve by the operation of the
31 drive train 200, 201, 202. The drive train 200, 201,
32 202 meshes with an upper row of teeth 206 on the gear

1 205. Spur gear 205 also carries a lower row 207 of
2 teeth which are clearly also driven in rotation by
3 operation of the drive train 200, 201, 202. A further
4 set of gears 210, 211, 212 mesh in a fashion similar to
5 that described for the gears 180, 181, 182 with the
6 lower teeth 207 of the spur gear 205. The gear 210 is
7 located on a drive shaft connected to a right angled
8 gearbox 215 where a bevel gear or similar arrangement
9 drives rotation of a perpendicular second shaft 216,
10 which through a pulley wheel drives the rotation of the
11 drum 190 around its own axis by a belt, chain or
12 similar such means. This allows the motor to hoist in
13 or lower the power or signal cable on the drum. The
14 gear box 215 is mounted on the drum support arm 191,
15 which is held in place by a notched securing nut 220.

16
17 The locating C nut 220 secures the winch support arm,
18 the double row toothed gear 205 the single row toothed
19 gear and two shims, which all slide up onto the lower
20 half of the central rotating notched cylinder 17.

21
22 More than one drum can be provided on the embodiment
23 described, and where two drums are provided, they can
24 be rotated in opposite directions.

25
26 The central rotating notched cylinder is held in
27 position by the thrust bearing and the main support
28 bearing within which it can rotate freely.

29
30 The main support plate is attached to the ship or other
31 structure and provides the support for the motors and

1 the bearing housings for the main support bearing and
2 thrust bearing.

3

4 All components preferably have a notch cut in them to
5 allow the load-bearing rope to be swung into the
6 mechanism. By use of the motor to rotate the winch
7 drum around the load-bearing rope the central rotating
8 notch can be lined up with the notch in the bearings
9 and the main support plate. Using the motor to rotate
10 the gear its notch can also be aligned and the load-
11 bearing rope can either be placed within the mechanism
12 or removed from it.

13

14 The teeth on the gears 180; 181; 182 etc can be
15 replaced by a pulley system such as that shown in Fig.
16 14c which uses a notched belt 185b running on gears
17 180'; 181'; 182' driving gear 185'.

18

19 The motors used for driving any of the presently
20 described embodiments can be of any suitable type.
21 Conventional motors available for many years are
22 eminently suitable, and any standard electric or
23 hydraulic motors available for over 15 years by any of
24 the manufacturers Charlin, Eaton, White, Mannesmann
25 Rexroth, Hawker Sidley and many others are suitable.
26 Various different kinds of motors available for the
27 winch and frame driving motors etc will be well known
28 to one of moderate skill in the art.

29

30 Fig. 18 shows a further device having a first drum 350u
31 arranged above a second lower drum 350l, both of which
32 are arranged around a load-bearing rope 1 which passes

1 through their axes. The drums 350 each have a
2 respective arm 359u/359l and spooling gear 360u/360l
3 which spools off the cables in the upper and lower
4 drums in different directions and can wind different
5 cables (for example a fibre optic communications cable
6 on the upper drum 350u and a high voltage power cable
7 on the lower drum 350l) in opposite directions around
8 the central load-bearing rope 1 in the same manner as
9 the embodiment described with regard to Fig. 8 and 9.

10

11 In the Fig. 18 apparatus, two different cables wound
12 onto respective drums 350u and 350l are paid out while
13 the arms 359u/359l rotate around the load-bearing rope
14 1.

15

16 Drums 350u have a top hat structure with a pair of
17 annular flanges provided at the lower end of side
18 walls. The cable is stored between the annular
19 flanges, and the side walls define a cylinder through
20 which the hoist rope 1 can pass axially. The arms 359
21 are each mounted on a sleeve with an annular bevel gear
22 cut into an opposing edge to allow a single bevel
23 drivehead 360 to drive each of the arms in opposite
24 directions. The same or a different bevel drivehead
25 can be used for each. Bevel drivehead 360 engages
26 bevelled edges on the arms 350 and drives them in
27 opposite directions simultaneously. By a single force
28 exerted from a motor (not shown), the arms can thus be
29 driven in opposite contra-rotating directions around
30 the central axis of the load-bearing rope 1 as it is
31 paid out.

32

1 The drums are hung on a frame 320 which holds bearings
2 and slip rings as previously described.

3
4 Although the embodiment shown in Fig. 18 is driven
5 through a motor and bevel gear 360, the apparatus could
6 also be driven from a sleeve forming part of an arm or
7 a drum and which could in certain embodiments protrude
8 out of the assembly and be rotated using belts, gears,
9 chains or similar mechanisms. The bevel gear
10 arrangement shown in Fig 18 could in that embodiment
11 still remain to contra-rotate the arms under the power
12 applied to the sleeve and therefore bevel gear 360.

13
14 The arms could also be driven independently using two
15 separate motors.

16
17 Fig 19 shows a further cable winding device which has a
18 trough 5t rather than a drum 5 for storing the service
19 cable 2. This is very useful for very thick or heavy
20 cables not suitable for storage on a drum 5. The
21 trough 5t is provided with spooling gear in the form of
22 sheaves and can optionally incorporate tensioning
23 devices such as a linear winch e.g. a pair of tyres
24 through which the cable can run and which retard the
25 cable thereby tensioning it slightly. A further trough
26 can be added to provide another service cable to be
27 wrapped around the rope in the opposite direction to
28 that of the first cable.

29
30 Fig 20 shows a further cable winding device which
31 dispenses with the need for slip rings. The Fig 20
32 device is suitable for cables which will withstand a

1 twist every turn or a pretwisting of the cable before
2 it is run onto the drum. The turns per metres of the
3 cable paid out will be dependant on the diameter of the
4 cable on the cable winch.

5
6 In the Fig 20 device the signal/power service cable can
7 be wound from a power supply or other service
8 connection (not shown) via several guide sheaves onto a
9 first drum 5s of small diameter. The small diameter
10 drum 5s can be located on an upper part of the winch
11 drum which can either be turned by a motor, or can
12 remain stationary with an arm revolving to unwrap the
13 cable from it. The purpose of the small diameter drum
14 is to allow limited movement on the main drum as the
15 hoist rope may twist thereby requiring more turns of
16 the signal/power cable drum than were originally put
17 onto the hoist rope as it was paid out.

18
19 The cable 2 is typically paid out from the main cable
20 winch drum 5l by a rotating arm 9a rotating in a
21 direction which unwinds the cable 2 from the drum 5l.
22 The rotating arm 9a rotates in the opposite direction
23 to wind on the cable 2. The arm 9a can be set to pay
24 out at a preset tension and hoist if the tension is
25 less than that preset tension.

26
27 In the Fig 20 device, the service cable 2 is connected
28 to the service (power signal etc) and wound first onto
29 the small drum 5s. An aperture in the small drum wall
30 allows the cable 2 to pass into the axial bore of the
31 drum 5 where it runs parallel to the rope 1 to the
32 level of the main lower drum 5l. It passes through the

1 wall of the main drum 51 and onto the spool from which
2 it is unwound by the spooling gear on the rotating arm
3 9a in much the same manner as has been described
4 previously. The cable can be applied to the drum 5
5 with a pretwist so as to avoid kinking in the cable
6 during use.

7

8 Further signal cables can be applied to the rope using
9 the Fig.20 device.

10

11 In other embodiments the cable drum can be arranged to
12 rotate around the rope and/or can rotate on its own
13 horizontal axis in order that the rope can be spooled
14 off in a similar manner to other embodiments.

15

16 Fig. 21 illustrates a further embodiment in which the
17 service cable 2 is reeled on a drum 3 and the drum 3 is
18 itself rotated about the hoist rope 1 to achieve a
19 helical wrap and unwrap. The service cable drum 3 may
20 be constituted by a drum 12 removably mounted on a hub
21 motor 11 which is carried on the end of an arm 18
22 rotatably mounted on a fixed frame 20 and driven by a
23 motor 10. The arm 18 has a hinge 18h connecting it to
24 the frame 20 and a hydraulic ram 18r to pivot the arm
25 18 about the hinge 18h relative to the frame 20 from
26 the lower position shown in Fig 2 to the higher
27 position, so as to move the cable drum 3 out of the way
28 of large loads being lifted by the hoist rope 1.

29

30 Further service cable drums could be added to be
31 rotated by the motor 10.

32

1 Fig. 22 shows a further embodiment similar to the Fig.2
2 embodiment in which the service cable drum 3 is
3 rotatably mounted on the lower part of the frame 20
4 with the rope 1 passing through an axial aperture in
5 the cable drum 3 and driven in rotation by a motor 6.
6 The arm of the mounting frame 9 has a hinge 9h and a
7 hydraulic ram 9r connecting two shoulders on opposite
8 sides of the hinge 9h. The ram can be activated to
9 draw the sheave-bearing part of the arm 9 upwards out
10 of the way of large objects being lifted.

11

12 Fig 23 shows a further embodiment in which the service
13 cable 2 is held on a drum 5a which is fixed to an arm
14 30 that can rotate about the axis of the rope 1. The
15 drum 5a does not need to be rotatably mounted on the
16 arm 30 so that it rotates on its own axis but instead
17 has a further arm 31 that rotates about the axis of the
18 drum 5a and carries the cable via spooling gear 32 to
19 the rope 1.

20

21 The drum 5a may have a tapered surface and this
22 provides another aspect of the invention.

23

24 Other modifications may be made within the scope of the
25 invention.

1 CLAIMS

2

3 1. Apparatus for use in handling a load comprising a
4 load-bearing rope (1,19,35), a mechanism for paying out
5 and recovering the rope (1,19,35), a first cable holder
6 (3,12,15,16,31,32) for holding a first service cable
7 (2,17) with a length of the first service cable (2,17)
8 extending therefrom, a second cable holder
9 (3,12,15,16,31,32) for holding a second service cable
10 (2,17) with a length of the second service cable (2,17)
11 extending therefrom, and a wrapping device for rotating
12 said lengths of service cable around the rope (1,19,35)
13 as the rope (1,19,35) is payed out to wrap the service
14 cables (2,17) around the rope (1,19,35), characterised
15 in that one of the first and second service cables
16 (2,17) is wrapped over the other.

17

18 2 Apparatus according to claim 1, wherein each
19 service cable holder (3,12,15,16,31,32) comprises a
20 drum.

21

22 3 Apparatus according to claim 1 or claim 2, wherein
23 the wrapping device can recover the service cables
24 (2,17) to their respective cable holders
25 (3,12,15,16,31,32) during recovery of the rope
26 (1,19,35) and cables (2,17).

27

28 4 Apparatus according to any preceding claim,
29 wherein the mechanism for paying out and recovering the
30 rope (1,19,35) comprises a rope sheave (4) and a rope
31 winch (13), and wherein the rope (1,19,35) passes from
32 the rope winch (13) over the rope sheave (4) and

1 thereafter extends to the load along a substantially
2 straight axis.

3

4 5 Apparatus according to any preceding claim,
5 wherein the wrapping device comprises the or each
6 service cable holder (3,12,15,16,31,32) being arranged
7 for rotation about an axis which coincides with the
8 axis of the rope (1,19,35) .

9

10 6 Apparatus according to any preceding claim,
11 wherein the or each service cable holder
12 (3,12,15,16,31,32) has a central aperture through which
13 the load-bearing rope (1,19,35) passes.

14

15 7 Apparatus according to claim 4 or any claim
16 dependent thereon, comprising a service cable sheave
17 (5,14) rotatably mounted on the apparatus and capable
18 of movement in a circular path around the substantially
19 straight axis, and wherein the length of service cable
20 (2,17) passes over the service cable sheave (5,14) .

21

22 8 Apparatus according to claim 4 or any claim
23 dependent thereon, having a structural member (18) upon
24 which the or each service cable holder
25 (3,12,15,16,31,32) is rotatable, the or each structural
26 member (18) being arranged for movement in a circular
27 path about said substantially straight axis.

28

29 9 Apparatus according to claim 4 or any claim
30 dependent thereon, wherein the rope winch (13), the or
31 each service cable drum (3,12,15,16,31,32) and the

1 wrapping device each have a respective driving motor
2 (6,7,62,177).

3

4 10 Apparatus according to claim 4 or any claim
5 dependent thereon, wherein the rope winch (13), the or
6 each service cable drum (3,12,15,16,31,32) and the
7 wrapping device are driven by a single source
8 (6,7,62,177) through appropriate mechanical linkages.

9

10 11 Apparatus according to any preceding claim,
11 wherein each service cable (2,17) has a respective
12 service cable sheave (5,14) being capable of rotation
13 in opposite directions to one another.

14

15 12 Apparatus according to any preceding claim,
16 wherein the service cables (2,17) are overwrapped in
17 the same direction but at different pitches.

18

19 13 Apparatus according to any preceding claim,
20 wherein the wrapping device includes at least one
21 annular component having at least one gap (15) in the
22 annulus to facilitate attachment of the wrapping device
23 to the load-bearing rope (1,19,35).

24

25 14 Apparatus according to claim 13, wherein the at
26 least one gap (15) extends axially on one or more
27 components of the apparatus.

28

29 15 Apparatus according to claim 13, wherein the at
30 least one component is driven in rotation by a drive
31 train (180,181,182,200,201,202) having more than one
32 point of contact with said at least one component.

1

2 16 Apparatus according to claim 15, wherein the drive
3 train (180,181,182,200,201,202) comprises at least two
4 transmission gears which contact said at least one
5 component at spaced-apart locations.

6

7 17 Apparatus according to claim 15 or 16, wherein the
8 drive train (180,181,182,200,201,202) comprises a belt
9 driven by a driver and contacting said at least one
10 component in at least two spaced-apart locations.

11

12 18 Apparatus according to any preceding claim,
13 wherein the wrapping device rotates around the axis of
14 the rope (1,19,35), but does not rotate about its own
15 axis.

16

17 19 Apparatus according to any preceding claim,
18 wherein at least part of the wrapping device is
19 moveable relative to the axis of the apparatus so that
20 part of the wrapping device can be moved out of the
21 path of a large object hoisted by the rope (1,19,35).

22

23 20 A method for use in handling a load, the method
24 comprising paying out a load-bearing rope (1,19,35) and
25 wrapping first and second service cables (2,17) around
26 the rope (1,19,35) as it is payed out, and subsequently
27 unwrapping the service cables (2,17) from the rope
28 (1,19,35) as the rope (1,19,35) is recovered,
29 characterised in that one of the service cables (2,17)
30 is wrapped over the other.

31

1 21 A method according to claim 20, wherein the
2 service cables (2,17) are wrapped around the load-
3 bearing rope (1,19,35) in opposite directions.

4
5 22 A method according to claim 20 or claim 21,
6 including the steps of attaching the load-bearing rope
7 (1,19,35) to a mechanism for paying out and recovering
8 the load-bearing rope, attaching the load-bearing rope
9 (1,19,35) to the load, and subsequently attaching to
10 the load-bearing rope (1,19,35) apparatus for wrapping
11 the service cable around the load-bearing rope
12 (1,19,35), wherein the wrapping device includes at
13 least one component having at least one gap (15) in the
14 annulus through which the load-bearing rope (1,19,35)
15 passes as the wrapping device is being attached to the
16 load-bearing rope (1,19,35).

17
18
19