United States Patent

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[54] YARN CREEL AND METHOD OF POSITIONING YARN CONES

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[51] **Int. Cl.** **D02h 1/00,** D03j 5/08, B65h 49/02

[58] **Field of Search** 242/131, 131.1; 28/28, 32, 28/34; 139/241

[56] **References Cited**

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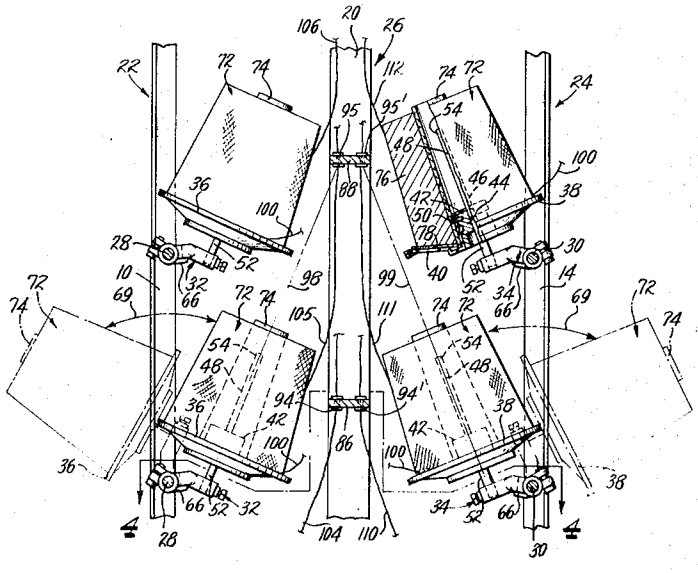
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[57] **ABSTRACT**

Spaced apart uprights interconnected by headers form a vertical longitudinally extending creel frame having an open front face, a laterally spaced apart open rear face, and an inner zone between the faces. A plurality of transversely spaced apart longitudinally extending bars are mounted adjacent each face, each bar supporting a plurality of longitudinally spaced apart hinges. Main yarn guides and auxiliary yarn guides are mounted in the inner zone. Each hinge pivotally supports a yarn holder for pivoting between an inner position wherein the post of the holder is upwardly inclined toward and aligned with a main guide and an outer position wherein the post is accessible from outside its corresponding open face. The yarn holders are arranged in pairs, and in the inner position, the posts of each pair of holders are inclined toward each other and aligned with the same main guide.

21 Claims, 4 Drawing Figures



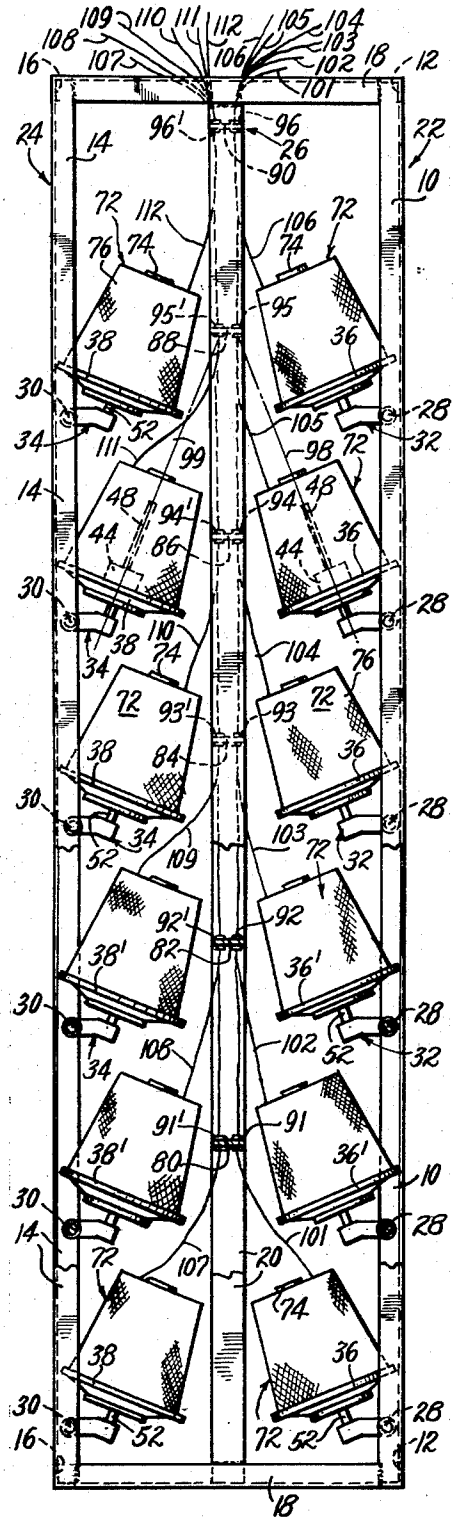


Fig. 2.

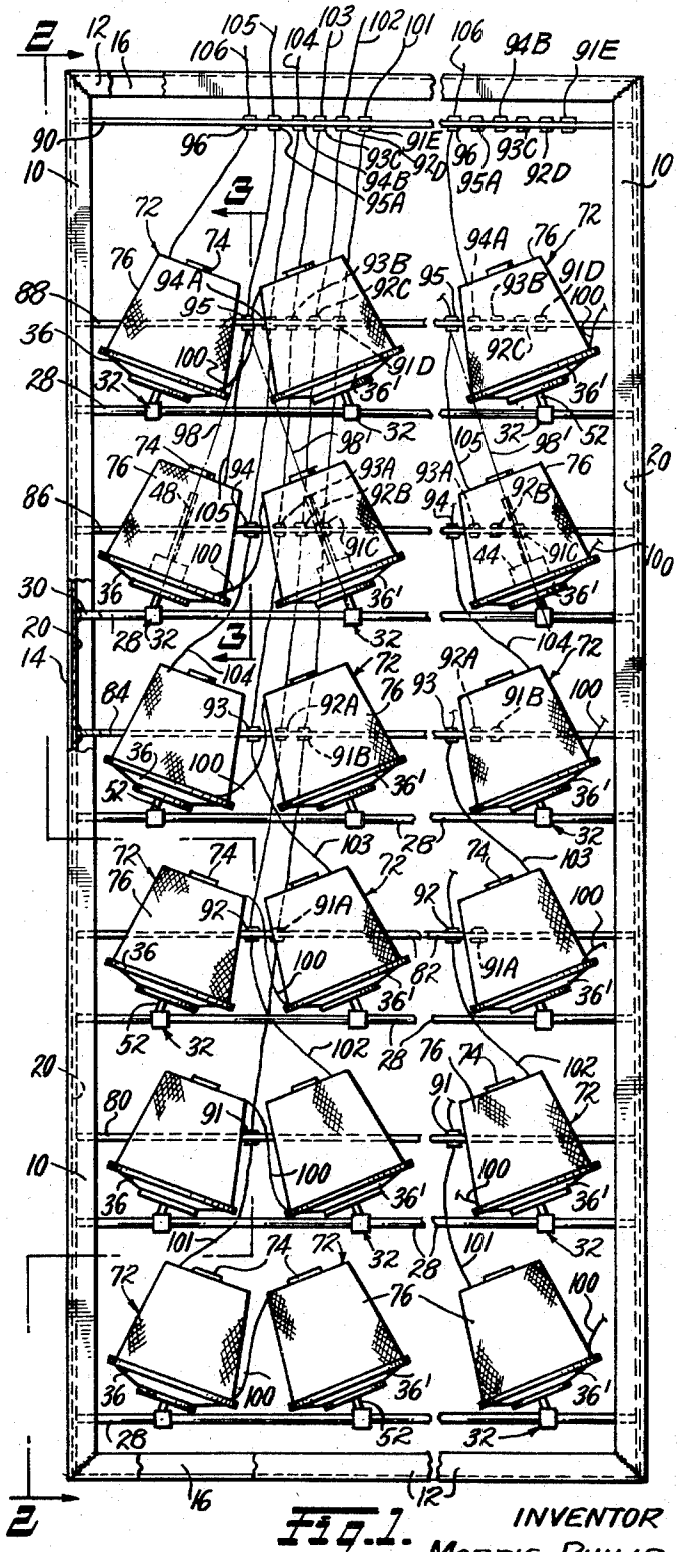


Fig. 1.

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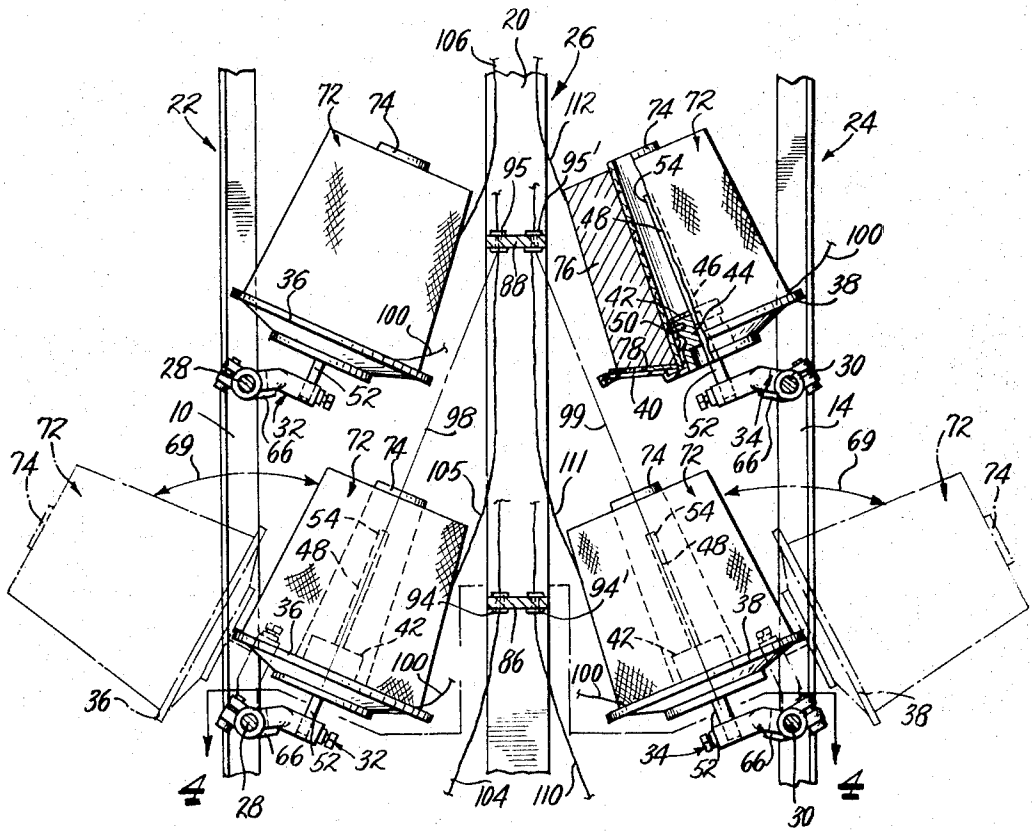


Fig. 3.

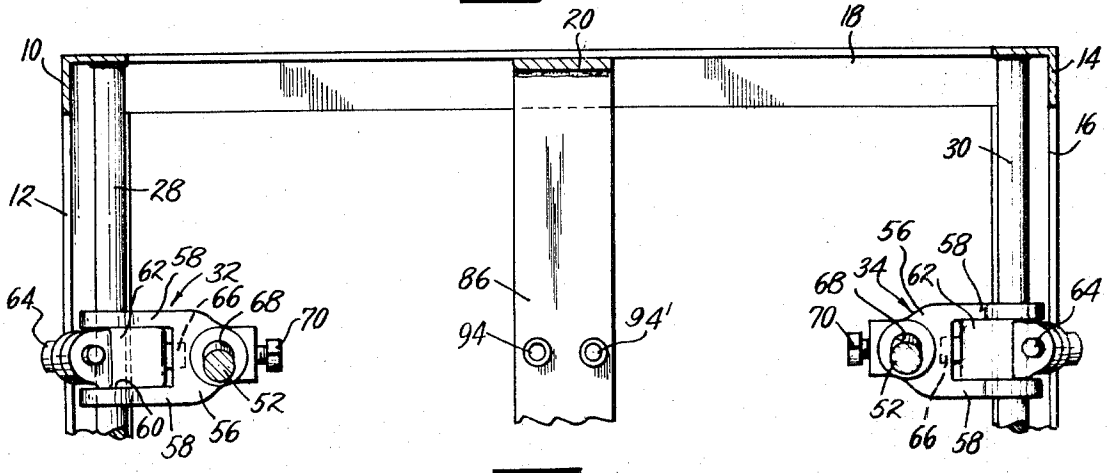


Fig. 4.

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YARN CREEL AND METHOD OF POSITIONING YARN CONES

This invention relates to a yarn creel and to a method of positioning a plurality of yarn cones on a creel frame, and more particularly it relates to a creel and a method for obtaining efficient utilization of space.

The invention is particularly concerned with a yarn supply holding a plurality of cones of yarn and to deliver a plurality of ends of yarn to a multifeed knitting machine, particularly, a multifeed circular knitting machine. For many years the yarn cones which supply the ends of yarn for a multifeed circular knitting machine have been positioned on a yarn stand above the machine. With such stands the yarn holders on which the cones are mounted are usually distributed in an array comprising a plurality of concentric circles. As the art developed to increase the number of feeds on the machine, the size of the yarn stands increased accordingly. The number of feeds on the machine has increased to such a degree that it has become very difficult and unwieldy to conveniently accommodate a sufficient number of cones on a yarn stand.

As is well known, the length of yarn supplied on a cone varies from cone to cone so that even if a machine were to commence knitting with all the cones full of yarn, some cones would run out of yarn before others. When a cone is about to run out of yarn it is necessary to watch the machine and stop the machine just as the cone is exhausted so that the exhausted cone can be replaced by a new cone. This means that an operator must be in constant attendance at the machine when any one of the yarn cones is approaching exhaustion and it also means that the machine must be stopped each time an exhausted cone is being replaced by a full cone.

Although this may not be a serious problem with a machine having only a few feeds, such a procedure results in a tremendous loss of labor and machine time with multifeed machines having 48 or 96 feeds, for example. A 96 feed machine will have at least 96 cones and one cone or another will always be approaching exhaustion. Therefore, instead of stopping the machine and replacing an exhausted cone immediately upon its exhaustion, there has developed a practice of providing the yarn stand with a pair of yarn holders for every feed and the two cones of a pair are "pigtailed" or double tied. This means that the terminal portion of the yearn of one cone is tied to the beginning portion of the other cone of the pair so that when one cone is exhausted the yarn continues feeding from the other cone. Then the empty cone can be replaced without interrupting the operation of the machine and the new cone is double tied to the cone which is feeding. This practice has doubled the number of yarn holders which have to be supported on the yarn stand, thereby requiring a still larger yarn stand.

In order to eliminate the requirement for the tremendously large yarn stand over the machine, together with the problems of the operator being able to reach the yarn holders to make replacements, many factories have replaced the overhead yarn stand with a creel. The creel usually stands on the floor next to the machine and despite its size the yarn holders and cones thereon are more readily accessible to the operator.

The present invention is particularly directed to an improved creel of the type just described, in that the creel of the present invention results in a much more efficient utilization of space in the creel. This efficient utilization of space reduces the size of the creel and reduces the size of the floor space taken up by the creel. It is well known in the art that in order to permit the yarn to be readily unwound or removed from a yarn cone, the first yarn guide, or main guide, through which the yarn passes after leaving the cone should be oriented in a particular manner relative to the cone of yarn. Briefly, the main guide for a particular cone must be substantially aligned with the axis of the cone and must be spaced away from the top of the cone at least a certain distance, which can be called the operative distance. If the main guide is too close to the cone or not substantially aligned with the axis of the cone, the yarn cannot freely be removed from the cone. The distance, as well as the degree of alignment, depends on the size of the cone, as well as the nature of the yarn. For example, the minimum operative distance is less for a smooth slippery yarn than a relatively rough yarn. This orientation of the main guide relative to its yarn cone is well known and is within the skill of an ordinary worker in the art.

In the prior art creels, space had to be provided to permit the main guides to be properly oriented relative to their respective cones. According to the present invention, it has been discovered that by inclining the cones, as will be described hereinafter, much of this previously wasted space can be utilized, with the main guides being located between cones and thereby eliminate the need for additional space.

Therefore, according to one aspect of the present invention, there is provided a yarn creel for supporting an array of yarn cones, comprising a vertical longitudinally extending frame defining at least a vertical longitudinally extending open front face and a vertical longitudinally extending inner zone laterally spaced apart and rearward of said front face, a plurality of yarn holders each comprising a base and a post extending upwardly therefrom terminating in an upper free end, means movably supporting said yarn holder bases on said frame in an array comprising transversely spaced apart rows of longitudinally spaced apart bases adjacent each open face, said means supporting each of said bases for individual movement between an inner position and an outer position, and a plurality of spaced apart yarn guides mounted in said frame in said inner zone for guiding the yarn from cones on said holders to outside said frame, said guides comprising at least main yarn guides, in said inner position of a base its post being upwardly and inwardly inclined toward said inner zone with the axis of said post being substantially aligned with one of said main guides and said free upper end being the innermost portion of said post so that yarn from a cone mounted on said post is first threaded through said main guide, and in said outer position of a base at least the free upper end of its post being outwardly laterally displaced from its location in said inner position sufficient to be accessible from outside its corresponding open face so that a yarn cone can be placed on or removed from said post. Preferably said frame also defines a vertical longitudinally extending open rear face laterally spaced apart from said openfront face, said inner zone being located substantially medially of said front and rear faces.

According to another aspect of the invention there is provided a yarn creel wherein said yarn holder bases are arranged in pairs, two adjacent bases at the same level constituting a pair, in said inner position the axes of the posts of both members of a pair being substantially aligned with the same one of said main guides, whereby when yarn cones are placed on the posts of a pair the yarn of said cones can be double tied to provide for continuous feeding through the same main guide.

According to another aspect of the invention each main guide is disposed in said inner zone at a level above that of the bases of the row of bases immediately above the post aligned with said guide.

According to still another aspect of the invention there is provided a method of positioning a plurality of yarn cones and yarn guides in a creel frame so as to obtain efficient utilization fof space, comprising positioning a plurality of yarn cones adjacent a vertical longitudinally extending open face of a creel frame in an array comprising transversely spaced apart rows of longitudinally spaced apart cones, positioning a plurality of yarn guides, including at least main guides, inwardly of and adjacent to said array of cones, said cones being positioned so as to be movable between an inner position and an outer position, in said inner position each cone being upwardly and inwardly inclined toward said guides with the axis of said cone being substantially aligned with one of said main guides and in said outer position at least the upper end of said cone being outwardly laterally displaced from its location in said first position sufficient to be accessible from outside said open face so that the yarn cone can be removed from or placed on said frame, each main guide being spaced apart from the top of its

aligned corresponding cone an operative distance greater than the diameter of the top of said yarn cone, each main guide being located at a level above the bottom of the yarn cone in the row immediately above said corresponding cone. Preferably the yarn cones are positioned in a similar array adjacent the vertical longitudinally extending open rear face of the creel.

According to another aspect of the invention the cones are arranged in pairs, two adjacent cones at the same level constituting a pair, in the inner position the axes of both members of a pair being substantially aligned with the same one of said main guides, whereby the yarn cones of a pair can be double tied to provide for continuous feeding through the same main guide.

These and other aspects of the invention will be readily apparent from the following description in connection with the accompanying drawings, wherein:

FIG. **1** is a fragmentary front elevation, partly in section, diagrammatically illustrating the creel of the invention;

FIG. **2** is an end elevation looking at the left end, partly in section, taken along the line **2—2** of FIG. **1**;

FIG. **3** is an enlarged fragmentary cross section taken along the line **3—3** of FIG. **1**, one yarn cone being shown in detail, partly in section;

FIG. **4** is a fragmentary cross section taken along the line **4—4** of FIG. **3**.

Referring to the illustrated embodiment, the frame of the creel is comprised of longitudinally spaced apart front uprights **10**; transversely spaced apart longitudinally extending front headers **12** interconnecting front uprights **10**; longitudinally spaced apart rear uprights **14** opposed to, and laterally spaced apart from, front uprights **10**; transversely spaced apart longitudinally extending rear headers **16** interconnecting rear uprights **14**, said rear headers **16** being opposed to, and laterally spaced apart from, front headers **12**; and transversely spaced apart laterally extending headers **18** interconnecting opposed front uprights **10** and rear uprights **14**. Longitudinally spaced apart upright yarn guide supporting members or bars **20** are secured to laterally extending headers **18** about medially between opposed front uprights **10** and rear uprights **14**. The various members which form the frame can be made of any suitable material and can be secured to each other in any desirable manner in order to provide a rigid frame. In the illustrated embodiment members **10, 12, 14, 16** and **18** are made of angle iron, uprights **20** are flat metal bars and all the members are secured to each other by welding.

It is apparent that the frame as just described defines a vertical longitudinally extending open front face **22** (formed by uprights **10** and headers **12**), a vertical longitudinally extending open rear face **24** (formed by uprights **14** and headers **16**), said open rear face being laterally spaced apart from the open front face, the two faces being secured to each other by laterally extending headers **18**. In between the open front face **22** and the open rear face **24**, the frame defines a vertical longitudinally extending inner zone **26** substantially medially of said front and rear faces and aligned with the upright yarn guide supporting members **20**. In the illustrated embodiment the front face is identical to the rear face.

A plurality of transversely spaced apart longitudinally extending yarn holder supporting members or bars **28** are mounted in the frame adjacent the front face **22**, the ends of the bars **28** being welded to uprights **10**. A similar series of transversely spaced apart longitudinally extending yarn holder supporting members or bars **30** are mounted in the frame adjacent the open rear face **24**, the ends of bars **30** being welded to rear uprights **14**. In the illustrated embodiment each bar **28** and **30** is circular in cross section. On each bar **28** there are secured a plurality of longitudinally spaced apart individual yarn holder supporting means or hinges **32** and on each bar **30** there are also secured a plurality of longitudinally spaced apart similar hinges **34**. On each hinge **32** there is mounted a yarn holder **36** or **36'** and on each hinge **34** there is mounted a yarn holder **38** or **38'** so that there is provided adjacent each face an array of transversely spaced apart rows of longitudinally spaced apart yarn holders.

Each yarn holder **36, 36', 38** and **38'** (see FIG. **3**) comprises a circular dished flange or plate **40** which may be molded from plastic. Each plate has an upwardly extending central hollow hub **42** which is force fitted about a metal core **44** having a central vertical bore **46** therethrough. A pin or rod **48** passes through the bore **46**, and the hub **42** and core **44** are secured to pin **48** by means of set screw **50** in threaded engagement with the core. The lower portion **52** of the pin **48** extends below the plate **40** and provides means for securing the yarn holder to its hinge. The pin **48** also extends upwardly from the hub and terminates in an upper free end **54**. The hub **42** and the portion of the pin **48** extending upwardly therefrom constitute , in the illustrated embodiment, the central post of the yarn holder.

Each hinge **32** and **34**, shown diagrammatically in FIGS. **1** and **2** and in detail in FIGS. **3** and **4**, comprises a body portion **56** having opposed spaced apart arms **58** extending outwardly therefrom, the arms **58** having aligned longitudinal circular bores **60** therethrough. Each bar **28** passes through the aligned bore **60** of the hinges **32** mounted thereon so that the body portion **56** can freely pivot around bar **28**, the axis of pivoting being the axis of bar **28** and the plane of pivoting being a plane perpendicular to the bar **28**. In a similar manner each body portion **56** of each hinge **34** is pivotally mounted on its bar **30** by said bar passing through the aligned bores **60**. To limit the angle of pivoting and to prevent each hinge from sliding longitudinally along its bar, each hinge includes a split clamping knuckle or shackle **62** surrounding bar **28** (in connection with hinges **32**) or bar **30** (in connection with hinges **34**) between opposed arms **58**. The knuckle or shackle **62** is tightened around its bar by means of a bolt **64** threaded into the free ends of the knuckle or shackle **62**, so that the knuckle **62** is fixed relative to its bar **28** or **30**. The longitudinal extent of each knuckle **62** is sufficient to fill the space between its opposed arms **58** to prevent said arms from sliding along the bar on which they are mounted. Of course, the arms and the knuckle are slipped on the bars before the bars are secured to the frame.

The underside of each knuckle **62** is provided with a rear projection or stop **66** which is abutted by the underside of the body portion **56** of the hinge when the body is in its inner pivotal position shown by the solid lines in FIG. **3**. The body portion **56** has an upright bore **68** therethrough which receives the lower portion **52** of the rod or pin **48** and this lower portion is secured in this bore by means of a set screw **70** in threaded engagement with body portion **56**.

The pivoting of the yarn holders is particularly shown in connection with the lower holders **36** and **38** of FIG. **3**, wherein the hinge **32** adjacent the front face and the yarn holder **36** mounted thereon are pivotable about the axis of rod **28** from an inner position shown in solid lines counterclockwise to an outer position shown in phantom, and clockwise back to its inner position as shown by arrow **69**. In a similar manner the yarn holder **38** in the rear face, the lower right hand one in FIG. **3**, is pivotable from its inner position shown in solid lines clockwise to its outer position shown in phantom and counterclockwise back to its inner position. In other words, each yarn holder, including its central post, is pivotally supported by its hinge for movement between an inner position and an outer position. In the inner position of a yarn holder its post is upwardly and inwardly inclined toward the inner zone **26** and away from its corresponding face. In the outer position, in the illustrated embodiment, the post of the yarn holder is upwardly and outwardly inclined away from the inner zone.

When a yarn holder is in the outer position the free upper end of its post is outwardly laterally displaced from its location in its inner position so that it is accessible from outside its corresponding open face whereby a yarn cone **72**, either full of yarn, partially empty of yarn, or empty of yarn, can be positioned on the yarn holder or removed therefrom. The yarn

holder is placed in this position when it is desired to remove a cone therefrom and replace it with another cone. The yarn holder can then be swung to the inner position, which may be called the operative position, since in the inner position the yarn cone on the holder is in the position to supply an end of yarn therefrom to its main yarn guide.

Abutment of the underside of the body portion **56** of a hinge with the stop **66** limits the inward movement of the yarn holder. Outward movement of the yarn holder is limited by the abutment of the body portion **56** with the upper end of bolt **64**, or if the bolt **64** does not project through the shackle **62**, with the upper surface of the shackle. The angle at which a post of the yarn holder is inclined when in the inner position is substantially critical, as will be described hereinafter, and therefore when the shackle **62** is tightened around its bar, it is positioned so that the stop **66** will limit inward movement of the yarn holder at the proper angle. The angle of incline of the post in the outer position is not critical, it merely being necessary for the post to be accessible from outside its corresponding open face so that a yarn cone can be placed thereon or removed therefrom.

A yarn cone **72** is positioned on each yarn holder. In FIGS. **1** and **2** the yarn cones are shown diagrammatically and one cone is shown in detail, in partial cross section, in FIG. **3**. The yarn cone comprises a hollow conical core **74** about which is wound the yarn body **76**. Normally, a disc of foam rubber or plastic **78** is positioned on the plate **40** and the bottom of the yarn body **76** rests on this disc. The conical core usually extends above and below the body of yarn **76** and the lower extremity of the core is received within the central recess of plate **40**, the post of the holder being received within the hollow of the core, so that the yarn cone is substantially coaxial with the center post. The construction of the yarn cones is well known in the art and, of course, any type of yarn cone can be used with the present invention. Frequently the yarn is supplied by what are called tubes or spools and these may also be used on the creel of the invention. However, since normally the core and the body of the yarn are both conical, the words "yarn cone" are frequently used to refer to actual cones as well as tubes, spools, etc., and it will be understood that whenever reference is made in this application and claims to yarn cones, that this language includes the other forms of yarn as well.

Any conventional yarn holder may be used with the creel of the invention and therefore the invention is not limited to the particular holders disclosed. Yarn holders are well known in the art and in essence they comprise two elements, namely, a base and a central post extending upwardly therefrom terminating in an upper free end. The base comprises the lower portion of the holder by which the holder is mounted on its support and in the disclosed embodiment the lower portion **52** of rod **48** may be considered such a base. In the illustrated embodiment the central post comprises hub **42** and the portion of rod **48** extending upwardly therefrom. In some holders the rod **48**, or at least the portion projecting above the hub **42**, may be eliminated (not shown) so that the hub itself would be considered the post. If it is desired to have the core fit snugly around the post, either a wider hub can be utilized, or a retaining ring (not shown) may be fitted around either the hub or the rod, with the outer diameter of the retaining ring approximating the inner diameter of the core.

The bottom portion **52** of the rod of each yarn holder is bent just above the body portion **56** of the hinge to which it is secured (see FIG. **1**) so that at least when a yarn holder is in the inner position, its plate and central post are inclined toward an end of the frame. When viewing the creel from the front, as shown in FIG. **1**, each yarn holder **36** adjacent the front face, as well as yarn holder **38** directly behind and adjacent the rear face, has its post upwardly inclined toward the right end of the frame and the post of each yarn holder **36'** adjacent the front face, as well as yarn holder **38'** directly behind and adjacent the rear face, has its post upwardly inclined toward the left end of the frame.

Longitudinally along each front bar **28** yarn holders **36** alternate with yarn holders **36'** so that, when viewing the creel from the front, along each bar proceeding from left to right, there will be a first yarn holder **36**, followed by a first yarn holder **36'**, followed by a second yarn holder **36**, followed by a second yarn holder **36'**, etc. The post of the first yarn holder **36** is upwardly inclined toward the post of the next adjacent yarn holder which is first yarn holder **36'**, whose post in turn is upwardly inclined toward the post of first yarn holder **36**. The next adjacent yarn holder, which is second yarn holder **36**, has its post upwardly inclined toward the still next adjacent yarn holder which is second yarn holder **36'**, whose post in turn is upwardly inclined toward the post of second yarn holder **36**, and so on the length of each bar **28**. On each bar **28**, therefore, the yarn holders are arranged in pairs, each pair comprising a yarn holder **36** and a yarn holder **36'**, with the posts of each pair being upwardly inclined toward each other. The yarn holders adjacent the rear face, namely yarn holders **38** and **38'**, are mounted in similar pairs on each rear bar **30**.

It will be appreciated from the foregoing description that the yarn holders adjacent each face are arranged in an array comprising transversely spaced apart rows of longitudinally spaced apart holders, the holders of each row being arranged in pairs with the posts of each pair being upwardly inclined toward each other.

In the illustrated embodiment, adjacent each face, there are six rows of yarn holders, each row being supported by its associated front bar **28** or rear bar **30**. For convenience we may number each row starting at the bottom so that the bottommost row of yarn holders in the front will be called the first front row and the bottommost row in the rear will be called the first rear row. The bottommost bar **28** is called the first bar **28**, since it supports the first front row of yarn holders and the bottommost bar **30** is called first bar **30** since it supports the first rear row of yarn holders. Using this system of numbering the uppermost row of yarn holders in each face will be the sixth row with the uppermost associated bars **28** and **30** being the sixth bar **28** and the sixth bar **30**.

In the inner zone **26** there are mounted a plurality of transversely spaced apart longitudinally extending yarn guide bars **80**, **82**, **84**, **86**, **88** and **90**. These yarn guide bars are mounted in the frame by having their ends fastened to upright guide supporting members **20**. In the illustrated embodiment there are six yarn guide bars and they are numbered beginning from the bottom, so that the bottommost yarn guide bar **80** is the first yarn guide bar, **82** is the second, **84** is the third, **86** is the fourth, **88** is the fifth, and **90** is the sixth.

Through each of said yarn guide bars there are a plurality of vertical bores in each of which is fastened a yarn guide or eyelet. The yarn guides are arranged in each bar in two laterally spaced apart rows, a front row and a rear row, each row containing a plurality of longitudinally spaced apart guides. The front row of guides is laterally closer to the front face of the frame and the guides of that row receive and guide the yarn from the yarn cones mounted adjacent the front face. The rear row is laterally closer to the rear face of the frame and the guides of that row receive and guide the yarn from the yarn cones mounted adjacent the rear face. The yarn guides comprise main guides and auxiliary guides. Although both types of guides are of the same construction, they serve different functions and are located differently in the yarn guide bars. A main guide is a guide which receives an end of yarn directly from a yarn cone, that is, it is the first guide through which the yarn passes after it leaves the cone. There is one main guide for each pair of yarn holders and the yarn cones thereon so that each main guide corresponds to a particular pair of yarn holders and cones thereon. As will be pointed out hereinafter, the orientation of a main guide to its corresponding yarn holders and cones thereon is relatively critical. Auxiliary guides are the guides through which an end of yarn passes after it has passed through its main guide and there is no criticality in the orientation of the auxiliary guides. Their only function is to guide and direct the yarn away from the main guide and out of the creel.

The arrangement of the yarn guides or eyelets will be particularly described in connection with the front row of each yarn guide bar. The front row of guides in each yarn guide bar comprises a plurality of longitudinally spaced apart main guides, guides **91** being the main guides of first yarn guide bar **80**; guides **92**, the main guides of second bar **82**; guides **93**, the main guides of third bar **84**; guides **94**, the main guides of fourth bar **86**; guides **95**, the main guides of fifth bar **88**; and guides **96**, the main guides of sixth bar **90**. Since main guides **91** of the front row of first guide bar **80** receive the yarn from the first front row of cones positioned on the first row of yarn holders supported by first bar **28**, the front row of guides of the first yarn guide bar **80** corresponds to the first front row of yarn holders (and the yarn cones thereon) and first bar **28**, the front row of guides of the second yarn guide bar **82** corresponds to the second front row of yarn holders and second bar **28**, etc. In the illustrated embodiment each main guide corresponds to a particular pair of yarn holders, that is, it receives the yarn from the yarn cones ona particular pair of holders in the row corresponding thereto.

The front row of each yarn guide bar other than the first bar **80** is also provided with auxiliary guides in addition to said main guides. In the front row of second bar **82** there is one auxiliary guide **91A** adjacent to and longitudinally spaced apart from each main guide **92**. In the front row of third bar **84** adjacent each main guide **93** there are two auxiliary guides **92A** and **91B**. In the front row of fourth bar **86** adjacent each main guide **94** there are three auxiliary guides **93A**, **92B** and **91C**. In the front row of fifth bar **88** adjacent each main guide **95** there are four auxiliary guides **94A**, **93B**, **92C** and **91D**. In the front row of sixth bar **90** adjacent each main guide **96** there are five auxiliary guides **95A**, **94B**, **93C**, **92D** and **91E**.

In each of yarn guide bars **80**, **82**, **84**, **86**, **88** and **90** there is also a rear row of main and auxiliary guides similar to the front row and these carry the same reference characters as those of the front row but with the addition of a prime, only main guides **91'**, **92'**, **93'**, **95'** and **96'** being visible in the drawings. The rear row of guides of the first yarn guide bar **80** corresponds to the first rear row of yarn holders and first bar **30**, the rear row of guides of the second yarn guide bar **82** corresponds to the second rear row of yarn holders and second bar **30**, etc.

In the illustrated embodiment (seeparticularly FIGS. **1** and **2**) the first yarn guide bar is disposed at a vertical level above the second bar **28** (or **30**) and below the third bar **28** (or **30**), the level of first yarn guide bar **80** being above second bar **28** (or **30**) about one-third the distance between second bar **28** (or **30**) and third bar **28** (or **30**). It is therefore apparent that first yarn guide bar **80** is at a level with the space occupied by the second row of yarn holders. The yarn guide bars are vertically spaced from each other the same distance as bars **28** (or **30**) are spaced from each other, so that the second yarn bar **82** is therefore at a level with the third row of yarn holders, the third yarn guide bar **84** is at a level with the fourth row of yarn holders, etc.

The alignment of the yarn holders, and more particularly with central posts thereof, with their corresponding main guides will now be described. The alignment is best described with reference to the axis of the central post, the axis being an imaginary line passing through the longitudinal center of the central post, the axis beginning at the lower end of the post and extending upwardly through the free end and continuing in that direction. Since in the present description we are not concerned with the prolongation of the axis below the post, the axis hereinafter will be considered as a vector in the direction away from the lower end of the post, toward and through the free upper end. When a cone is positioned on the yarn holder, the cone is substantially concentric with the central post of the yarn holder and therefore the axis of the yarn cone substantially coincides with the axis of the post.

In the drawing the axes **98**, **98'**, and **99** of the yarn holders **36**, **36'** and **38**, respectively, are shown in phantom for the yarn holders of the fifth row (see FIGS. **1** and **2** and the bottommost yarn holders **36** and **38** of FIG. **3**). As can be seen in the drawings, each axis **98** passes through its corresponding main guide **95** and each axis **98'** passes through its corresponding main guide **95**, with the axes **98** and **98'** of a pair of yarn holders **36** and **36'**, respectively, passing through the same main guide **95**. Stated differently, each main guide **95** is aligned with the axis of each post of the yarn holders of the pair corresponding to that main guide **95**. It is also noted, as can be seen with reference to the pair of yarn holders **36** and **36'** shown in FIG. **1**, that the main guide **95** corresponding to that pair lies in the intersection of the axes **98** and **98'** of that pair and lies in a vertical plane substantially medially of the yarn holders which constitute the pair. The axes of all the pairs of yarn holders of all the front rows are similarly aligned with their corresponding main guides.

The alignment of the main guides with the axes of the posts of the yarn holders adjacent the rear face of the creel is similar to the alignment just described with reference to the yarn holders of the front face. However, since in the drawings there is only visible one yarn holder **38** and no yarn holders **38'**, there is only shown the axis **99** of the post of the one yarn holder **38**. Nevertheless, the pairs of yarn holders of the rear face are aligned with their main guides in the same manner as are the yarn holders of the front face.

At any one time only the end of yarn from one yarn cone on one holder of each pair is feeding yarn through the main guide corresponding to the pair, the cone on the other yarn holder of the pair being kept in reserve. In order to provide that the reserve yarn cone automatically starts feeding when the other yarn cone is exhausted, the two cones of a pair are pigtail tied or double tied. The yarn of each yarn cone is provided with a beginning tail and a terminal tail, the yarn being unwound beginning with the beginning tail. Continuous feeding is effected by tying the terminal tail of the feeding cone to the beginning tail of the reserve cone so that as soon as the feeding cone becomes exhausted the yarn continues feeding from the reserve cone. The tied tails are called a pigtail and such pigtails **100** are shown tying together the cones of the pairs in FIG. **1**. The pigtails have been omitted for purposes of clarity in FIG. **2**, since no two members of a pair are visible in that figure.

In the illustrated embodiment, the yarn cones on the left hand pair of yarn holders of the front face (as viewed in FIG. **1**) which are feeding, are the cones on holders **36** of the first, fourth, fifth and sixth rows and the cones on holders **36'** of the second and third row. The cones on each of the holders **36'** at the extreme right hand side (as viewed in FIG. **1**) of each row are feeding, but the drawing only shows these ends of yarn as being fed through their main guides and does not show the path taken by these ends thereafter. In the rear face, the cones on holders **38** of the first, fourth, fifth and sixth rows are feeding as are the cones on holder **38'** of the second and third row.

As has been previously pointed out, only the positioning of the main guides relative to their corresponding cones is critical, the positioning of the auxiliary guides not being critical. The purpose of the auxiliary guides is to direct each end of yarn from its main guide to the exterior of the creel and the creel is provided with as many auxiliary guides as desired. An end of yarn **101** from a cone in the first front row proceeds from its cone through its main guide **91**, then successively through auxiliary guides **91A**, **91B**, **91C**, **91D**, **91E**, and then out of the creel. An end of yarn **102** from the second row proceeds from its cone through its main guide **92** and then successively through auxiliary guides **92A**, **92B**, **92C**, **92D**, and then out of the creel. An end of yarn **103** in the third row proceeds through its main guide **93** and then successively through its auxiliary guides **93A**, **93B**, **93C** and then out of the creel. An end of yarn **104** in the fourth row proceeds through its main guide **94** and then successively through its auxiliary guides **94A**, and **94B**, and then out of the creel. An end of yarn **105** in the fifth row proceeds through its main guide **95** and then through its auxiliary guide **95A**, and then out of the creel. An end of yarn **106** in the sixth row proceeds through its main guide **96** and then out of the creel, no auxiliary guides being

necessary. Additional auxiliary guides may be provided to direct each end of yarn as desired after it leaves its main guide.

In asimilar manner, the yarns of the cones of the rear face are directed through their main and auxiliary guides, with the end of yarn **107** of a cone of the first rear row proceeding first through its main guide **91'** and then through auxiliary guides similar to those through which the equivalent end **101** of the front face passed. End of yarn **108** of the second row of the rear face goes through its corresponding main guide **92'** and auxiliary guides, end **109** of the third row through main guide **93'** and auxiliary guides, end **110** of the fourth row through main guide **94'** and auxiliary guides, end **111** of the fifth row through main thecone, and auxiliary guide, and end **112** of the sixth row through main guide **96'**. The auxiliary guides which correspond to the rear row of holders are now shown in the drawing.

The ends of yarn after they leave the creel go directly or indirectly to the knitting stations of the knitting machines, being guided by such additional guides (not shown) as necessary. For example, the ends of yarn may go from the creel to a positive feeding device (not shown) located on top of the creel and then to the knitting stations. In any event, either by the operation of the knitting machine itself or by the operation of the positive feeding device, the ends of yarn are pulled out of the creel so as to be unwound from the yarn cones.

The creel normally would stand on the floor adjacent the knitting machine, and if desired, it may be fastened to the floor by bolts (not shown). If one creel does not supply sufficient ends of yarn, more than one creel may be used and they can be positioned in any desirable manner adjacent the machine. One excellent arrangement would be for the first creel to be adjacent the machine and for the second creel to be laterally spaced apart and behind the first creel, there being an aisle between the machine and the first creel and an aisle between the first and second creel, so that the operator can have access to the open faces of the creels.

The cones of yarn are placed on the yarn holders by swinging the yarn holders to their outer position whereby a cone is positioned thereon and then the yarn holder with its cone thereon is swung to the inner position. The cones of each pair are pigtail tied or double tied to each other. Periodically the operator can inspect the creel and wherever a cone has become exhausted, its holder is swung to the outer position, the empty core removed and replaced by a full cone. It is emphasized that each hinge supports its yarn holder independently of the others so that each holder can be selectively individually moved between its inner and outer positions without interfering with the other holders on the creel.

By using the concepts of the invention there is obtained excellent utilization of the space of the creel and there will now be given a specific example of dimensions which give excellent results. For example, the bars **28**, bars **30**, and yarn guide bars **80** through **90** are positioned on 11-inch centers. The hinges which constitute a pair may be 12 inches apart and two longitudinally adjacent hinges not constituting a pair may be 6 inches apart. The front and rear faces may be laterally spaced apart about 20 inches. With such dimensions, each yarn holder can readily accommodate a yarn cone whose outer diameter at the widest portion, namely the bottom of the cone, is 8 inches and whose outer diameter at the narrowest portion, namely the top of the cone, is 6 inches, with the axial length of the yarn body being about 6 ½ – 7 inches. Therefore, a creel about 75 inches long, 75 inches high and 20 inches deep can accommodate in each face six rows, each row containing eight cones, so that there will be an array of 48 cones in each face, or 96 cones in the entire creel. When the **96** cones are double tied, such a creel can supply a 48 feed multifeed knitting machine and two creels can supply a 96 feed machine. Preferably to improve the rigidity of the creel, for a creel of this length there will be, in addition to members **10**, **14**, **18** and **20** at each end, an additional upright **10**, **14**, **20**, as well as additional headers **18** located about midway between the ends.

Each yarn holder, and therefore each post and yarn cone, has a double incline in that it is inclined from front to back and from left to right. However, to simplify the drawings the cones and holders in each view are shown diagrammatically so that this double incline is not readily apparent in any one view. Referring to FIGS. **2** and **3**, the axis of each holder post and the cone thereon, when inthe inner position, makes an angle of about 25° with the vertical when projected to a vertical plane parallel to the end of the creel. Referring to FIG. **1**, each axis makes an angle of about 15° with the vertical when projected to the plane of one of the faces of the creel, so that in such a plane the angle between the axes of a pair would be about 30°. However, because of the compound inclination of the axis, the actual angle between the axis and the vertical, when measured in the plane in which the axis lies, is about 30°. In the outer position the axis has been swung about 90° from the inner position.

With these dimensions each main guide is about 10 inches from the top of each of its corresponding cones, the distance being measured along the axis. In order for the yarn to freely unwind from its cones, the yarn, in its passage from its yarn cone to the main guide, should not touch the bottom of the yarn holder or cone immediately above. Although in the drawings it appears that the yarn being unwound from any particular cone will be interfered with by the holder and cone immediately above, in actual practice this does not occur because of the double inclination of each axis. With these exemplary dimensions the top edge of the cones of a pair almost touch when the cones are full, it being merely necessary to have sufficient space for the yarn to unwind. Similarly, adjacent cones in each row which do not constitute a pair are also very close to each other. Such adjacent cones, for example, would comprise a cone **36'** and a cone **36** adjacent to each other but with their axes being upwardly inclined away from each other.

The axial distance between the top of a yarn cone and its main guide is substantially critical in order to enable the yarn to freely unwind from the cone. It is only the minimum distance that is critical, the maximum distance merely being a desirable distance to effect adequate utilization of space. The minimum distance depends upon the nature of the yarn, that is, whether it is rough or smooth, whether it is slippery or not slippery, etc. The minimum distance is also related to the diameter of the top of the yarn cone. The determination of such a minimum distance is well within the skill of a worker in the art and this minimum distance may be called the minimum operative distance. Generally it can be said that the minimum operative distance is a distance equal to the diameter of the top of the yarn cone and a good operative distance is a distance at least equal to about 1 ½ times the diameter of the top of the cone.

The above discussion of the minimum operative distance or spacing between a yarn cone and its main guide brings out a significant concept of the invention. If the axis in the inner position were not inclined toward the inner zone so that the axis would lie in a vertical plane, it would be necessary to increase the spacing between the rows of yarn holders. In other words, each bar **28**, for example, would have to be sufficiently above the tops of the cones of the row below to render it possible to locate the main guide the operative distance away from the tops of the cones. This would probably increase the vertical spacing between adjacent bars **28** at least the height of another cone. In effect this is what has been suggested prior to the present invention.

Instead of spacing the row s of cones so far apart to provide room for the main guides, the present invention utilizes the space between cones, particularly the space between the cones of the front face and rear face. In other words, according to the preferred form of the invention, each main guide is disposed in the inner zone at a level above the level of the longitudinally extending yarn holder supporting bar immediately above the supporting bar which supports a post aligned with that main guide. For example, the first guide bar **80** is at a

level above the second bar **28** (or **30**) and, most preferably, not above the level of the third bar **28** (or **30**). When referring to holder bases, it can be said that each main guide is disposed at a level above that of the bases of the row of bases immediately above the post aligned with that main guide. When referring to yarn cones, it can be said that each main guide is located at a level above the bottom of the yarn cone in the row immediately above the yarn cone corresponding to that main guide. This emphasizes that the rows of cones or holders are closer to each other than they would be if there were provided extra space to accommodate the main guides.

As has been stated, the exemplary angles and distances effect efficient utilization of space. It is apparent that the angle of inclination of the axis in the inner position can be varied from the example. However, if the angle is decreased significantly, a yarn holder or cone will interfere with the unwinding of the yarn from the cone below. On the other hand, as the angle of inclination is increased, obviously the inner zone will have to be displaced further laterally from the front face and this increases the width of the creel.

In the illustrated embodiment each axis is precisely aligned with its main guide so that each main guide actually lies on the axis of the corresponding yarn holder. Such precise alignment is not necessary. It is merely necessary that there by substantial alignment. The degree of alignment to obtain satisfactory unwinding is well known in the art and therefore lies within the skill of a worker in the art. For example, in the illustrated embodiment the main guide can be shifted about an inch from its perfectly aligned position and still be satisfactorily operative.

It is apparent that numerous variations can be made from the illustrated embodiment without departing from the concept of the invention. For example, although the arrangement of the auxiliary guides as described is a very convenient arrangement, there is no criticality in the location of any guides after the main guides so that, for example, an end of yarn, after it leaves its main guide, can be conducted longitudinally (not shown) toward an end of the creel. It may be desirable to provide a creel which can be adjustable for different size yarn cones. This can be done by adjustably mounting (not shown) the bars **28** and **30** in the frame. Instead of bending the lower end **52** of the rod **48** in order to achieve the side to side inclination, the rod can be a straight rod and the mounting bore in the hinge can be at angle (not shown). Alternatively, the hinge can have a universal joint (not shown) so that the angle can be adjusted.

Although the described creel is particularly adaptable for double tying the yarn cones, it can be used without double tying so that each yarn holder and the yarn cone mounted thereon will supply an end of yarn to the knitting machine. Of course, in that event there should be a separate main guide for each holder (not shown) although under ideal circumstances a single main guide can accommodate two ends of yarn from adjacent cones.

In the illustrated embodiment the pairs of cones which are double tied to each other are cones longitudinally spaced apart in the same row. Alternatively, the pair can comprise a holder in the front face and the holder at the same level therewith in the rear face. For example, referring to FIG. **2**, the bottom holder **36** and the bottom holder **38** may constitute a pair. In that event, of course, the aligned front and rear main guides such as **91** and **91'** would be replaced by a single guide (not shown) aligned with the axes of both holders **36** and **38** which constitute the pair and, of course, the pigtail connecting the two cones would be over the yarn guide bar between the two cones. To keep within the spirit of the invention it is only necessary that the pair of cones is constituted by two adjacent yarn holders (and the cones thereon) at the same level, whether the two cones of the pair be laterally spaced apart as in the alternative just described or be longitudinally spaced apart as in the illustrated embodiment.

The optimum utilization of space is obtained when the creel frame defines two open faces as has been described. However, it will be realized that there may be provided a creel with only one open face (not shown). As a matter of fact, it is clearly contemplated that the user of the creel might only use the yarn holders adjacent one face.

Means other than that illustrated can support the yarn holders adjacent their corresponding open faces for individual movement, pivotal or rectilinear (not shown), between an inner positionand an outer position. The axes of each pair of yarn holders and the yarn cones thereon need be inclined toward each other at least when the holders and cones are in their inner position, since it is in this position that they need be substantially aligned with their corresponding main guide, such alignment not being necessary in the outer position.

It is also apparent that the illustrated hinges can be replaced by hinges having a different structure and that the axis about which each yarn holder pivots can be different from that of the illustrated embodiment. Preferably each hinge mounts its yarn holder and cone thereon for individual pivotal movement about a substantially longitudinal axis which may coincide with, or be spaced from, or intersect, the axis of the bar **28** (or **30**) and/or may be somewhat inclined to the horizontal, and/or may be somewhat inclined relative to the plane of an open face. For desirable utilization of space, each holder and cone thereon, particularly the upper portion of the holder post, in its movement from the inner to the outer position, should move in a path as directly as possible away from the inner zone toward the open face so that neither the holder nor the yarn cone appreciably approaches an adjacent cone or holder in the same or different row during this movement. By doing this, it is not necessary to provide additional spacing between adjacent holders to provide clearance for such movement.

I claim:

1. A yarn creel for supporting an array of yarn cones, comprising a vertical longitudinally extending frame defining at least a vertical longitudinally extending open front face and a vertical longitudinally extending inner zone laterally spaced apart and rearward of said front face, a plurality of yarn holders each comprising a base and a post extending upwardly therefrom terminating in an upper free end, means movably supporting said yarn holder bases on said frame in an array comprising transversely spaced apart rows of longitudinally spaced apart bases adjacent each open face, said means supporting each of said bases for individual movement between an inner position and an outer position, and a plurality of spaced apart yarn guides mounted in said frame in said inner zone for guiding the yarn from cones on said holders to outside said frame, said guides comprising at least main yarn guides, in said inner position of a base its post being upwardly and inwardly inclined toward said inner zone with the axis of said post being substantially aligned with one of said main guides and said free upper end being the innermost portion of said post so that yarn from a cone mounted on said post is first threaded through said main guide, and in said outer position of a base at least the free upper end of its post being outwardly laterally displaced from its location in said inner position sufficient to be accessible from outside its corresponding open face so that a yarn cone can be placed on or removed from said post.

2. A yarn creel according to claim **1**, wherein said yarn holder bases are arranged in pairs, two adjacent bases at the same level constituting a pair, in said inner position the axes of the posts of both members of a pair being substantially aligned with the same one of said main guides, whereby when yarn cones are placed on the posts of a pair the yarn of said cones can be double tied to provide for continuous feeding through the same main guide.

3. A yarn creel according to claim **2**, wherein the posts of each pair are upwardly inclined toward each other at least when said posts are in said inner position.

4. A yarn creel according to claim **1**, wherein each main guide is disposed in said inner zone at a level above that of the bases of the row of bases immediately above the post aligned with said main guide.

5. A yarn creel according to claim 1, wherein said means supporting each of said bases includes a plurality of transversely spaced apart longitudinally extending yarn holder supporting members mounted in said frame adjacent each face, and mounting means movably mounting a plurality of yarn holder bases longitudinally spaced apart on each of said supporting members for individual movement between said inner and outer positions.

6. A yarn creel according to claim 5, wherein said mounting means comprises a plurality of longitudinally spaced apart hinges secured to said supporting members, each of said bases being secured to one of said hinges, each hinge mounting said base for pivotal movement above a substantially longitudinal axis between said inner and outer positions.

7. A yarn creel according to claim 6, wherein said yarn holder bases are arranged in pairs, two adjacent bases at the same level constituting a pair, in said inner position the axes of the posts of both members of a pair being substantially aligned with the same one of said main guides, whereby when yarn cones are placed on the posts of a pair the yarn of said cones can be double tied to provide for continuous feeding through the same main guide.

8. A yarn creel according to claim 7, wherein the posts of each pair are upwardly inclined toward each other at least when said posts are in said inner position, and wherein the adjacent bases which constitute a pair are in the same row.

9. A yarn creel according to claim 8, wherein each main guide is disposed in said inner zone at a level above the level of the longitudinally extending yarn holder supporting member immediately above the supporting member supporting a post aligned with said main guide.

10. A yarn creel according to claim 1, wherein said frame also defines a vertical longitudinally extending open rear face laterally spaced apart from said open front face, said inner zone being located substantially medially of said front and rear faces.

11. A yarn creel according to claim 10, wherein said yarn holder bases are arranged in pairs, two adjacent bases at the same level constituting a pair, in said inner position the axes of the posts of both members of a pair being substantially aligned with the same one of said main guides, whereby when yarn cones are placed on the posts of a pair the yarn of said cones can be double tied to provide for continuous feeding through the same main guide.

12. A yarn creel according to claim 11, wherein the posts of each pair are upwardly inclined toward each other at least when said posts are in said inner position, and wherein the adjacent bases which constitute a pair are in the same row.

13. A yarn creel according to claim 10, wherein said means supporting each of said bases includes a plurality of transversely spaced apart longitudinally extending yarn holder supporting members mounted in said frame adjacent each face, and mounting means movably mounting a plurality of yarn holder bases longitudinally spaced apart on each of said supporting members for individual movement between said inner and outer positions.

14. A yarn creel according to claim 13, wherein said yarn holder bases are arranged in pairs, two longitudinally spaced apart adjacent bases constituting a pair, in said inner position the axes of the posts of both members of a pair being substantially aligned with the same one of said main guides and wherein the posts of each pair are upwardly inclined toward each other at least when said posts are in said inner position, whereby when yarn cones are placed on the post of a pair the yarn of said cones can be double tied to provide for continuous feeding through the same main guide.

15. A yarn creel according to claim 14, wherein said mounting means comprises a plurality of longitudinally spaced apart hinges secured to said supporting members, each of said bases being secured to one of said hinges, each hinge mounting said base for pivotal movement about a substantially longitudinal axis between said inner and outer positions.

16. A yarn creel according to claim 15, wherein each main guide is disposed in said inner zone at a level above the level of the longitudinally extending yarn holder supporting member immediately above the supporting member supporting a post aligned with said main guide.

17. A yarn creel according to claim 16, wherein said guides are mounted on longitudinally extending yarn guide bars transversely spaced apart in said inner zone.

18. A method of positioning a plurality of yarn cones and yarn guides in a creel frame so as to obtain efficient utilization of space, comprising positioning a plurality of yarn cones adjacent a vertical longitudinally extending open face of a creel frame in an array comprising transversely spaced apart rows of longitudinally spaced apart cones, positioning a plurality of yarn guides, including at least main guides, inwardly of and adjacent to said array of cones, said cones being positioned so as to be movable between an inner position and an outer top of in said inner position each cone being upwardly and inwardly inclined toward said guides with the axis of said cone being substantially aligned with one of said main guides and in said outer position at least the upper end of said cone being outwardly laterally displaced from its location in said first position sufficient to be accessible from outside said open face so that the yarn cones can be removed from or placed on said frame, each main guide being spaced apart from the top of its aligned corresponding cone an operative distance greater that the diameter of the top of said yarn cone, each main guide being located at a level above the bottom of the yarn cone in the row immediately above said corresponding cone.

19. A method according to claim 18, wherein the cones are arranged in pairs, two adjacent cones at the same level constituting a pair, in the inner position the axes of both members of a pair being substantially aligned with the same one of said main guides, whereby the yarn cones of a pair can be double tied to provide for continuous feeding through the same main guide.

20. A method according to claim 19, wherein the cones of each pair are upwardly inclined toward each other at least when said cones are in said inner position.

21. A method according to claim 20, wherein another similar array of a plurality of cones is positioned adjacent another vertical longitudinally extending open face of the creel frame, said other open face being laterally spaced apart from said first named open face, said yarn guides being positioned between said two arrays of yarn cones.

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