ABSTRACT: Extendable, self-deploying boom apparatus wherein the boom is of any present type fabricated from thin metal strip having a tendency to unwrap when wound upon a cylindrical storage spool. The end portion of the boom is restrained between the storage spool and a cooperating roller serving first to restrain the boom in place upon the storage spool. Resilient springs compress together the cylindrical surfaces of the spool and roller along a mutual line of pressure, thus producing, in a portion of the boom between rollers, a force acting parallel to the boom major axis. Such force is derived from the storage energy of the boom and will permit self-deployment of the boom when the spool and roller are unrestrained for counterrotating motion. The springs maintain a mutual line of pressure between the rollers as additional portions of the boom progressively unwind. Additional equipment may be utilized, for example, a deployment prevention control, a retracting mechanism, a deployment rate control and an increment deployment control.
MINIMECH SELF-DEPLOYING BOOM MECHANISM

The invention described herein was made by employees of the United States Government and may be manufactured and used by or for the Government for governmental purposes without the payment of any royalties thereon or therefor.

FIELD OF INVENTION

The present invention relates to a simplified storage and dispenser apparatus permitting self-deployment of a boom of any type fabricated from an elongated ribbon of metal adapted for storage on a cylindrical storage spool and wherein the metal ribbon itself has a tendency to unwrap when wound upon the cylindrical storage spool. The present invention is especially suited for deploying any present type of boom including the single element overlap, interlock and bistern. Additionally, the present invention provides a simplified and reliable apparatus permitting self-deployment of such booms by utilizing the mechanical energy potential arising from the stresses present in such booms when wound upon storage rollers.

BACKGROUND OF THE PRIOR ART

Prior art booms of the self-deploying type are commonly wrapped upon a storage spool. A protruding end of the boom is affixedly secured and the storage spool is unrestrained to rotate and translate away from the secured end of the boom. When the boom becomes fully extended, the storage spool is ejected. Several disadvantages exist in such prior art booms. Ejection of the storage spool prevents retraction of the boom when fully extended. In prior art designs where the storage spool is not ejected only relatively short lengths of the stored boom could be deployed from the storage reel. Special construction was required of the storage spool to insure its translational without a side-slipping or spiraling motion. Ejection of a storage reel made ground testing of the boom deployment difficult. Controlling the unwrapping tendency of a wound self-deploying-type boom has frequently been a problem in the prior art. A retracting capability of a prior art self-deploying boom requires complicated spool winding mechanisms. Of course, no retracting capability could be incorporated if the storage spool was ejected. When a fully deployed boom was no longer needed, a separate mechanism was required to sever the same.

SUMMARY OF THE INVENTION

The present invention relates to apparatus for storing and dispensing a self-deployed-type boom. Conceptually, the present invention utilizes two cooperating cylindrical rollers, one roller serving as a storage spool upon which a boom is wound, and the other roller acting as a boom restraint and guide. The storage spool is mounted for rotation on the frame, whereas the restraining and guiding roller is mounted for translation as well as rotation in the frame. Also, the spool and guiding roller may be interchanged upon the frame. The end portion of the stored boom is initially maintained between the cooperating cylindrical surfaces of the rollers. Spring loading continuously urges the rollers to exert a common line of pressure upon the boom portion therebetween. The thus cooperating rollers maintain the boom tightly wound upon the storage roller as it self-deploys, the guiding and restraining roller in such a manner that any individual wrap of the boom does not slip with respect to any other wrap on the cylindrical surface of the storage spool as it deploys. Additionally, such cooperating roller structure assures rewinding of the boom without danger of damage thereto or a need for complicated rewinding mechanism. In a modification, the cooperating rollers may be end-supported between elongated arms replacing the frame. In such configuration, the present invention may be utilized as a spool ejection type self-deploying boom.

It is therefore an object of the invention to provide apparatus for permitting self-deployment of a boom without ejection of a storage spool therefor.

Another object of the invention is to provide apparatus permitting self-deployment of a boom while simultaneously maintaining the boom tightly wound upon its storage spool.

A further object of the invention is to provide cooperating roller structure permitting self-deployment of a boom and subsequent retraction of the boom without damage thereto and without the need for complicated retracting mechanism.

Still another further object of the invention is to provide apparatus for storing, permitting deployment and retracting a self-deploying-type boom.

A further object of the invention is to provide an extendable boom wound upon a storage spool with a cooperating roller aiding in deployment, rewinding and wrapping the boom tightly upon the storage spool. Still another object of the invention is to provide an extendable boom wound around a storage spool with a cooperating roller serving to maintain the boom in tightly wound condition on the storage spool as the boom self-deploys to an extended condition.

Other objects and other attendant advantages of the present invention will become apparent upon perusal of the following detailed description of the preferred embodiment taken in conjunction with a description of the drawings.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective of an assembled self-deploying boom mechanism wherein a self-deploying boom is wrapped upon a reciprocating spool connected to a pressure roller by a pair of assembly arms;

FIG. 2 is an exploded perspective of the device illustrated in FIG. 1;

FIG. 3 is a schematic of another preferred embodiment of the preferred invention illustrating a pair of cooperating boom storage spools each having wound thereon a portion of a self-deploying boom of the bistern type;

FIG. 4 is a perspective of another preferred embodiment of the present invention wherein a self-deploying boom is wrapped upon a fixed roller connected to a reciprocating pressure roller by a U-shaped bracket, and further illustrating in phantom a spool braking and retracting mechanism;

FIG. 5 is a plan view of a preferred embodiment of the invention illustrating a plurality of self-deploying boom storage spools each provided with a cooperating pressure roller and arranged within minimal space relationships; and

FIG. 6 is a plan view of another preferred embodiment, illustrating a plurality of spring-loaded reciprocating self-deploying boom storage rollers each associated with a common single pressure roller.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

With more particular reference to the drawings, there is illustrated in FIG. 1, a self-deploying mechanism illustrated generally as 10 and including a generally cylindrical boom storage spool 12 over which is wound a plurality of tightly wrapped turns 14 of a self-deploying boom 16. The particular boom illustrated is of the overlapped type, but it should be understood that other present types of self-deploying boom may be thus utilized. The spool 12 is end supported for rotation by a pair of spaced, generally similar connecting arms 18. Operatively associated with the spool 12 is a cylindrical pressure roller 20 which is also end-mounted for rotation to the pair of connecting arms 18.

With more particular reference to FIG. 2, the particular construction of the assembled device illustrated in FIG. 1 is shown in greater detail. The spool 12 is of generally hollow construction with an inner bore diameter 22. Each end of the spool 12 receives therein a cylindrical outer race 24 of a roller bearing, one of which is illustrated at 24. Each inner race 26 of the bearing 24 fixedly receives therein an end portion 28 of a reduced diameter shaft 30 which extends completely through the spool 12. The shaft 30 is provided with a reduced diameter portion 32 intermediate of its terminal ends. A remaining end portion 34 of the shaft 30 is provided with a protruding
machine screw 36. In similar fashion, the cylindrical pressure roller 20 is of hollow construction with an inner bore diameter 38. Each end of the roller 20 is provided with a bearing 40, the outer race of each bearing being received in the bore 38. The inner race 42 of each bearing receives therein an end portion 44 of a reduced diameter cylindrical shaft 46, extending completely through the roller 20 and provided with a reduced diameter portion 48 intermediate of its terminal ends thereof. The remaining end portion 50 of the shaft 46 is provided with a protruding machine screw 52. Still reference to FIG. 2, each connecting arm 18 is generally elongated vertically and provides a spring like feature. This feature extends parallel with the notches 54 located generally in the uppermost portion of each connecting arm 18. A lowermost portion 56 of the connecting arm 18 is provided with a generally central aperture 58, generally aligned with the major axis of said elongated notch 54. When the device is assembled, the end portion 28 of the shaft 30 is received within the inner race 26 of the bearing 24. Additionally, each shaft portion 28 partially protrudes from the bearing inner race and is received for reciprocation in the slot 54 of a connecting arm 18. The reduced portion 32 of the shaft 30 receives a generally E-shaped retaining clip 60 which partially surrounds the shaft 30 and overlaps the adjacent side margins of the elongated slot 54, thereby retaining the spool 12 in position between the spaced-opposed connecting arms 18. In portion 44 of the shaft 40, the bearing 42 is received through the aperture 58 of a connecting arm 18 and is received within the inner race 42 of a corresponding bearing 40. The reduced diameter portion 48 of the shaft 46 receives a generally E-shaped retaining clip 62, similar in construction and function to the clip 60, whereby the pressure roller 20 is maintained in position between the opposed retaining arms 18. Additionally, the protruding screws 36 and 52 are connected by a coil spring 64, the ends of which are connected to the screws by any well-known technique.

In operation, the coil springs 64 resiliently urge the wrapped turns 14 of the boom 16 against the cylindrical surface of the roller 20. More particularly, the spool 12 and the roller 20 are forced together along a common line of pressure along their corresponding cylindrical surfaces with an unoccupied end portion of the boom 16 initially compressed therebetween. Initially, the end portion of the boom may be fixed to any available mounting surface, not shown. Also, the spool 12 is constrained to prevent its rotation by any well-known device, not shown. When it is desired to deploy the boom 16, the elongating device releases the spool 12 for rotation upon its bearings 24. The wound turns 14 of the boom 16 possess a well-known tendency to unwind when wrapped upon the storage spool 12. However, since the boom is constrained between the storage spool and the pressure roller 20, the well-known storage energy of the wrapped turns 14 is utilized to rotate the storage spool 12 and produce a counterrotation in the pressure roller 20. Such counterrotation forces the boom 16 to unwind tangentially to the cylindrical surfaces of both the storage spool 12 and the pressure roller 20. As the boom 16 thus unwinds, the cooperating spool and pressure roller are free to translate along the length of the self-deploying boom 16. Also, the coil springs 64 continuously urge the spool 12 to reciprocate within the slot 54 of the connecting arms 18 in order to maintain engagement of the pressure roller 20 against the turns 14 of the remaining wrapped portion of the self-deploying boom 16. Thus, the pressure roller 20 initially acts to constrain the tendency of the wrapped turns 14 to unwind from the spool 12 and additionally, as the boom 16 self-deploys, maintains the turns 14 remaining on the spool in tightly wrapped formation on the spool 12. The spool 20 further serves to guide the boom 16 as it self-deploys from the rotating spool 12. Accordingly, the preferred embodiment shown and described in FIGS. 1 and 2 is particularly adapted for a self-deploying boom mechanism of the type which may be ejected after complete deployment of the boom.

Another preferred embodiment of the present invention is illustrated in FIG. 3. The embodiment of FIG. 3 is a modification of the embodiment illustrated in FIGS. 1 and 2. A first generally cylindrical storage roller or spool 66 is provided thereover with a plurality of closely wrapped turns 68 of a first boom portion 70. A second storage roller or spool 72 is provided similarly with a plurality of closely wrapped turns of an elongated boom ribbon portion 76. The spools 66 and 72 are mounted for counterrotation and resilient engagement along a common line of pressure, in similar fashion to the spool 12 and pressure roller 20 of the embodiment illustrated in FIGS. 1 and 2. With the spools 66 and 72 thus mounted, the boom portions 70 and 76 are maintained in parallel abutting relationship in compression between the spools 66 and 72. In operation, the boom portions 70 and 76 simultaneously self-deploy with the spools 66 and 72 in counterrotation, permitting the plurality of turns 68 and 74 to unwrap from the counterrotating spools. Accordingly, in the embodiment illustrated in FIG. 3, the spools 66 and 72 each function as a storage spool. Additionally, each roller 66 and 72 additionally serve as guiding and restraining rollers for each other. More particularly, the spool 66 is resiliently urged in compression against the spool 72 by coil springs (not shown) similar in function and construction to the coil springs 64 of the embodiments of FIGS. 1 and 2. Accordingly, the spool 66 initially restraining the boom portion 76, preventing its tendency to unwind from the spool 72. Additionally, the spool 66 guides the boom 76 as it self-deploys, thereby insuring that it deploys tangentially from the storage spool 72. Additionally, as the boom portion 76 self-deploys, the roller 66 applies pressure upon the spool 72 in order to maintain the plurality of remaining turns 74 in closely wrapped relationship over the spool 72. In turn, the spool 72 provides the same restraining and guiding functions, enabling self-deployment of the boom portion 70 from the spool portion 76. Accordingly, the embodiment illustrated in FIG. 3 is especially suited for a storage and deploying mechanism for a bistem-type boom.

Another preferred embodiment of the present invention is particularly illustrated in FIG. 4. Such embodiment is similar in construction to the embodiment illustrated in FIGS. 1 and 2. Accordingly, the corresponding parts will be indicated by like numbers differing only by primed designations. Accordingly, with more particular reference to FIG. 4, with reference being made to both FIGS. 1 and 2, a modified self-deployed mechanism is generally indicated as 80 and comprises a generally U-shaped bracket having a base 82 and two parallel spaced, also an elongating device 84 which are connected to the booms 84 and 86. The sidewalks 84 and 86 are provided with opposed aligned vertically downward projecting parallel sidewalk notches 88 and 90 in spaced relationship from the base 82. The U-shaped bracket is purposely constructed to be substituted for the connecting arms 18 of the previously described embodiment of the present invention. A boom storage spool 12' and a cooperating pressure roller 20' are mounted for rotation in the bracket, said spool and pressure roller being mounted in inverted relationship with their corresponding relationships in the embodiment of FIGS. 1 and 2. More particularly, the storage spool 12' is provided with a projecting shaft 90'. Said shaft 90' has attached thereto a protruding screw 36'. Similarly, the pressure roller 20' is provided with a shaft 90', carrying a projecting screw 52'. The screws 36' and 52' are connected by a coil spring 64'. In addition, the storage spool 12' is provided thereover with a plurality of tightly wrapped turns 14' of an extendible self-deploying boom 16'.

In operation, the storage spool 12' and the storage roller 20' are maintained in compression by the coil spring 64' the boom end portion being initially maintained between the spool and roller along a common line of pressure. In such manner, the pressure roller 20' serves to prevent the well-known tendency of the boom to unwrap from the storage spool. Any well-known braking and retracting drive mechanism, generally illustrated in phantom line at 92 is adapted to initially engage and restrain the storage spool 12' from rotation. When deployment of the boom 16' is desired, the mechanism 92 will, in the well-known manner, release its...
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restraint upon the spool 12', allowing it to rotate upon its shafts 30'. The storage energy of the boom 16' creates a tendency thereof to unwind from the storage spool 12'. However, as mounted to the center of a corresponding disc plate 96'. An inadvertently, radially directed parallel sidewall 112 is provided for each of a corresponding desired individual boom deployment mechanism. A boom storage roller 114 is received in each notch 112 and is end-supported between the mounting plates 96'. A tie-down point 117, which may comprise, for example, a dowel or aperture, is radially in line with each elongated notch 112 and the central shaft 110 and is provided to fixedly receive the end of a coil spring 118. The remaining end of the coil spring 118 is secured to one end portion of a shaft of a corresponding storage roller 114. The other plate also is provided with corresponding similar features. Accordingly, the end-mounted springs resiliently urge each storage roller 114 into pressurized engagement upon the outer cylindrical periphery of the central mounted roller 108. The cylindrical spool 114 is provided with a plurality of turns of an extensible boom 116, which boom is maintained compressed between the cylindrical peripheries of the central roller 108 and its corresponding cooperating storage spool 114. Each additional desired boom deployment and storage mechanism is fabricated in similar fashion. The tendency for each of the booms 116 to unwind from their corresponding storage rollers 114 simultaneously produces a counterclockwise rotation in a corresponding storage spool and a corresponding clockwise rotation of the central roller 108. Additionally, the device of FIG. 6 illustrates a mechanism for simultaneously deploying a plurality of extensible booms utilizing but a single pressure roller common to each of a plurality of desired boom storage spools.

The structure shown in FIGS. 5 and 6 may be modified by either adding or subtracting individual storage rollers to deploy any desired number of booms. In actual practice, for example, a structure corresponding to that of FIG. 6 was modified with two storage rolls, thereby permitting deployment of two booms which could be used in a dipole antenna system. When provided with four storage rollers, the structure may be used to deploy four booms which may serve as four antennas extending 90° with respect to one another.

Many other embodiments and modifications of the preferred embodiments are contained within the spirit of the invention as defined in the scope of the appended claims.

We claim:
1. A self-deploying boom mechanism, comprising:
a. storage means including a cylindrical spool;
b. a self-deploying boom initially mounted on said storage means;
c. pressure applying means cooperating with said storage means initially to compress a portion of said boom therebetween and to maintain said boom in tightly wrapped relationship on said storage means, including a cylindrical roller, said spool and said roller being so constructed and arranged to counterrotate during deployment of said boom and maintain the remaining undeployed portion of said boom in tightly wrapped relationship on said storage means during deployment of said boom;
d. means for continuously urging said roller and said spool in compression along a common line of pressure with a portion of said boom therebetween and

e. actuatable means initially preventing rotation of said spool and being actuatable subsequently to release said spool for rotation permitting self-deployment of said boom to an extended position from said spool.

2. The structure as recited in claim 1 and further including:
a. said spool being mounted for rotation in said bracket, said roller being mounted for rotation in said bracket and further mounted for sliding motion in said bracket, and said resilient means continuously slidable urging said roller in cooperation with said spool to maintain a line of pressure therebetween.
3. A self-deploying boom mechanism, comprising:
a. storage means including a cylindrical spool;
b. a self-deploying boom initially wrapped on said storage
means and adapted for self-deployment to an extended
position;
c. pressure applying means cooperating with said storage
means initially to compress a portion of said boom
therebetween and to maintain said boom in tightly
wrapped relationship on said storage means, including a
cylindrical roller, said spool and said roller being so con-
structed and arranged to counterrotate during deploy-
ment of said boom and maintain the remaining un-
deployed portion of said boom in tightly wrapped rela-
tionship on said storage means during deployment of said
boom;
d. a pair of arms, said roller being mounted for rotation
between said arms, said spool being mounted for rotation
and sliding motion between said arms; and,
e. means for continuously slidably urging said spool in
cooperation with said roller to maintain a common line of
pressure therebetween.