United States Patent

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[54] MAGNET YOKE FOR LIFTING IRON BARS

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[52] **U.S. Cl.** **294/65.5**

[51] **Int. Cl.** **B66c 1/04**

[58] **Field of Search** 294/65.5; 212/14, 81, 84, 89, 212/126; 254/144, 184

[56] **References Cited**

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[57] **ABSTRACT**

A yoke for lifting sectional irons comprising a girder beneath which a plurality of electromagnets are suspended vertically displaceable in slings from spring suspension means. These means are mounted on a rotatable shaft in the girder, said shaft extending longitudinally of the girder and being supported in fixed bearings. Preferably each spring suspension means comprises two rope pulley nuts which are rotatable in relation to the shaft and resting on a sliding sleeve. This sleeve is axially displaceable in relation to the shaft and acted upon by a pressure spring which is coaxial with the sleeve. The two rope pulley nuts are rotatable in relation to each other with inside screwthreads of opposite hand having identical screwthread diameter and slope angle. The sliding sleeve has on its outer side a first screwthread section and a second screwthread section with screwthreads corresponding to the two rope pulley nuts.

15 Claims, 5 Drawing Figures

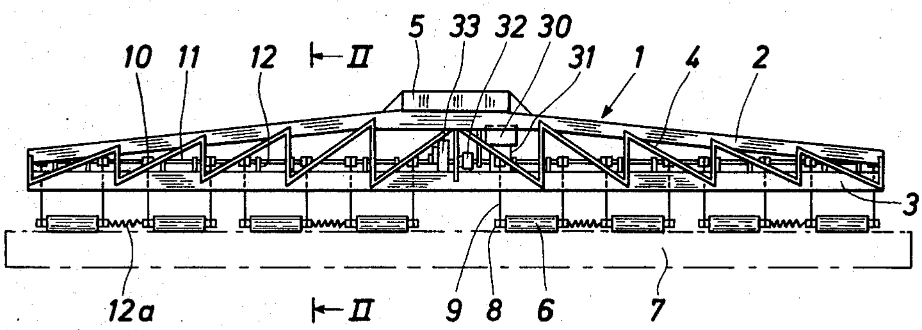

Fig. 1

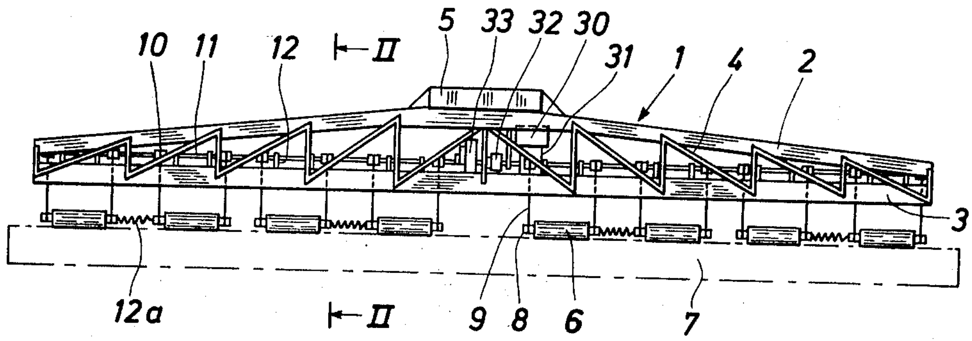

Fig. 2

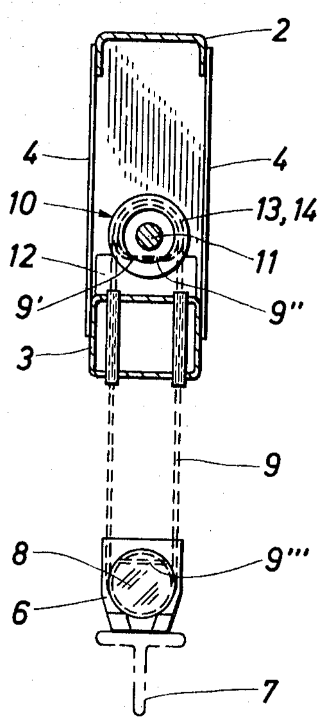

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Fig. 3

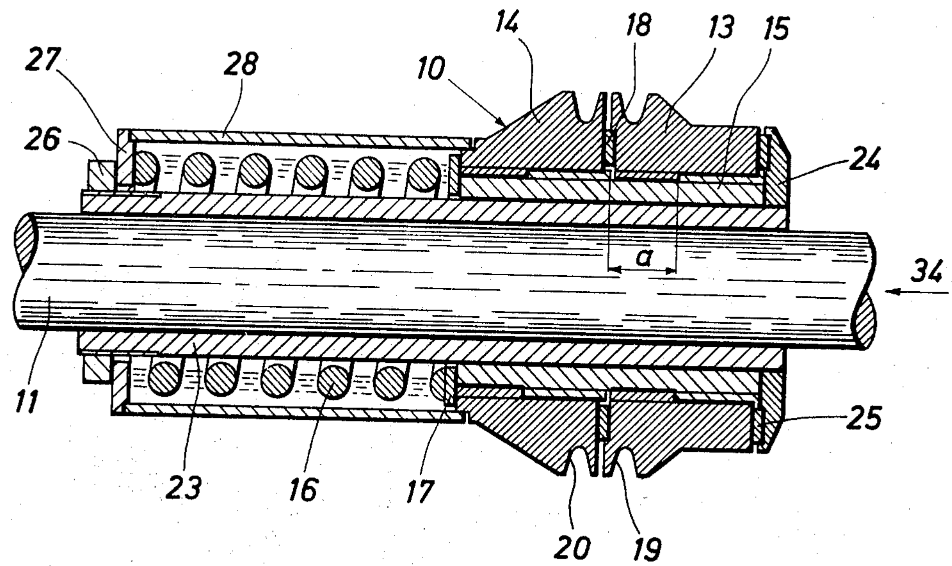


Fig. 4

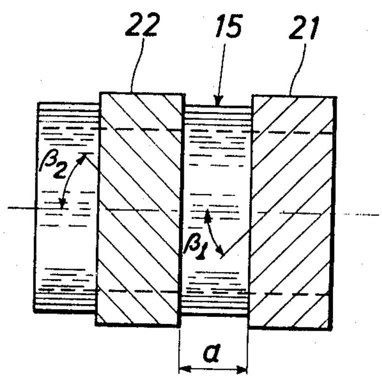
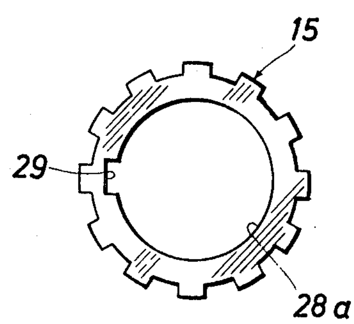


Fig. 5



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MAGNET YOKE FOR LIFTING IRON BARS

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention relates to a magnet yoke for lifting iron bars, for example sectional irons. The said magnet yoke has a main flange and a foot flange interconnected by means of side lattices to form a lattice girder beneath which are provided a number of long, narrow electromagnets carrying end pins at each of their ends, the said magnets being by means of ropes or slings attached to the end pins suspended vertically displaceable from spring suspension means mounted in the lattice girder and the magnets being rotatable by means of a shaft extending longitudinally of the lattice girder and supported in fixed bearings provided in the said girder.

2. Description of the Prior Art

Danish Pat. specification No. 111,837 discloses a magnet yoke of the said kind in which each magnet is suspended from a spring suspension member provided in the main flange of the girder. In the spring suspension member is a vertically and resiliently arranged fork which projects somewhat beneath the spring suspension member and at its lower end carries two rope pulleys. From the end pins of each magnet the two ends of a rope or sling are passed up through the foot flange and further up around the corresponding rope pulleys and then down for attachment to two rope pulleys attached to the shaft, which rests in fixed bearings on the upper side of the foot flange. A serious drawback is that the individual spring suspension members with corresponding rope pulley and intermediate rope pulley occupy much space, the distance between the spring suspension member and the rope pulley being approximately equal to the distance between main flange and foot flange. Another serious drawback is that with the use of uniform lengths of slings for the individual magnets of the magnet yoke the provision of the spring suspension members in the main flange of the known magnet yoke involves that the main flange has to be adapted to receive the said members and to extend parallel to the foot flange; this involves at suspension of the magnet yoke in hoisting mechanism by its central part an undesired, comparatively high construction of the outer ends of the magnet yoke.

SUMMARY OF THE INVENTION

The object of the invention is to provide a magnet yoke of the kind referred to in the introductory part of the specification with a simple and cheap suspension of the magnets from the lattice girder.

This is accomplished by a magnet yoke which according to the invention has the essential feature that the spring suspension means are provided on the shaft that is adapted to turn the magnets.

In the said embodiment each sling may be passed from its magnet up for attachment to the corresponding spring suspension member and thus be brought into direct mechanical connection with the shaft for turning the magnets without use of any extra length of sling between the spring suspension member and the shaft. Since the spring suspension member is placed on the shaft and not in the main flange of the lattice girder, the main flange may, dependent upon the number and location of the suspension points of the lattice girder in a hoisting apparatus be of a suitable embodiment, for example with a horizontal central flange and rectilinear downwardly sloping end flanges on either side of same. The result obtained is thus on the whole a simple and cheap suspension of the magnets from the lattice girder.

An essential feature of one embodiment of the magnet yoke according to the invention is that each spring suspension member has a divided rope pulley rotatable in relation to the shaft and resting on a sliding sleeve that is axially displaceable in relation to the shaft and acted upon by a pressure spring which is coaxial with the sleeve. The result obtained is a compact construction of the spring suspension member.

An essential feature of another embodiment of the magnet yoke according to the invention is that the rope pulley consists of a first and a second rope pulley nut located beside each other, spaced apart by means of a slide disc, and being rotatable in relation to each other, with inside screwthreads of opposite hand having identical screwthread diameter and slope angle, the sliding sleeve cooperating with the rope pulley nuts having on its outer side a first and a second screwthread section with screwthreads corresponding to the first and the second rope pulley nut, respectively, the said first and second screwthread section being spaced apart. The result obtained is a pure rotation of one rope pulley nut in relation to the shaft, caused by unwinding or winding of the sling length lying on the rope pulley nut through engagement of the inside oblique screwthreads of the rope pulley, and the corresponding screwthread section of the sliding sleeve will cause the said sleeve to perform a pure axial movement in relation to the shaft. The other screwthread section of the sliding sleeve will by its axial movement be brought into engagement with the oblique screwthread of the other rope pulley nut, and the said screwthread will perform a pure rotation in the opposite direction of the rotation of the first mentioned rope pulley nut as the two rope pulley nuts and the two screwthread sections have screwthreads of opposite hand. Since the said screwthreads have slope angles of equal size, the rope pulley nuts will rotate by an equal amount to either side so that equal lengths of the suspended sling parts are unwound or wound.

An essential feature of a third embodiment of the magnet yoke according to the invention is that the slide disc is made of nylon with an embedded casting of molybdenum disulphide. The result obtained is a slide disc with substantial lubricating qualities so that the friction between the two rope pulley nuts which are rotatable in relation to each other is highly reduced.

An essential feature of a fourth embodiment of the magnet yoke according to the invention is that the slope angle is 45°. This affords an adequate travelling of the sliding sleeve and identical efficiency of movement in either direction.

A fifth embodiment of the magnet yoke according to the invention is that the first and the second rope pulley nuts are each provided with a groove known per se for a rope or sling, the bottom of the said grooves having each a distance from the central axis of the shaft approximately equal to the radius of the end pins of the individual magnets. The result obtained is that the turning angle of the rope pulley nuts and consequently of the shaft is equal to the turning angle of the magnets, which simplifies the operation of the magnet yoke. A further result obtained is that such parts of the slings as extend upwardly from the end pins of the magnets are parallel and may be passed through non-oblique guide tubes provided on, and at right angles to, the upper and undersides of the foot flange, which facilitates mounting of the guide tubes in the foot flange.

An essential feature of a sixth embodiment of the magnet yoke according to the invention is the provision of an axially displaceable spring ring between the sliding sleeve and the pressure spring, the said spring ring having a diameter and a ring width corresponding substantially to the diameter and the width of the solid cross-section of the pressure spring. The result obtained is an adequate contact surface for the end winding of the pressure spring for transmitting pressures from the sliding sleeve, so that the surface pressure exerted against the said end winding will be a minimum.

An essential feature of a seventh embodiment of the magnet yoke according to the invention is that between the shaft on one side and the sliding sleeve, the spring ring and the pressure spring on the other side there is provided a tubular hub attached to the shaft. The outer surface of the said hub will constitute a bearing for the said three axially movable elements.

An essential feature of an eighth embodiment of the magnet yoke according to the invention is that the hub at the end where the rope pulley nuts are provided is provided with the stop flange, which by means of an intermediate slide disc rests against the end surface of the outermost rope pulley nut, that the hub at the other end has a stop ring, the outside end surface of which by means of a screwthread provided on the end of the hub is resting against a nut screwed on the said screwthread, the inside end surface of the said stop ring resting against the end of the pressure spring, which does not touch the spring ring, and that between the stop ring and the innermost rope pulley nut there is provided a tubular cover surrounding the pressure spring, By this means the elements of the spring suspension member are joined in axial direction, so that the rope pulley nuts cannot move in axial direction in relation to each other or in relation to the shaft.

An essential feature of a ninth embodiment of the magnet yoke according to the invention is that the bearings of the shaft are attached on top of the foot flange. The result obtained is an efficient support of the shaft and, since the latter is mounted on top of the foot flange and thus located inside the lattice girder, a substantial protection of the shaft against impact from outside.

An essential feature of a tenth embodiment of the magnet yoke according to the invention is that the shaft is mechanically connected with a driving motor, for example a gear motor, mounted at the central part of the lattice girder. Owing to this arrangement of the driving motor at the central part of the foot flange, there will only be low torques at both ends of the shaft, and as a result the pole shoe surfaces of the magnets will always be located in approximately the same plane.

An essential feature of an eleventh embodiment of the magnet yoke according to the invention is that the driving motor is located above the shaft, attached to the foot flange by means of stiffeners. As the driving motor is arranged inside the lattice girder, the result obtained is a compact construction of the magnet yoke, the driving motor being simultaneously protected against impacts from outside.

An essential feature of a twelfth embodiment of the magnet yoke according to the invention is that the driving motor is mechanically connected with the shaft via a friction coupling mounted on same and provided with overload safety device. As a result, the driving motor is protected against overload due to lifting or turning of an iron bar or a similar load.

An essential feature of a thirteenth embodiment of the magnet yoke according to the invention is that at the central part of the foot flange there is provided an electric stop member to ensure that the maximum turning of the magnets does not exceed predetermined turning angles, more particularly ±90° in relation to a vertical plane. The said stop member will stop the driving motor and consequently the shaft, if the maximum turning of the magnets exceeds the said angles, thus preventing that the turned iron bar on any further turning strikes against the sling parts between the end pins of the magnets and the shaft.

BRIEF DESCRIPTION OF THE DRAWING

The invention will now be further described with reference to the drawing, in which

FIG. 1 is a sideview of an embodiment of a magnet yoke according to the invention with spring suspension means and electromagnets, and a sectional iron beam lifted by these.

FIG. 2 shows on an enlarged scale a section taken on the line II—II of FIG. 1,

FIG. 3 is, on a still larger scale, a longitudinal section taken through a spring suspension member,

FIG. 4 is a sideview of a sliding sleeve for the spring suspension member shown in FIG. 3, and

FIG. 5 is an endview of the sliding sleeve shown in FIG. 4.

FIG. 1 shows a magnet yoke having a lattice girder **1** consisting of a main flange or upper flange **2** and a foot flange or lower flange **3** which are interconnected by means of two side lattices **4**. As indicated in FIG. 2 the main flange **2** consists of a U-shaped flange, whereas the foot flange **3** consists of a square tube. The lattice girder **1** is by means of a suspension part **5** suspended at its central part from a hoisting apparatus (not shown). Beneath and along the lattice girder **1** are suspended a number of long, narrow electromagnets **6** which as shown in FIGS. **1** and **2** lift a sectional iron beam **7**, indicated by a dash- and dotted line. The magnets **6** carry at each of their ends end pins **8**, and by means of ropes or slings **9** attached to the said end pins the magnets are suspended vertically displaceable from spring suspension members **10**. As a result, the magnets **6**, which are resilient in vertical direction, may each of them separately adjust themselves to a sectional iron beam that is not straight and be caused to lift approximately an equal weight. The spring suspension members **10** are mounted on a shaft **11** which extends longitudinally of the lattice girder **1** and rests in fixed bearings **12** provided in same. The shaft **11** is, in addition to carrying the magnets **6**, adapted to turn these via the spring suspension members **10** and the slings **9**. The magnets **6** are connected, preferably in pairs, by springs **12*a*** in order to dampen any vibrations of the magnets in relation to the lattice girder **1**.

FIG. 3 shows a longitudinal section through a spring suspension member **10** which has a divided rope pulley **13, 14** that is rotatable in relation to the shaft **11**. The said rope pulley is carried by a sliding sleeve **15** which is axially displaceable in relation to the shaft **11** and acted upon by a pressure spring **16** which according to FIG. 3 is designed as a cylindrical pressure spring of round wire. The pressure spring **16** is mounted coaxially with the sliding sleeve **15**. Between the said sliding sleeve **15** and the pressure spring **16** is provided an axially displaceable spring ring **17** having a diameter and ring width substantially corresponding to the diameter and the width of the cross-section of the spring wire. The result obtained is an adequate contact surface for the end winding of the pressure spring for transmitting pressures from the sliding sleeve, so that the surface pressure exerted on the end winding by the spring ring **17** is reduced to a minimum.

The divided rope pulley consists of a first rope pulley nut **13** and a second rope pulley nut **14** located side by side, rotatably in relation to each other. To reduce the friction between the two rope pulley nuts there is provided a slide disc **18** between them. The said slide disc is preferably made of nylon with an embedded casting of molybdenum disulphide, so that the slide disc provided has an exceptionally low coefficient of friction. The two rope pulley nuts are provided with inside, opposite hand screwthreads having identical screwthread diameter and slope angle $\beta_1=\beta_2$ (FIG. 4). The slope angles β_1 and β_2 are preferably 45°.

Each rope pulley nut **13** and **14** has along its outer circumference a machined groove **19** and **20**, respectively (FIG. 3), in which either end of the sling **9** is resting (not shown in FIG. 3). The grooves **19** and **20** are of identical cross-section and in the identical distance from the central axis of the shaft **11**. The bottoms of the grooves **19** and **20** are spaced a distance apart preferably equal to the radius of the end pins **8** of the magnets **6**. As indicated in FIG. 2, which shows a vertical section through the lattice girder **1**, each of the two sling parts passed upwards are resting in contact with its separate groove corresponding to an angle of embrace of abt. 220°, their ends **9′** and **9″** being in suitable manner each attached to their separate rope pulley nut **13, 14**. Below at the end pin **8** of the magnet **6** the sling **9** is wound one turn and a half around the end pin and along an upper sling part **9‴** attached by suitable fixing means (not shown) to the end pin **8**.

In FIG. 4 the sliding sleeve **15**, which is made of bronze, is represented in a sideview. On its outer side it has a first screwthread section **21** and a second screwthread section **22** corresponding to the screwthreads of the first rope pulley nut **13** and the second rope pulley nut **14**. Thus, the screwthread section **21** is, for example, left-hand cut, whereas the screwthread section **22** is right-hand cut. The screwthread sections **21** and **22** are spaced a distance *a* apart (FIGS. 3 and 4). The said distance *a* corresponds to the maximum axial displacement possible for the sliding sleeve **15** (to the left in FIG. 3), since the screwthread section **21** by further movement of the sliding sleeve **15** will strike against the opposite hand screwthread of the other rope pulley nut **14**.

As indicated in FIG. 3, the sliding sleeve **15**, the spring ring **17** and the pressure spring **16** are mounted on a tubular hub **23** which is attached to the shaft **11** by means of an axial tongue and groove (not shown). Such end of the hub **23** on which the rope pulley nuts **13** and **14** are mounted, that is, the right-hand end in FIG. 3, is provided with a stop flange **24** which, for example, may be connected with the hub **23** by welding. The said flange abuts through an intermediate slide disc **25** with the end surface of the outermost rope pulley nut **13**. To reduce the friction between the said rope pulley nut **13** and the stop flange **24** the slide disc **25** is similarly as the slide disc **18** made of nylon with an embedded casting of molybdenum disulphide. On the opposite end of the hub **23** is inserted a stop ring **27** the outside end surface of which rests against a nut **26** screwed on an outer screwthread provided on the end of the hub and secured against working loose in suitable manner. The inside end surface of the stop ring **27** is resting against such end of the pressure spring **16** as does not touch the spring ring **17**. Between the stop ring **27** and the inmost rope pulley nut **14** is mounted a tubular cover **28** surrounding the pressure spring **16**. Between the cover **28** and the rope pulley nut **14** is a slight clearance, for example of 0.1–0.2 mm, to permit rotation of the rope pulley nut **14** in relation to the cover. By means of the stop flange **24** and the stop ring **27** provided in the ends of the hub **23** and the cover **28** the two rope pulley nuts **13** and **14** are prevented from axial displacement.

The sliding sleeve **15** is on its inner side provided with a smooth bore **28a** with an axial sliding groove **29** as will appear from FIG. 5. By means of a corresponding axial sliding groove and tongue (not shown in FIG. 3) provided in the hub **23** the sliding sleeve **15** may slide or be displaced on the hub **23**, but not turn in relation to the hub.

To obtain an efficient support of the shaft **11** in the lattice girder **1** the bearings **12** are as shown in FIGS. 1 and 2 attached on top of the foot flange **3**. The shaft **11** is mechanically connected with the driving motor **30**, for example a gear motor located above the shaft **11** and attached to the central part of the foot flange **3** by means of stiffeners **31**. To protect the driving motor **30** against overloading due to lifting or turning of the sectional iron beam **7**, the driving motor **30** is connected with the shaft **11** via a friction coupling **32** with overload safety device.

Furthermore, an electric stop member **33** is provided on the foot flange **3** at the central part of same. The said stop member will stop the driving motor **30** and consequently the shaft **11** if the maximum turning of the magnets exceeds predetermined turning angles, preferably ±90° in relation to a vertical plane.

The mode of operation of the spring suspension member will be described in the following by way of examples.

When the shaft **11** is turned, the turning movement is transmitted via the hub **23** and the sliding sleeve **15** to the rope pulley nuts **13** and **14**, by which the sling parts **9** resting in the grooves **19** and **20** and hanging downwardly on opposed sides of the shaft **11** are turned, one sling part being passed downwards and unwound from one rope pulley nut, whereas the other sling part is passed upwards and wound on the other rope pulley nut. By this movement of the sling parts turning of the end pin **8** (see FIG. 2) is effected and consequently the desired turning of the individual magnets **6**.

When, for example, a sectional iron beam is lifted, this will usually involve an extension of the individual slings **9** since the shaft **11** remains stationary. An extension of one sling part, for example to the first rope pulley nut **13**, will by the sling part being wound off the rope pulley nut **13** cause the said rope pulley nut to turn in relation to the stationary shaft **11**. Owing to the oblique left-hand screwthread of the rope pulley nut **13** it will tend to perform a helical movement, for example to the right in FIG. 3, assuming that the sling part attached to the rope pulley nut **13** is passed downwards on such side of the shaft **11** as is away from the observer looking at FIG. 3. Since the rope pulley nut **13** cannot be displaced axially, being guided laterally by the stop flange **25** and the other rope pulley nut **14**, the rope pulley nut cannot perform the helical right-hand movement. The said helical movement may be divided, partly into a pure rotational movement, directed clockwise when the shaft **11** is viewed in the direction of the arrow **34**, partly a pure rectilinear axial movement to the right in FIG. 3. The tope pulley nut will therefore only perform the pure rotational movement, whereas the sliding sleeve **15**, which by means of its screwthread section **21** is in engagement with the inner screwthread of the rope pulley nut, will perform the rectilinear axial movement a certain distance to the left. The sliding sleeve **15** will thereby force the spring ring **17** to the left, so that the pressure spring **16** is compressed by an amount equal to the rectlininear axial movement. Simultaneously, owing to the sliding sleeve and consequently its second screwthread section **22** moving axially to the left, the said screwthread section **22** will by its engagement with the inside right-hand screwthread of the other rope pulley nut **14** cause the said rope pulley nut to perform a pure rotational movement of the same magnitude, but counter to the rotational direction of the first rope pulley nut, that is, counter clockwise if the shaft **11** is viewed in the direction of the arrow **34**. As the second sling part, which is attached to the rope pulley nut **14**, is located on the other side of the shaft **11** in relation to the sling part belonging to the rope pulley nut **13**, the second sling part will thus be located on the front of the shaft **11** shown in FIG. 3. The rotational movement of the rope pulley nut **14** will therefore involve that the second sling part is unwound by the same amount as the first sling part belonging to the first rope pulley nut **13**. As a result, the two sling parts will be extended by an equal amount.

What is claimed is:

1. A magnet assembly for use in lifting iron bars, comprising,
   - a lattice girder,
   - fixed bearings mounted on the lattice girder, a shaft rotatable in said bearings and extending longitudinally of the lattice girder,
   - a plurality of long, narrow electromagnet assemblies located beneath the lattice girder,
   - connector means on the shaft,
   - elongated flexible sling means having a pair of vertical legs extending between the connector means and the electromagnets for supporting the electromagnets and for producing rotational movement of the electromagnets upon rotation of the shaft,
   - said connector means including resilient means mounted on the shaft for urging both vertical legs of the elongated flexible means upwardly to permit vertical displacement of the associated electromagnet means when subjected to downward forces.
2. A magnet assembly as claimed in claim 1 wherein
   - each of the connector means includes a sliding sleeve axially movable on the shaft a divided rope pulley movably mounted on the sliding sleeve, and pressure spring coaxial with and acting upon the sleeve.
3. A magnet assembly as claimed in claim 2, characterized in that the rope pulley **13**, **14** includes a first rope pulley nut **13** and a second rope pulley nut **14** located side by side and being rotatable in relation to each other, with inside screwthreads of opposite hands having identical screwthread diameter and angle of slope β_1 β_2, the sliding sleeve **15** cooperating with the rope pulley nuts **13**, **14** having on its outer side a first screwthread section **21** and a second screwthread section **22** with screwthreads corresponding to the first rope pulley nut **13** and the second rope pullet nut **14**, respectively.
4. A magnet assembly as claimed in claim 3 having an antifriction disc **18** located between the rope pulley nuts, said antifriction disc being made of nylon with an embedded casting of molybdenum disulphide.
5. A magnet assembly as claimed in claim 3, characterized in that the angle of slope β_1 β_2 is 45°.
6. A magnet assembly as claimed in claim 3, wherein the first rope pulley nut **13** and the second rope pulley nut **14** are

each provided with a groove **19, 20** for receiving the elongated flexible member, the bottom of the said grooves **19, 20** having each a distance from the central axis of the shaft **11** approximately equal to the radius of the end pins **8** of the individual magnets **6**.

7. A magnet assembly as claimed in claim **3**, wherein between the sliding sleeve **15** and the pressure spring **16** there is provided an axially displaceable spring ring **17** having a diameter and a ring width corresponding substantially to the diameter and the width of the solid cross-section of the pressure spring.

8. A magnet assembly as claimed in claim **7** wherein a tubular hub is attached to the shaft and located between the shaft **11** and, respectively, the sliding sleeve **15**, the spring ring **17** and the pressure spring **16**.

9. A magnet assembly as claimed in claim **8** characterized in that the hub **23** at the end where the rope pulley nuts **13, 14** are situated is provided with a stop flange **24**, an intermediate antifriction disc **18** located between the stop flange and the end surface of the outermost rope pulley nut **13**, the other end of the hub having a stop ring **27**, a hub screwthread provided on the external surface of said other end of the hub, a nut **26** screwed on the hub screwthread, the inside end surface of the said stop ring **27** resting against the end of the pressure spring **16** which does not touch the spring ring **17**, and a tubular cover **28** surrounding the pressure spring **23** and located between the stop ring **27** and the innermost rope pulley nut **14**.

10. A magnet assembly as claimed in claim **7** wherein the lattice girder includes a main flange, a foot flange and lattice elements connecting said flanges, the bearings **12** of the shaft **11** being attached on top of the foot flange **3**.

11. A magnet assembly as claimed in claim **10** wherein the shaft **11** is mechanically connected with a driving motor **30** arranged at the central part of the lattice girder **1**.

12. A magnet assembly as claimed in claim **11**, wherein the driving motor **30** is located above the shaft **11** and attached to the foot flange **3** by means of of stiffeners.

13. A magnet assembly as claimed in claim **11** wherein a friction coupling **32** mechanically connects the driving motor **30** with the shaft **11** said friction coupling **32** having an overload safety device mounted on the shaft.

14. A magnet assembly as claimed in claim **13** wherein an electric stop member **33** is located at the central part of the foot flange **3**, said electric stop member **33** including means for ensuring that the maximum turning angle of the magnets **6** does not exceed 90°, in relation to a vertical plane.

15. A magnet assembly as claimed in claim **1** wherein each of the connector means includes a sleeve rotationally fixed and axially movable on the shaft, a pair of rope pulley nuts mounted on the sleeve and a pressure spring coaxial with the shaft and biasing the sleeve in one direction, and threaded engagement means operable between the sleeve and the rope pulley nuts for moving the sleeve to compress the spring in response to opposite rotational movement of the rope pulley nuts.

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