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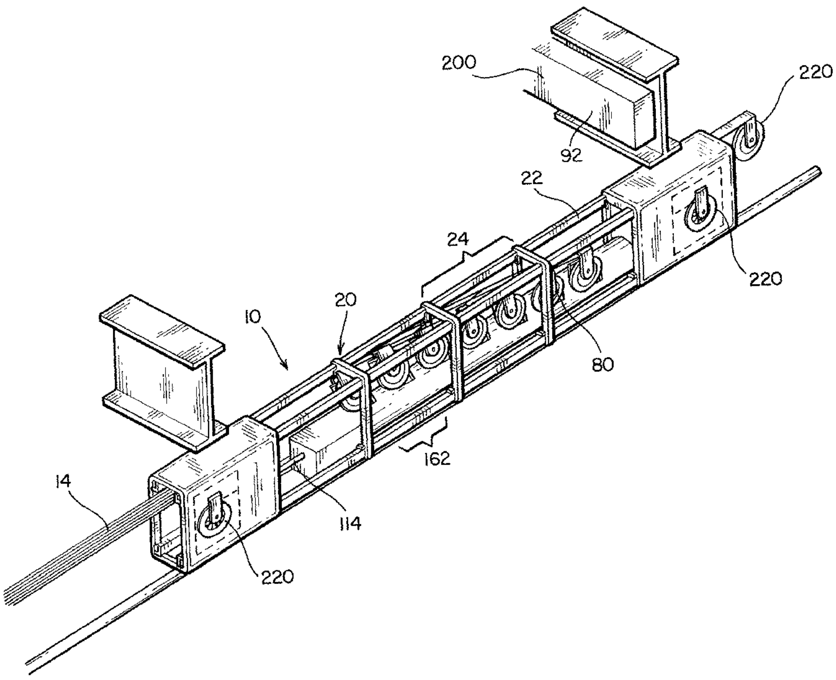
(54) Title: MODULAR LIFT ASSEMBLY



(57) Abstract: A lift assembly having a drum rotatably mounted to a frame and linearly translatable with respect to the frame. A plurality of head blocks are connected to the frame along a helical mounting path, wherein linear translation of the drum during take-off or take-up maintains a predetermined fleet angle between a take-off point from the drum and the head block.

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MODULAR LIFT ASSEMBLY

Field of the Invention

The present invention relates to lift and hoist mechanisms, more particularly, to a lift assembly that can be employed for raising and lowering a load in theatrical and staging environments, wherein the lift assembly is a modular self contained unit that can be readily installed in a wide variety of building configurations.

Background of the Invention

Performance venues such as theaters, arenas, concert halls, auditoriums, schools, clubs, convention centers and television studios employ battens or trusses to suspend lighting, scenery, drapery and other equipment which is moved relative to a stage or floor. These battens usually include pipe or joined pipe sections that form a desired length of the batten. The battens can be 50 feet or more in length. To support heavy loads or where suspension points are spaced 15-30 feet apart, the battens may be fabricated in either ladder, triangular or box truss configurations.

Battens often need to be lowered for exchanging and servicing the suspended equipment. To reduce the power necessary to raise and lower the battens, the battens are often counterweighted. The counterweights reduce the effective weight of the battens and any associated loads.

A typical counterweight system represents a significant cost. The creation of T-bar wall 70 feet to 80 feet in height and 30 feet deep may require over three weeks. Even after installation of the T-bar wall, head block beams, loading bridges, index lights and hoist systems must be integrated. Therefore, a substantial cost is incurred in the mere installation of a counterweight system. The total installation time may range from 6 to 12 weeks.

A number of elevating or hoisting systems are available for supporting, raising and lowering battens. One of the most common and least expensive batten elevating systems is a counterweighted carriage which includes a moveable counterweight for counterbalancing the batten and equipment supported on the batten.

Another common elevating or hoisting system employs a winch to raise or lower the battens. Usually hand or electric operated winches are used to raise or lower the battens. Occasionally in expensive operations, a hydraulic or pneumatic motorized winch or cylinder device is used to raise and lower the batten.

Many elevating systems have one or more locking devices and at least one form of overload limiting device. In a counterweight system, a locking device may include a hand operated rope that is attached to one end of the top of the counterweight arbor (carrying device) and then run over a head block, down to the stage, through a hand rope block for locking the counterweight in place, and then around a floor block and back up to the bottom of the counterweight arbor. The hand rope lock locks the rope when either the load connected to the batten or the counterweight loads are being changed and rebalanced and locks the loads when not moving.

In a sandbag counterweight system, the locking device is merely a rope tied off to a stage mounted pin rail, while the overload limit is regulated by the size of the sandbag. In this rigging design, however, a number of additional bags can be added to the set of rope lines, and thereby exceed the safe limit of suspension ropes and defeat the overload-limiting feature.

Hand operated winches will occasionally free run when heavily loaded and will then dangerously drop the suspended load. Other types of hand winches use a ratchet lock, but again these winches are also susceptible to free running when they are heavily loaded and hand operated.

Therefore, the need exists for a lift assembly that can replace traditional counterweight systems. The need further exists for a lift assembly that can be readily installed into a variety of building configurations and layouts. A need further exists for a lift assembly having a modular construction to facilitate configuration to any of a variety of installations. A need also exists for a lift assembly that can maintain a predetermined fleet angle during raising or lowering of a load.

Summary of the Invention

The present invention provides a lift assembly that can be employed in a variety of environments, including theater or stage configurations. The present system is also configured to assist in converting traditional counterweight systems to a non-counterweighted system. The present invention further provides a lift assembly that can be configured to lie substantially within the footprint of the associated drop lines.

The present invention includes a lift frame, a plurality of head blocks connected to the frame, and a drum rotatably connected to the frame about a longitudinal axis of the drum, the drum also being translatable along its longitudinal axis relative to the head blocks to maintain a predetermined fleet angle between the head blocks.

In a further configuration, the present invention may include a bias mechanism such as a torsion spring connected between the frame and the drum for reducing the effective weight of the load or batten and any associated equipment.

The lift assembly of the present invention employs a modular frame for accommodating a different number of head blocks. The lift assembly also includes a modular drum construction which allows for the ready and economical configuration of the system to accommodate various stage sizes. The lift assembly further contemplates the head blocks connected to the frame to be radially spaced about the axis of drum rotation. In a further configuration, the head blocks are radially and longitudinally spaced relative the to axis of drum rotation, to lie in a helical or a serpentine path relative to the drum.

The lift assembly of the present invention further contemplates a load brake for reducing the risks associated with drive or motor failures. In addition, the present invention contemplates a clip assembly for readily engaging the frame with structural beams, which can have any of a variety of dimensions. In addition, a power/control strip is provided for supplying the power to a lift assembly as well as control signals.

The present invention further includes loft blocks for guiding the cable from the modular frame to the battens. In a further configuration, the present invention contemplates selective height or trim adjustment for a section of a batten relative to the respective cable. A further configuration of the present invention provides a safety stop for terminating movement of batten upon detection of an obstacle in an intended travel path of the batten.

The present invention provides a turnkey lift assembly having rigging; power and control for the manipulation of battens, without requiring construction of traditional counterweight systems or relying on previously installed counterweight systems.

<u>Brief Description of the Drawings</u>

Figure 1 is a perspective partial cutaway view of a building having a plurality of structural members to which the lift assembly is connected.

Figure 2 is an enlarged perspective partial cutaway view of the installed lift assembly.

Figure 3 is an exploded perspective view of a drive mechanism for the lift assembly.

Figure 4a is a perspective view of the connection of the drum, drive mechanism and frame for rotation of the drum and translation of the drum and drive mechanism.

Figure 4b is an enlarged view of a portion of Figure 4a.

Figure 5 is a side elevational view of a drum.

Figure 6 is an end elevational view of a drum.

Figure 7 is a perspective view of a longitudinal drum segment.

Figure 8 is a cross-sectional view of a longitudinal drum segment.

Figure 9 is a perspective partial cut away view of a clip assembly.

Figure 10 is an exploded perspective view of a loft block.

Figure 11 is a cross-sectional view of the trim adjustment.

Figure 12 is a schematic representation of a plurality of frames connected to a building.

Figure 13 is a schematic of an alternative arrangement of the frame relative to a building.

Detailed Description of the Preferred Embodiments

Referring to Figure 1, the lift assembly 10 of the present invention is employed to selectively raise, lower and locate a batten 12 relative to a building or surrounding structure. Preferably, the lift assembly 10 moves a connected batten 12 between a lowered position and a raised position.

Although the term "batten" is used in connection with theatrical and staging environment, including scenery, staging, lighting as well as sound equipment, it is understood the term encompasses any load connectable to a windable cable.

The term "cable" is used herein to encompass any wire, metal, cable, rope, wire rope or any other generally inelastic windable material.

The term "building" is used to encompass a structure or facility to which the lift assembly is connected, such as but not limited to, performance venues, theaters, arenas, concert halls, auditoriums, schools, clubs, educational institutions, stages, convention centers, television studios showrooms and places of religious gathering. Building is also understood to encompass cruise ships which may employ battens.

Referring to Figures 1, 2 and 3, the lift assembly 10 includes a frame, at least one head block 80, a drive mechanism 100, a rotatable drum 160 and a corresponding loft block 220.

The lift assembly 10 is constructed to cooperate with at least one cable 14. Typically, the number of cables is at least four, but may be as many as eight or more. As shown in the Figures, a cable path extends from the drum 160 through a corresponding head block 80 to pass about a loft block 220 and terminate at the batten 12.

Frame

As shown in Figures 1 and 2, the frame 20 is a rigid skeleton to which the drum 160, the drive mechanism 100 and the head block 80 are attached. In a preferred configuration, the frame 20 is sized to enclose the drive mechanism 100, the drum 160, a head block 80 and a loft block 220. However, it is understood the frame can form a backbone to which the components are connected.

The frame 20 may be in the form of a grid or a box. The frame 20 can be formed of angle irons, rods, bars, tubing or other structural members. Typically, the frame 20 includes interconnected runners, struts and crossbars 22. The runners, struts and crossbars may be connected by welding, brazing, rivets, bolts or releasable fasteners. The particular configuration of the frame is at least partially dictated by the intended operating environment and anticipated loading. To reduce the weight of the frame 20, a relatively lightweight and strong material such as aluminum is preferred. However, other materials including but not limited to metals, alloys, composites and plastics can be used in response to design parameters. Although the frame 20 is shown in skeleton configuration, it is understood the frame may be enclosed as a box or enclosure having walls to define and enclose an interior space.

Preferably, the frame 20 is formed from a plurality of modular sections 24, wherein the sections may be readily interconnected to provide a frame of a desired length. Thus, the frame 20 may accommodate a variety of cables and hence drum lengths.

The frame 20 is constructed to be connectable to the building. The frame 20 can include a fixed coupler and a sliding coupler, wherein the distance between the fixed coupler and the sliding coupler can be varied to accommodate a variety of building spans. Typically connections of the frame 20 to the building include clamps, fasteners, bolts and ties. These connectors may be incorporated into the frame, or are separate components attached during installation of the frame. As set forth herein, adjustable clip assemblies 40 are provided for retaining the frame relative to the building.

The frame 20 also includes or cooperatively engages mounts for the drive mechanism and bearings for the drum. Specifically, the frame includes a pair of rails for supporting the drive mechanism, a translating shaft and a threaded keeper. As set forth in the description of the drive mechanism 100, the drive mechanism is connected to the frame 20 for translation with the drum along the axis of rotation of the drum.

In the first configuration of the frame 20, the frame has an overall length of approximately 10 feet, a width of approximately 11 inches and a height of approximately 17 inches.

The frame 20 includes a head block mount 30 for locating the head blocks in a fixed position relative to the frame. In a preferred construction, the head block mount 30 is a helical mount concentric with the axis of drum rotation. The inclination of the helical mount is at least partially determined by the length of the drum 160, the size of associated head blocks 80, the spacing of the installed frame and the number of cables to be drawn from the drum. Thus, the helical head block mount 30 may extend from approximately 5° of the drum to over 180°. The helical mounting allows the head blocks 80 to overlap along the longitudinal axis of drum rotation, without creating interfering cable paths.

Although the helical mount 30 is shown as a continuous curvilinear strut, it is understood a plurality of separate mounts can be employed, wherein the separate mounts are selected to define a helical or a serpentine path about the axis of rotation of the drum 160.

In a further construction, the head block mounts 30 can be merely radially spaced about the axis of drum rotation at a common longitudinal position along the axis of drum rotation. That is, rather than being disposed along the longitudinal axis of the drum 160, the head block mounts 30 are located at a fixed longitudinal position of the drum. However, it has been found that the width of the frame 20 can be reduced by radially and longitudinally displacing the head blocks 80 along a serpentine path about the axis of drum rotation, wherein the head blocks lie within approximately 100° and preferably 90° of each other.

As shown in Figures 1 and 2, in the seven-cable configuration, the lift assembly 10 includes two internal and five external loft blocks 220. The internal loft blocks 220 are located within the frame 20 and the external loft blocks 220 are operably mounted outside the frame, as seen in Figure 1. However, the lift assembly 10 can be configured to locate a plurality of external loft blocks 220 from each end of the frame. That is, two or more loft blocks 220 may be spaced from one end of the frame 20 and two or more loft blocks may be spaced from the remaining end of the frame.

In addition, depending upon the configuration of the lift assembly 10, the number of internal loft blocks 220 can range from none to one, two, three or more.

Hoisting Adapter

In addition, the frame may include a hoisting adapter 26 or mounts for releaseably engaging the hoisting adapter. It is anticipated a plurality of hoisting adapters can be employed, as at least partially dictated by the size of the frame 20 and the configuration of the building. The hoisting adapter 26 includes a sheave 28, such as a loft block connected to spaced apart locations of the frame. The hoisting adapter 26 can also include a clip assembly 40 for releaseably engaging a beam of the building. The hoisting adapter 26 is selected so that the frame may be hoisted to an operable location and connected to the building by additional clip assemblies 40.

Head Blocks

A plurality of head blocks 80 is connected to the head block mount 30. The number of head blocks corresponds to the number of cables 14 to be controlled by the lift assembly 10. The head blocks 80 provide a guide surface about which the cable path changes direction from the drum 160 to a generally horizontal direction. The guide surface may be in the form of sliding surface or a moving surface that moves corresponding to travel of the cable. Each head block 80 draws cable 14 from a corresponding winding section along a tangent to the drum 160. The angle between the head block 80 and the respective cable take off point from the drum 160 may be repeated by each of the head blocks 80 relative to the drum.

As the head blocks 80 are mounted to the head block mount 30, such as the helical mount, the head blocks can overlap along the axis of drum rotation. The overlap allows for size reduction in the lift assembly 10. That is, a helical mounting of the head blocks 80 allows the head blocks to overlap radially as well as longitudinally relative to the axis of drum rotation. By overlapping radially, the plurality of head blocks 80 can be operably located within a portion of the drum circumference, and preferably within a 90° arc. Thus, the operable location of the head blocks 80 can be accommodated within a diameter of the drum. By disposing the head blocks within a dimension substantially equal to the diameter of the drum 160, the frame 20 width can be reduced to substantially that of the drum diameter.

Each head block 80 generally includes a pair of side plates, a shaft extending between the side plates, accompanying bearings between the plates and the shaft, and a pulley (sheave) connected to the shaft for rotation relative to the side plates. The head block 80 may also include a footing for connecting the head block to the head block mount and hence the frame. It is understood the head blocks 80 may have any of a variety of configurations such as guide surfaces or wheels that permit translation of the cable relative to the head block, and the present invention is not limited to a particular type of construction of the head block.

Drive Mechanism

The drive mechanism 100 is operably connected to the drum 160 for rotating the drum and translating the drum along its longitudinal axis, the axis of drum rotation. Referring to Figures 4a and 4b, the drive mechanism 100 includes a motor 110, such as an electric motor, and a gearbox 120 for transferring rotational motion of the motor to a drive shaft 114. The motor 110 may be any of a variety of high torque electric motors such as ac inverter duty motors, dc or servo motors as well as hydraulic motors.

The gearbox 120 is selected to rotate the drive shaft 114, and the drum, in a winding (raising) rotation and an unwinding (lowering) rotation. The gearing of the gearbox 120 is at least partially determined by the anticipated loading, the desired lifting rates (speeds) and the motor. A typical gearbox is manufactured by SEW or Emerson.

The drive mechanism 100 may be connected to the frame 20 such that the drive mechanism and the drum 160 translate relative to the frame during rotation of the drum. Preferably, the drive mechanism 100 and the frame 20 are sized so that the drive mechanism is enclosed by the frame. Alternatively, the drive mechanism 100 may be connected to a platform that slides outside the frame 20 and thus translates along the axis of rotation with the drum. The choice for connecting the drive mechanism 100 to the frame 20 is at least partially determined the intended operating parameters and manufacturing considerations.

In a preferred construction shown in Figures 4a and 4b, the drive shaft 114 includes a threaded drive portion. The drive portion may be formed by interconnecting a threaded rod to the shaft or forming the shaft with a threaded drive portion. The threaded drive portion is threadingly engaged with a keeper 115, which in turn is fixedly connected to the frame 20. The keeper 115 includes a threaded portion or a nut affixed to a plate which receives the threaded portion. That is, referring to Figure 2, rotation of the shaft 114 not only rotates the drum 160, but the drum translates to the left or the right relative to the frame 20 and hence relative to the attached head blocks. As the drive mechanism 100 is attached to the drum 160 and attached to the frame 20 along a linear slide 111, the drive mechanism also translates along the axis of drum rotation relative to the frame.

The drive shaft can have any of a variety of cross sections, however, a preferred construction of the drive shaft has a faceted cross section such as hexagonal.

Drum

The drum 160 is connected to the frame 20 for rotation relative to the frame about the axis of rotation and translation relative to the frame along the axis of rotation. Thus, the drum 160 is rotatable relative to the frame 20 in a winding rotation with accompanying winding translation and an unwinding rotation with accompanying unwinding translation for winding or unwinding a length of cable 14 about a respective winding section.

As shown in Figures 1 and 2, the drum 160 is horizontally mounted and includes the horizontal longitudinal axis of rotation. The drum 160 includes at least one winding section 162. The winding section 162 is a portion of the drum 160 constructed to receive a winding of the cable 14 for a given drop line. The winding section 162 may include a channeled or contoured surface for receiving the cable. Alternatively, the winding section 162 may be a smooth surface. The number of winding sections 162 corresponds to the number of cables 14 to be controlled by the lift assembly 10. As shown in Figure 2, there are seven winding sections 162 on the shown drum.

Each winding section 162 is sized to retain a sufficient length of cable 14 to dispose a connected batten 12 between a fully lowered position and a fully raised position. As shown, a single winding of cable 14 is disposed on each winding section 162. However, it is contemplated that the drum 162 may be controlled to provide multiple layers of winding within a given winding section 162.

As shown in Figures 5-8, in one configuration of the lift assembly 10, the drum 160 is a modular construction. The drum 160 is formed of at least one segment 170. The drum segment 170 defines at least a portion of a winding section 162. In a first configuration, each drum segment 170 is formed from a pair of mating halves about the longitudinal axis. Each half includes an outer surface defining a portion of the winding section and an internal coupling surface. The internal coupling surface of the drum corresponds to a portion of the cross section of the drive shaft 114.

When assembled, the drum halves form an outer winding section and the internal coupling surface engages the faceted drive shaft for rotating the drum. Although the internal coupling surface of the drum can have a variety of configurations including slots, detents or teeth, a preferred construction employs a faceted drive 114 shaft such a triangular, square, hexagonal, octagonal cross-section.

Referring to Figure 8 in an alternative modular construction of the drum 160, the segments 170 are formed of longitudinal lengths 176, each length being identical and defining a number of windings. Preferably, the longitudinal lengths 176 are identical and are assembled by friction fit to form a drum of a desired length. Each segment 170 includes a plurality of tabs 172 and corresponding recesses 174 for engaging additional segments. In this configuration, it has been found advantageous to dispose the longitudinal segments 176 about a substantially rigid core 180 such as an aluminum core as seen in Figure 6. The core 180 provides structural rigidity for the segments 176. In addition, the core 180 does not require extensive manufacturing processes, and can be merely cut to length as necessary.

The modular construction of the drum 160 allows for the ready assembly of a variety of drum lengths. In a first configuration, the drum has an approximate 7-inch diameter with a 0.20 right handed helical pitch. In addition, the drum can be constructed of a plastic such as a thermosetting or thermoplastic material.

The drum 160 includes or is fixedly connected to the drive shaft 114, wherein the drive shaft is rotatably mounted relative to the frame 20.

Bias Mechanism

Although the lift assembly 10 can be employed without requiring counterweights, it is contemplated that a bias mechanism can be employed to reduce the effective load to be raised by the lift assembly. For example, a torsion spring may be disposed between the shaft 114 and the frame 20 such that upon rotation of the shaft in a first direction (generally an unwinding direction), the torsion spring is biased and thus urges rotation of the drum in a winding or lifting rotation. Further, the present lift assembly 10 can be operably connected to an existing counterweight system, wherein the drive mechanism 100 actuates existing counterweights.

Cable Path

The location of the head blocks 80 on helical head block mount 30, the drum diameter and the cable sizing are selected to define a portion of the cable path and particularly a cable take off point. The cable path starts from a winding section 162 on the drum, to a tangential take off point from the winding about the drum 160. The cable path then extends to the respective head block 80. The cable path is redirected by the head block 80 to extend horizontally along the length of the frame 20 to a corresponding loft block 220, wherein the loft block may be internal or external to the frame. Each cable path includes the take-off point and a fleet angle, the angle between the take of point and the respective head block 80.

As a portion of the cable path for each cable extends parallel to the longitudinal axis of the drum, the take off points for the plurality of winding sections 162 are spaced about the circumference of the drum 160 due to the mounting of the head blocks 80 along the helical head block mount 30. In a first configuration of Figure 2, the seven take off points are disposed within an approximate 90° arc of the drum periphery.

In general, an equal length of cable 14 is disposed about each winding section. The length of the cable paths between the take off point and the end of the frame 20 is different for different cable paths. Thus, a different length of cable 14 may extend from its respective take off point to the end of the frame 20. However, the lift assembly 10 is constructed so that an equal length of each cable 14 may be operably played from each winding section 162 of the lift assembly 10.

Load Brake

The load brake 130 is located mechanically intermediate the drum 160 and the gearbox 120, as shown in Figure 3. The load brake 130 includes a drive disc 132, a brake pad 134, a driven disc 136, and a peripheral ratchet 138, a tensioning axle 140 and a tensioning nut 146.

The drive disc 132 is connected for rotation with the drive shaft 114 in a one-to-one correspondence. That is, the drive disc 132 is fixedly attached to the drive shaft 114. The drive disc 132 includes a concentric threaded coupling 133. The driven disc 136 is fixably connected to the drum 160 for rotation with the drum. The driven disc 136 is fixably connected to the tensioning axle 140. The tensioning axle 140 extends from the driven disc 136. The tensioning axle 140 includes or is fixably connected to a set of braking threads 141 and a spaced set of tensioning threads 143. The brake pad 134, friction disc, is disposed about the tensioning axle 140 intermediate the drive disc 132 and the driven disc 136 and preferably includes the peripheral ratchet 138, which is selectively engaged with a pawl 139.

To assemble the load brake 130, the tensioning axle 140 is disposed through a corresponding aperture in the gearbox 120 such that the tensioning threads 143 protrude from the gearbox. The braking threads 141 engage the threaded coupling 133 of the drive disc 132. The tensioning nut 146 is disposed on the tensioning threads 143. The brake pad 134 is thus disposed between the drive disc 132 and the driven disc 136 to provide a friction surface to each of the discs.

In rotating the motor 110 in a raising or winding direction, the braking threads 141 screw into the corresponding threaded coupler 133 on the drive disc 132, thereby causing the driven disc 136 and the drive disc 132 to compress the brake pad 134. That is, the longitudinal distance between the drive disc 132 and the driven disc 136 decreases. The drive disk 132, the brake pad 134 and the driven disc 136 thus turn as a unit as the cable 14 is wound upon the drum 160.

. To lower or unwind cable 14 from the drum 160, the motor 110 and hence drive disc 132 are rotated in the opposite direction. Upon initiation of this direction rotation, the pawl 139 engages the ratchet 138 to preclude rotation of the brake pad 134. As the drive disc 132 is rotated by the motor 110 in the lowering direction, the breaking threads 141 tend to cause the driven disc 136 to move away from the drive disc 132 and hence the brake pad 134, thus allowing the load on the drum 160 to rotate the drum in an unwinding direction. Upon terminating rotation of the drive disc 132 in the lowering direction of rotation, the load on the cable 14 causes the drum 160 and hence driven disc 136 to thread the braking threads 141 further into the coupler 133 against the now fixed braking pad 134 thereby terminating the unwinding rotation of the drum.

The tensioning nut 146 is used to determine the degree of release of the driven disc 136 from the brake pad 134. The tensioning nut 146 can also be used to accommodate wear in the brake pad 134. The present configuration thus provides a general balance between the motor induced rotation of the drive disc 132 in the unwinding direction and the torque generated by the load on the cable 14 tending to apply a braking force as the driven disc 136 is threaded toward the drive disc 132.

Clip Assembly

The frame 20 and external loft blocks 220 are mounted to the building by at least one adjustable clip assembly 40. Each clip assembly 40 includes a J-shaped sleeve 50, a retainer 60 and a J-shaped slider 70. The sleeve 50 and the slider 70 each have a closed end and a leg. The closed end of the sleeve 50 and the slider 70 are constructed to engage the flange of a beam, as shown in Figure 1.

The leg of the sleeve 50 is sized to slideably receive the retainer 60 and a section of the leg of the slider 70. The sleeve 50 includes a plurality of inwardly projecting teeth 52 at regularly spaced distances along the longitudinal dimension of the leg of the sleeve.

The retainer 60 is sized to be slideably received within the leg of the sleeve 50. The retainer 60 includes a pair of opposing slots 63 as shown in Figure 9. A capture bar 62 having corresponding ears 64 is disposed within the slots 63. The slots 63 in the retainer 60 and the ears 64 of the capture bar 62 are sized to permit the vertical displacement of the capture bar between a lower capture position and a raised release position. The capture bar 62 is sized to engage the teeth 52 of the sleeve 50 in the capture position and be disposed above the teeth in the raised position, whereby the teeth can pass under the capture bar. The retainer 60 further includes a threaded capture nut 66 fixed relative to the retainer.

The slider 70 is connected to the retainer 60 by a threaded shaft 72. The threaded shaft 72 is rotatably mounted to the slider 70 and includes an exposed end 76 for selective rotation of the shaft. The rotation of the threaded shaft 72 may be accomplished by a Phillips or regular screw head, a hex–head or any similar structure. The threaded shaft 72, the retainer 60 and the slider 70 are selected to permit the retainer to be spaced from the slider between a maximum distance approximately equal to the distance between adjacent teeth 52 in the sleeve 50, and a minimum distance, where the retainer abuts the slider.

In addition, the sleeve 50 includes an elongate slot 53 extending along the length of the leg having the teeth 52. The slot 53 allows an operator to contact the capture bar 62 and urge the capture bar upward to the raised release position thus allowing the sleeve 50 and the retainer 60 /slider 70 to be moved relative to each other and the beam, thereby allowing either release of the clip assembly 40 or readjustment to a different sized beam section. In a preferred construction, the sleeve 50, the retainer 60 and the slider 70 are sized to accommodate the beam flanges having a 4" to a 10" span. The sleeve 50, the retainer 70 and the slider 70 are formed of 1/8" stamped steel.

Control-Power Strip

As shown in Figure 2, the present invention also contemplates a control/power strip 90 sized to be disposed between the flanges of a beam. The control strip 90 includes a housing 92 and cabling for supplying electricity power as well as control signals. The housing 92 provides support to the cabling and can substantially enclose the cabling or merely provide for retention of the cabling. Typically, the control strip 90 includes interconnects at 12 inch centers for engaging a plurality of frames 20. The control strip 90 is attached to the beam by any of a variety of mechanisms including adhesives, threaded fasteners as well as clamps.

Loft Block

As shown in Figure 1, the plurality of loft blocks 220 corresponding to the plurality of head blocks 80, is connected to the building in a spaced relation from the frame 20. The loft blocks 220 are employed to define the portion of the cable path from a generally horizontal path section that extends from the frame 20 to a generally vertical path section that extends to the batten 12 or load. Depending upon the length of the batten 12 and the width of the stage, there may be as few as one or two loft blocks 220 or as many as six, eight, twelve or more.

As shown in Figure 2, two internal loft blocks 220 are located within the frame 20 to allow for cables 14 to pass downward within the footprint of the frame. Thus, the present invention reduces the need for wing space in a building to accommodate counterweight systems.

Typically, at each loft blocks 220, there is a load cable 222 and a passing cable 224, wherein the load cable is the cable redirected by the loft block to extend downward to the batten 12 and the passing cable continues in a generally horizontal direction to the subsequent loft block. In a preferred configuration, the loft blocks 220 accommodate the load cable 222 as well as any passing cables 224.

Referring to Figure 10, each loft blocks 220 includes a load sheave 230, an optional carrier sheave 240, an upstream guide 250, a downstream guide 260 and a pair of side plates 270. The load sheave 230 is constructed to engage and track the load cable 222, and the carrier or idler sheave 240 is constructed for supporting the passing (through) cable 224. It is contemplated the load sheave 230 and the carrier sheave 240 may be a single unit having a track for the load cable 222 and separated track or tracks for the passing cables 224. In a preferred construction, the carrier sheave 240 is a separate component that engages the load sheave 230 in a friction fit, wherein the load sheave and the carrier sheave rotate together. This construction allows the loft block 220 to be readily constructed with or without the carrier sheave 240 as necessary. Alternatively, the load sheave 230 and the carrier sheave 240 can be separately rotatable members.

The upstream guide 250 includes a through cable inlet 251 and a load cable inlet 253, wherein the through cable inlet is aligned with the carrier sheave 240 and the load cable inlet is aligned with the load sheave 230. The upstream guide 250 is configured to reduce a jumping or grabbing of the cables 14 in their respective sheave assembly. The downstream guide 260 is located about the exiting path of load cable 220. Typically, the downstream guide includes a load cable exit aperture 263.

The side plates are sized to engage the load and carrier sheaves 230, 240 as well as the upstream and downstream guides 250, 260 to form a substantially enclosed housing for the cables 14. The side plate 270 includes a peripheral channel 273 for engaging and retaining the upstream guide 250 and the downstream guide 260. The peripheral channels 273 include an access slot 275 sized to pass the upstream guide 250 and the downstream guide 260 therethrough. In the operating alignment, the peripheral channel 273 retains the upstream guide 250 and the downstream guide 260. However, the side plates 270 can be rotated to align the access slot 275 with the upstream guide 250 or the downstream guide 260 so that the guides can be removed from the side plates. The loft block 220 thereby allows components to be removed without requiring pulling the cables 14 through and subsequent re-cabling.

The loft block 220 includes a shaft about which the load sheave 230, the carrier sheave 240 (if used), and the side plates 270 are concentrically mounted.

The loft block 220 engages a coupling bracket 226, wherein the coupling bracket maybe joined to a clip assembly 40 such that the coupling bracket is moved about a pair of orthogonal axis to accommodate tolerances in the building.

Controller

It is further contemplated the present invention may be employed in connection with a controller 200 for controlling the drive mechanism 100. Specifically, the controller 200 be a dedicated device or alternatively can include software for running on a personal computer, wherein control signals are generated for the lift assembly 10.

Stop Sensor

A proximity sensor or detector 280 can be fixed relative to the load, the batten 12 or the elements connected to the batten 12. The sensor 280 can be any of a variety of commercially available devices including infra red, ultrasound or proximity sensor. The sensor 280 is operably connectable to the controller by a wire or wireless connection such as infrared. The sensor 280 is configured to detect an obstacle in the path of the batten 12 moving in either or both the lowering direction or the raising direction. The sensor 280 provides a signal such that the controller 200 terminates rotation of the motor 110 and hence stops rotation of the drum 160 and movement of the batten 12 upon the sensing of an obstacle.

It is contemplated the sensor 280 may be connected to the batten 12, wherein the sensor includes an extendable tether 282 sized to locate the sensor 280 on a portion of the load carried by the batten. Thus, the sensor 280 can be operably located with respect to the batten 12 or the load. Preferably, the sensor is sized and colored to reduce visibility by a viewing audience. It is also understood the sensor can be selected to preclude the batten from contacting the deck, floor or stage.

Trim Adjustment

Referring to Figure 11 the present invention further provides for a trim adjustment 290. That is, the relatively fine adjustment of the length of cable in the drop line section of the cable path.

In a first configuration of the trim adjustment 290, the structure is sized and selected to be disposed within the cross-sectional area of the batten 12. Thus, the trim adjustment 290 is substantially unobservable to the audience. The trim adjustment can be located within a length of the batten 12, or form a portion of the batten such as a splice or coupler.

The trim adjustment 290 includes a translator 292 that is rotatably mounted to the batten 12 along its longitudinal dimension and includes a threaded section. The trim adjustment 290 further includes a rider 294 threadedly engaged with the threaded section of the translator 292, such that upon rotation of the translator, the rider is linear disposed along the translator.

The cable 14 is fixedly connected to the rider 294 such that is the rider is translated relative to the batten 12, additional cable 14 is either drawn into the batten or is passed from the batten.

Rotation of the translator 292 is provided by a user interface 296 such as a socket, hex head or screw interface. Typically, the user interface includes a universal joint 298 such that the interface may be actuated from a non-collinear orientation with the translator.

While the (linear) translator 292 and associated rider 294 are shown in the first configuration, it is understood that a variety of alternative mechanisms may be employed such as ratchets and pawls, pistons, including hydraulic or pneumatic as well as drum systems for taking up and paying out a length of cable 14 within a cross-sectional area of a batten 12 to function as trim adjustment height in a rigging system.

Installation

Preferably, the lift assembly 10 is constructed to accommodate a predetermined number of cables 14, and hence a corresponding number of winding sections 162 on the drum 160 and head blocks 80. In addition, upon shipment, the internal loft blocks 220 as well as the external loft blocks 220 are disposed within the frame 20. In addition, each cable 14 is pre-strung so that the cable topologically follows its own cable path.

The hoisting adapters 26 are threaded with the cable 14 and the separate clip assemblies 40 are connected to a pair of cables from the drum 160. The cable 14 is fed from the respective winding section and the clip assemblies are connected to the building. The drum 160 is then rotated to hoist the frame 20 to the installation position. Clip assemblies 40 connected to the frame 20 are connected to an adjacent beam of the building. The clip assemblies 40 are engaged with the respective beams and sufficiently tightened to retain the clip relative to the beam. The hoisting clip assemblies on the cables 14 are removed from the building and the cables, and the hoisting adapter are removed from the frame. The frame 20 is thus retained relative to the structure.

Upon the frame 20 being attached to the respective beams, the external loft blocks 220 are removed from the frame and sufficient cable 14 drawn from the drum 160 to locate the loft block adjacent to the respective structural beam. The loft block 220 is then connected to the beam by the clip assembly 40. The load cable 222 from each loft block 220 is operably connected to a batten 12 or load. The trim adjustment 290 is then employed to adjust the relative length of the drop line, as necessary.

As the head blocks 80 longitudinally overlap along the axis of rotation of the drum 160, the frame 20 has an approximate 9-11 inch width. Thus, a plurality of frames 20 can be connected to the building in an abutting relation with the drum axis in parallel to provide location on 12-inch centers as seen in Figure 12. Alternatively, as shown in Figure 13, as the frame 20 can be constructed to include the external loft blocks 220 in any relation to the internal loft blocks, the frames can be staggered along the width of the stage. That is, the second frame is spaced from the first frame in the longitudinal direction such that the ends of the sequential frames are spaced apart.

Operation

In operation, upon actuation of the motor 110, the drive shaft 114 and the drum 160 rotate in the unwind rotation. This rotation locks the brake pad 134 and threads the driven disc 136 away from the drive disc 132, which allows cable 14 from each winding section to be paid out from the drum 160 at the respective takeoff point.

The rotation of the shaft 114 which winds or unwinds cable 14 to or from the drum 160 also causes rotation of the threaded portion of the shaft. Rotation of the threaded portion relative to the keeper 115 induces a linear translation of the drum 160 along the axis of drum rotation during winding and unwinding rotation of the drum.

The threading of the threaded portion, the sizing of the drum 160 and the cable 14 are selected such that the fleet angle, or fleet angle limit, is maintained between each head block 80 and the takeoff point of the respective winding section 162. Thus, by longitudinally translating the drum 160 during unwinding and winding rotation, the fleet angle for each head block 80 and corresponding take off point in the winding section 162 is maintained.

As the fleet angles are automatically maintained, there is no need for a movable connection between a plurality of head blocks 80 along the helical mount and the frame to maintain a desired fleet angle.

In the bias mechanism configuration, as the drum 160 is rotated with an unwinding rotation, tension is increased in the torsion spring. Thus, upon rotation of the shaft and hence drum in the winding direction, the torsion spring assists in such rotation, thereby reducing the effect of weight of the load such as the batten and any accompanying equipment. This reduction in the effective load allows the sizing of the motor, and gearbox to the adjusted accordingly.

Although the present invention has been described in terms of particular embodiments, it is not limited to these embodiments. Alternative embodiments, configurations or modifications which will be encompassed by the invention can be made by those skilled in the embodiments, configurations, modifications or equivalents may be included in the spirit and scope of the invention, as defined by the appended claims.

We claim:

1. A lift assembly, comprising:

(a) a frame;

(b) a plurality of head blocks connected to the frame, and

(c) a drum rotatably connected to the frame about an axis of rotation and having a plurality of winding sections, the drum translatable relative to the frame along the axis of rotation.

2. The lift assembly of Claim 1, wherein translation of the drum along the longitudinal axis maintains a fleet angle between a given winding section and a corresponding head block.

3. The lift assembly of Claim 1, further comprising a bias mechanism connected between the frame and the drum and inhibiting rotation of the drum in a first rotation direction.

4. The lift assembly of Claim 1, wherein the frame is sized to enclose the head blocks and the drum.

5. The lift assembly of Claim 1, further comprising a loft block connected to the frame.

6. The lift assembly of Claim 4, further comprising a drive motor and gearing connected to the frame.

7. The lift assembly of Claim 1, wherein the drum includes a threaded shaft.

8. The lift assembly of Claim 7, further comprising a threaded keeper connected to the frame, the keeper sized to receive the threaded shaft.

9. The lift assembly of Claim 1, wherein the head blocks are connected to the frame along a helical path relative to the axis of rotation of the drum.

10. The lift assembly of Claim 1, further comprising a helical mount extending about the axis of rotation of the drum.

11. A lift assembly, comprising:

(a) a frame;

(b) a drum rotatably mounted to the frame for rotation about an axis of rotation, the drum having a first winding section;

(c) a first head block connected to the frame to define a fleet angle between the first head block and the first winding section; and

(d) a load brake connected to the drum to resist an unwinding rotation of the drum.

12. The lift assembly of Claim 11, further comprising a second head block connected to the frame and a second winding section on the drum, the translation of the drum being sufficient to maintain a predetermined fleet angle between the first winding section and the first head block and between the second head block and the second winding section.

13. A method of lifting a load, comprising:

(a) passing a cable from a vertical path about a loft block connected to a frame to pass in a generally horizontal direction;

(b) passing the cable about a head block connected to the frame to pass to about a drum rotatably connected to the frame; and

(c) translating the drum along the axis of drum rotation.

14. A lift assembly, comprising:

(a) an enclosed housing defining an interior, the housing having a drop line aperture;

(b) a drum disposed within the interior and rotatable connected to the frame;

(c) a head block located in the interior; and

(d) a loft block located in the interior and spaced from the head block, the loft block located to define a cable path passing through the drop line aperture.

15. A lift assembly, comprising:

(a) a frame having a foot print;

(b) a drum rotatably mounted to the frame;

(c) a head block connected to the frame; and

(d) a loft block connected to the frame and spaced from the head block to define a drop line within the footprint of the frame.

16. A method of installing a lift assembly to a plurality of building beams, comprising:

(a) connecting a frame having a rotatable and translatable drum to a building beam;

(b) locating a head block on the frame; and

(c) connecting a loft block to a spaced beam to provide a cable path extending from the drum, about the head block to the spaced loft block.

17. A trim adjustment mechanism for a batten having a cross-sectional area, the batten connected to a cable, the trim adjustment mechanism comprising:

(a) a housing having a cross-sectional area substantially equal to the cross-sectional area of the batten, the housing including a drop line aperture and an adjusting aperture;

(b) a rider located in the housing, the rider connected to the cable and moveable between a lowered position and a raised position; and

(c) an actuable interface connected to the rider and exposed to the adjusting aperture to permit actuation through the adjusting aperture.

18. A trim adjustment mechanism for adjusting a batten relative to a drop line, the batten having cross sections comprising:

(a) a take up connected to the drop line, the take up disposed within the cross section of the batten.

19. The trim adjustment of Claim 18, further comprising an actuator exposed to a user, the actuator located within the cross section of the batten.

20. A lift assembly having a load brake for a drum rotatable in a winding direction and an unwinding direction, comprising:

(a) a tensioning axle fixedly connected to the drum, the tensioning axle including braking threads and spaced tensioning threads.

(b) a drive disc concentrically mounted to the tensioning axle, the drive disc including a threaded coupling sized to engage the braking threads;

(c) a friction disc concentrically mounted about the tensioning axle, intermediate the drive disc and the driven disc; and

(d) a tensioning nut connected to the tensioning threads to selectively vary a maximum distance between the drive disc and the driven disc.

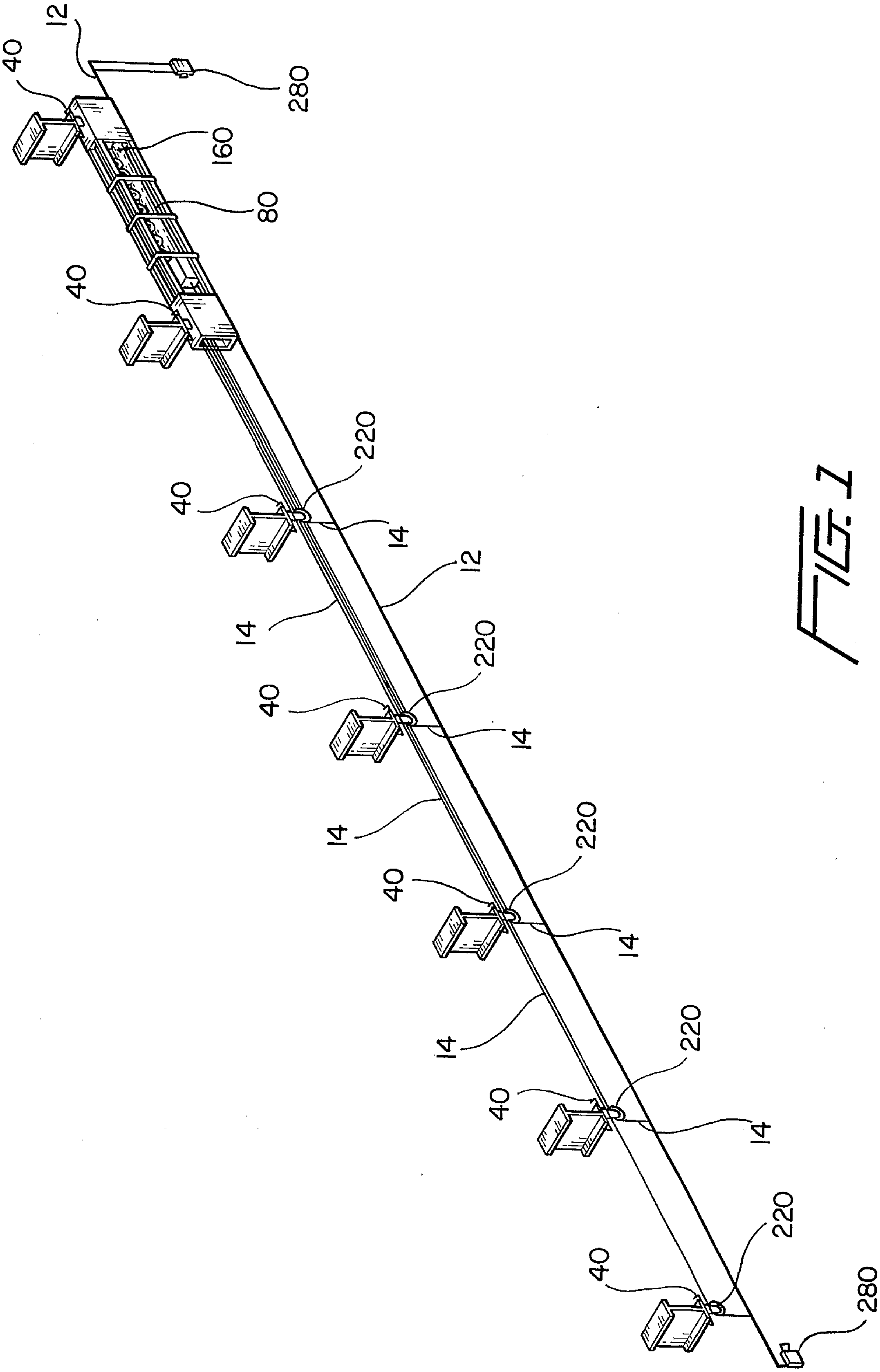
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FIG. 1

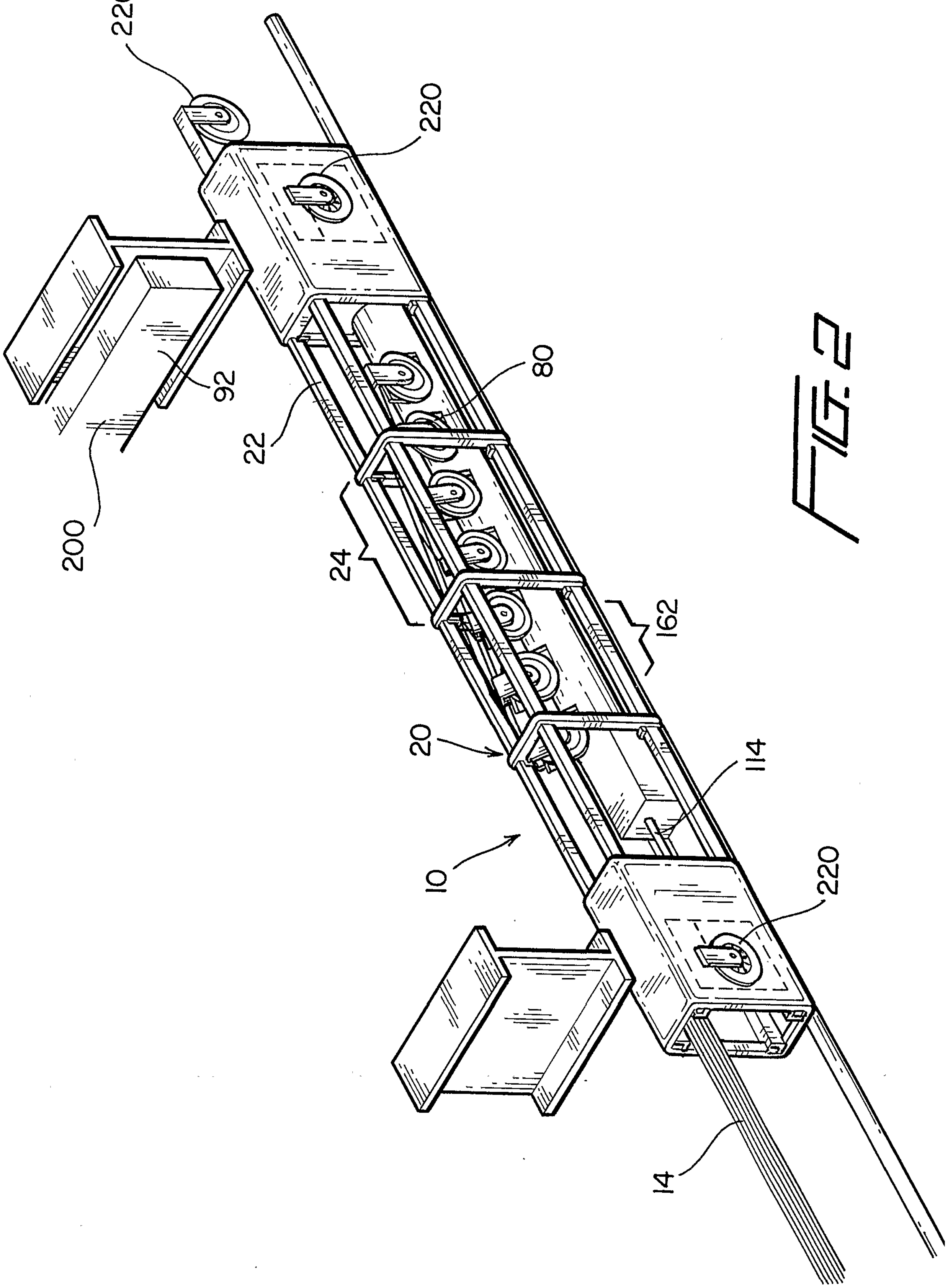


FIG. 2

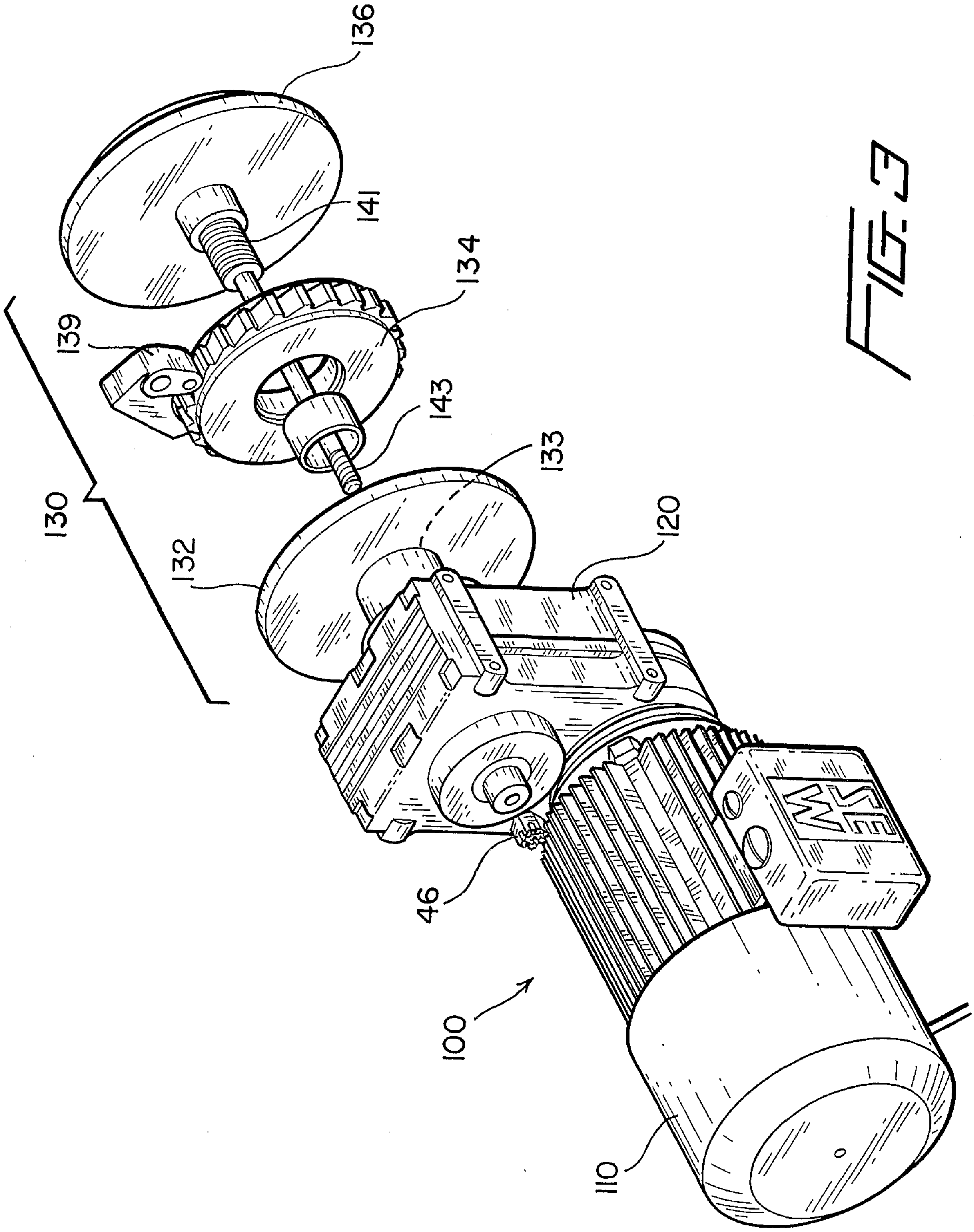
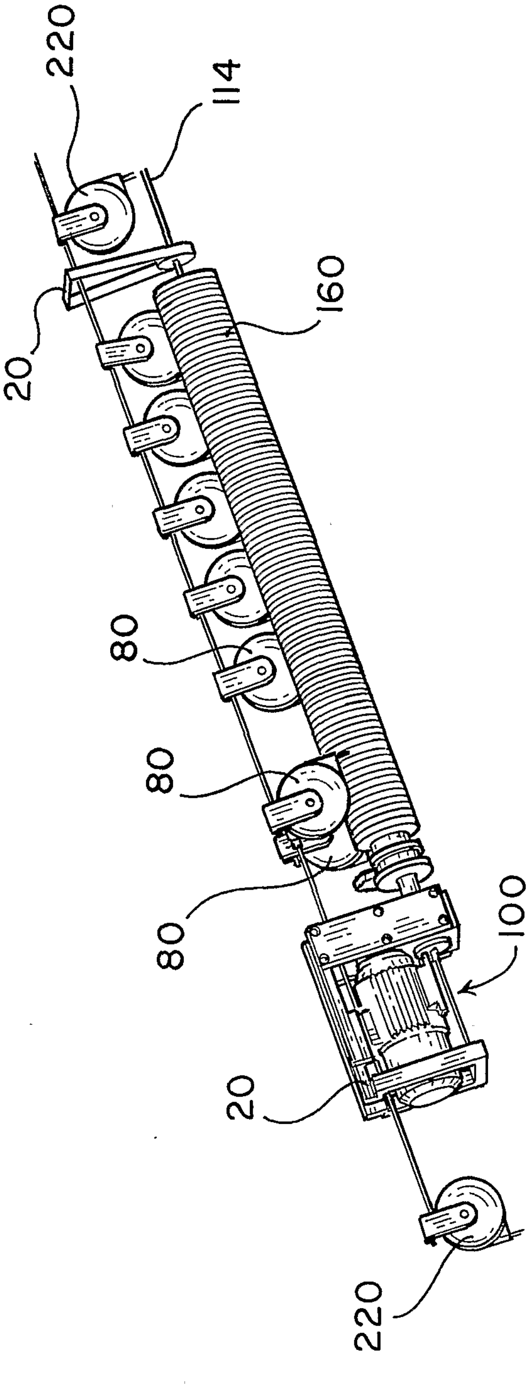


FIG. 3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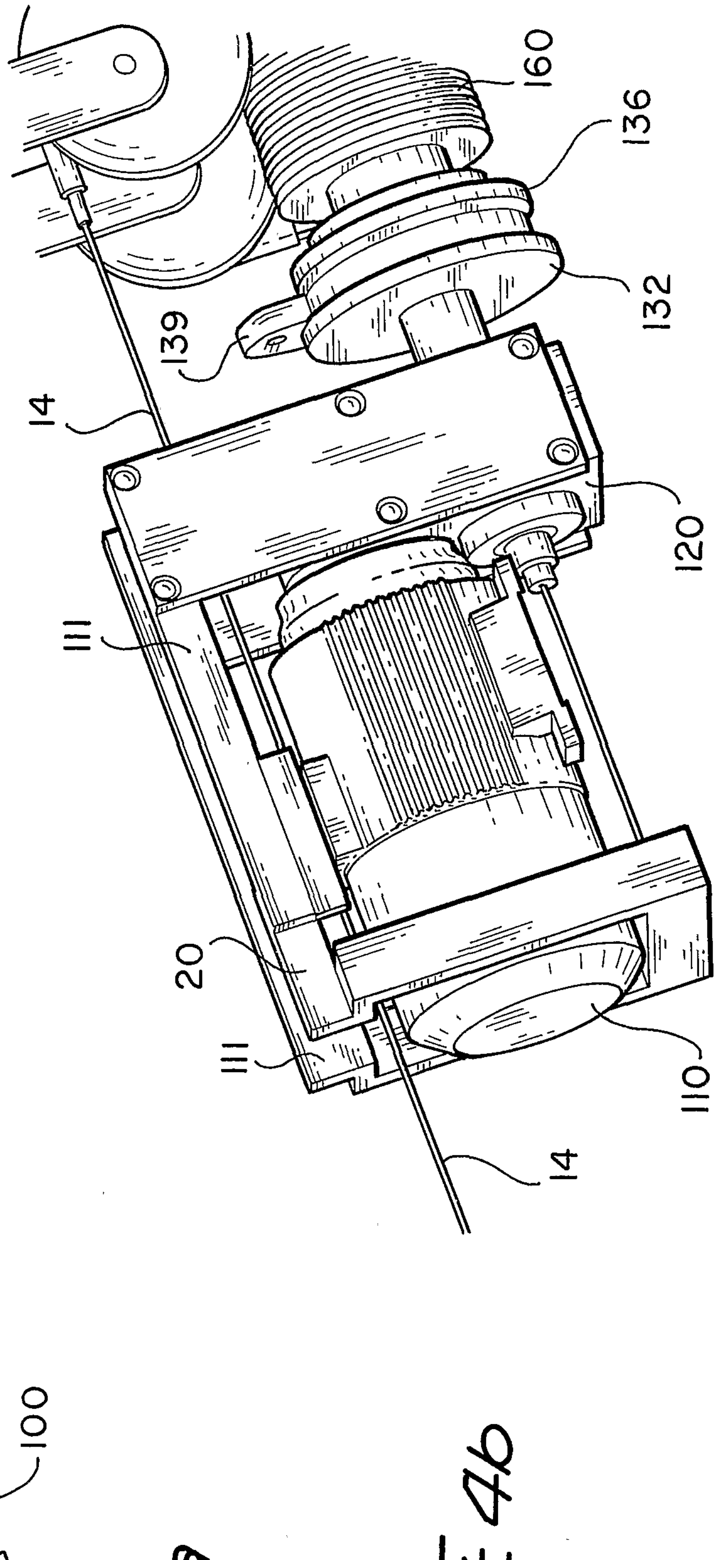
220

FIG. 4a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110
14

FIG. 4b

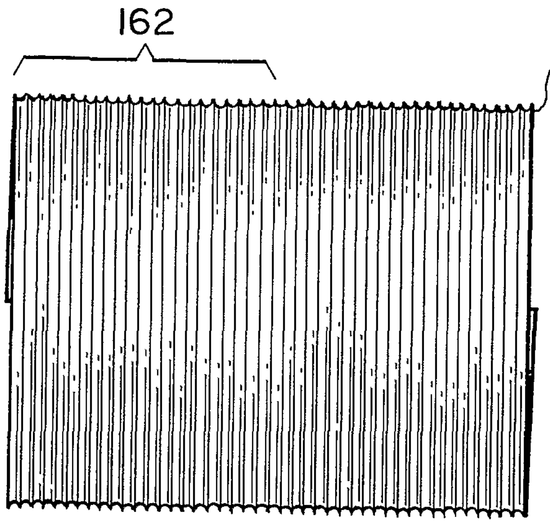


FIG. 5

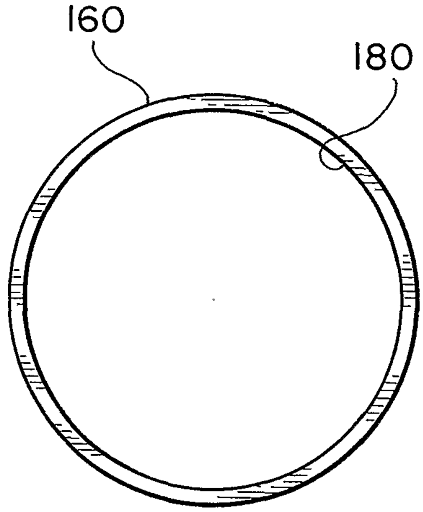


FIG. 6

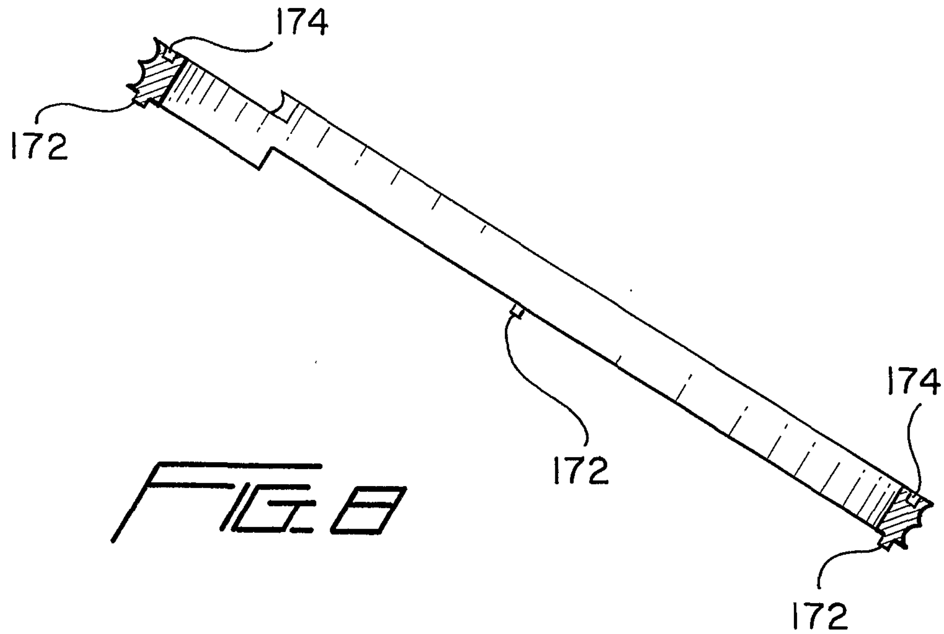


FIG. 8

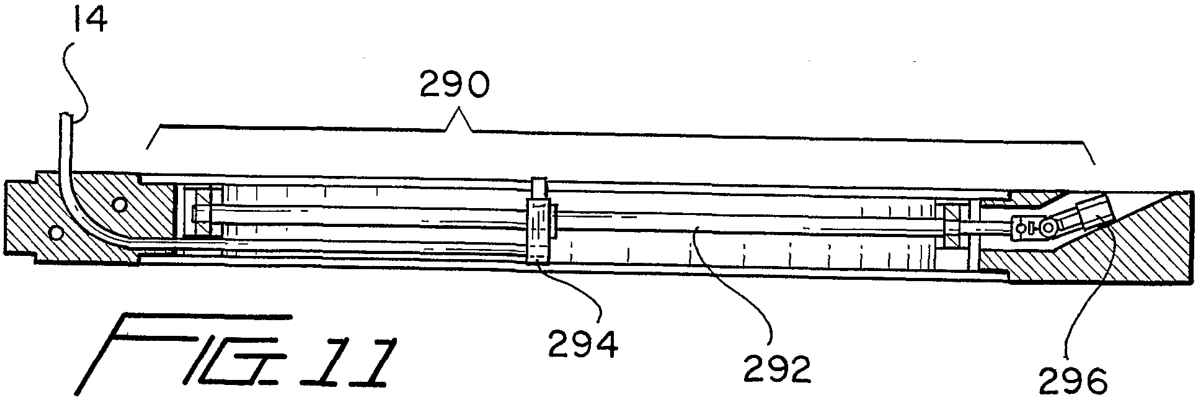


FIG. 11

FIG. 7

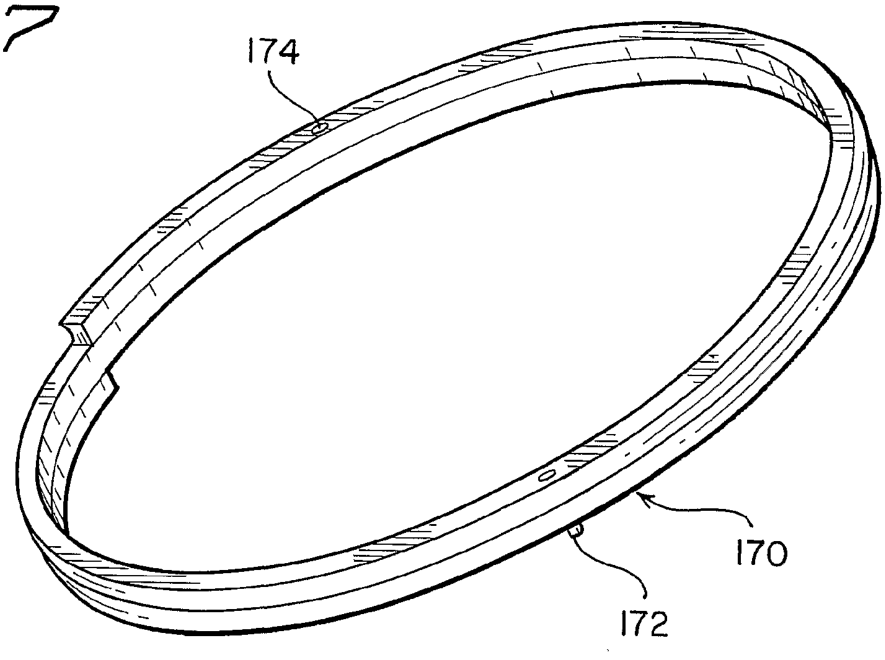
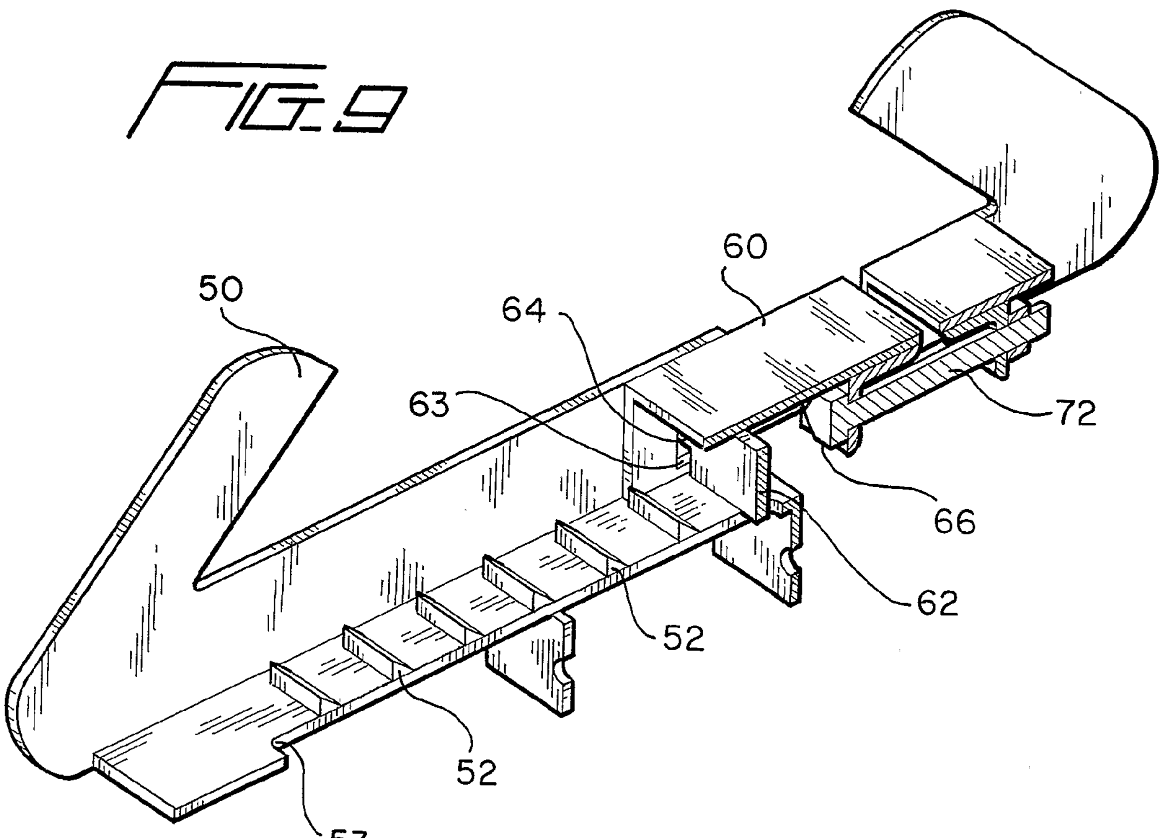


FIG. 9



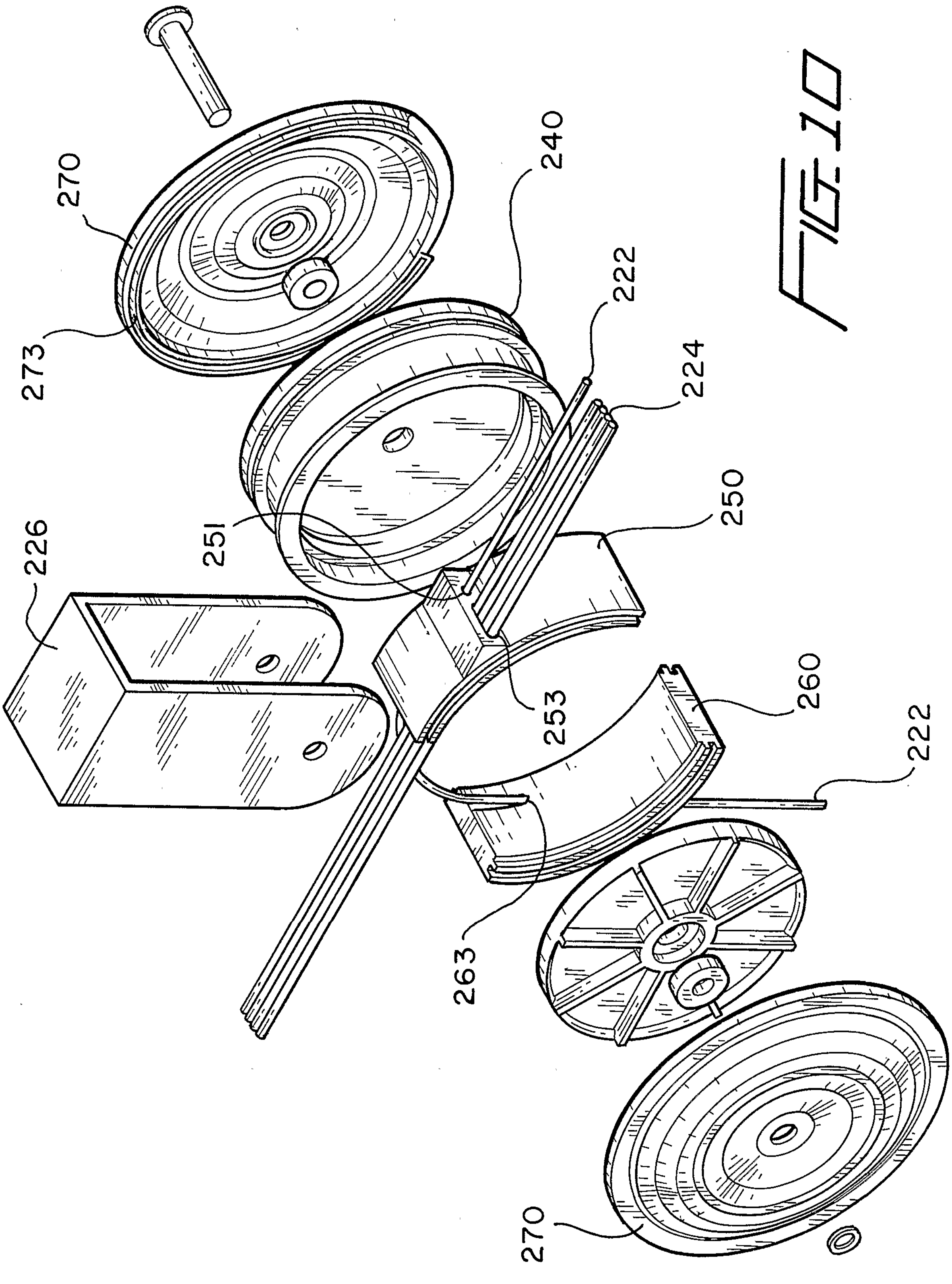


FIG. 10

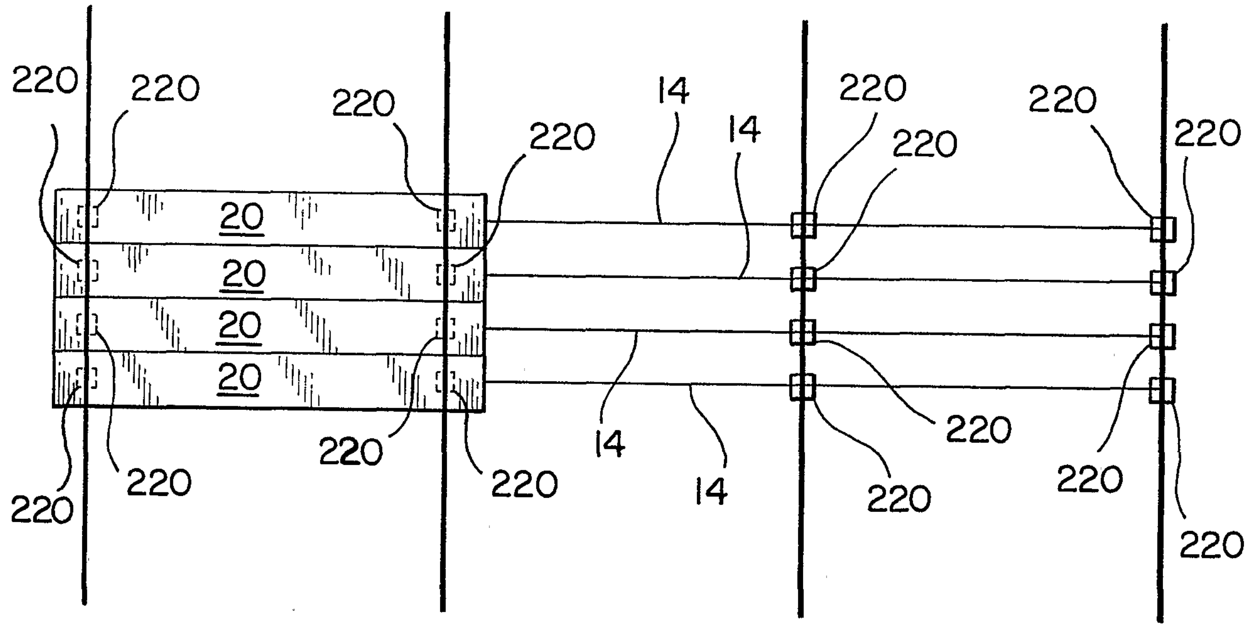


FIG. 12

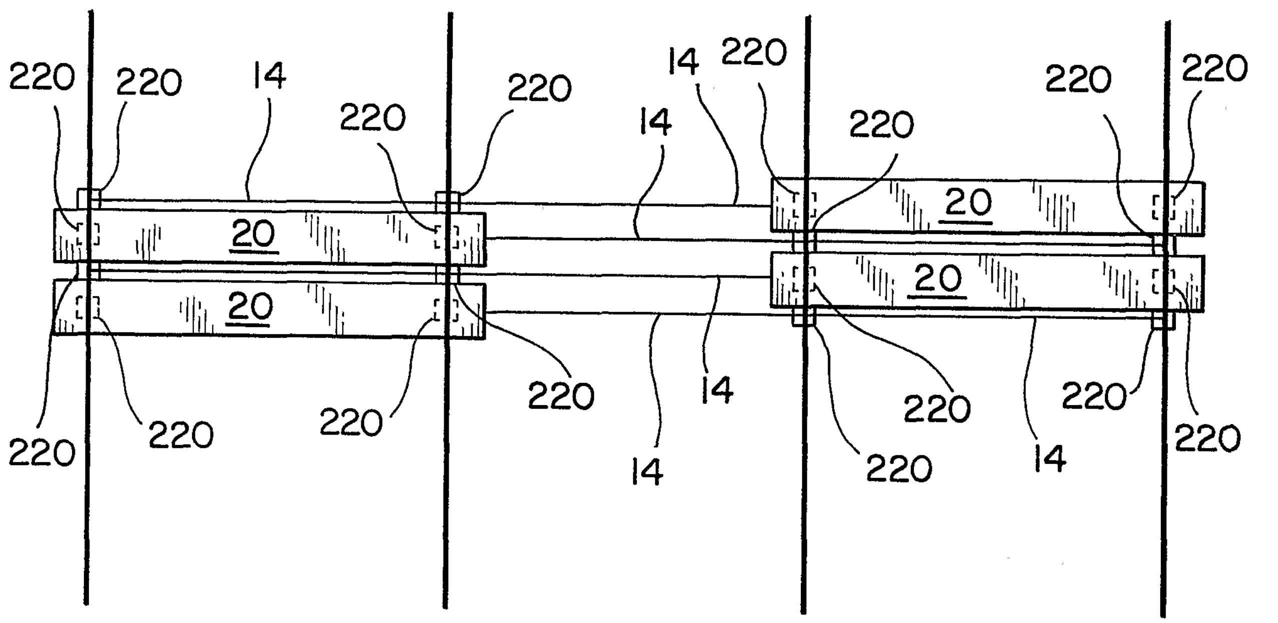


FIG. 13