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(57) **ABSTRACT**

A release device for vertically adjustable barriers (theatrical curtains, advertising banners, sun control systems, environment altering systems, acoustic control systems or scenic back drops, etc.), with a support assembly (e.g., roll assembly) with first and second roll supporting frame structures and a tensioner extending between the frame structures. The tensioner can be a cable extending parallel to the roll's axis of rotation. The tensioner compensates for gravity induced sagging of the roll (e.g., a multi-sectional roll). The frame structures are suspended with suspension lines that extend down from an overhanging mount and the frames compress the ends of the roll and negate sag in intermediate area of roll. The roll is supported by bearing sets on the frame structures.

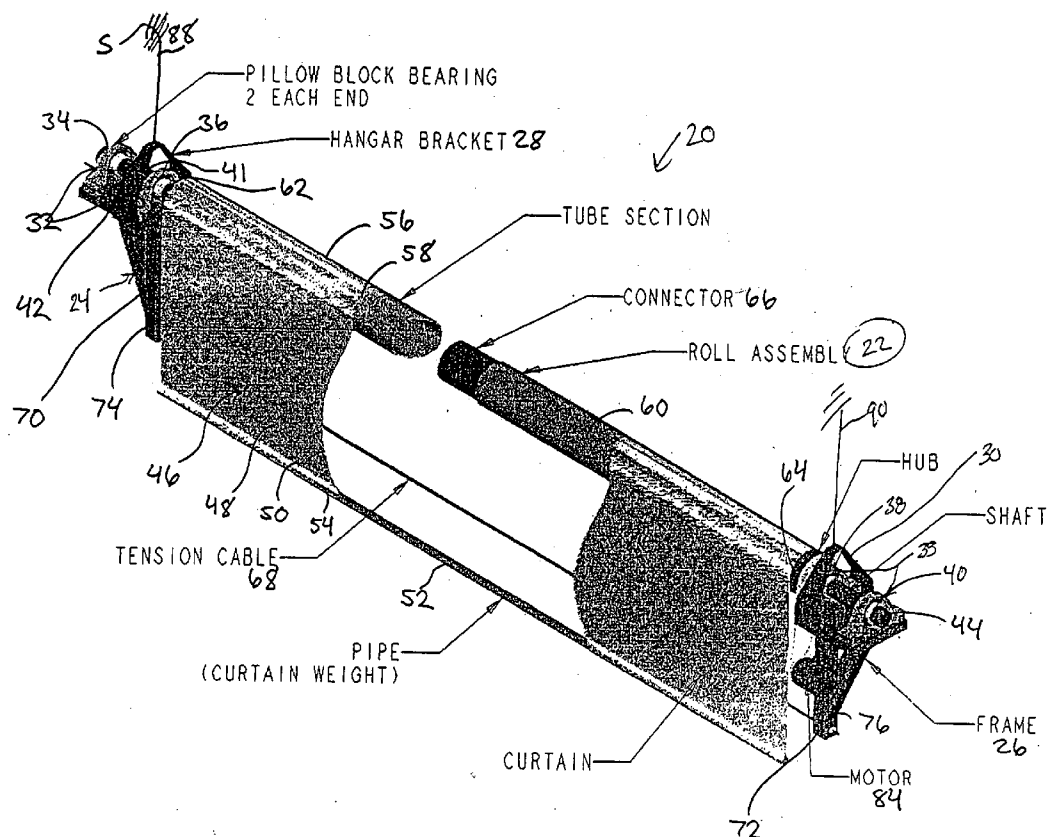
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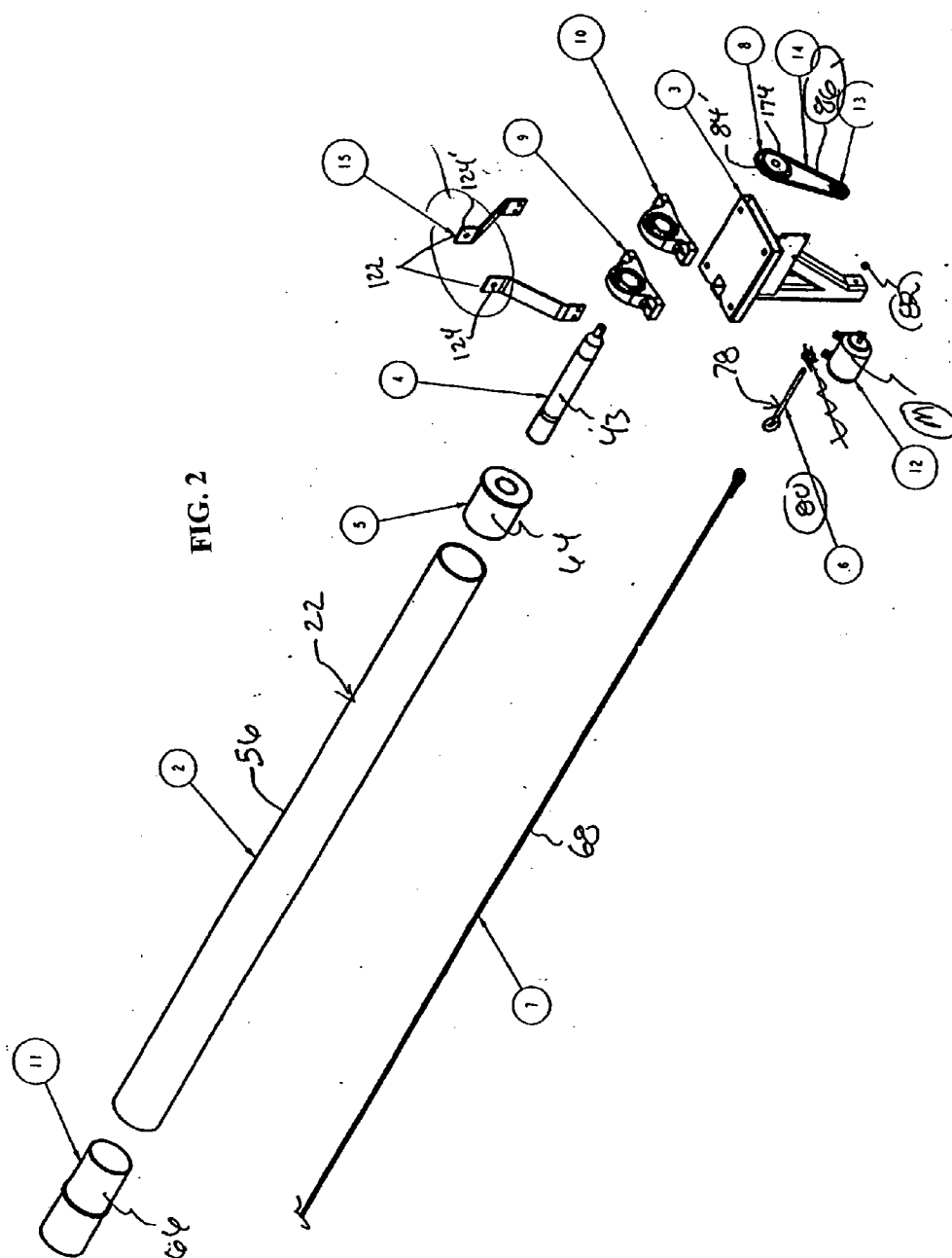
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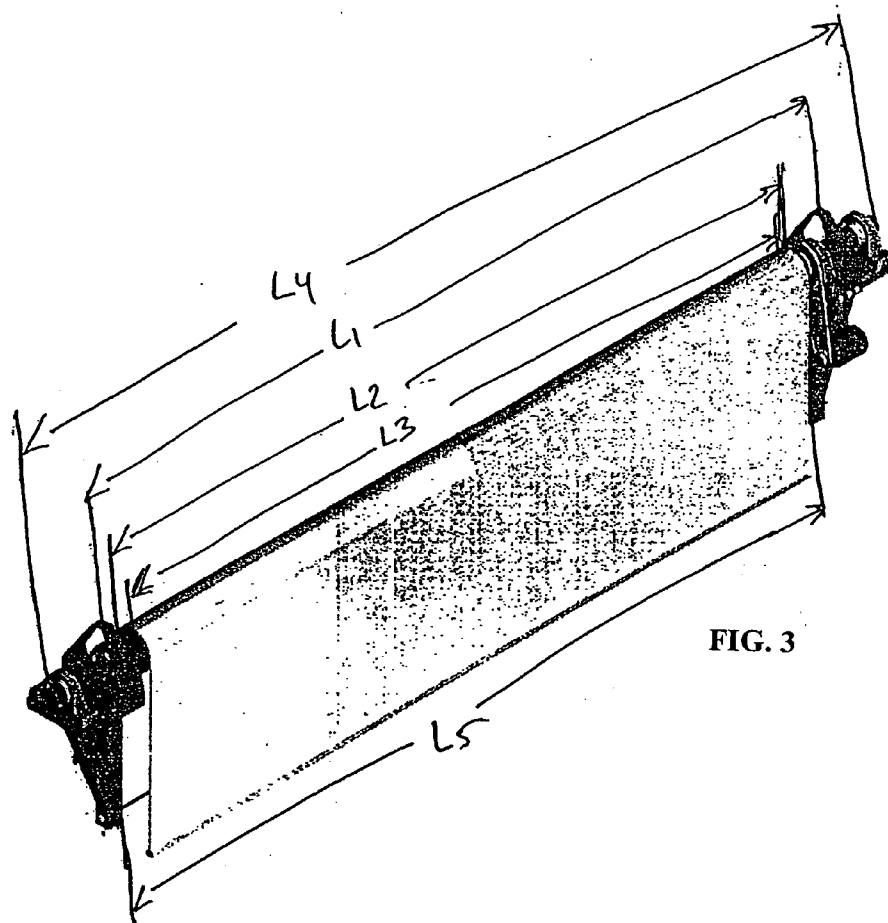


FIG. 3

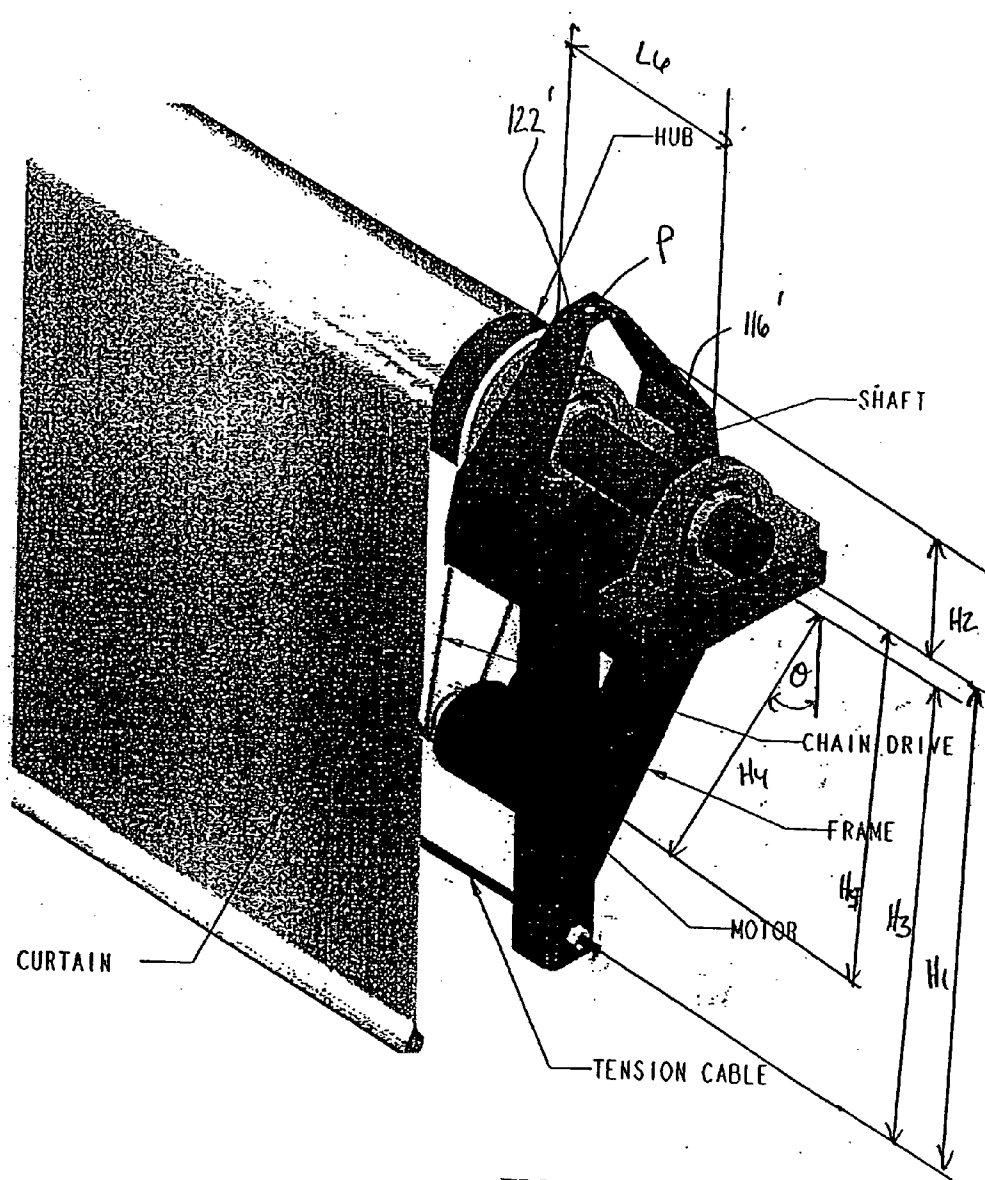
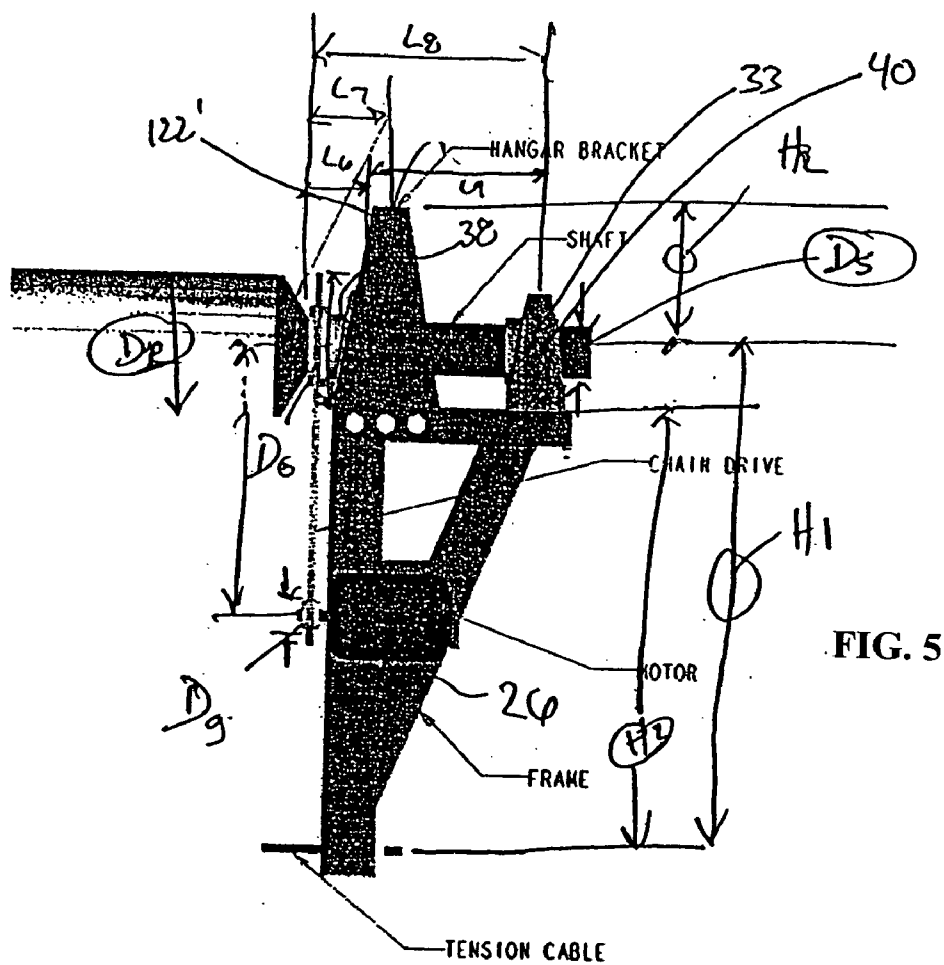


FIG. 4



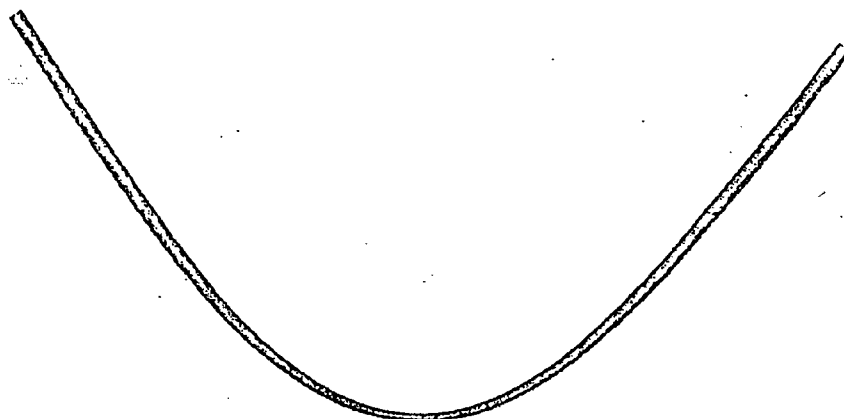


FIG. 6A



FIG. 6B

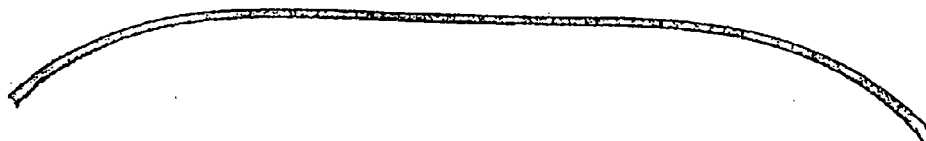
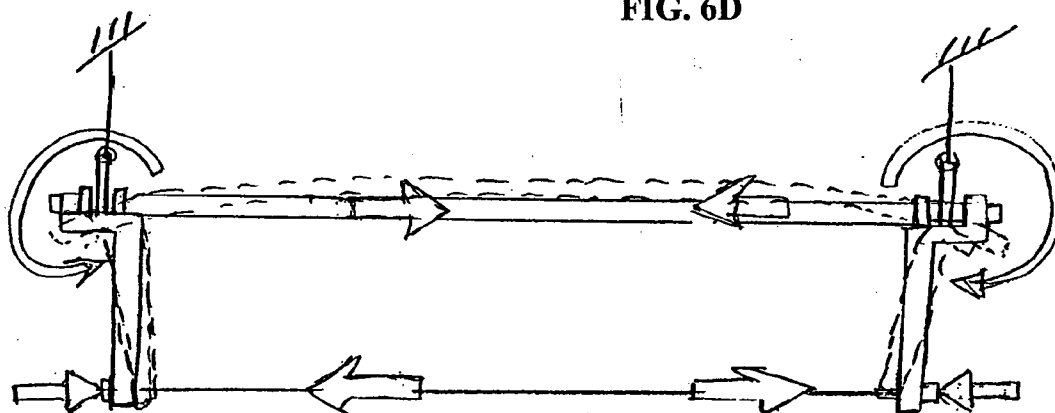
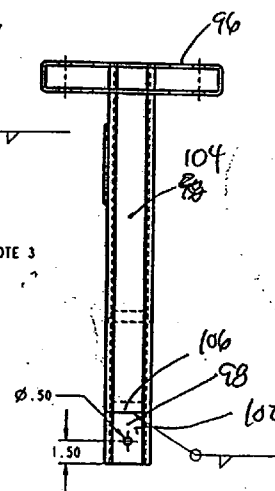
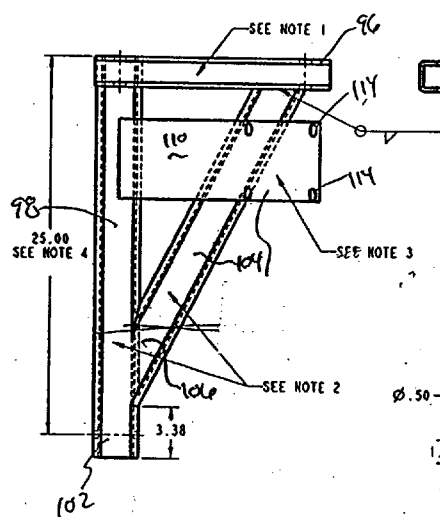
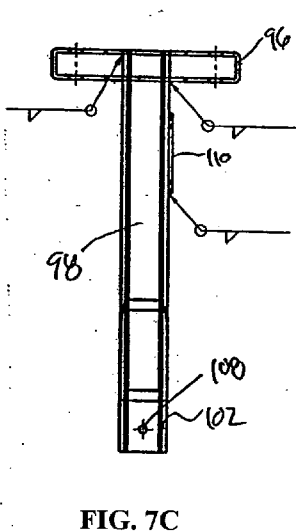
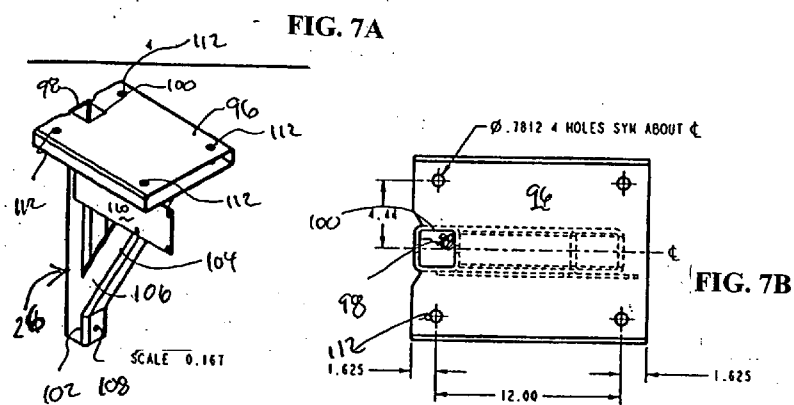


FIG. 6C

FIG. 6D





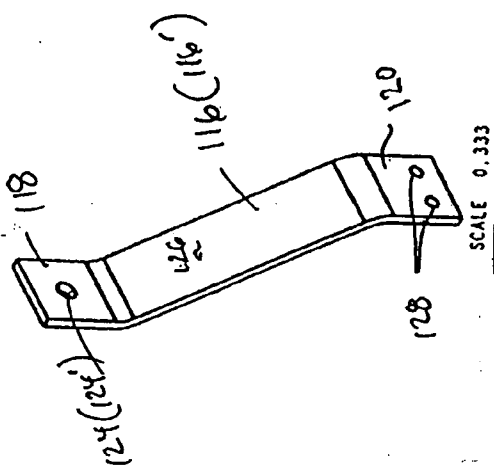


FIG. 8C

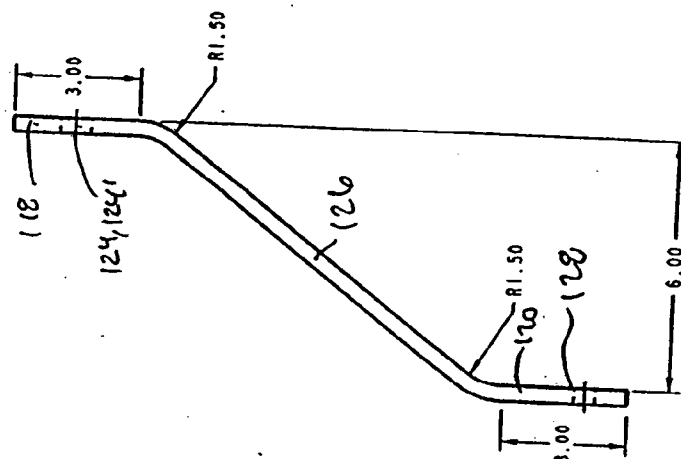
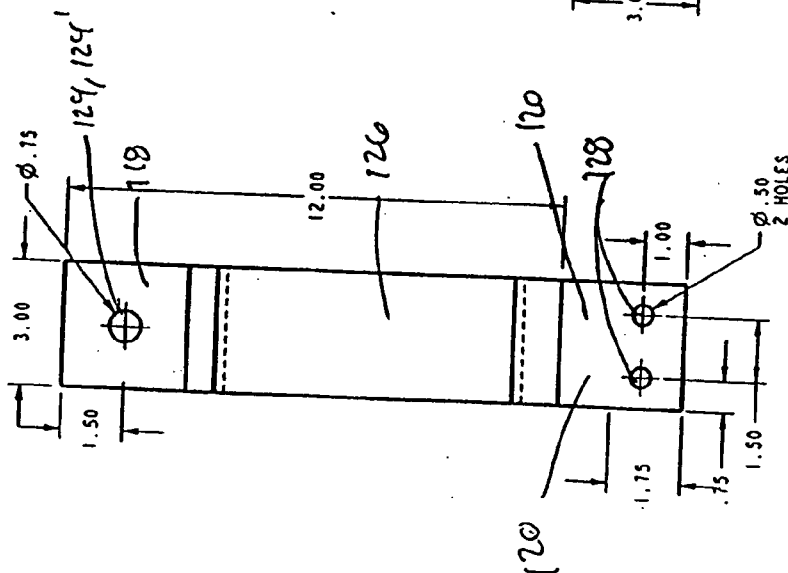
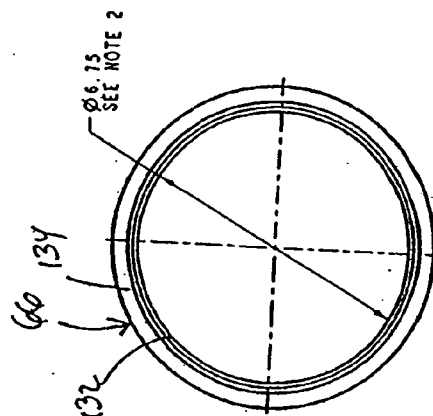
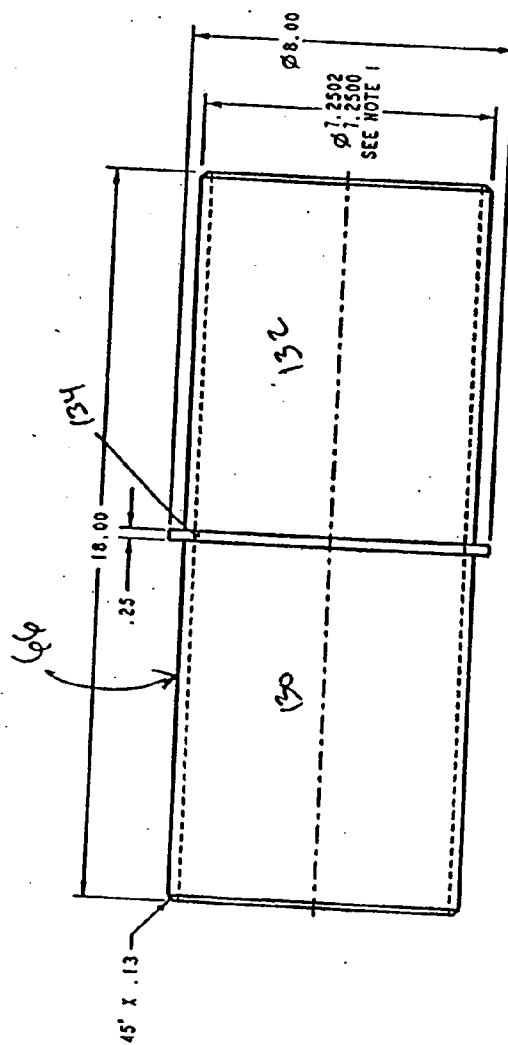
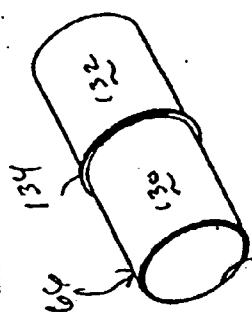
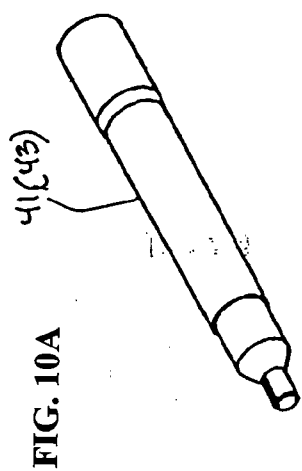


FIG. 8B



.38 THICK





SCALE 0.250

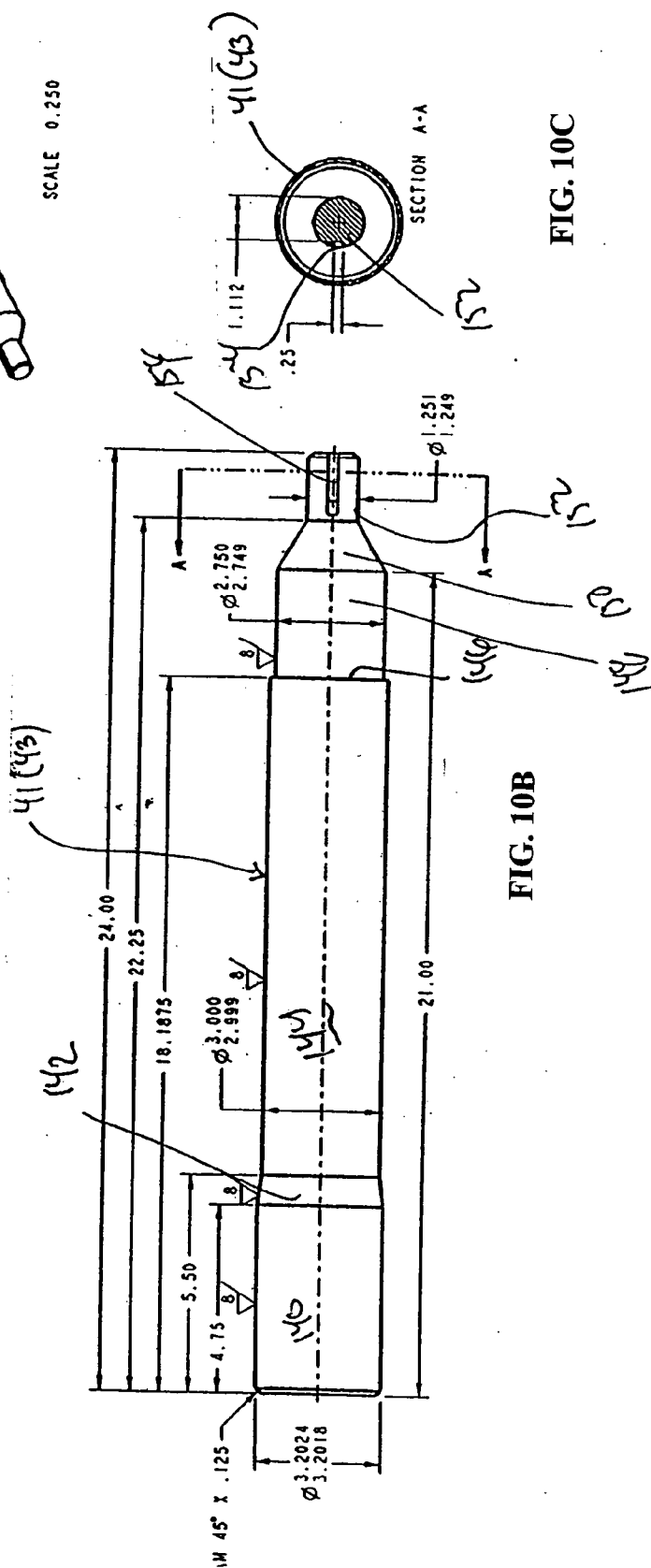


FIG. 10C

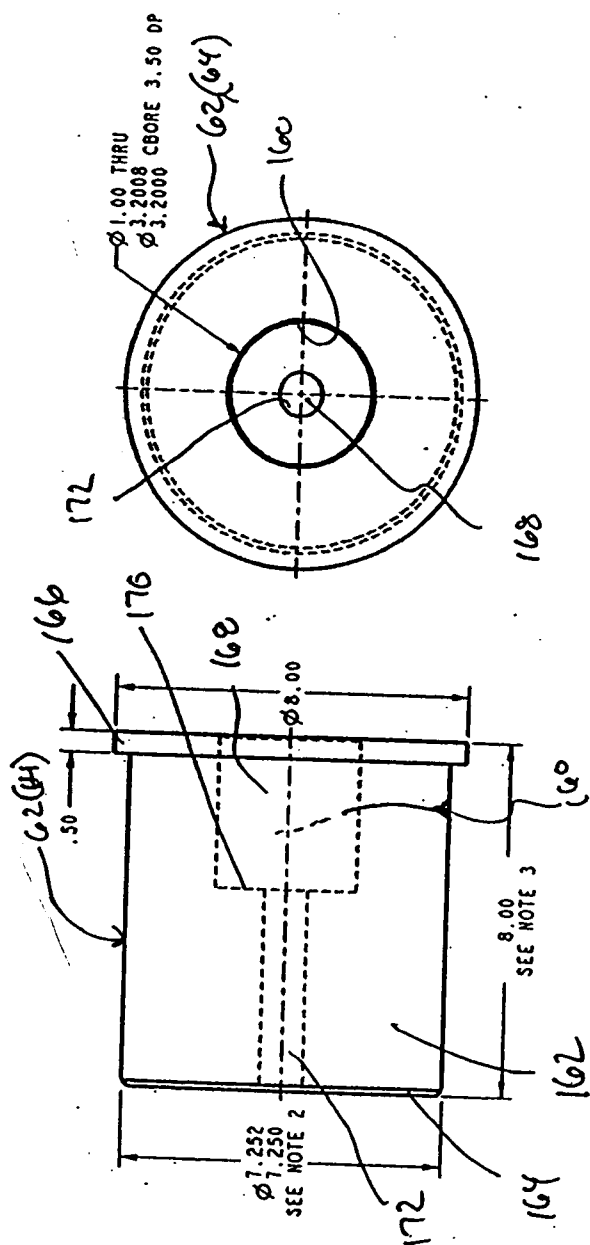


FIG. 11C

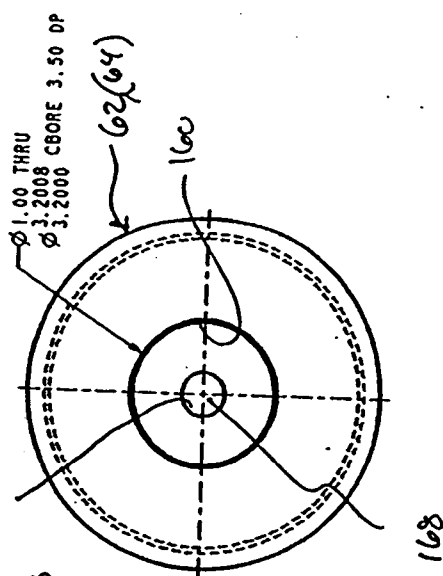
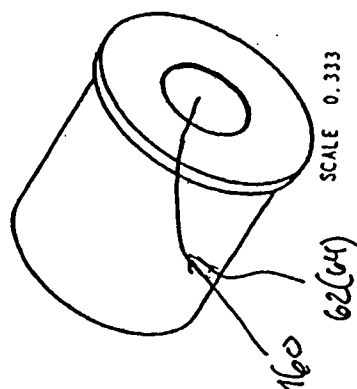
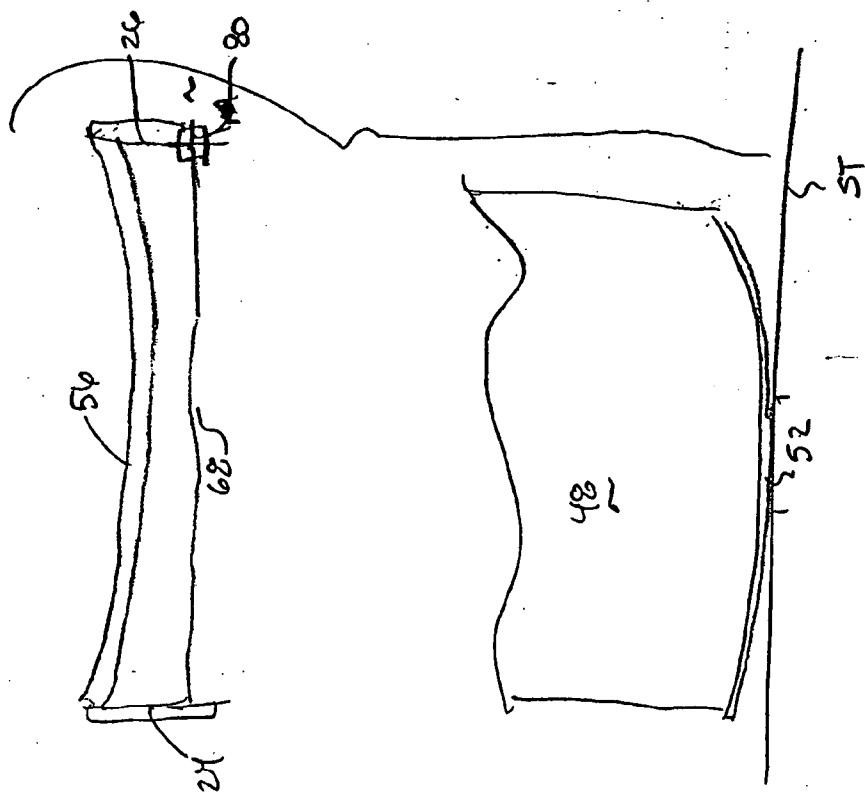
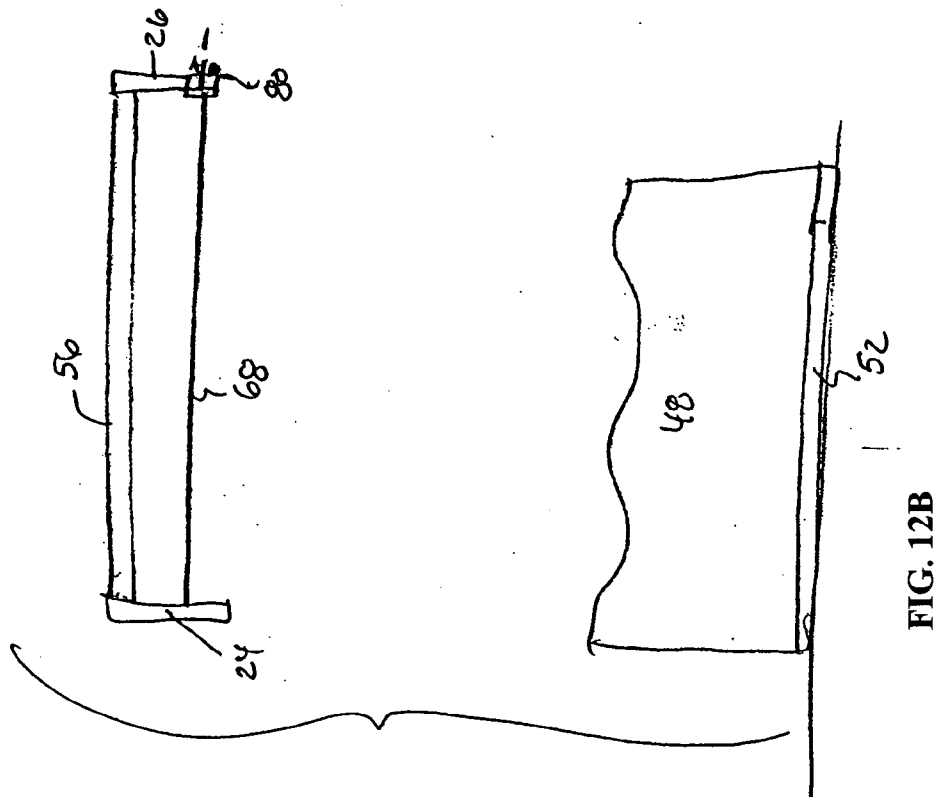


FIG. 11A





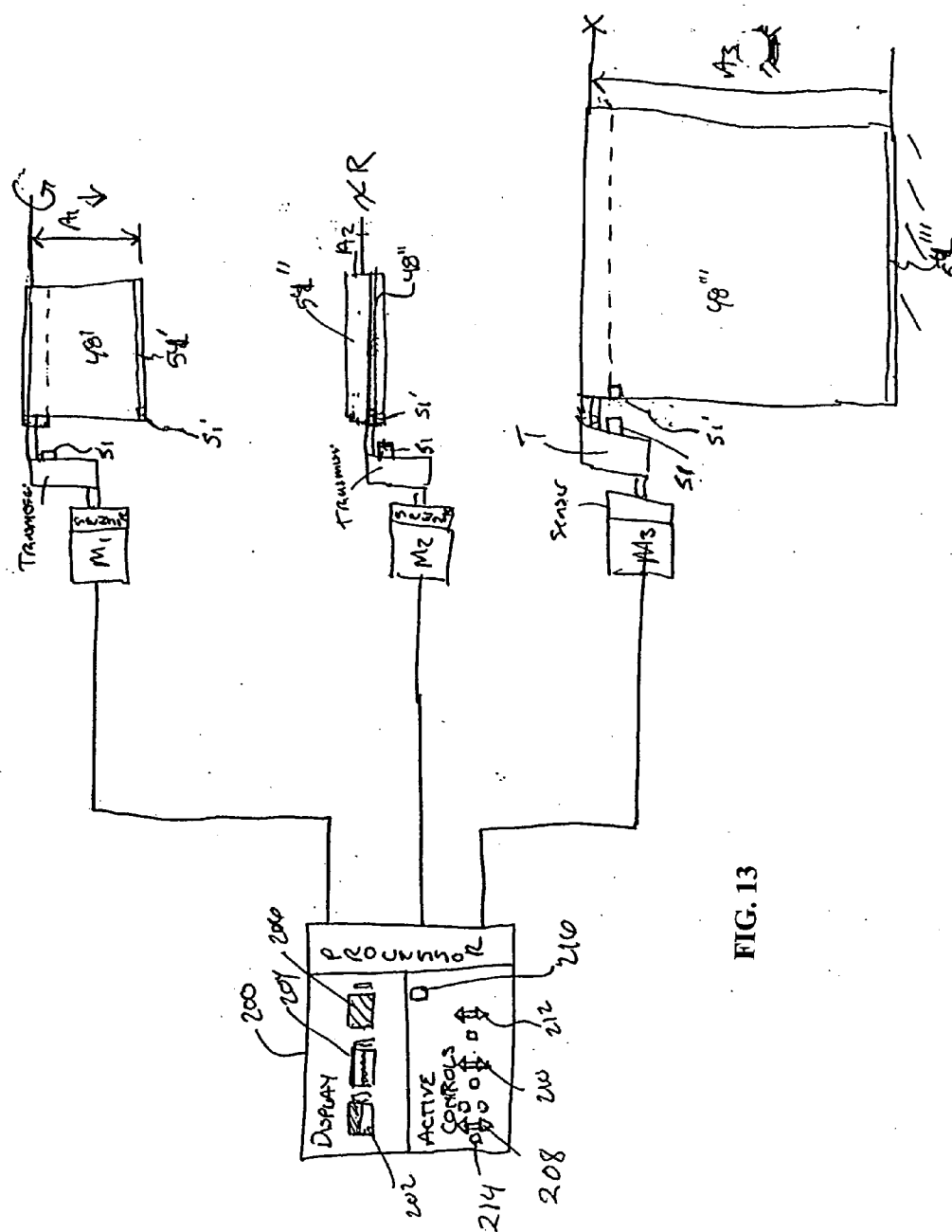


FIG. 13

RELEASE DEVICE AND METHOD OF MANUFACTURING, INSTALLING AND OPERATING THE SAME

FIELD OF THE INVENTION

[0001] The present invention relates to a release device such as an adjustable barrier roll release device used in supporting flexible (e.g., textile) visual, acoustic and/or environmental blocking barriers such as curtains (e.g., theater), environmental protective barrier sheets (e.g., sun blocks or shades), room dividers, backdrops, netting, advertising banners, etc., and is particularly suited for use with large span roll drop assemblies.

BACKGROUND OF THE INVENTION

[0002] A variety of flexible barrier or curtain supports have been developed including those designed for handling large spans such as with theatrical curtains or gymnasium dividers and the like. To retract or remove a barrier, particularly one extending over a long span, there has been utilized the technique of transverse sliding of a flexible curtain along an above supported runner with a plurality of carriers each having suspension lines extending down into supporting contact with the curtain (e.g., U.S. Pat. No. 4,091,857).

[0003] In some uses, as in scenic or stage curtain theatrical use, a transverse runner is undesirable with vertical lifting and dropping being more desirable. For example, scenic roll drop devices have been used previously in the theatre, and typically are fabricated by the theatre's scenery shop. They often consist of a roller or tube fabricated from wood which is attached to the bottom of a scenic drop. The top of the drop is attached to a pipe or batten. The bottom roller extends past the sides of the drop. Ropes are wound around the ends of the tube. When pulled, the movement of the ropes causes the tube to roll or spin resulting in the tube "climbing" the drop, thereby raising the bottom of the drop. Manufacturers of theatrical equipment also fabricate roller devices as a means of storing and deploying velour or other heavy fabric for the purpose of acoustic dampening in concert halls and other live performance spaces. These devices feature a simple aluminum tube spun or rotated by means of a roller chain sprocket and motor attached to one end. These devices are limited in span length based on the lack or need for stiffening the tube or pipe. Physics and typical space and budget constraints have tended to limit these devices often to a width of twenty-four feet or less.

[0004] Manufacturers of motorized projection screens are also in existence and generally utilize a simple aluminum tube rotated by means of an electric motor for the purpose of storing and deploying projection screens. For similar span support reasons, widths have tended to be limited to twenty-four feet, the point at which the utilized tube supported only at its ends will deflect or sag beyond practical use. Or devices which require a fixed steel frame which may be utilized only with a fixed, predetermined load and which do not allow for changing the load.

[0005] As many areas desired for use with a barrier span larger distances (e.g. 40 to 100 feet), there is introduced the complexity of providing support for these large spans while still providing for efficient roll up and/or down of the barrier. As the weight of the curtain material alone in the curtains

used to cover such spans can be quite high (e.g., 1000 to 1500 lbs or more), as in multiple curtains arranged in series, there is also a need for providing sufficient structural integrity over the spans through the use of high strength materials (with corresponding costs) and extensive or frequent support arrangements along the span such as multiple independent barrier roll assemblies arranged in series, which also increases cost and adds to the roll up complexity. Architects and contractors know how difficult and expensive it is to build or renovate theaters with standard rigging equipment. Counterweight systems have been the classic solution for providing cycloramas, scrims or painted scenic drops. The typical counterweight system requires a minimum of 1.25 times the height of the proscenium opening. In other words, a traditionally equipped 20' high proscenium can need to be built 45' tall.

SUMMARY OF THE INVENTION

[0006] Embodiments of the present invention provide an apparatus and method which is highly versatile in providing a release device that can be used as a roll release device for short spans and for longer spans (e.g. 25 feet or more as in 60 feet or more spans) with minimal deflection and with a single roll. In addition to providing for minimal deflection, a preferred embodiment of the present invention also provides a roll release device that can be suspended from overhead mounts (e.g. left and right end mounts only) and that can be "tuned" for different roll lengths, curtain weights, etc.

[0007] The preferred motorized drop assembly of the present invention spans long distances as up to 60' with virtually no sag and deflection. The inventive subject matter also uses minimal vertical storage, which makes it ideal for easy retro-fit installation in low-profile theater, arena, etc. spaces. The compact design capability of the inventive subject matter makes, for example, painted scenic drops, scrim effects and other flexible banners (e.g., textile banners) up to 60' wide possible with roughly the same amount of overhead space as standard duct work. This space reduction can mean significant savings in construction or renovation costs. Plus, architects are freed from the design constraints imposed by traditional counterweight systems. The present invention also provides for flexible barriers as in textile banners to be compact, quiet and easily controlled. This provides for an alternative solution for the installation and management of sound control systems. Acousticians can replace multiple acoustic banners with just one under the present invention, which can be raised and lowered via a single motor that easily interfaces with most control panels. With custom widths of, for example, up to 60', the present invention can bring significant cost savings while providing efficient, user-friendly sound control for theaters, concert halls, etc.

[0008] Flexible barriers also comprise advertising banners such as those used in arenas and other large public meeting areas. Often static advertising banners are used in such environments, but static advertising banners in arenas quickly fade into the background. Banners that appear and disappear or even change their message gain higher audience awareness. The present invention can be readily installed in arenas or other indoor or outdoor venues to provide advertisers with active, mobile name and product recognition—but without the expense or technical complex-

ity of electronic displays. The banners of the present invention can also be quickly and easily attached and controlled with, for example, a simple switch that can be integrated into a master control panel.

[0009] A preferred embodiment of the roll release device of the present invention features a roll release device with a roll assembly having a first end and a second end, a first frame structure supporting the first end, and a second frame structure supporting the second end, together with a tensioning device extending between and supported by the first and second frame structures and positioned at a location spaced from an axis of rotation of a roll of the roll assembly. The use of "end" in the present application is used in a broad sense and is not limited to the outer most portion of an object but regions inward or to the left and right of the central most portion of the referenced object. Preferably the tensioning device extends parallel to the axis of rotation of said roll assembly at a spaced location (e.g. 1 to 4 feet) and includes an adjuster for increasing or decreasing the level of tension in the tension member and a degree of compression imposed on the roll. In a preferred embodiment the tensioning device is a cable that extends between and through the lower, free end portions of the frame structures with the cable being essentially (e.g., within 10 degrees) aligned with an axis of rotation of the roll such that the axis of rotation of the roll and a central axis of the cable are essentially parallel and vertically spaced along a common vertical plane. To achieve the common vertical plane relationship there may be involved counter-weighting, such as where there exists a motor of the driving means that is not centered on a supporting frame structure.

[0010] An embodiment of the present also features a multi-section roll comprised of multiple roll sections such as at least three sections with roll sections projecting preferably ranging from 3 to 20 feet, and the overall length of the roll is preferably 25 feet or more, with 40 feet and 60 feet roll spans being well suited for covering many desired areas.

[0011] A preferred embodiment of the invention also provides for deflection values of less than 1 inch and more preferably less than $\frac{1}{4}$ inch for spans of 40 feet or more including roll supported curtain or barrier material having weights in excess of 750 pounds, for example. The invention subject matter is also directed at providing deflection values of even less than an inch such as $\frac{1}{8}$ of an inch or less (e.g. $\frac{1}{8}$ of an inch) for example, for 60 foot roll spans even with excess weights involved. Also, a preferred embodiment of the invention includes roll section connectors for interconnection of the adjacent ends of roll sections which are preferably hollow roll sections or have hollow reception ends for receiving the connectors.

[0012] The roll release device of the present invention also preferably includes a first bearing assembly supported by the first frame structure and in a bearing relationship with a far end portion of the first end of the roll assembly and a second bearing assembly supported by the second frame structure and in a bearing relationship with a far end portion of the second end of the roll assembly. The first bearing assembly includes a first pair of bearings axially spaced along the far end portion of the first end of the roll assembly and a second pair of bearings axially spaced along the far end portion of the second end of the roll assembly. An embodiment of the roll assembly also comprises a first shaft and a second shaft,

with the first shaft in bearing contact with the first bearing assembly and supporting a first end of the roll and the second shaft being in bearing contact with the second bearing assembly and supporting a second end of the roll.

[0013] An embodiment of the present invention further comprises a first and a second hub with the first hub interconnecting the first shaft with the first end of the roll and the second hub interconnecting the second shaft with the second end of the roller. The first and second hubs can have radial barrier guidance flanges extending radially out from a main body of the hubs for edge position control of the flexible barrier material being rolled up on the roll (the barrier preferably connected along a first edge to the roll with fasteners and/or adhesive or other securement means and the second end having a looped over free end portion with a bar or extra folds to give it some added end, free edge weight). A flexible barrier in the form of a theater curtain with a weighted bar free edge and a length of more than 25 feet such as a 40 to 60 foot curtain is illustrative of a representative barrier well suited for use with the present invention. The shaft and hub combinations at each end feature shafts and hubs dimensioned to carry imposed loads and to fit to prevent rotational slippage and wobble in the recipient tube.

[0014] An embodiment of the roll release device of the present invention further comprises driver means in driving engagement with a roll of said roll assembly for inducing rotation in the roll and barrier and positioning sensing means to monitor the location of the extension or retraction of the barrier.

[0015] For a preferred embodiment suspended from left and right overhead mounts, first and second hanger devices are secured to respective first and second frame structures, as in hanger bracket assemblies extending up from the frame structures to opposite sides of the bearing assemblies supported on those frame structures and connected with suspension means. The suspension means provide for compressive force development in the roll of the roll assembly to provide means for compensating for the gravity induced deflection force imposed on the suspended roll of the roll assembly. The suspension means, which are in a supporting suspension relationship with the first and second frame structures, can take on a variety of forms under the present invention with cables, chains, and other flexible lines or non-rigidly secured and movement compensating bar and bar support combinations being illustrative. The suspension means preferably includes one flexible line only attached to each frame structure with the remainder of the roll extending between the frame structures being in a free suspension state without any form of support between the two suspension lines and corresponding frame/bearings support locations.

[0016] An embodiment of the present invention also includes a roll drop device having a roll assembly having a roll (e.g., 40 feet or longer and formed of multiple interconnected sections (e.g., tubes)) as well as means for supporting the roll assembly and tensioning means for placing said roll in a state of compression. The roll is supported under the present invention to have minimized deflection even when extending over large spans (e.g., an inch or less for a 60 foot span). Also, while a single, multi-section roll of material extending across the non-deflecting support provided by the roll assembly is featured, the subject mater

of the present invention can further include a unitary, single roll support or an arrangement featuring a series of the featured invention to span even greater lengths.

[0017] The invention further includes a method of adjusting a roll release device, comprising providing (i) a roll assembly having a roll, (ii) a first frame structure, (iii) a second frame structure, (iv) and an adjustment device extending between the first and second frame structures and manipulating the adjustment device so as to negate at least to some degree a deflection level in the suspended roll. Adjusting the adjustment device preferably includes tensioning a tensioning device such as a cable extending between the first and second frame structures at a location removed from a rotation axis of the roll.

[0018] The invention further includes a method of “tuning” a roll assembly for operation as in a theatrical roll drop device, advertising banner device, acoustic banner device, etc., having a barrier fixed at one end to a motorized roll supported by a roll assembly which in turn is supported at its far end regions with a bearing set supported on left and right frame structures which are individually suspended from overhead mounts with non-rigidly fixed suspension lines. The method includes leveling the roll assembly, dropping the free edge of the curtain until a central portion of the curtain makes contact with an underlying surface (e.g., stage or arena floor) and then adjusting the tension in the tensioning means as to have the remainder of the free end of the curtain become parallel and in contact with the underlying supporting surface. That is, by adjusting the tension line between the frame structures and putting the roll in a higher degree of compression, the downward, gravity induced bowed deflection of the roll is compensated upon the tensioning means placing the roll into compression which acts to negate the downward, centralized bowing of the roll and associated curtain. When the central portion and the ends of the curtain become generally in alignment and closer to a parallel state with the underlying surface there is achieved a corresponding parallel alignment in a majority (all of central portion between the far end regions of the roll) of the roll (which is typically equal to or less than the banner width supported by the roll) and the cable tensioning means.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] Other features and technical advantages of the present invention will become more apparent from a study of the following description and the accompanying drawings, in which:

[0020] **FIG. 1** illustrates a partially cut away perspective view of a preferred embodiment of roll release (e.g., drop) assembly of the present invention supported by overhead support means;

[0021] **FIG. 2** illustrates an exploded view of a portion of the roll drop assembly of the present invention;

[0022] **FIG. 3** illustrates a similar perspective view as that in **FIG. 1**, except at a different angle, not in cut-away and without the overhead supports shown;

[0023] **FIG. 4** shows an enlarged perspective view of the right end portion of the roll drop device shown in **FIG. 1**;

[0024] **FIG. 5** shows a front view of that which is shown in **FIG. 4** except for the curtain removed for added clarity of the support roll;

[0025] **FIG. 6A** illustrates a schematic representation of a simply supported roll with exaggerated deflection;

[0026] **FIG. 6B** illustrates a schematic representation of a rigidly mounted roll with exaggerated deflection;

[0027] **FIG. 6C** illustrates a schematic representation of a roll subject to mounting forces in the roll drop device of the present invention;

[0028] **FIG. 6D** illustrates an anticipated schematic force diagram of the roll drop device which, in general, shows the roll in a state of bowed compression for countering sag;

[0029] **FIGS. 7A, 7B, 7C, 7D and 7E** illustrates, respectively, a perspective, top plan, interior end, front elevational and an exterior end view a preferred embodiment of the frame structure of the present invention;

[0030] **FIGS. 8A, 8B, and 8C** illustrate, respectively, a perspective, front elevational and side edge view of a hanger bracket of the present invention;

[0031] **FIGS. 9A, 9B, and 9C** illustrate, respectively, a perspective, side elevational and end view of a roll segment connector for a multi segment roll embodiment as shown in **FIG. 1**;

[0032] **FIGS. 10A, 10B, and 10C** illustrate, respectively, a perspective, side elevational and end view of a shaft for the roll embodiment shown in **FIG. 1**;

[0033] **FIGS. 11A, 11B, and 11C** illustrate, respectively, a perspective, side elevational and end view of a hub of the roll drop device of **FIG. 1**;

[0034] **FIGS. 12A and 12B** illustrate a tension setting method under the present invention;

[0035] **FIG. 13** provides a schematic illustration of an operation controlled set of multiple curtains;

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS OF THE PRESENT INVENTION

[0036] **FIG. 1** illustrates, in perspective, a preferred embodiment of a release device **20** in the form of a roll drop device (hereafter referred to as roll drop device **20**) which is well suited for use as a roll drop such as for theatrical banners (e.g., curtains) acoustic banners, sun and environmental control banners, advertising banners, etc. Roll drop device **20** comprises roll assembly **22** which is supported at opposite ends by first frame **24** and second frame **26**. First frame **24** is connected with first support connector (e.g., a first hanger bracket assembly) **28**, while second frame **26** is connected with second support connector (e.g., a second hanger bracket assembly) **30**. As explained in greater detail below, first frame **24** supports bearing assembly **32** (e.g., a bearing set **34, 36**) and second frame **26** supports bearing assembly **33** (e.g., a second bearing set **38, 40**). The first and second bearing assemblies are shown arranged on the frames to receive the “exposed” shaft ends **42** and **44** of shafts **41** and **43** (two individual shafts at opposite ends of the roll assembly are preferred as compared, for example, to a single shaft extending from one bearing to the other through hollow roll sections) which extend out at opposite ends of the roll assembly **22** of which they form a part.

[0037] FIG. 1 further illustrates visual or environmental blocking or barrier means 46, which in the illustrated embodiment is a flexible textile banner assembly comprising a main banner body 48 (e.g., a theatrical curtain), which is flexible enough for rolling take up or retraction by the roll assembly, and curtain weight 52 at its free or lower end 54. In the illustrated embodiment, curtain weight 52 is in the form of a straight pipe received within a looped reception sleeve 54 at the curtain's free end, although various other weighting means such as extra folded material or other material filled pockets are featured in the present invention. In the embodiment illustrated banner 46 is a flexible (solid visual barrier) formed of a cloth or plastic sheet material, although the present invention is suited for various other covers and barriers such as open netting, multi-strips in adjacent relationship (contacting or spaced apart), visual backdrops, room dividers, sun and environmental blockage or absorption devices, awnings, quarantine barriers, advertising banners, etc. Also, while the present invention is particularly suited for vertical roll release and retraction, a variety of other orientations (e.g. oblique or transverse to the vertical) are also applicable under the present invention. However, the present invention is particular well suited for a vertical roll drop assembly where the curtain is free standing such that the entire curtain load is placed on the roll assembly.

[0038] With particular reference to FIGS. 1 and 2, roll assembly 22 can be seen to further comprise roll 56, which in a preferred embodiment is made up of a plurality of roll sections (e.g., roll sections 58 and 60 depicted in FIG. 1), although a roll section set of more than two roll sections (such as six at 10 feet each for a total of 60 feet) is illustrative of a preferred longer span roll assembly under the present invention. In other words, while a single roll section embodiment is a feature of the present invention, the present invention is particularly suited for a large span roll assembly made up of multiple roll sections (e.g., 3 to 10 roll sections varying from 5 to 10 feet in axial length). In a preferred embodiment, the respective ends of the roll sections closest to the frame structures are connected to respective shafts 41 and 43 preferably by way of an intermediate hub as represented by first and second hubs 62 and 64. For those embodiments of roll 52 comprised of multiple roll sections, each adjacent roll section end set (one or more sets depending on the number of roll sections involved) are interconnected with intermediate connector 66. The hub/shaft combination and roll section or tube with connector combination are preferably arranged with a tool-less, friction/press connection suited for preventing slippage (the bearing assemblies providing for rotation).

[0039] As also seen from FIGS. 1 and 2, roll drop device 20 further comprises tensioner 68 which in a preferred embodiment includes a flexible cable as represented by cable 68 shown in the Figures received by reception means 70 and 72 at the free ends 74, 76 of the frames 24 and 26. Tensioner 68 further preferably comprises tension adjustment means 78 such as the draw bolt and nut combination 80, 82, best seen in FIG. 2. Tensioner 68 provides for drawing the frames 24, 26 closer together so as to place the roll 56 in compression which influences an upward bowing and shaft end pointing down orientation as explained in greater detail below. Tensioner 68 provides a tensioning means and can take on alternate forms than the illustrated cable including—non-metal (limited elasticity) chord mate-

rial, chains, rod (a thin metal aluminum rod), etc., but in view of the preferred spans (e.g. 60 feet) and the desired tension levels a metal cable represents a preferred embodiment (e.g., a ½" diameter, 6×19 galvanized aircraft cable terminated with a heavy pattern thimble and swage fitting at each end which provides for tensioning of the cable and a pre-loading of the roller tube assembly).

[0040] Roll drop device 20 of the present invention further comprises in a preferred embodiment roll rotation means 84 which in the illustrated embodiment includes motor M and transmission 86. Additional (either alternate or supplemental) roll rotation means that preferably feature electric motorization (e.g., DC or AC motor) or feature other than an electric motorized system, include, as a few examples, gas powered motors, fluid/hydraulic driven devices or hand powered hand crank devices (not shown) such as one used as a back-up mechanism, or power tool driven devices (e.g., socket reception for heavy duty electric or air driven drill with appropriate gear down transmission), as the main source or as a back-up supplemental source of power. For some uses, (e.g., theater and acoustic barriers) quiet operation is desirable which is provided with, for example, a ⅓ hp 120V AC electric motor preferably having an integral electric break and also preferably with a break motor associated with a gear box reducer as in an electromechanical break with manual release. The break also preferably is of the type that releases by energizing the coil simultaneously with the motor winding to provide fail safe breaking in the event of a power failure. The motor is further preferably designed to provide a drop speed of 30 feet per minute or greater as in about 40 or 45 feet per minute.

[0041] FIG. 1 also illustrates the preferred mounting of roll drop device which is by way of suspension off suspension lines 88, 90 which have a first (lower) end connected to support connectors 28 and 30 and a second end 92, 94 fixed to overhead support S which can be either be a common or different support structure such as a beam or truss structure (e.g., a ceiling support truss structure in a theater). Suspension lines 88 and 90, which are preferably formed of for example, cables, chains, rods (e.g., pivotably supported within a vertical plane or universally supported and having means for compensation for compression forces to be imposed on the roll) to provide for compression on the rod when the tensioning means is active. Thus support roll drop device 20 is in, for example, a "free" suspension state (or common plane, free rotation state), which provides for roll 56 being in a state of compression when the tension level of cable 68 is in a tensioned state.

[0042] The roll drop "span" is represented in FIG. 3 by L1 which extends from a center of contact point of the interior bearing at one end to its equivalent at the interior bearing at the opposite end. In FIG. 3, length L2 is representative of roll length which, in the illustrated embodiment, runs from the outer end of the first hub to the outer end of the second hub. L3 in FIG. 3 represents the length of the curtain itself from outer edge to outer edge received by the roll. L4 in FIG. 3 represents the total length of the roll assembly (e.g., from outer end of a first shaft to an outer end of a second shaft). Lastly, L5 in FIG. 3 illustrates the tensioning means length which in the illustrated embodiment is defined as being the interior frame contact point at one side to an equivalent interior frame contact location at the opposite side which length generally conforms to the full length of the

tension cable and the draw bolt disregarding the thickness of the free ends of the frames through which the tensioning means extends and the tension means abutment members at the outer sides of the frame ends.

[0043] With reference to **FIGS. 4 and 5** some additional preferred dimension references are provided to facilitate the discussion to follow. As shown in **FIG. 4**, the distance **L6** represents the axial length from the outer exposed end of the hub **64** to the (axial elongation) center of the interior bearing **38** on the receiving shaft end. The distance **L7** represents the axial elongation distance from the end of the hub **64** to the center of axial elongation of the suspension line extension (i.e., a line extending through the hanger suspension contact point **P** to the center of the shaft vertically below), while **L8** represents the axial elongation distance from the end of the hub to the center of axial elongation of the outer bearing **40**. Thus, **L8-L6** represents the axial separation distance from a center of an interior bearing **38** to a center of an outer bearing **40** within a common bearing set. In a preferred embodiment there is a symmetrical relationship at each end such that the distances for one end are the same for the opposite end. Considering a preferred 1 to 2.5 feet shaft for use with long spans as in the aforementioned 60' span with a third or less received in the hub and a third or less of the full shaft length free extending out from the outer bearing (the interior bearing similarly spaced out from the outer surface of the hub's radial extension). With the forgoing information the relative percentage values for **L1** to **L8** are illustrated. Also, the relative axial bearing house spacing is about 8 to 12 inches and the interior bearing being about 4 to 8 inches from the end of the roll, with the hanger bracket being within 1 to 4 inches of the interior bearing housing. **L8** is preferably about equal to the upper support platform axial length of 1 foot.

[0044] **FIG. 4** also illustrates distance **H1**, representing the distance along a common plane between the central axis of the roll/shaft and the central axis of the tensioning cable with the dimension being taken for a shaft as though received in the bearing set without roll load deflection and with the tension cable being based on a straight line extension relative to the reception openings in the frame structure which represents a parallel relationship relative to the straight roll extension. **H2** represents the vertical distance from point **P** to the shaft central axis, while **H3** represents the vertical distance from the planar upper surface of frame **26** to the central axis of the tension cable with the difference **H1-H3** this representing the distance the central shaft axis is above the frame's upper bearing support surface. **H4** represents the distance from the central axis of the driving shaft of motor **M** to the central axis of the driven shaft, with angle Θ (theta) representing the angle of offset (e.g. 0 to an acute or obtuse angle range) relative to a vertical plane transverse to the central axis of shaft **44**. The above spacing distances are also applicable to the opposite end with the possible exception of the distance **H4** which is not applicable in an embodiment having a motor on only one of the two frames (with either frame providing a suitable stable platform for the motor). As seen from **FIG. 5**, the preferred values to the **H** and **D** values shown generally conform to the percentage distance relation shown in the figure with **H2** being about 2 feet (tensioner 1 to 3 inches up from the bottom most end of the frame to the very end) with **H1** being 2 to 5 inches greater than **H2**.

[0045] **FIG. 5** illustrates as well the above noted distances **H1**, **H2**, **H3** in the front elevational view of the right end of the roll drop device shown in **FIG. 1**. **FIG. 5** also illustrates diameter **Ds** for the shaft diameter, **Dr** for the roll (free of curtain) with **Ds** preferably being 2 to 6 inches and the roll about two to three times greater in diameter than the shaft, **Dn** for the driven gear pitch diameter and **Dg** for the drive gear pitch diameter. The gear diameters are arranged to provide the preferred greater than 30 feet per minute barrier adjustment.

[0046] A preferred embodiment of the present invention features a roll drop which spans (**L1**) a distance of 60 feet with minimal deflection (e.g. a deflection of less than an inch or more preferably 0.2 of an inch or less over a distance up to 60 feet). With increases in span, the minimal deflection value under the present invention is still minimized but to a lesser extent.

[0047] An embodiment of the invention also features a preferred maximum diameter for **Dr** of 8 to 10 inches for the roll as larger diameters are stiffer and, while possibly used, are not easily conformable with the tensioning means of the present invention to the desired level of reduced deflection. Thus, while the present invention can be used on larger diameter rolls (e.g. 8 to 12 inches) a value equal to or less than 8 inches for the roll diameter **Dr** is preferred with (a range of 4 to 8 inches being illustrative).

[0048] For a better understanding of the problems addressed under the present invention reference is made to **FIGS. 6A-6D**. **FIG. 6A** is illustrative of a simply supported roll with exaggerated deflection (e.g., 100x). A simply supported roll is one wherein there is only provided single bearing support at each end (e.g., within the last 0 to 15% end region on each side). With this type of support the roll will deflect or sag significantly under the rolls own weight and even more so when the weight of the barrier supported thereby is taken into consideration. For example, a simple supported 60 foot hollow aluminum tube (6 sections at 10 feet each) having an 8.0 inch diameter with $\frac{3}{8}$ inch wall thickness is estimated to have a sag of about 5 inches in the center in a simple support environment. **FIG. 6A** shows the deformed shape assumed by a simply supported roll (with deflection exaggerated by 100x to better illustrate the deformed shape). This level of deflection is problematic such as in the performance or the rolling portions of the curtain drop and the high loads on the bearings and shaft, for example, induced by the deflection misalignment.

[0049] If the roll is rigidly mounted as illustrated in **FIG. 6B** such as by way of four total bearings, the deflection is reduced to, for example, closer to 1 inch for a 60 feet length roll. A rigidly mounted arrangement introduces disadvantages, however, such as high loads on the roll and mounting hardware requiring corresponding enhancements in the material and/or sizing to handle the large loads, and relatively high costs associated with the number of bearings and material and size requirements. Also, with a rigid support arrangement there is not a suspension or free suspension support potential as the rigid mounts need to be rigidly supported and secured to strong reaction surfaces to achieve the lowered deflection levels illustrated. Further, while the deflection levels are significantly reduced relative to the simple support arrangement, the maximum deflection for a rigidly supported roll as shown is still above the desired

maximum deflection level intended for preferred embodiments of the present invention.

[0050] FIG. 6C is a schematic roll deformation illustration of a roll with large span as described above for FIGS. 6A and 6B supported in accordance with a preferred arrangement of the present invention. In other words, the roll illustrated in FIG. 6C provides an illustration of the deflection characteristics of a roll supported by, the illustrated roll drive device 20 of the present invention

[0051] FIG. 6D provides an anticipated schematic illustration of the force (e.g., tension/compression interrelationship) amongst the various forces and moments involved in the roll drop device of the present invention. As shown, under the arrangement of the present invention the roll deflection is biased upward in opposition to the gravity induced sag in the roll. In a preferred embodiment this biasing against the sag forces on the roll is neutralized or negated or at least reduced in level by way of a tensioning means such as the aforementioned tensioner 68 in FIG. 1. As can be seen from FIGS. 1 and 6D, the tension cable is hung below the roll and attached at opposite ends to the respective frames which are secured in turn to the roll cylinder shaft supported by the two bearing sets (32 and 33). Gravity also helps position the frames and cable to the preferred orientation with the tension means hung directly below the center of the roll arrangement. When the cable is slack and not in a tensioned state, the roll deflection is essentially simply freely supported like the arrangement shown in FIG. 1 with the two free ends of the roll (or roll with shaft extensions such as in FIG. 1, with "roll" being used generally relative to this load and roll shape discussion) pointing up and a centralized downward sag. Under the preferred arrangement shown in FIGS. 1 and 6D, as the cable 68 is tensioned, the ends of the roll undergo a conversion from the upward pointing arrangement to a neutral (ends extending horizontal) location (presenting an arrangement similar to FIG. 6B) and upon further-tensioning the ends go to a downward pointing orientation. With the tensioning means in a tension state, the roll is placed in a state of compression as the suspended frames are drawn together against the intermediate positioned roll assembly. As the tensioning means is further tensioned, the roll ends continue to pivot until they point downward as shown in FIG. 6C. That is, as the cable is tensioned, the roll ends are pivoted downward by the action of the frame through the bearings means. This causes the roll to slope upward near its ends. The center of the roll is still subjected to the sagging forces and thus sags while the ends slope upward so as to approximate a wide M in overall deformity. This wide M deformation is close to a preferred operating point of the present invention as the deflections are very small. With some fine tuning or slight increase in cable tension the central region of the roll becomes essentially horizontal as represented in FIG. 6C which shows as well an exaggerated (100×) vertical down deflection in the ends of the roll. With a proper tensioning a maximum deflection value for a 60 foot roll span, is preferably less than or equal to one inch (e.g., 0.2 inch to 1.00 inch, or 0.3 to 0.8 with 0.75+/-0.15) presenting a representative maximum deflection value ranges under the present invention). FIG. 6D shows in dashed lines an upward bowing due to the compression generated on the roll by the tensioning means which deflection is reduced by gravitational forces as discussed above but not illustrated in FIG. 6D to help visualize

the comparison induced bowing forces generated by the tension means and associated frame structure and a bearing support.

[0052] Thus, with the arrangement of the present invention, there is provided a roll drop device that can be suspended from overhead mounts such as non-rigid cables, has deflection values at or below those typically associated with a rigidly mounted roll, and can be "tuned" for different roll lengths, curtain weights, environmental conditions, etc.

[0053] For a better appreciation of the features of a preferred embodiment of the present invention there is provided additional discussion of the components illustrated in FIG. 1. FIGS. 7A to 7E illustrate a preferred frame support for the roll assembly 22. In reference to FIGS. 1 and 7A to 7E, frames 24 and 26 are positioned at opposite ends of the roll assembly 22 and are dimensioned and arranged to apply a moment (in addition to the compression) to ends of the roll assembly upon tensioning of tension cable or wire 68, and to provide mounting points for all components and hardware such as the roll shafts 41, 43, bearing means 32, 33 and roll rotation means 84. Frames 24, 26 are made of a sturdy design such as of a weldment made from structural steel tubing (e.g. A36 or similar alloy) and a preferred embodiment features an upper planar platform 96 formed, for example, of a square tube (e.g., a 3×3× $\frac{3}{8}$ inch square tube). Extending down from an inner end of platform 98 is a vertically extending rectangular frame tube extension 98 (e.g., a 12×2× $\frac{1}{4}$ inch steel tube of A36 or similar alloy). As shown in FIG. 7A, tube extension 98 has a first end received in a correspondingly shaped closed border aperture 100 formed in an interior end of the platform and a second free end 102. Strut tube 104 is shown in FIGS. 7A to 7E extending in oblique fashion (e.g., 30° to 60°) between the free end 102 of the interior tube section and the lower surface of the outer end of the platform 96. These components are preferably all welded or otherwise fixed or formed together to form an integrated unit. Also at the free end 102 of the vertical rod 98, below the lower end 106 of strut 104, there is provided hole 108 (e.g., interior to exterior through-hole), for receiving the tension adjustment means such as an arrangement where drawbolt 80 with nut 82 positioned at one frame through hole 108 and a suitable cable clamp or pass through blocking means (not shown) is placed in abutment with the other frame's outer surface at the location where the cable extends through the frame extension through hole. Suitable washers or bearing means to distribute the load between the cable and frame contact portion are also featured under the present invention although not shown.

[0054] At least one frame also preferably includes motor mount plate 110 (e.g. on one roll assembly end only or on each of the two frames for support of a secondary or manual back-up power drive or for simplicity in initial manufacture (universal frame concept)). Motor plate 110 is secured (e.g., welded) at a desired location relative to the other frame structure components such as on a common plane or side of the frame structure's vertical rod and oblique strut. Various other positions are also possible based on, for example, the motor size and configuration. Platform 96 of each frame 24, 26 also preferably includes attachment means for bearing means attachment such as bolt apertures 112 at respective corners of the platform. Similarly, the motor mount plate 110 is shown having means for motor attachment such as a

plurality of bolt holes **114** (**FIG. 7D**) formed at suitable locations to conform to the motor base bolts or bolt apertures. The vertical height of the frame is represented by, for example, the length **H3** between the tension adjustment means contact or extension through point with the frame structure (e.g., at the reception through hole **100** for the adjustment means) and the location where the bearings are supported such as the top surface of the platform (See **FIG. 4**).

[0055] The length **H3** (**FIG. 4**) of the frame (e.g. the above noted vertical distance from the top of the support platform to the hole for the cable) established together with length **H1** from the central axis of a horizontally supported shaft to the adjustment means frame contact location to provide for the establishment of the low deflection levels described above relative to the span length. The vertical height of the frame and/or height of the bearing box base can be revised (as well as the shaft diameter within a limited range) to modify the distance between the axes of the tension cable and the shaft center. For a reduction in **H3**, for example, the length of the frame can be lessened while taking into consideration that there will be an increase in compression on the roll and an increase in load on the bearings which can decrease the life of the same. In a preferred embodiment, the overall maximum height of the roll release device is 6' or less as in less than 5 feet (e.g., a 60' span embodiment can use less than 4' of vertical length or overhead space (about the vertical height of large ductwork in buildings)) which makes is particularly useful in, for example, renovating/original installation where ceiling height is limited. A depth of less than 2' is also featured under the streamlined embodiment of the present invention.

[0056] For preferred functioning of a roll drop assembly embodiment of the invention, the tension cable is preferably placed in the same vertical plane as the roll centerline. The application of a counterweight (now shown) can be used to offset the motor weight to achieve the same vertical plane if the mounting and characteristics of the motor place the tension cable out of the vertical plane relationship or if any other features of the invention or the environment in which it is placed result in an offset. Also, ballast may be used to help maintain the cable positioned below the roll assembly in a roll drop assembly embodiment. The motor mount is also preferably of the type (e.g., slotted) that provides for adjustment of the drive chain tension setting.

[0057] The illustrated invention also features roll drop device support means which in a preferred embodiment comprises a pair of support connectors such as hanger assemblies **28, 30** featuring means for connecting with an overhead support structure (e.g., theater ceiling structural framework). In a preferred embodiment, each hanger assembly features first and second hanger brackets which are preferably of a common shape and brought together to define a hanging bracket assembly provided at respective opposite ends of the roll assembly **22** for attachment to a suspended cable, chain or other non-rigid/flexible suspension means (**88, 90** shown in **FIG. 1**) or a more rigid bar with a pivot axis transverse to the roll's pivot axis to allow for roll compression and slide slots to accommodate the variation in relative spacing of the free ends of the rods, or any other hanger support arrangement which allows for the above described negation or lessening of roll deflection function.

[0058] As shown by **FIGS. 8A to 8C**, the hanger structures are each preferably comprised of a pair of hanger brackets **116, 116** that have a common configuration and are brought together. Each bracket **116, 116** includes a capture end **118** for receipt of the suspension means and a frame securement section **120** which attaches to the frame structure supporting the end of the roll. As shown in **FIG. 2**, the hanger brackets **116, 116** are dimensioned so as to form converged end **122** for single point attachment to the suspension means (e.g. aligned apertures **124, 124** through which extends a grasping member (e.g. locked hook connection) of the suspension means (not shown). The brackets diverge in a preferred embodiment for attachment to opposite sides of the supporting frame structure. In the illustrated embodiment each bracket has a multi-plane (generally Z-shaped) configuration with an upper short plane extension **118** with fastening hole **124, 124** or the like and an intermediate plane section **126** which extends obliquely out from the first noted (e.g., vertical) plane section with a bottom, second (e.g., vertical) section **120** for attachment with the frame structure. Fastener holes for receiving bolts or the like are provided at each of the connection ends of the brackets, with the end not receiving the suspension means preferably having a pair of bolt holes **128** (e.g. spaced apart horizontally) to reduce relative rotation between the frame and the bracket. In an alternate embodiment, the upper bracket ends have two overlapping horizontal flange extensions with aligned vertical holes for receiving, for example, a bulbous end of cable suspension line (as opposed to a grasping hook or the like which is suited for securement with a horizontally aligned pair of holes (See **FIGS. 1 and 4**)).

[0059] Depending on the desired span length, a multi-section roll may be desired under the present invention. If so, each facing end of two adjacent roll sections (e.g., **58, 60** of **FIG. 1**) is preferably inter-connected by way of means for inter-connecting roll sections together such as intermediate connector **66** shown in **FIG. 1** and **FIGS. 9A to 9C**. Connector **66** is shown in these Figures having a cylindrical body with opposite insertion ends **130, 132** and an intermediate ring abutment flange **134**. A preferred connector body thus features two cylindrical segments each having a common diameter sized for insertion into a reception port of the adjacent roll section (e.g., **58, 60**). Because the entire roll assembly **122** is in compression, only relatively light interference fits are required without fear of separation. To some extent, this facilitates both manufacture and assembly/disassembly as there is not a need for threading roll sections together or for dimensioning for a tension compensating axial fixation friction interference fit. The center annular flange ring **134** helps an assembler know when the connector has proper penetration into the reception areas of the roll sections receiving the connector. An aluminum (e.g., 6062-T6) material is well suited for connector manufacturing through, for example, molding (e.g., cast body forming) or some alternate metal or plastic molding technique, for example.

[0060] The annular stop ring **134** of the connector preferably has an outer diameter which conforms to the outer, common diameter of the two roll sections being connected. In this way, the supported load (e.g., banner) is received on a continuous, smooth roll surface for the entire span. A rigid connector is preferred to best accommodate the compression state assumed by the roll upon tensioning of the tension means.

[0061] The roll drop assembly **22** is preferably sized for the applicable span length with the present invention being well suited for relatively large spans such as a 60 foot span. Depending on desired usage, shorter or longer spans may be utilized. For shorter spans, rigidity increases and structural loads decrease and vice versa for longer spans such as the noted 60 feet. The components making up the roll drop assembly may be reduced in size to accommodate shorter span lengths such as a common reduction in roll sections making up the roll. It is preferable that the roll sections (e.g., **58, 60**) are 10 feet or less.

[0062] Provided at each end of the roll assembly **122** is a shaft (**141, 143**) having one end received in a respective hub cavity (discussed in greater detail below) and having an opposite end received by a respective bearing set (**34, 36** and **38, 40**). In the illustrated embodiment of a preferred embodiment of the invention, the arrangement is such that the shaft is the most critically stressed component in the design and relatively tight tolerances are desired for proper fits with bearings and hub. In addition, added surface finish steps are preferably taken to avoid short fatigue life in the bearings which work to support the roll assembly and rotate the roll of the roll assembly for raising and lowering a drop curtain.

[0063] The shaft illustrated in **FIGS. 10A-10C** is readily machinable from a block or rod of metal such as a 3.35 inch bar stock of ASTM A193-B7 bar stock (which is a heat treated 4140 chrome-moly alloy steel) that meets the preferred minimum tensile strength level of 130 ksi. Other materials such as other steel alloys can be relied upon which provide the desired strength and surface finish or surface finish foundation with some requiring additional heat treatment to reach the characteristics of the ASTM A 193-B7 stock.

[0064] The roll shaft **41 (43)** also preferably represents the component in the roll assembly subject to the driving force of roll rotation means **84** (shown in **FIG. 1** as being comprised of Motor M and transmission **86**). In **FIG. 1**, the transmission means can be provided on the interior side of the frame for driving engagement with a gear supported by the roll shaft between the hub and interior bearing. **FIG. 2** illustrates an alternate embodiment wherein the motor shaft extends outwardly rather than inwardly and the transmission means is connected to the roll shaft on an external side of the frame and external to the outer bearing. As shown in **FIGS. 2 and 10A-10C** shaft **43, (41)** is preferably of the same form on each end, although the second one need not have the other's transmission connection means (although from a universal use stand point they preferably are the same at each end). As shown in **FIGS. 10A-10C** shaft **43** has a hub reception end **140** of a first diameter D₁, a conical step down **142**, a bearing contact extension **144** of diameter D₂, shoulder step down **146**, a further shaft extension **148**, a second conical step down **150** and a short end extension **152** of D₃, having driving gear reception slot **154**. Diameter D₁ of shaft **41 (43)** features a shaft diameter of 1 to 8 inches with the diameter being influenced by shaft load support/span requirements and the shaft material. A 3.25 inch D₁ diameter is well suited for large diameter section **140** with the axial length being sufficient for good axial support of the roll via the intermediate hub (e.g., 2-6 inches with 4.75 inches diameter hub being well suited). The axial length of the shaft section **140** is dimensioned for receipt within a shaft reception recess **160** in hub **62 (64)** (described in

greater detail below) provided at the end of roll with, for example, a screw thread attachment between hub and shaft through the smaller diameter section of the through-hole or an interference friction relationship is relied upon.

[0065] The conical shaft step down **142** provides for an abutment edge-to-edge relationship relative to the below described bearings and leads to intermediate shaft section **144** (intermediate from a diameter standpoint and also relative to the axial length of the noted shaft sections). Intermediate shaft section **144** is dimensioned for bearing rotation relative to the interior bearing **34 (38)** of each bearing means **32 (33)**. Preferably the bearing contact location of each interior bearing **34 (38)** is on the interior half of intermediate shaft section **144** which has a preferred axial length of 6 to 18 inches (e.g., 12¾ inches) and a preferred diameter of 1 to 6 (e.g., 3 inches).

[0066] Axially out from intermediate section **144** is positioned shaft step down **146** (e.g., a 0.25 inch step down as in the conical diameter step down **142**). Extending out from step down **146** in further shaft extension **148** which is sized (e.g. an axial extension of 1 to 5 inches with about 2¾ being representative of a preferred embodiment for the above described roll assembly) for forming a bearing relationship with an outward, preferably smaller bearing **36 (40)** of bearing means **32 (33)**. Axially outward of shaft extension **148** is outer step down **150** which bridges section **144** and drive end extension **152** and preferably features a slotted end section with step down or side groove **156** opening out at the shaft's outer end for a key slot connection with the below described driven gear shaft of transmission **86**.

[0067] In other words, a driven gear of transmission **86** is slid along the end extension **156** until it abuts the base of step down section **150** with the protrusion of the driven shaft providing for driven gear engagement upon receipt within groove **154**. A suitable fixation means (e.g., threaded end fastener or cotter pin or some other axial movement blocking means including direct welding or the like is further provided to secure the driven gear to the shaft). In an alternate embodiment, the driven shaft is placed inward of the outer bearing or inward of both the inner and outer bearings in the bearing sets forming bearing means **32 (33)** for example, the driven shaft supported by the shaft can be sized for engagement with outer shaft section **144** such as at the boundary between conical step down **142** and section **144**.

[0068] Reference is now made to **FIGS. 11A to 11C** providing illustrations of one form of a means for connecting the shaft to a roll in a roll assembly. As illustrated, this connecting means is shown in the form of hub **62 (64)**, although direct shaft to roll section connections or other intermediate connection members can be relied upon with the goal being to provide stable end support for the ends of the supported roll. Hub **62 (64)** can be formed of any material with sufficient structural strength with aluminum (e.g., 6061-T6) being one example of a suitable hub material. Hub **62 (64)** features main body **162** which is shown as being cylindrical and of a diameter D_H which is sized for insertion into the open reception end of an end roll section in an interference fit relationship with or without additional free relative rotation blocking means such as a countersunk insert screw or a radial protrusion/axial groove relationship

(not shown). The interior end of main body **162** features chamfered edge **164** which facilitates initial insertion of the hub into the roll section.

[0069] At the outer end of the hub **62 (64)** is provided annular ridge extension **166** which is shown as having a diameter larger than that of main body **162**, preferably to the extent that the diameter of the annular ridge extension **166** corresponds to the outer diameter of the roll section (e.g., roll section **60**). During assembly, the receiving roll section is axially aligned with hub **62 (64)** and axially brought together until the roll section's free end abuts the interior side wall of the ridge extension. With this arrangement, the ridge extension's radial thickness essentially corresponds to the radial thickness of the hollow roll section's wall thickness. Thus, an assembler will know that a proper degree of insertion has been reached upon abutment of these contact surfaces and a smooth roll/hub surface is presented based on the matching outer diameter. In an alternate embodiment, ridge extension **166** is made to have a diameter which is greater than that of roll-section **60** so as to be either less than, equal to or greater than, the overall diameter of the roll when the flexible curtain **X1** (reference to "curtain" and banner in the present application is intended to be in a broad sense including, for example, various visual or environmental and or acoustic barriers that are subject to manipulation by the roll assembly) is rolled entirely up on the roll, (e.g., a $\frac{1}{4}$ inch to 12 inch flange extension). With this arrangement a side curtain edge control is provided to help avoid curtain roll up misalignment. Hub **62 (64)** further comprises stepped through-hole **168** having the aforementioned shaft reception cavity **160** which terminates at step wall **170** and further includes the smaller diameter portion **172** of the stepped through hole **168**. The step wall **170** provides axial blocking and contact recognition upon shaft insertion. The smaller diameter hole provides for threaded bolt securement of the hub to the shaft (e.g., via a reception bolt hole in the shaft, not shown).

[0070] The axial length of hub **62 (64)** is preferably made relatively long such as 6 to 12 inches (e.g., 8 inches with a $\frac{1}{2}$ inch ridge extension axial thickness) so as to provide sufficient support to the roll sections which preferably are each in the 2 feet to 10 feet range in axial length.

[0071] Alternate hub roll section combinations are also possible such as having a decreased diameter roll section at the end of the outer roll sections which is received in the interior of a hub having an outer diameter corresponding to the maximum diameter of the roll section. Also, non-circular cross-sections (not shown) such as multi-walled, and female/male connection arrangements are also suited as means for connecting a hub to a roll section under the present invention.

[0072] In an alternate embodiment of the invention (not shown), there is provided an interior and an exterior hub section preferably divided by an axial intermediate ridge extension with the exterior hub section extending out over an underlying frame (e.g., an additional reception housing designed to receive the exterior hub section). This provides an additional fail safe feature in the event of shaft breakage in that the hub can also support the roll, at least temporarily.

[0073] As described above, the extension and retraction of the curtain is preferably based on a motor and transmission driver assembly **84**, although other techniques, both motor-

ized and non-motorized, are featured under the present invention. An example of a non-motorized and non-motorized driving means includes a hand tool for manipulating lever and crank combinations or a biased pawl gear system with appropriate extension and retraction of the curtain. In a preferred embodiment of the invention, motor **M** has sufficient power to adequately achieve the retraction speed desired for the intended load (e.g., the curtain weight, system frictional resistance, etc.). Thus, motor **M** is designed to handle, for instance, the raising and preferably also the lowering of a stage curtain or the retraction or opening of a cover or curtain against a closure biasing means such as a counterweight or spring assembly. For many uses a minimum required motor power is $\frac{1}{4}$ HP (while a $\frac{1}{3}$ or $\frac{1}{2}$ HP motor are also examples of alternatives if a greater degree of reserve power is desired under a similar setting). The drive transmission means **86** is designed to transmit the power of the motor to the drive reception means **174** supported on the roll assembly at a desired location to achieve a rotation speed in the roll which is efficient (e.g., 40 RPM or more preferred), but within rotation rate parameters to avoid curtain roll-up problems (e.g., a theater curtain might have a desired rate of descent or rise for visual effect). A $\frac{1}{3}$ hp 120 AC electric AC motor is well suited, for example, in providing rapid roll adjustment and provides a very quiet operation. A DC motor is also suitable and can facilitate the providing of speed control means and position monitoring means as described in greater detail below. Suitable DC motors include both brush based and brushless motors with or without controller position monitoring means. For example, stepper or server controlled motors preferably with continuous positioning feedback and monitoring are utilized preferably also together with an external or backup home position sensor set in conjunction with the motor's own encoder sensor. For example, magnetic or light transmitters and corresponding receptors positioned on the curtain free end edge as represented by sensor section **S1, S1'** shown in **FIG. 13** are available for use as a home sensor for an encoded motor system for monitoring location of the curtain relative to the roll.

[0074] The motor is preferably chosen at an output speed that provides for simplified transmission means. For example, a gear motor with an output speed of 20 to 100 RPM allows for the use of a direct chain drive (with suitable drive and driven sprocket sizing) and the avoidance of the need for a more complicated triple-reduction chain system. A chain and sprocket system is well suited for many applications of the present invention, although other transmission means are suitable (e.g., pulley and toothed or smooth belt, axially-direct shaft attachments, bevel gear, screw gear, hydraulic, etc.) as the manner in which to transmit driving force, between the power source and the driven roll. The motor is also positioned and fastened relative to the roll assembly in a stable fashion to accommodate the torque levels that develop and with suitable spacing accommodation for servicing and replacement of the transmission (e.g., chain tensioning and replacement).

[0075] With a chain and sprocket assembly the desired conditions will dictate a suitable motor speed and chain and sprocket sizing and teeth number, although a #50 chain is adequate for many intended uses of the present invention. For example, for a curtain speed of 40 feet per minute, the roll assembly should rotate at approximately 20/RPM and the sprocket sizes preferably are selected such that $S \times N_{dr} /$

Ndn=20 with S representing motor speed, Ndr the number of drive teeth on the driving sprocket and Ndn the number of teeth on the driven sprocket. A motor speed of not greater than 100 RPM is recommended for a single stage reduction setting. With the use of a chain and sprocket assembly, a tapered hub mount is preferred.

[0076] The motor and transmission means for transferring motor torque (or other power sources including manual activation) is preferably provided at one end of the roll assembly, although other arrangements are encompassed under the present invention including dual end synchronous roll rotation means for dual side extension/retraction (preferably with processor control and position encoding). Separate motor or back-up arrangements are also covered under the present invention (e.g., a motorized assembly at one end and a hand cranked, back-up assembly at the other end). Also, a centrally positioned motor with suitable accommodating transmission system/added structural framework can be utilized (e.g., a cut-out or axially spaced curtain strip arrangement with intermediate roll sprocket or multi-directional transmission directing forces to an end roll sprocket). A preferred embodiment features an end mounted motor and chain and sprocket transmission assembly to avoid such added structural complexity. Also, as an alternate to the above described AC motor, a DC motor with position encoding/monitoring means by way of an encoder and sensor combination (e.g., an internal motor sensor using a Hall effect for sensing (not shown) for monitoring the DC motor status and a microprocessor for monitoring position signals) is employed. In an alternate embodiment, this processor output is preferably linked to a display. This illustrates one way to monitor the location of the curtain at all times which knowledge allows for the operator and display to be remotely located (e.g., an operator display board for the control of one or multiple banners as in, for example, a theater curtain, advertising banner, acoustic banner, etc., wherein the height position of each curtain end whether the curtain in a stopped, roll out or rollup state is indicated on the display). This control board is also a suitable location for activating and stopping the roll up or roll down of a curtain by way of microprocessor signals to the motor for example, a more detailed discussion of such an arrangement is formed below in the discussion of **FIG. 13**.

[0077] The present invention further comprises shaft reception means for receiving the ends of the respective left and right shafts of the roll assembly and for transmitting forces from the tension means to the shaft through the frame and bearings supported by the end frames. As shown in **FIG. 1**, bearing means **31**, **33** are supported on respective frame structures provided at the opposite ends of the roll assembly. In a preferred embodiment, there is provided at each end of the roller assembly an inboard or internal bearing device and an outboard or exterior bearing device that are axially spaced apart along bearing means **31** and **33**. Each of bearing means **31** and **33** is designed to secure in position the shaft end received. Inboard and outboard "pillow block" bearing of the same or different sizes (e.g., to accommodate different diameter shaft sections) are preferably used (see the end shaft discussion above). If different sizes are used, the inboard bearing is preferably designed to handle the larger diameter shaft section which handles the higher loads applied to that large load portion of the shaft while the outboard bearing is designed for bearing engagement smaller diameter shaft section. If a common size set of

bearings is used they can be axially space and the extremities of a common shaft section such as shaft section **144**.

[0078] Bearings having axial shaft contact lengths of, for example, 1 to 6 inches are preferable, preferably together with the illustrated spacing (**L9** or **L8-L6**) between facing surfaces being illustrative of suitable bearing set axial spacing. In a preferred embodiment, well suited for a 60 foot span, there is provided an inboard pillow block bearing with a 3 inch bore for shaft reception (e.g., Link Belt P3-U2E48N or equivalent) and an outboard pillow block bearing with a 2¾ inch bore for shaft reception. A corresponding pair of inboard and outboard pillow block bearings are provided on the opposite end of the roll assembly. Each of the noted pillow block bearing are preferably closed embodiments (no upper slotting—although a slotted pillow block bearing can be utilized) and feature caged ball bearing rings with lubrication and seals, or in place of caged ball bearings a self lubricating sleeve material such as "fluoroNyliner" Pillow Block bearing from Thomson-Industries can be utilized. The less expensive caged ball bearing embodiment is preferred as such devices can continue to operate, particularly at low speeds, even past a point considered to be a ball bearing failure point as bearing failure is generally non-critical to continued temporary operation.

[0079] In a preferred embodiment, roll assembly **22** comprises roll tube **56** (singular or plural tube sections) which supports the barrier means such as a theater curtain. Roll tube **56** is formed, for example, of an aluminum alloy or other lightweight, relatively high strength material, with the material chosen being consistent with the function of the roll of supporting the barrier such as the aforementioned theater drop curtain while minimizing load weight. Tubing such as aluminum alloy tubing is typically available in three forms: pipe, extruded tube, and drawn tube. Drawn tubing typically has the highest manufacture tolerances and is available in a variety of sizes and thicknesses. Both span length and load are influential in determining length, material, and outside and inside diameters when a hollow tube roll is chosen, and dimensions and material can be varied to meet desired performance characteristics. Hollow tubing of 4 to 12 inches with ¼ to ¾ inch wall thickness (outside diameter—inside diameter) are suited for use in the present invention and parameters are representative of a preferred range. A 6061-T6 aluminum alloy tube with 8.00 inch outside diameter with ⅝ inch wall thickness is well suited for large spans such as a 60 foot theater curtain span. A suitable pipe embodiment for similar span relatively large span lengths includes 8.00 inch Nominal Schedule 40 pipe. As diameter and wall thickness differ between the different types of tubes (e.g., pipes and drawn tube) the dimensions of the connector(s) and hubs are made to conform to the type of tube or tube section chosen. To facilitate good function of the roll drop assembly, the roll tube section(s) (whether extruded, pipe or drawn) preferably have a straightness tolerance of 0.02 in/ft. (which facilitates achievement of, for example, a maximum vertical deflection of ⅛ inch in a roll over a 60 foot span (i.e., ⅛ inch or less of deflection)).

[0080] While a high degree of axial friction retention or fixation is not required between the roll sections in view of the compression setting on the roll tube, it is preferable to have relatively close or "snug" tolerance fits, particularly when dealing with relatively large spans such as 40 to 70 feet. In a preferred embodiment, there is a snug fit with a

minimum amount of interference (ANSI LNS or tighter). Thus, at 7.375 inch for an ID, the tolerances are preferably less than 0.002 although higher tolerances are workable in many embodiments of the invention with attention to relative fitting relationship (e.g., avoiding assembling two component parts at the far range of the tolerance range and/or minor machining of the inside of the tube and/or heating/cooling the connector).

[0081] The tensioning in cable **68** is adjusted with cable tensioning adjustment means **78** such as drawbolt or turn-buckle **80** with nut or drawing means **82** of the tensioning means.

[0082] A suitable cable or thin rod for short span lengths provides for establishing a suitable minimum tensile load rating of, for example, 5 tons. A reduction in the distance between cable and roll leads to an increase in the load rating for the cable tensioning means. In a preferred embodiment which is suitable for use in a 60 foot span a braided steel cable represents a suitable cable which has a looped and clamped end connected with a high strength drawbolt with its threaded end extending through one the two frames and its opposite end extending through the other frame's free end (e.g., a larger sized clamp at one end with the drawbolt receiving end of the cable being able to pass through that end of the frame until the larger sized clamp contracts the outer end of the frame's free end).

[0083] To illustrate the tensioning technique of the present invention to provide for a minimal deflection roll despite high loads on that roll, reference is made to **FIGS. 12A and 12B**. Adjusting tension in the cable tensioning means to the desired setting is preferably carried out following roll assembly mounting and leveling with a carpenter level or some alternate technique. With the load (curtain or other visual, acoustic or environmental (e.g., sunblock) barrier means) installed on the mounted and leveled roll assembly and no tension in the cable, the tension adjustment procedure is initiated by lowering the curtain until the center of the curtain reaches (just touches—e.g., less than 12 inches curtain edge contact which is usually in the central area of the curtain corresponding to the point of initial maximum roll deflection) the desired full extension location such as the stage floor when a theater curtain is involved. This positioning is illustrated schematically in **FIG. 12A**. The cable tensioning means is then adjusted until the bottom edge or contact portion (e.g., a U-Shape looped curtain relies on a curtain fold or curve back contact edge as its contact surface) is level over the entire length.

[0084] Excessive tension on the cable or spanning tension means has the potential for inducing potentially degrading high loads on the bearings and shaft. Thus, the bearings and shaft components are preferably designed to accommodate excessive tensioning although the system makes it easy for an operation to avoid a high load environment on the bearings in its ability to minimize roll sag or deflection. Also cable markings (e.g., color coding or fastened or signaling means) or blocking means (fastened rings or clips) can be provided for warning of reaching an excessive tension level or blocking further tensioning in the cable. The material, diameter and design (e.g., braided cross-section) for the cable are chosen to provide a cable which can avoid stretching beyond suitable tolerance levels due to prolonged tensioning state and which has a temperature expansion/con-

traction characteristic that maintains the desired tension state within suitable tolerance levels despite wide temperature fluctuations (e.g., -20 to 120° F.).

[0085] With the minimized deflection in the roll and the associated high degree of curtain bottom straightness, the properly tensioned curtain of the present invention is well suited for automated control of the extension and retraction of a curtain or the like. Also through use of, for example, servo or stepper motor sensor/motion controls, the location of the free end **54** of the curtain is actively controlled and the position of, for example, the free edge **54** known at all times.

[0086] **FIG. 13** illustrates a schematic representation of remote control panel for positioning multiple banners as in a multi-stage theater, an acoustic barrier arrangement, a building complex with large sun or wind or rain barriers (in the latter two cases lower barrier lock down means may be desirable to environment induce barrier movement), an arena with a multitude of advertising or other indicia presenting arrangement, etc. As shown in **FIG. 13**, control panel **200** is provided having processor **202** for outputting and receiving sensor and control signals. The sensed position of the roll driving motor is known and provides for a determination of the relative position of the free end **54** of the curtain, which in turn can be conveyed to barrier means status display panels **202, 204, 206** for the three **48', 48"** and **48"** curtains. For instance, panel display **202** corresponds with curtain **48'** and shows it at an intermediate level (e.g., screen half filled in) with color coding or the like (e.g., red, green) showing whether curtain is moving (green) or stationary (red) and with **208, 210, 212** display indications showing whether the curtain-active state is up or down at that current time. Barrier **48"** and **48"** have their free ends in a full roll upstate (with corresponding location stop signal being generated as well as a confirmation check using home position sensors **S1, Si** (XR referencing a stop state in the drawings). **FIG. 13** further illustrates barrier **48"** in a full extension state (also with a preferred motor stop signal upon reaching the stage or platform level and sensor **S1, S1'** confirmation). Suitable override and length control inputs—means **214** are also preferably provided and interfaced with the processor (e.g., override button with associated adjustment and motor speed input means). With this arrangement, an operator can be positioned at a location remote from the curtain location which provides for greater flexibility relative to operator positioning and avoids the problem of visual obstacles (e.g., darkness, blocking, stage sets) precluding an accurate determination when a barrier is properly set.

[0087] It should be emphasized that the above-described embodiment of the present invention, particularly, any “preferred” embodiments, are merely possible examples of implementations, merely set forth for a clear understanding of the principles of the invention. Many variations and modifications may be made to the above-described embodiment(s) of the invention without departing substantially from the spirit and principles of the invention. For example, while some of the preferred “loads” are discussed above, a variety of alternate span type loads which can benefit from a low sag, wide span are intended to fall under the subject matter of the support release featured under the present invention and thus the aforementioned load terminology “barrier” or “banner” are used in broad sense to correlate with the benefits achieved with the spanning support function of the present invention, and the invention has shown to

be well suited for rotating release and/or pick up systems as in the roll drop embodiment described herein. Also, all such modifications and variations are intended to be included herein within the scope of this disclosure and the present invention and protected by the following claims.

What is claimed is:

1. A barrier release device, comprising:
 - a barrier support assembly having a first end and a second end;
 - a first frame structure supporting said first end;
 - a second frame structure supporting said second end;
 - a tensioning device extending between said first and second frame structures and positioned at a location spaced from an axis of elongation of said support assembly.
2. The roll release device of claim 1 wherein said tensioning device extends parallel to the axis of extension of said support assembly and is supported by said first and second frame structures.
3. The release device of claim 2 wherein said support assembly comprise a flexible barrier roll assembly and said tensioning device is spaced from the axis of rotation of said roll assembly by a distance of 1 to 4 feet.
4. The release device of claim 1 wherein said tensioning device includes an adjuster for increasing or decreasing the level of tension in said tensioning device.
5. The roll release device of claim 1 wherein said support assembly comprises a roll assembly, and said roll assembly, first and second frame structures and tensioning device are arranged such that when said tensioning device is in a tensioned state said roll assembly is in a state of compression.
6. The roll release device of claim 5 wherein said roll assembly includes a multi-section support roll having roll sections.
7. The roll release device of claim 6 wherein said multi-section roll is comprised of multiple interconnected hollow tubes.
8. The roll release device of claim 6 wherein there are at least 3 roll sections and the total length of said roll exceeds 40 feet, and said tensioning device has a substantially parallel arrangement with an axis of rotation of said roll assembly.
9. The roll release device of claim 1 wherein said support assembly comprises a roll that is at least 40 feet in length.
10. The roll release device of claim 9 wherein there is a maximum deflection in said roll of an inch.
11. The roll release device of claim 10 wherein said roll is at least 60 feet in length.
12. The roll release device of claim 1 wherein said support assembly comprises a roll assembly which includes a roll comprised of multiple roll sections and means for interconnecting said roll sections.
13. The roll release device of claim 12 wherein there are at least 3 roll sections of 5 feet or greater in length and said roll has a length exceeding 40 feet and an unsupported span deflection value of not more than 0.2 inch.
14. The release device of claim 1 wherein said support assembly comprises a roll assembly and said release device further comprising a first bearing assembly supported by said first frame structure and in a bearing relationship with a far end portion of the first end of said roll assembly and a

second bearing assembly supported by said second frame structure and in a bearing relationship with a far end portion of the second end of said roll assembly.

15. The roll release device of claim 14 wherein said first bearing assembly includes a first pair of bearings axially spaced along the far end portion of the first end of said roll assembly and said second bearing assembly comprises a second pair of bearings axially spaced along the far end portion of the second end of said roll assembly.

16. The release device of claim 14 further comprising a first shaft and a second shaft, and said roll assembly comprising a roll with said first shaft in bearing contact with said first bearing assembly and supporting a first end of said roll and said second shaft being in bearing contact with said second bearing assembly and supporting a second end of said roll.

17. The release device of claim 16 further comprising a first hub and a second hub with said first hub interconnecting said first shaft with the first end of said roller and said second hub interconnecting said second shaft with the second end of said roller.

18. The release device of claim 17 wherein said first and second hubs have radial barrier guidance flanges extending radially out from a main body of said hubs.

19. The roll release device of claim 14 wherein said roll assembly comprises a plurality of roll sections and a plurality of connector members which interconnect adjacent ends of said roll sections to form said roll.

20. The release device of claim 19 wherein at least some of said connector members include a first and a second outer extension dimensioned for receipt within a receiving cavity of an adjacent pair of roll sections and an intermediate annular flange having an outer periphery configured to conform with an outer peripheral configuration of said roll sections.

21. The release device of claim 1 further comprising a flexible barrier supported by said support assembly.

22. The release device of claim 21 wherein said support assembly comprises a roll assembly and said barrier is a flexible barrier selected from the group consisting of a theater curtain banner, environment control banner, an acoustic control banner and an advertising banner.

23. The release device of claim 1 wherein said support assembly is a roll assembly and said release device further comprising driver means in driving engagement with a roll of said roll assembly for inducing rotation in said roll.

24. The release device of claim 23 further comprising a flexible textile barrier supported on said roll and having 40 or more feet supported by said roll.

25. The release device of claim 1 wherein said support assembly comprises a roll assembly having a roll, and said tensioning device comprises a cable extending into contact with said first and second frame structures at a location spaced from a central axis of rotation of said roll.

26. The release device of claim 25 wherein said cable extends between a lower end of each of said first and second frame structures and said roll assembly is supported at a location spaced above the cable.

27. The release device of claim 26 further comprising cable tension adjustment means in tensioning communication with said cable.

28. The release device of claim 26 wherein said cable is essentially parallel with an axis of rotation of said roll.

29. The release device of claim 1 further comprising a first and a second hanger device with each hanger device having a free suspension hanger end and a frame structure connection end, with said hanger end of each of said hanger devices being configured for engagement with a support assembly suspension device.

30. The release device of claim 1 wherein said support assembly comprises a roll assembly and said release device further comprising roll device suspension means in a supporting suspension relationship with said first and second frame structures, with said suspension means providing for said tensioning device to place said roll assembly in a state of compression.

31. The release device of claim 30 further comprising a first hanger device and a second hanger device, with said first hanger device connected with said first frame structure and said second hanger device connected with said second frame structure and said suspension means includes first and second flexible suspension members with said first flexible suspension member secured to said first hanger device and said second flexible suspension member connected to said second hanger device.

32. A roll drop device, comprising:

a roll assembly having a roll;

means for supporting said roll assembly;

tensioning means for placing said roll in a state of compression.

33. The roll drop device as recited in claim 32 wherein said roll is comprised of roll sections having a length of 40 feet or more.

34. The roll drop device as recited in claim 33 wherein said roll has a maximum deflection value of an inch or less for a roll length of 40 feet or more.

35. The roll drop device as recited in claim 34 wherein said roll has a length of 60 feet or more.

36. The roll drop device as recited in claim 32 further comprising a flexible curtain supported on said roll of at least 25 feet.

37. The roll drop device of claim 32 further comprising motorized means for rotating said roll.

38. The roll drop device of claim 32 wherein said means for supporting said roll assembly comprises a first frame structure and first bearing assembly supporting a first end of said roll assembly and a second frame structure and second bearing assembly supporting a second end of said roll assembly, and said tensioning means includes a tensioning device extending between and in contact with said first and second frame structures at a location spaced from an axis of rotation of said roll.

39. The roll drop device of claim 38 wherein said first and second bearing assemblies comprise a pair of bearing member spaced apart axially at each end of said roll assembly.

40. The roll drop device of claim 39 wherein said roll assembly comprises first and second shaft members received at opposite ends of said roll and with said first shaft supported by a first of said pairs of bearing members and said second shaft supported by a second of said pairs of bearing members.

41. A method of adjusting a roll release device, comprising:

providing (i) a roll assembly having a roll, (ii) a first frame structure, (iii) a second frame structure, (iv) and an adjustment device extending between said first and second frame structures; and

manipulating said adjustment device so as to negate to some degree a deflection level in said roll.

42. The method of claim 41 wherein adjusting said adjustment device includes tensioning a tensioning device extending between said first and second frame structures at a location removed from a rotation axis of said roll.

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