



(11) **EP 2 286 045 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
24.04.2013 Bulletin 2013/17

(21) Application number: **09754084.3**

(22) Date of filing: **23.03.2009**

(51) Int Cl.:
E04H 12/18^(2006.01)

(86) International application number:
PCT/GB2009/000764

(87) International publication number:
WO 2009/144439 (03.12.2009 Gazette 2009/49)

(54) **TELESCOPIC MAST**

TELESKOPISCHER MAST

MÂT TÉLESCOPIQUE

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO SE SI SK TR

(30) Priority: **31.05.2008 GB 0809977**

(43) Date of publication of application:
23.02.2011 Bulletin 2011/08

(73) Proprietor: **Abacus Holdings Ltd**
Nottingham NG17 5FT (GB)

(72) Inventors:
• **JENVEY, Alan, John**
Notts NG17 7FQ (GB)

• **NICHOLS, Philip, Anthony**
Notts NG18 4FR (GB)

(74) Representative: **Bhimani, Alan**
Marks & Clerk LLP
Alpha Tower
Suffolk Street Queensway
Birmingham B1 1TT (GB)

(56) References cited:
EP-A2- 0 201 645 AT-B- 395 627
GB-A- 2 282 862 US-A- 3 952 467
US-B1- 6 276 811

EP 2 286 045 B1

Note: Within nine months of the publication of the mention of the grant of the European patent in the European Patent Bulletin, any person may give notice to the European Patent Office of opposition to that patent, in accordance with the Implementing Regulations. Notice of opposition shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European Patent Convention).

Description

[0001] The present invention relates to a mast and more particularly to a mast which is intended in use to support a structure above a mast base section.

[0002] Masts are widely used for supporting lighting apparatus above the ground, such as, for example, at sports stadiums or the like. The height at which flood lighting apparatus can be held above the ground is of significant importance to the effective lighting of an area.

[0003] Conventional flood lighting masts, including the head frame on which the lighting equipment is mounted can be as tall as 40-50 metres or more. Accordingly the structural support required at the base of such masts is significant and conventional masts take the form of permanent structures which are erected and fixed in place until they are replaced or else dismantled for maintenance work.

[0004] Furthermore, wind loading on the lighting equipment held at such heights above ground level is a significant safety concern. The magnitude of stable wind loading alone can cause a significant moment about the base of the mast. However when this is coupled with the naturally transient nature of wind loading, it becomes difficult to accurately account for maximum peak load and also the effect of potential oscillations in the mast due to gusts or else shedding of the airflow from the edges of the lighting frame.

[0005] Such considerations further compound conventional thinking that a mast should be permanently fixed in place with adequate support to withstand the maximum possible loads at all times.

[0006] However there is increasing concern over the skyline and the adverse effect that such tall structures are considered to have on the appearance of the surrounding area. Accordingly it is becoming increasingly difficult for organisations to obtain planning permission for the erection of relatively large fixed masts required for effective flood lighting. In meeting such requirements it is often required to provide a mast of sub-optimal height.

[0007] In addition it is often necessary to provide a bespoke mast or else the closest height of mast selected from a range of masts to suit the given requirements. The tailoring of a mast design in this manner can add significant cost to the cost of the mast manufacture since masts must be effectively made to order.

[0008] Thus it is often necessary for a balance to be struck between the cost of manufacture and installation of a mast; the height at which the lighting equipment can be allowably maintained above the ground; and, the quality of the lighting required for a particular location.

[0009] Whilst the application proceeds in relation to lighting masts in particular, it will be appreciated that there are other applications in which tall, load bearing masts are required to support apparatus above the mast base, such as, for example, masts for wind turbines and telecommunications masts. The problems associated with lighting masts may equally be applied to any such other

types of mast.

[0010] AT 395 627 B discloses a mast according to the preamble of claim 1.

[0011] In view of the above problems, there is a need for a mast which offers a reduced negative impact on the appearance of the surrounding area.

[0012] According to the present invention, there is provided a mast for supporting equipment during use according to claim 1.

[0013] In one embodiment the mast comprises a third mast section, which may be elongate in shape and which may be oriented substantially coaxially with said first section and moveable relative to the first section. The third section may also be linearly moveable relative to the second section. The mast may be telescopic.

Accordingly the mast according to the present invention may be extended and retracted between an at rest condition and an in-use condition or else between different operating heights. This can be a significant benefit since it allows the mast to be extended into a usage condition for required periods of time, without providing an eyesore when not in use.

[0014] The present invention may also be particularly advantageous in that a mast may be permanently installed by fixation of the base section relative to a support surface, such as for example the ground. Thus the structural integrity of the mast need not be affected by the raising and lowering of the mast.

[0015] This is in contrast to raisable or lowerable mast systems according to the prior art, which typically require a mast of fixed length to be pivoted about a base in order to erect the mast. Such arrangements require a motor/winch drive to pivot the mast into an upright position. The maximum capacity of such winch/motor arrangements has been found to significantly inhibit the size of mast which can be erected according to this method.

[0016] Further unexpected advantages may also derive from the present invention. The size of conventional masts can push the boundaries of conventional crane lifting capabilities. However the reduced length of the retracted mast according to the present invention may significantly simplify installation of the mast on site.

[0017] Furthermore, the provision of an extending/retracting mast according to the present invention may allow a single mast design to be installed in a number of varying locations. The mast may be simply be extended to a greater or lesser extent during use to account for the varying requirements of different installation sites. In addition, different masts on the same site could be raised to different heights in use if required. Thus the present invention may allow customisation of lighting on a single site in a manner which was not hitherto possible.

[0018] The first section may comprise a base or pedestal section of the mast. Alternatively an alternative base or pedestal section may be provided such that any combination of the first and/or second sections may be moveable relative to the base. The base or pedestal section may be hollow and may house the drive means.

The drive means comprise an hydraulic drive means. The drive means comprises a linearly moveable drive member and comprise a piston and cylinder arrangement. The movement of the ram may be a fraction of the required movement of the second or further mast sections.

[0019] The transmission means comprise a pulley system. The pulley system may comprise one or more chains having a plurality of links, which may be metallic. The one or more chains may be connected in the force path between the drive means and one or more moveable mast sections. The pulley system is connected in the force path between each moveable section of the mast. A ram may drive the lowermost moveable mast section, which may be connected to an adjacent moveable mast section by a pulley system.

[0020] A chain may be connected between one end of one mast section and an opposing end of another mast section. The chain may be connected at one end to one mast section and at an opposing end to another mast section. The chain may pass about a pulley wheel. A chain may be connected at one end to a first mast section and may pass over a pulley mounted on a second mast section and may be connected at its second end to a third mast section. The second mast section may be intermediate the first and third mast sections.

[0021] Each of the mast sections may be generally tubular or sleeve-like in form such that each mast section may house a further mast section therein. The cross-sectional profile of the or each mast section may have one or more straight edges. Each mast section may have one or more faces which may be flat. Such an arrangement has been found to be beneficial in preventing rotation of the mast sections about the mast axis when compared to mast sections which are generally circular in cross-section. Any or each mast section may be for example rectangular, pentagonal, hexagonal or octagonal.

[0022] One or more mast sections may have an opening for passage of the chain therethrough. A pulley may be mounted on the mast section adjacent the opening. One or more mast sections may have attachment formations on an outer wall thereof for attachment of the chain thereto.

[0023] One or more alignment members may be provided between adjacent mast sections. The alignment members may comprise friction or buffer members located between one or more walls of adjacent mast sections. The members may be biased so as to urge the mast sections into correct relative or rotational alignment about their shared axis. This can help ensure that the mast sections do not jam due to misalignment.

[0024] A free end of one mast section may be provided with attachment means for attaching electrical equipment to the mast.

[0025] Typically the present invention is applicable to masts which support electrical equipment. The present invention is counter intuitive, since such electrical equipment typically requires permanent electrical connection via cables. The extension and retraction of the mast ham-

pers the use of permanent electrical connections. However the applicant has devised a cable management system suitable to allow a permanent electrical connection to be maintained between the extend and retracted mast conditions.

[0026] In one embodiment, one or more cables run through a hollow interior of the first and second mast sections. The or each cable may be held within a cable management structure. The cable management structure may comprise a series of members through which the cable passes, each member being attachable to an adjacent member in a hinge-like arrangement so as to constrain pivoting of adjacent members about only a single axis.

[0027] Working embodiments of the present invention are described in further detail below with reference to the accompanying drawings of which:

Figure 1 shows a rear view of a mast according to one embodiment of the present invention;

Figures 2A shows a longitudinal sectional view of a mast according to the present invention in a retracted condition;

Figure 2B shows a three-dimensional view of the mast section shown in figure 2A;

Figures 3A shows a longitudinal sectional view of the mast of figure 2 in an extended condition;

Figure 3B shows a three-dimensional view of the mast section shown in figure 3A;

Figure 4 shows a sectional view of additional detail of a mast according to one embodiment of the present invention; and,

Figure 5 shows an example of cable management apparatus for use in conjunction with one embodiment of the present invention.

[0028] Figures 1 to 3 show a mast 12 in an upright condition depending from a substantially horizontal support surface 38. All terms used to describe the position and or direction of travel of the mast are relative to the support surface and are not to be construed as being limited to use in conjunction with a horizontal support surface only.

[0029] Turning firstly to figure 1, there is shown a lighting apparatus 10 generally comprising a mast 12 supporting a lighting framework 14. The lighting framework is attached to the upper or head end of the mast 12 and comprises a spinal support member 16 and a plurality of arms 18 extending outwardly therefrom.

[0030] Lighting equipment (not shown) is typically mounted on arms 18 for use. In this embodiment, there is provided a connector 20, by which the lighting equip-

ment can be connected or disconnected from a power supply. Electrical cabling is provided within the mast 12 as described in further detail below. In conventional lighting mast arrangements, the head frame is permanently attached to the mast upon manufacture and the cables are permanently attached to the relevant lighting apparatus.

[0031] However the present invention allows for attachment of the head frame 14 to be connected to the mast 12 on site. Thus the plug/socket arrangement 20 on the lighting framework itself allows simple electrical connection and disconnection of the lighting apparatus as required. Power is supplied to lighting equipment mounted on arms 18 via the plug/socket arrangement 20.

[0032] The mast 12 comprises a base section 22 and a plurality of elongate mast sections 24 depending therefrom. The plurality of mast sections 24 comprise a first 26, a second 28, a third 30 and a fourth 32 mast section. Each mast section takes the form of a substantially hollow tubular formation, with the first section having the greatest lateral or width dimension such that it can house the second, third and fourth mast sections therein. The fourth mast section 32 is mounted within the third mast section which is mounted within the second mast section, which is in turn mounted within the first mast section in a concentric arrangement.

[0033] Each of the first, second and third mast sections has alignment formations comprising friction members 31 mounted therein. The friction members 31 are arranged to provide frictional contact between the mast section in which the pads are mounted and an adjacent mast section. In this embodiment, the pads contact the radially inner adjacent mast section. Such alignment formations may be provided at an or any combination of the upper, mid or lower region of the mast sections.

[0034] The first mast section 26 has at its lower end a circumferential mounting flange 33 which faces a similarly shaped mounting flange 34 on the base section 22. Bolts are passed through the opposing mounting flanges when they are in abutment so as to secure the base 22 and the first mast section in an end to end engagement.

[0035] The base 22 may have an opening 36 in order to provide access to its hollow interior. The base section is fixed in an upstanding orientation to a support surface 38. It will be understood by the person skilled in the art that an additional support structure or foundation for the mast may be provided below the level of the support surface 38 and may be sunk below ground level.

[0036] The fourth mast section 32 being the uppermost mast section when the mast is oriented as shown in figure 1 has a flange formation at its free end for attachment of the head frame 14 thereto. The spinal portion 16 of the head frame may have a corresponding opposing flange portion at its lower end.

[0037] Turning now to figure 2, there are shown longitudinal sectional views of the mast 12 taken through its centreline 40. The base section 22 of the mast has been removed. The mast 12 is in a retracted condition such

that each of the mast sections 28, 30 and 32 extend into the interior of the mast section 26. In this condition a minor portion of each of mast sections 28, 30 and 32 protrudes from an upper end of the section 26. A majority of the length of each of those sections is enclosed within section 26.

[0038] Each of sections 28, 30 and 32 are arranged to be movable relative to section 26 when the mast is converted to its extended or in-use condition as will be described below. Sections 28, 30 and 32 may be referred to hereinafter as the movable or moving mast sections.

[0039] The mounting flange formation 42 of the uppermost or fourth mast section 32 is shown in figure 2 and comprises an end plate of greater diameter than that of the tubular portion of mast section 32. The flange 42 has openings therein for bolting the head frame 14 thereto.

[0040] The other mast sections, namely the first 26, second 28 and third 30 sections, each have a collar formation 44 at the upper end thereof. The collar formations 44 protrude outwardly of the wall of the corresponding section and provides an abutment against which the collar 44 of the adjacent mast section can rest in the retracted condition. Each collar portion thus serves as a stop to ensure that the moveable mast sections are not completely retracted within the adjacent mast section.

[0041] In this embodiment, the collar formations each comprise a pair of spaced circumferential lip or rim formations which depend outwardly from the tubular body of each mast section.

[0042] As can be seen in figure 2, the mast sections are not circular in cross section. The mast sections each have a plurality of substantially flat side walls and, in this embodiment, the mast sections are octagonal in cross section. The non-circular nature of the side walls helps to provide torsional stability of the mast about its centreline and resists twisting such as, for example, as a result of wind loading. It is envisaged that other polygonal cross-sectional profiles or else an elliptical section may provide suitable alternatives for this purpose.

[0043] A drive means in the form of a hydraulic ram 46 is provided within the mast 12. In this embodiment, the ram 46 is mounted in the interior space of the first mast section 26. The first mast section is rigidly attached to the base section and not moved during extension or retraction of the mast.

[0044] The ram 46 comprises a piston 48 and cylinder 50 arrangement. The cylinder comprises an internal cavity 52, within which the piston 48 is seated. Fluid is applied under pressure to the internal cavity 52 to cause relative movement between the piston and cylinder. The ram 46 is anchored by a supporting rod formation 54 which passes into the base section 22. In this embodiment, the head of the piston 48 is attached to the base and the cylinder 50 is moveable relative thereto in use. The head of the piston is thus attached to the rod formation 54.

[0045] The cylinder 50 has connection formations in the form of opposing pins or lugs 56 which protrude outwardly of the cylinder body at its lowest end. The lugs 58

are received in correspondingly shaped openings 58 within an internal support member 60 of the second mast section 28. The lugs 58 and internal support member 60 are load bearing in that they allow transfer of force from the ram 46 to the second cylinder.

[0046] The internal support member 60 comprises an inwardly extending cross member which depends from the wall of the second mast section. The support member may span between opposing side walls of the second mast section. The support member may comprise opposing plate formations, between which the ram is mounted.

[0047] A pulley system is also provided for the transfer of force to the third and fourth mast sections during use. The pulley system allows the ram to indirectly actuate the third and fourth mast sections during operation as will be described in further detail below.

[0048] The pulley system comprises a first linked metal chain 62 which is connected at one end to the upper end of the first mast section 26. The first chain 62 is connected to the collar 44 of the first mast section by a bolt fastener. The first chain passes from the first mast section over a pulley 64 mounted at an upper end of the second mast section and terminates at a fastening 66 on the wall of the third mast section 30. The fastening 66 is provided part way along the length of the third mast section and typically towards its lower end (i.e. spaced from the upper end of the adjacent mast section). The chain 62 is connected to the fastening 66 by a bolt (not shown).

[0049] The first chain 62 provides a force path between the first and third mast sections which is actuable by movement of the second mast section.

[0050] A second chain 68 is connected at one end to the upper end of the second mast section. The second chain 68 is connected to the collar 44 of the second mast section by a bolt fastener. The second chain passes from the second mast section over a pulley 70 mounted at an upper end of the third mast section 30 and terminates at a fastening 72 on the wall of the fourth mast section 32. The fastening 72 is provided part way along the length of the fourth mast section and typically towards its lower end (i.e. spaced from the upper end of the adjacent mast section). The chain 68 is connected to the fastening 72 by a bolt (not shown).

[0051] The second chain 68 provides a force path between the second and fourth mast sections which is actuable by movement the third mast section.

[0052] Whilst only a first 62 and a second chain 68 are described for simplicity, it will be appreciated that additional chain and pulley systems may be used in parallel with the first and second chains for additional strength. Such an arrangement is shown in figures 2 and 3, in which an additional first chain 74 is provided on an opposing side of the mast in parallel with the first chain 62 which passes over an additional pulley mounted to the second mast section and having connections to the mast sections as described above. An additional second chain 76 and pulley system is also provided in parallel with the

second chain 68 and mounted on the opposing side of the mast.

[0053] Electrical cables 78 depend from the wall of the first mast section 26. The cable 78 passes beneath the lowermost ends of the moveable mast sections and is attached to the uppermost or fourth mast section. The cable may pass through an opening 80 in the end plate 42 of the fourth mast section for connection to the head frame 14 via the plug and socket arrangement 20 shown in figure 1. Thus the cable 78 is fixedly attached at each end to the first and fourth mast sections but hangs free in its mid section. The mid section may be provided with a cable management structure to control the freedom of movement of the cable within the mast.

[0054] The cable 78 may be connected to one or more power lines within the mast base or else may pass outside the mast through an opening in the wall thereof for connection to power lines outside of the mast.

[0055] Turning now to figure 3, the mast is shown in its extended condition, wherein the length of the mast is substantially greater than that shown in figure 2. However it will be appreciated that the mast is not a maximum extension.

[0056] In order to actuate the mast 12 between its retracted and extended conditions, pressure is applied to the cylinder chamber 52 of the ram 46. The cylinder is forced away from piston 48 and the force exerted by the pressurised fluid in the chamber 52 is transmitted to the second mast section 28 via the lugs 56 and cross member 60. Thus the second mast section 26 is actuated by the ram 46 and moves in unison therewith relative the first mast section.

[0057] The first mast section provides a rigid sleeve, through which force from the drive means can be transmitted to the other moveable mast sections via the pulley system. As the second mast section moves relative to the first mast section, a tension is applied to first chain 62 via pulley 64 which moves in unison with the second mast section 28. The first end of the first chain 62 is attached to the first mast section which is fixed in position, whereas the second end of the first chain is attached to the third mast section, which is moveable. The movement of the pulley 64 with the second mast section 28 causes the first chain 62 to ride upward on the pulley 64, resulting in a corresponding movement of the third mast section 30.

[0058] Similarly, the movement of the third mast section 30 and the pulley 70 mounted thereon, applies a tension in the second chain 68 which rides up the pulley 70. This results in movement of the fourth mast section 32 in unison with the third 30 and second 28 mast sections.

[0059] Thus the possible extension of the mast 12 far exceeds the maximum extension of the ram 46. In this example, the mast may be extended by a multiple of the movement of the ram based upon the number of moveable mast sections present. For example, a mast having three moveable sections may be extend by three times

the extension of the ram.

[0060] The relative width and length dimension of the masts shown in figures 1 to 4 are not intended to be to scale in order to clearly show the important technical features of the present invention.

[0061] By way of example only, a working mast according to the present invention may have a maximum length in the region of 20 to 50m and may have a maximum diameter in the region of 0.6 to 2m, excluding the head frame. The load to be supported by the mast for a laden head frame may be, by way of example, in the region of 3 tonnes. The length of travel of the piston/cylinder arrangement may be in the region of 5-8m and the total extension of the mast may be in the region of 15 to 24m or more dependent on the ram specification, the number of mast sections and pulley system used.

[0062] Further details of the lower end of the mast 12 are shown in figure 4. It can be seen that the first mast section is provided with reinforcing spline formations 82 running along the outer edge of the walls thereof. Similar formations may be provided along the other mast sections.

[0063] The lower end of the ram 46 is embedded within the interior of base section 22 and comprises a port for application of pressure thereto.

[0064] In addition, the alignment formations are shown in further detail. One or more alignment formations may be provided in a side wall of a mast section. In the embodiment shown, alignment formations are provided in opposing walls of each mast section, typically in each moveable mast section. More specifically, alignment members are provided in four of the eight faces of each of the moveable mast sections.

[0065] The relevant faces of the mast sections are provided with an aperture having a circumferential wall 84 thereabout. The aperture and wall 84 define an open-ended recess in which is received a friction member 86. The friction member 86 is formed of a body of resilient material such as a rubber or the like which is pressed against the corresponding wall of the adjacent mast section. Retaining members 88 are used to hold the friction member within its recess and may take the form of a pair of retaining formations which span the recess opening in the form a cross. The degree to which the friction members protrude from the recess can be adjusted to ensure a close fit between adjacent mast sections.

[0066] Friction members mounted at the mid or the lower regions of each mast section may be oriented to press against the inner face of the radially outer adjacent mast section, whereas friction members mounted at an upper end of each mast section may be oriented to press against the outer surface of the radially inner adjacent mast section. Any or every mast section may have a plurality of friction members mounted towards each end thereof and/or along its length.

[0067] It will be appreciated that any interruption to the retraction of the mast, such as by way of jamming or snagging of the chains or else misalignment of the mast

sections, could pose a significant problem due to the weight of the mast and head structure. Accordingly it is provided an active retraction system which drives the system between an extended and retracted condition.

5 **[0068]** In such an active retraction system, a further pulley system is employed which opposes the pulley system shown in figures 2 and 3. Similar to the pulley system shown in figures 2 and 3, the retraction pulley system may employ a pair of chains located on opposing sides of each section. Such retraction chains may be interposed between the pairs of chains shown in figures 2 and 3. The retracting pulley system is driven against the pressure applied to the cylinder chamber 52. A further drive means in the form of a piston/cylinder is required to drive the retraction mechanism. The pressure in the cylinder 52 will typically be released under control as the retraction mechanism is operated so as to maintain a tension in chains 62, 68, 74 and 76.

10 **[0069]** Figure 5 shows details of a cable management structure which may be used in conjunction with the present invention. During extension of the mast, the upper end of cable 78 travels in unison with the fourth mast section to which it is attached. This causes slack in the cable to be taken up. It will be appreciated that the length of the slack in the cable is equal to or greater than the maximum length of extension of the mast 12.

20 **[0070]** The cable management structure 89 as shown in figure 5, comprises a plurality of open ended housing members 90, each having opposing side wall formations 92. The side walls 92 are spaced by top and bottom members 94 which extend between the side walls so as to define an at least partial enclosure for the cable.

25 **[0071]** The side walls of the housing members are provided with connection formations in the form of lugs and correspondingly shaped apertures such that the lugs of one housing member can be inserted into the apertures of an adjacent housing member. In this manner a plurality of housing members can be attached in an end to end arrangement so as to create a length of housing members in the form of a one-dimensional array. Each member in the array is hinged relative to the adjacent members in the array such that the cable management structure is multiply pivotable about axes of rotation transverse to the length of the cable.

30 **[0072]** The formation of the cable management structure provides lateral stability and hinders deformation of the cable about any axis other than the axes of rotation permitted by the lug-and-aperture arrangement of the housing members. Thus the length of cable which is left slack when the telescopic mast is retracted falls in a predictable manner and does not form coils or randomly oriented loops which may snag and resists extension of the mast.

35 **[0073]** Whilst the above description relates to a mast having a fixed first section and three moveable sections, it will be appreciated that any number of moveable sections may be used to meet the necessary mast extension characteristics. The minimum requirement is a fixed base

section and a single moveable section. For such an arrangement, the ram may not be directly to the moveable mast section but may instead be connected thereto via a pulley system in order to multiply the degree of travel of the moveable mast section relative to the movement of the ram.

[0074] For masts having multiple moveable mast sections, the first mast section preferably shares a one-to-one movement ratio with the ram, which movement is used to actuate further mast sections via a pulley system.

[0075] The telescopic mast system described above is not limited to use with lighting apparatus and may be applied to, for example, wind turbines or the like, wherein the uppermost portion of the mast may be provided with suitable attachment formations for fixation of a wind turbine thereto. Similarly a retracting mast of this kind may be used for telecommunications applications such as for a telecommunication base station which may support telecommunications equipment for transmission and/or receipt of signals.

Claims

- 1. A mast for supporting equipment during use, the mast being fixable in a generally upstanding orientation relative to a support surface (38) and movable between retracted and extended positions, the mast comprising:

first and second elongate mast sections, the first and the second sections being oriented substantially coaxially;

first drive means for effecting linear movement of said second section relative to said first section such that the mast is actuatable between a first condition in which the second section is retracted relative to said first section, and a second condition, in which the second section is extended; and,

transmission means comprising a first pulley system connected in the force path between the drive means and the second mast section and arranged to increase the displacement of the second mast section relative to the first mast section applied by the drive means; **characterised in that** it further comprises:

an active retraction system comprising a second pulley system that opposes the first pulley system and a second drive means for driving the second pulley system, wherein the second pulley system and second drive means drives the mast from the extended position to a retracted position; wherein first and second drive means each comprises a piston and cylinder arrangement, wherein each cylin-

5

10

15

20

25

30

35

40

45

50

55

der comprises a cylinder chamber, arranged to be driven by fluid pressure and, in operation, the second pulley system and second drive means are driven against the pressure applied to the cylinder chamber of the first drive means to retract the mast; and fluid pressure in the cylinder chamber of the first drive means is released under control as the retraction system is operated so as to maintain tension in the first pulley system.

- 2. A mast according to claim 1 wherein the mast is telescopic and the first and second mast sections are arranged concentrically.

- 3. A mast according to any preceding claim, wherein the first mast section is substantially tubular in form having a width dimension greater than the width of the second mast section such that the second mast section is locatable within the first mast section.

- 4. A mast according to claim 4, wherein the second mast section comprises a collar of increased width at one end thereof, said collar providing an abutment for contacting a corresponding end of the first collar section in the retracted condition.

- 5. A mast according to any preceding claim, comprising a third mast section, which is elongate in shape and which is oriented substantially coaxially with said first section and linearly moveable relative to the first section.

- 6. A mast according to any preceding claim, wherein the first section comprises a base section arranged to be rigidly fixed in position relative to the support surface, within which the drive means is located.

- 7. A mast according to any one of claims 1 to 5, further comprising a base section arranged to be rigidly fixed in position relative to said support surface, the first and second mast sections arranged to be linearly moveable relative to said base section.

- 8. A mast according to claim 8, wherein the drive means actuates the first section directly between the retracted and extended conditions, and the movement of said first section causes concurrent movement of the second section via said transmission means.

- 9. A mast according to claim 8, wherein the pulley system comprises a first chain connected between a base mast section and the second mast section, the chain passing about an upper portion of said first mast section such that relative movement between the first section and the base section causes actuation of the second mast section via said chain.

10. A mast according to claim 8, wherein one or more mast sections has a pulley mounted thereto for passage of a force transmission chain thereabout.
11. A mast according to claim 8 further comprising a second chain connected between a base mast section and the second mast section, the chain passing about an upper portion of said first mast section such that relative movement between the first section and the base section causes actuation of the second mast.
12. A mast according to claim 10 wherein retraction system comprises a pair of chains locating on opposing sides of each section.
13. A mast according to claim 11 wherein the retracting chains are interposed between the chains for raising the mast.
14. A mast according to any one of the preceding claims, wherein the or each mast section is polygonal in cross section such that the or each mast section has a plurality of adjoining exterior faces.
15. A mast according to any one of the preceding claims, comprising one or more alignment members provided between adjacent mast sections, the alignment member being located between corresponding walls of the first and second mast sections such that the alignment member is in compression and serves to maintain a spacing between said walls of the first and second members, the alignment members provided on circumferentially adjacent or spaced side walls of the first and/or second mast section.
16. A mast according to any one of the preceding claims, wherein one or more power cables run through a hollow interior of the first and second mast sections, the cable being constrained within a cable retaining structure having a series of adjoining members through which the cable passes, each member being attachable to an adjacent member in a hinge-like arrangement so as to constrain the freedom of movement available to said cable.

Patentansprüche

1. Mast zum Tragen von Ausrüstung während der Verwendung, wobei der Mast in einer im Allgemeinen aufrechten Ausrichtung im Verhältnis zu einer tragenden Fläche (38) befestigt und zwischen eingezogenen und ausgefahrenen Stellungen bewegt werden kann, wobei der Mast Folgendes umfasst:

eine erste und eine zweite längliche Mastsektion, wobei die erste und die zweite Sektion im

Wesentlichen koaxial ausgerichtet sind, erste Antriebsmittel, um eine lineare Bewegung der zweiten Sektion im Verhältnis zu der erste Sektion zu bewirken derart, dass der Mast angetrieben werden kann zwischen einem ersten Zustand, in dem die zweite Sektion im Verhältnis zu der ersten Sektion eingezogen ist, und einem zweiten Zustand, in dem die zweite Sektion ausgefahren ist, und Übertragungsmittel, die ein erstes Scheibensystem umfassen, das in den Kraftweg zwischen den Antriebsmitteln und der zweiten Mastsektion geschaltet und dafür angeordnet ist, die durch die Antriebsmittel angewendete Verschiebung der zweiten Mastsektion im Verhältnis zu der ersten Mastsektion zu steigern, **dadurch gekennzeichnet, dass** er ferner Folgendes umfasst:

ein aktives Einzugssystem, das ein zweites Scheibensystem, das dem ersten Scheibensystem entgegenwirkt und ein zweites Antriebsmittel zum Antreiben des zweiten Scheibensystems umfasst, wobei das zweite Scheibensystem und das zweite Antriebsmittel den Mast von der ausgefahrenen Stellung zu einer eingezogenen Stellung antreiben, wobei die ersten und die zweiten Antriebsmittel jedes eine Anordnung von Kolben und Zylinder umfassen, wobei jeder Zylinder eine Zylinderkammer umfasst, angeordnet, um durch Fluiddruck angetrieben zu werden, und im Betrieb das zweite Scheibensystem und das zweite Antriebsmittel gegen den an die Zylinderkammer der ersten Antriebsmittel angelegten Druck angetrieben werden, um den Mast einzuziehen, und der Fluiddruck in der Zylinderkammer der ersten Antriebsmittel unter Regelung verringert wird, wenn das Einzugssystem betätigt wird, um so die Spannung in dem ersten Scheibensystem aufrechtzuerhalten.

2. Mast nach Anspruch 1, wobei der Mast teleskopisch ist und die erste und die zweite Mastsektion konzentrisch angeordnet sind.

3. Mast nach einem der vorhergehenden Ansprüche, wobei die erste Mastsektion im Wesentlichen röhrenartig in der Form ist, wobei sie eine Breitenabmessung hat, die größer ist als die Breite der zweiten Mastsektion derart, dass die zweite Mastsektion innerhalb der ersten Mastsektion angeordnet werden kann.

4. Mast nach Anspruch 3, wobei die zweite Mastsektion an einem Ende derselben einen Bund mit einer ge-

- steigerten Breite umfasst, wobei der Bund ein Widerlager zum berühren eines entsprechenden Endes der ersten Bundsektion in dem eingefahrenen Zustand bereitstellt.
5. Mast nach einem der vorhergehenden Ansprüche, die eine dritte Mastsektion umfasst, die länglich in der Form ist und die im Wesentlichen koaxial mit der ersten Sektion ausgerichtet und im Verhältnis zu der ersten Sektion linear bewegt werden kann.
6. Mast nach einem der vorhergehenden Ansprüche, wobei die erste Sektion eine Basissektion umfasst, die dafür angeordnet ist, starr in Position im Verhältnis zu der tragenden Fläche befestigt zu werden, innerhalb derer die Antriebsmittel angeordnet sind.
7. Mast nach einem der Ansprüche 1 bis 5, der ferner eine Basissektion umfasst, die dafür angeordnet ist, starr in Position im Verhältnis zu der tragenden Fläche befestigt zu werden, wobei die erste und die zweite Mastsektion dafür angeordnet sind, linear im Verhältnis zu der Basissektion beweglich zu sein.
8. Mast nach Anspruch 7, wobei die Antriebsmittel die erste Sektion unmittelbar zwischen dem eingezogenen und dem ausgefahrenen Zustand antreiben und die Bewegung der ersten Sektion eine gleichzeitige Bewegung der zweiten Sektion über die Übertragungsmittel verursacht.
9. Mast nach Anspruch 8, wobei das Scheibensystem eine erste Kette umfasst, die zwischen eine Basismastsektion und die zweite Mastsektion geschaltet ist, wobei die Kette über einen oberen Abschnitt der ersten Mastsektion verläuft derart, dass eine relative Bewegung zwischen der ersten Sektion und der Basissektion eine Betätigung der zweiten Mastsektion über die Kette verursacht.
10. Mast nach Anspruch 8, wobei eine oder mehrere Mastsektion(en) eine daran angebrachte Scheibe für den Durchgang einer Kraftübertragungskette um dieselbe hat.
11. Mast nach Anspruch 8, die ferner eine zweite Kette umfasst, die zwischen eine Basismastsektion und die zweite Mastsektion geschaltet ist, wobei die Kette über einen oberen Abschnitt der ersten Mastsektion verläuft derart, dass eine relative Bewegung zwischen der ersten Sektion und der Basissektion eine Betätigung der zweiten Mastsektion verursacht.
12. Mast nach Anspruch 10, wobei das Einzugssystem ein Paar von Ketten umfasst, die auf gegenüberliegenden Seiten jeder Sektion angeordnet sind.
13. Mast nach Anspruch 11, wobei die Einzugsketten

zwischen den Ketten zum Anheben des Masts angeordnet sind.

14. Mast nach einem der vorhergehenden Ansprüche, wobei die oder jede Mastsektion vieleckig im Querschnitt ist derart, dass die oder jede Mastsektion mehrere aneinanderstoßende Außenflächen hat.
15. Mast nach einem der vorhergehenden Ansprüche, der ein oder mehrere Ausrichtungselemente umfasst, die zwischen benachbarten Mastsektionen bereitgestellt werden, wobei das Ausrichtungselement zwischen entsprechenden Wänden der ersten und der zweiten Mastsektion angeordnet ist derart, dass sich das Ausrichtungselement in Kompression befindet und dazu dient, einen Abstand zwischen den Wänden des ersten und des zweiten Elements aufrechtzuerhalten, wobei die Ausrichtungselemente auf in Umfangsrichtung aneinanderstoßenden oder mit Abstand angeordneten Seitenwänden der ersten und/oder der zweiten Mastsektion bereitgestellt werden.
16. Mast nach einem der vorhergehenden Ansprüche, wobei ein oder mehrere Stromkabel durch ein hohles Inneres der ersten und der zweiten Mastsektion laufen, wobei das Kabel innerhalb einer Kabelrückhaltstruktur eingespannt ist, die eine Reihe von aneinanderstoßenden Elementen hat, durch die das Kabel hindurchgeht, wobei jedes Element in einer scharnierartigen Anordnung an einem benachbarten Element befestigt werden kann, um so die für das Kabel verfügbare Bewegungsfreiheit einzuschränken.

Revendications

1. Mât destiné à supporter un équipement en service, le mât pouvant être fixé dans une orientation généralement verticale par rapport à une surface de support (38) et pouvant être déplacé entre des positions rétractée et étendue, le mât comprenant :
- des première et deuxième sections de mât allongées, les première et deuxième sections étant orientées de manière pratiquement coaxiale ;
un premier moyen d'entraînement, pour entraîner un déplacement linéaire de ladite deuxième section par rapport à ladite première section, de sorte que le mât peut être actionné entre un premier état, dans lequel la deuxième section est rétractée par rapport à la première section, et un deuxième état, dans lequel la deuxième section est étendue ; et
un moyen de transmission comprenant un premier système de poulie connecté dans la pre-

mière trajectoire de force entre le moyen d'entraînement et la deuxième section du mât, et destiné à accroître le déplacement de la deuxième section du mât par rapport à la première section du mât, entraîné par le moyen d'entraînement ; **caractérisé en ce qu'il** comprend en outre :

un système de rétraction actif, comprenant un deuxième système de poulie, opposé au premier système de poulie, et un deuxième moyen d'entraînement pour entraîner le deuxième système de poulie, le deuxième système de poulie et le deuxième moyen d'entraînement entraînant le mât de la position étendue vers une position rétractée ; des premier et deuxième moyens d'entraînement, comprenant chacun un dispositif à piston et cylindre, chaque cylindre comprenant une chambre de cylindre, agencés de sorte à être entraînés par la pression de fluide, le deuxième système de poulie et le deuxième moyen d'entraînement étant entraînés en service contre la pression appliquée à la chambre de cylindre du premier moyen d'entraînement, pour rétracter le mât ; et

la pression de fluide dans la chambre de cylindre du premier moyen d'entraînement étant relâchée sous contrôle lors de l'actionnement du système de rétraction, de sorte à maintenir la tension dans le premier système de poulie.

2. Mât selon la revendication 1, dans lequel le mât est télescopique, les première et deuxième sections du mât étant agencées de manière concentrique.
3. Mât selon l'une quelconque des revendications précédentes, dans lequel la première section du mât a une forme pratiquement tubulaire, avec une dimension de la largeur supérieure à la largeur de la deuxième section du mât, de sorte que la deuxième section du mât peut être positionnée dans la première section du mât.
4. Mât selon la revendication 3, dans lequel la deuxième section du mât comprend un collet à largeur accrue au niveau d'une extrémité, ledit collet établissant une butée en vue du contact avec une extrémité correspondante de la première section du collet dans l'état rétracté.
5. Mât selon l'une quelconque des revendications précédentes, comprenant une troisième section de mât, ayant une forme allongée et orientée de manière pratiquement coaxiale par rapport à ladite première section, et pouvant être déplacée linéairement par rap-

port à la première section.

6. Mât selon l'une quelconque des revendications précédentes, dans lequel la première section comprend une section de base destinée à être fixée de manière rigide dans sa position par rapport à la surface de support, dans laquelle est agencé le moyen d'entraînement.
7. Mât selon l'une quelconque des revendications 1 à 5, comprenant en outre une section de base destinée à être fixée de manière rigide dans sa position par rapport à ladite surface de support, les première et deuxième sections du mât étant agencées de sorte à pouvoir être déplacées de manière linéaire par rapport à ladite section de base.
8. Mât selon la revendication 7, dans lequel le moyen d'entraînement déplace la première section directement entre les états rétracté et étendu, le déplacement de ladite première section entraînant un déplacement simultané de la deuxième section par l'intermédiaire dudit moyen de transmission.
9. Mât selon la revendication 8, dans lequel le système de poulie comprend une première chaîne, connectée entre une section de base du mât et la deuxième section du mât, la chaîne passant autour d'une partie supérieure de ladite première section du mât, de sorte que le déplacement relatif entre la première section et la section de base entraîne l'actionnement de la deuxième section du mât par l'intermédiaire de ladite chaîne.
10. Mât selon la revendication 8, dans lequel une ou plusieurs sections de mât comportent une poulie qui y est montée, pour permettre le passage d'une chaîne de transmission de force.
11. Mât selon la revendication 8, comprenant en outre une deuxième chaîne, connectée entre une section de base du mât et la deuxième section du mât, la chaîne passant autour d'une partie supérieure de ladite première section du mât, de sorte que le déplacement relatif entre la première section et la section de base entraîne l'actionnement de la deuxième section du mât.
12. Mât selon la revendication 10, dans lequel le système de rétraction comprend une paire de chaînes agencées sur les côtés opposés de chaque section.
13. Mât selon la revendication 11, dans lequel les chaînes de rétraction sont agencées entre les chaînes destinées à soulever le mât.
14. Mât selon l'une quelconque des revendications précédentes, dans lequel la ou chaque section de mât

a une section transversale polygonale, de sorte que la ou chaque section du mât comporte plusieurs faces externes adjacentes.

15. Mât selon l'une quelconque des revendications précédentes, comprenant un ou plusieurs éléments d'alignement agencés entre des sections de mât adjacentes, l'élément d'alignement étant agencé entre des parois correspondantes des première et deuxième sections du mât, de sorte que l'élément d'alignement est sous compression et sert à maintenir un espacement entre lesdites parois des premier et deuxième éléments, les éléments d'alignement étant agencés sur des parois latérales circumférentiellement adjacentes ou espacées de la première et/ou de la deuxième section du mât.
16. Mât selon l'une quelconque des revendications précédentes, dans lequel un ou plusieurs câbles électriques passent à travers une partie interne creuse des première et deuxième sections du mât, les câbles étant retenus dans une structure de retenue des câblés, comportant une série d'éléments adjacents que traverse le câble, chaque élément pouvant être fixé sur un élément adjacent dans un agencement du type à charnière, de sorte à limiter la liberté de mouvement disponible pour ledit câble

5

10

15

20

25

30

35

40

45

50

55

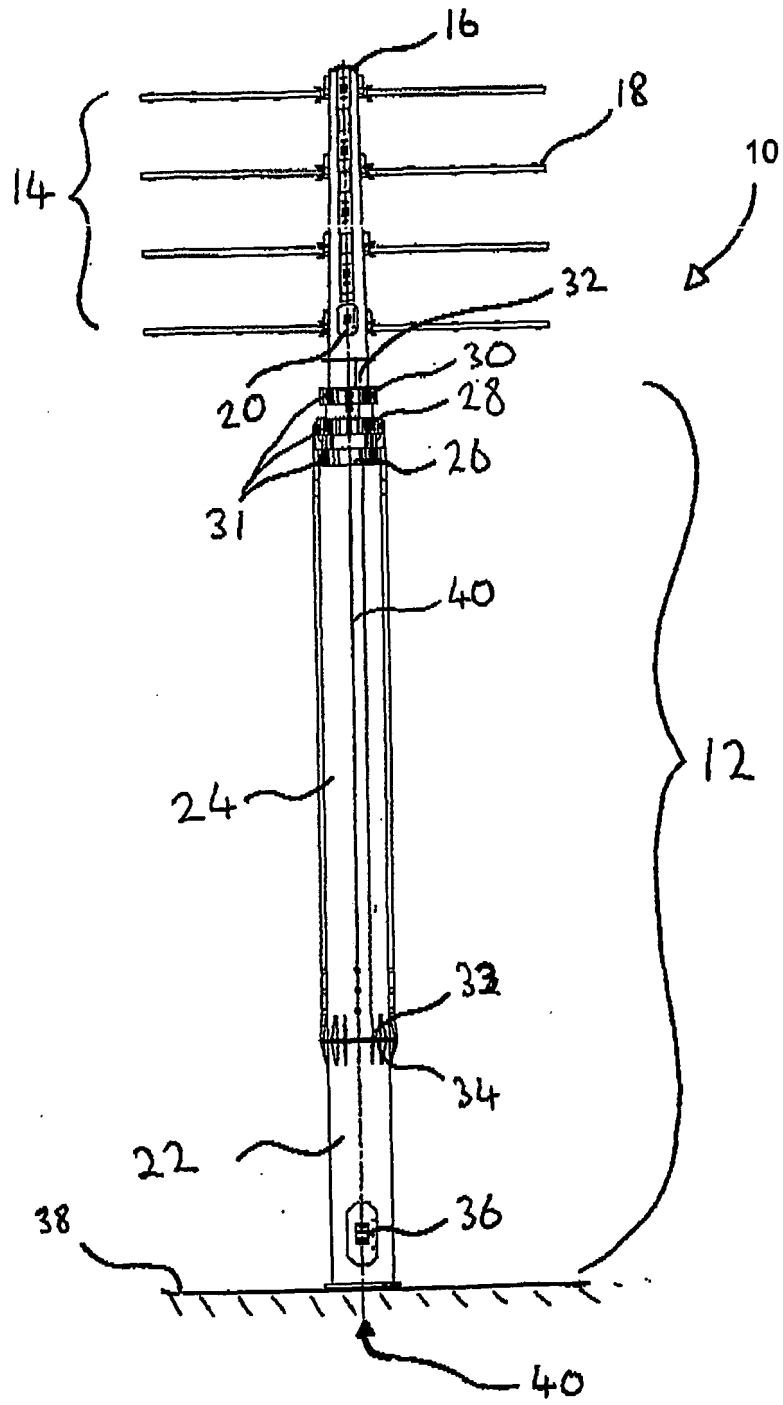


Fig. 1

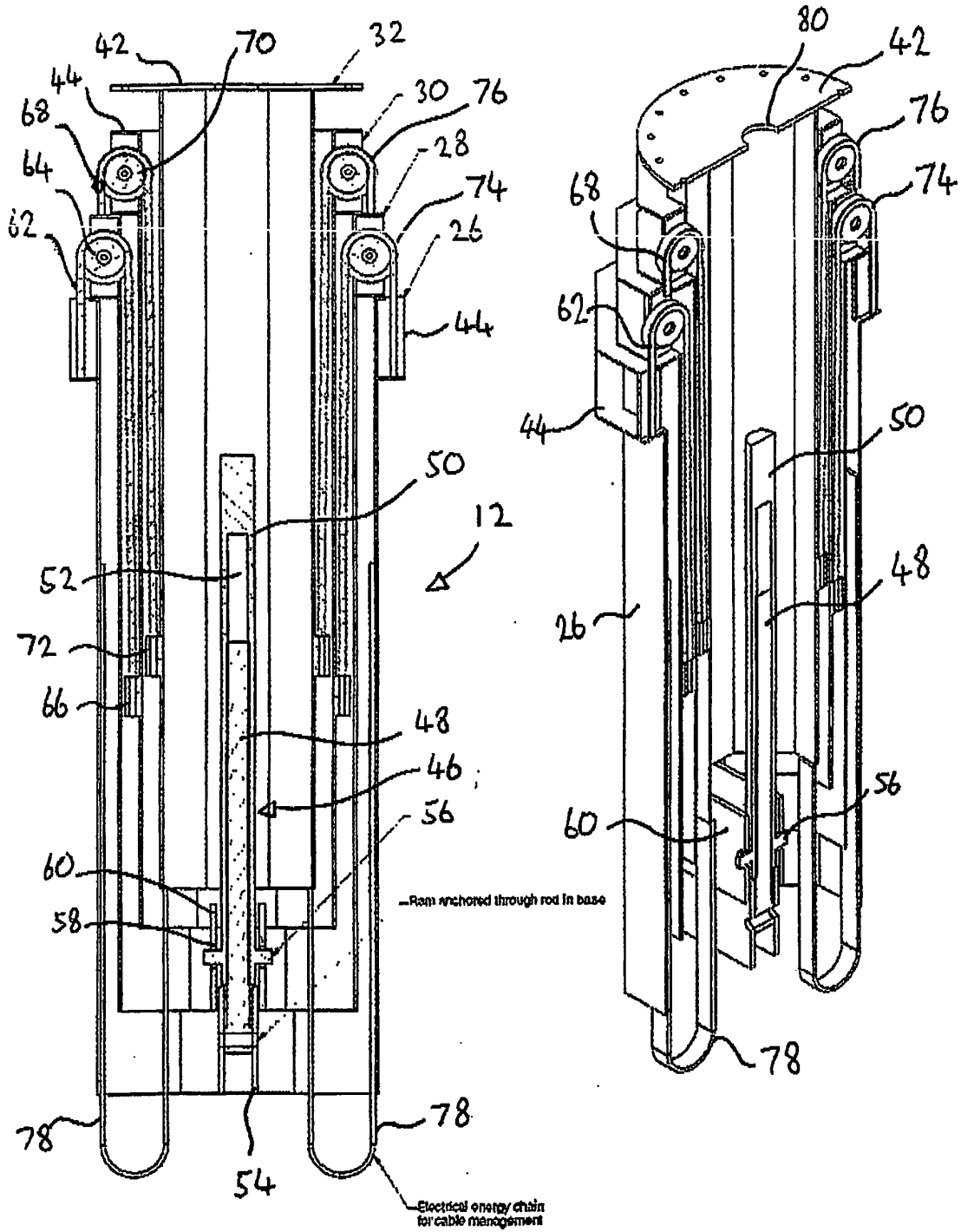


Fig. 2A

Fig. 2B

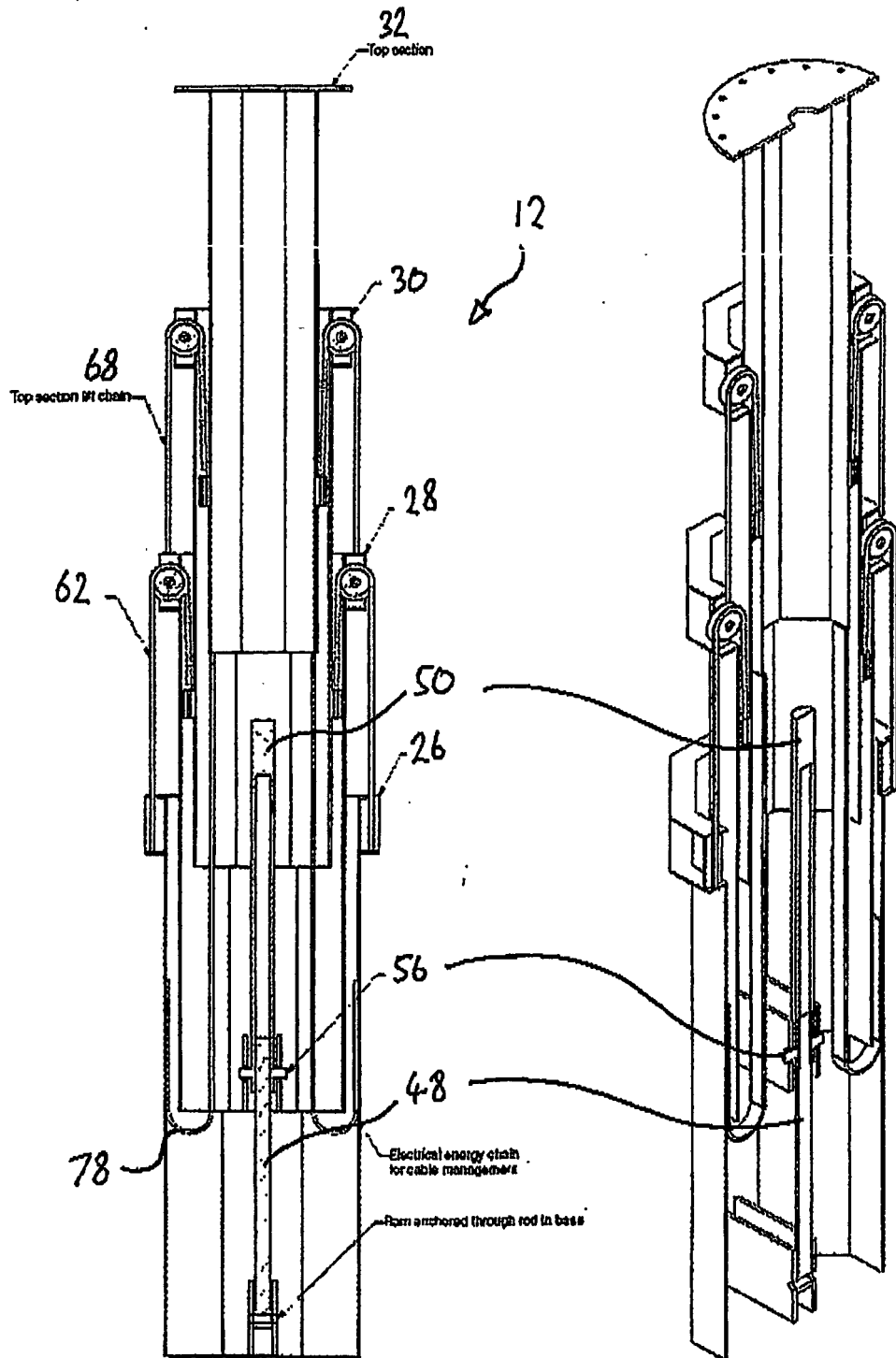


Fig. 3A

Fig. 3B

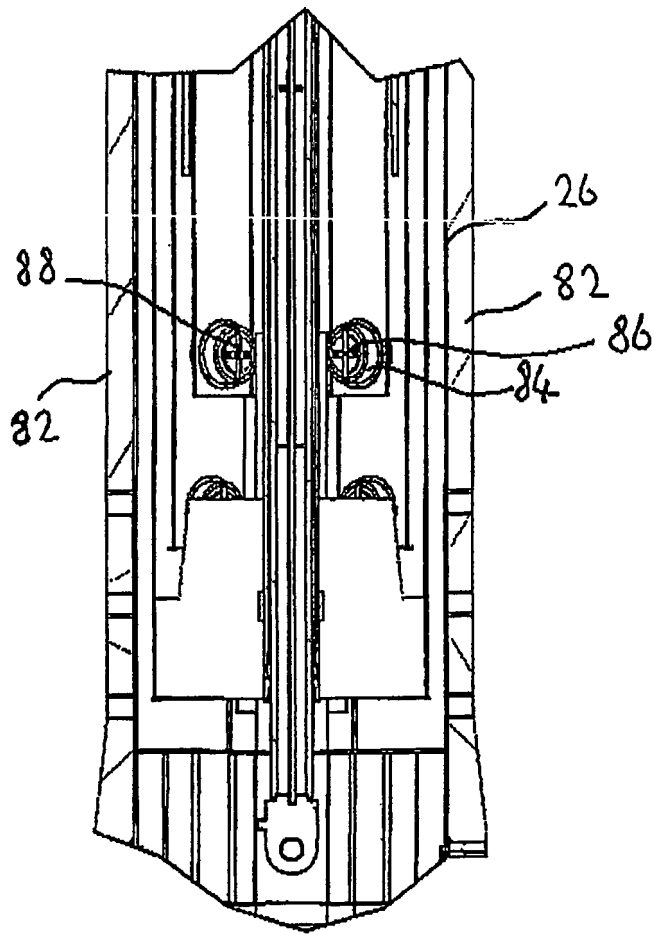


Fig. 4

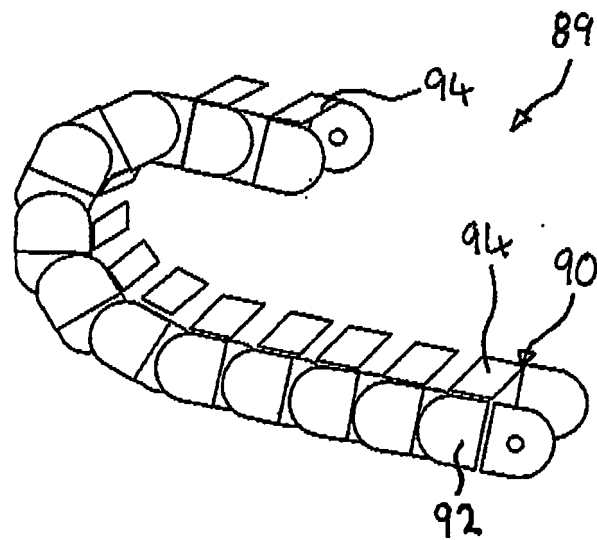


Fig. 5

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- AT 395627 B [0010]