

[54] GYMNASTIC POLE AND PROCESS OF MAKING SAME

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[51] Int. Cl.: A63b 9/00

[58] Field of Search: 272/1 R, 57 R, 60; 273/80 R, 80 B, DIG. 7; 43/18; 156/184, 185, 187, 188

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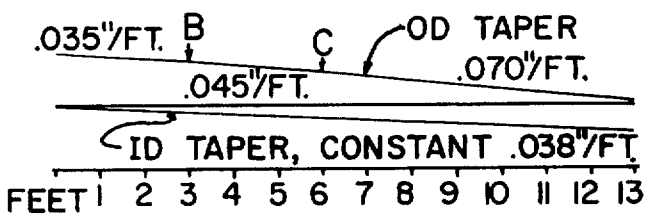
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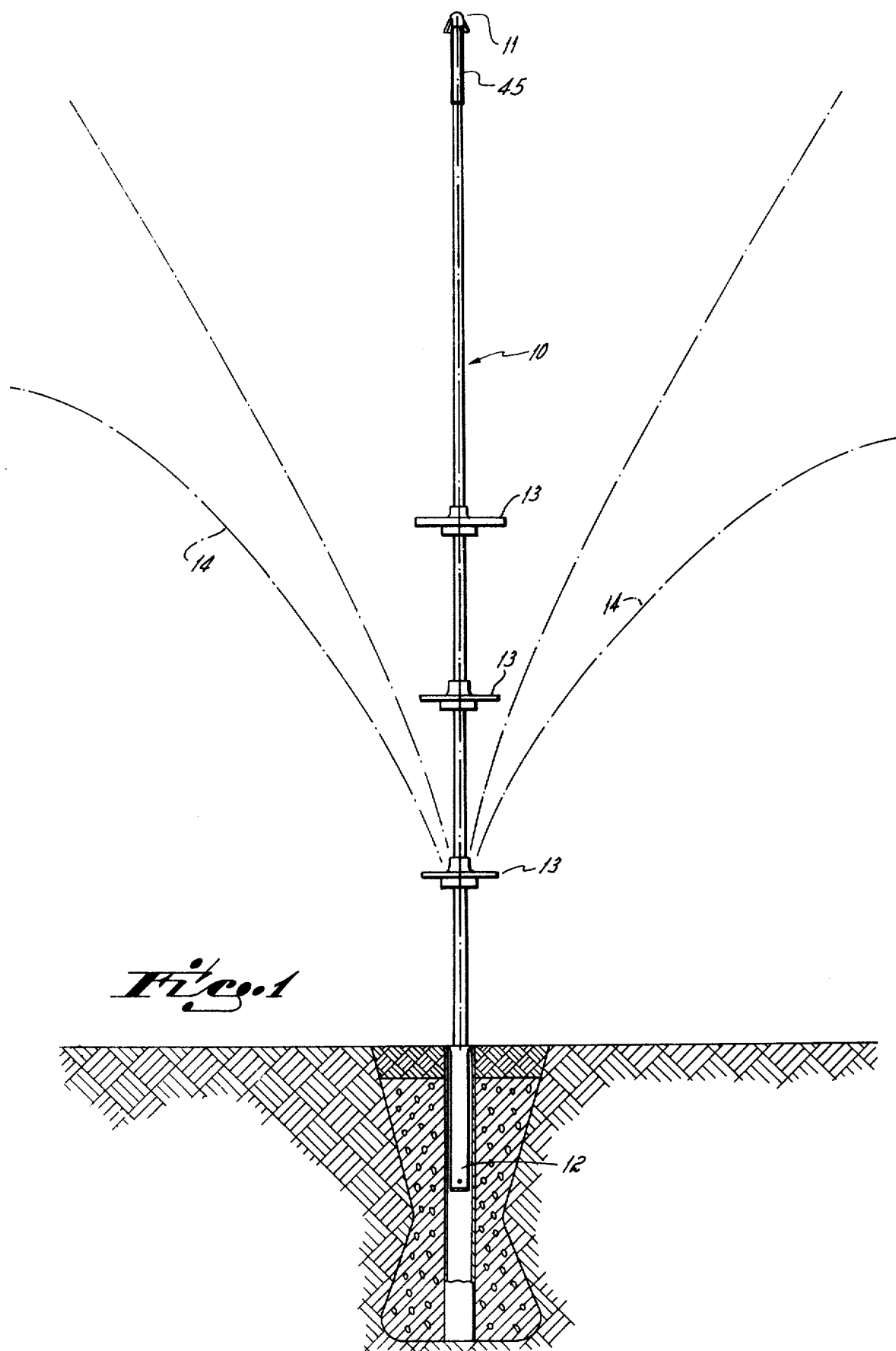
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[57] ABSTRACT

A fiberglass gymnastic pole and the method of designing and making it. The pole is hollow and formed by wrappings of different shapes and fiber orientation of fiberglass fabrics to vary the taper. The final product is wrapped in a thin polyvinyl fluoride sheath. The sheath is ultraviolet absorbant to retard degradation of the polymeric binder by solar radiation. Strain gages are utilized to optimize the design characteristics.

2 Claims, 11 Drawing Figures





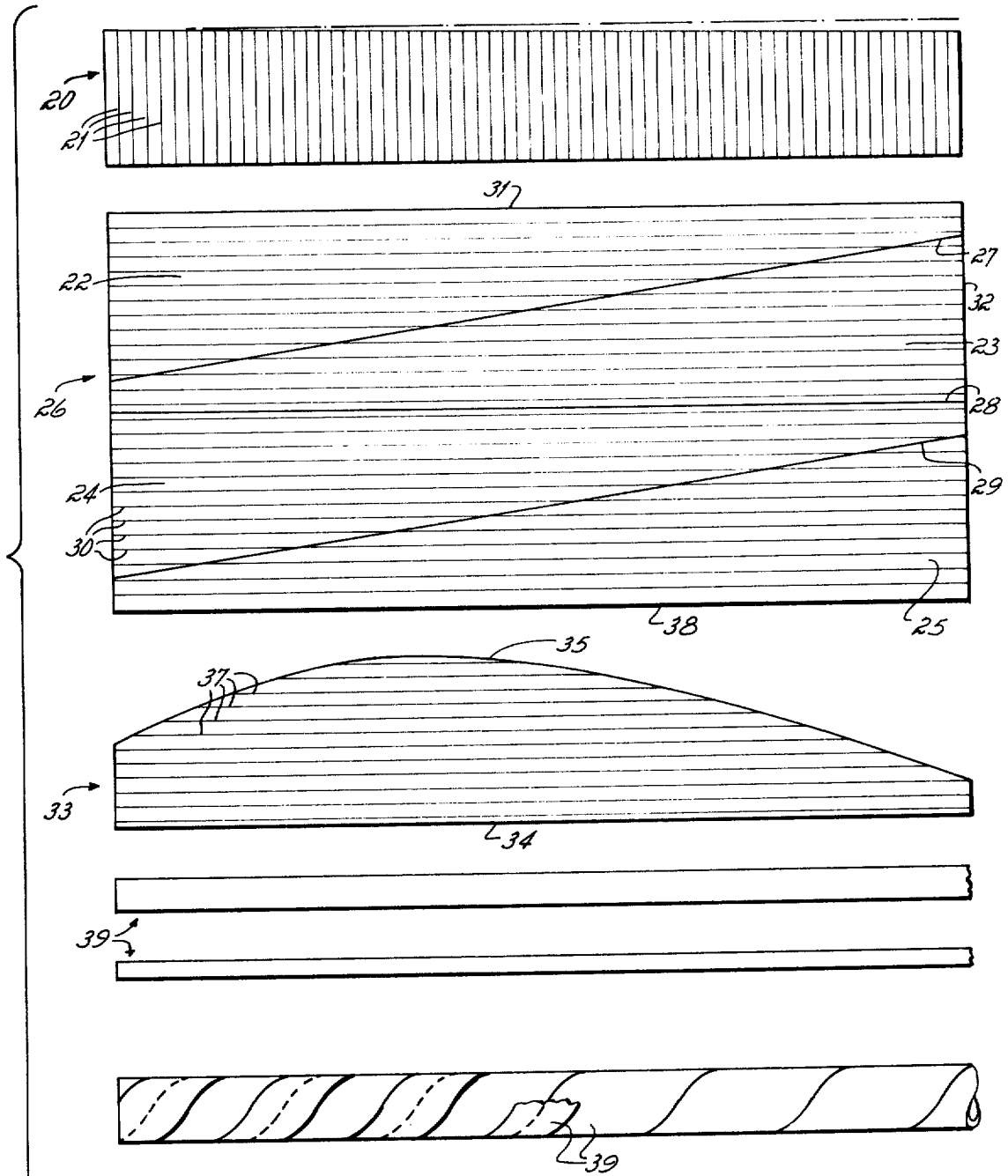


Fig. 2

POLE X

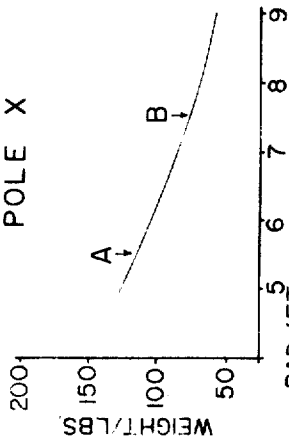


Fig. 3

OD TAPER, CONSTANT .045"/FT.

ID TAPER, CONSTANT .038"/FT.

FEET 1 2 3 4 5 6 7 8 9 10 11 12 13

Fig. 6

POLE Y

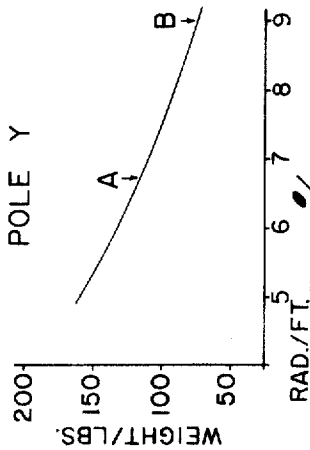


Fig. 4

OD TAPER
.035"/FT. A } .055"/FT.

ID TAPER, CONSTANT .038"/FT.

FEET 1 2 3 4 5 6 7 8 9 10 11 12 13

Fig. 1

POLE Z

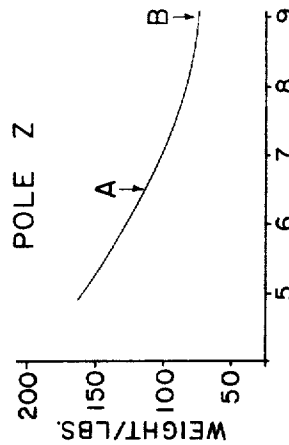


Fig. 5

OD TAPER
.035"/FT. B } .070"/FT.

ID TAPER, CONSTANT .038"/FT.

FEET 1 2 3 4 5 6 7 8 9 10 11 12 13

Fig. 8

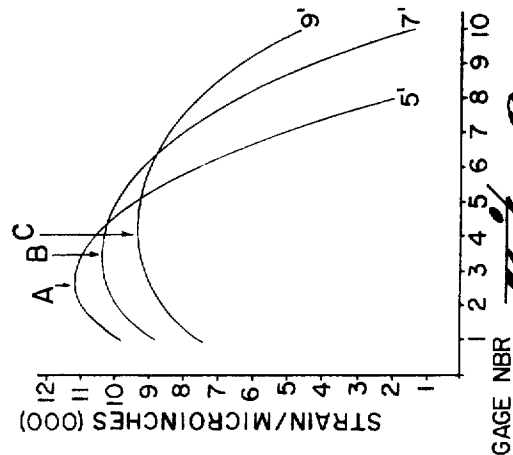


Fig. 9

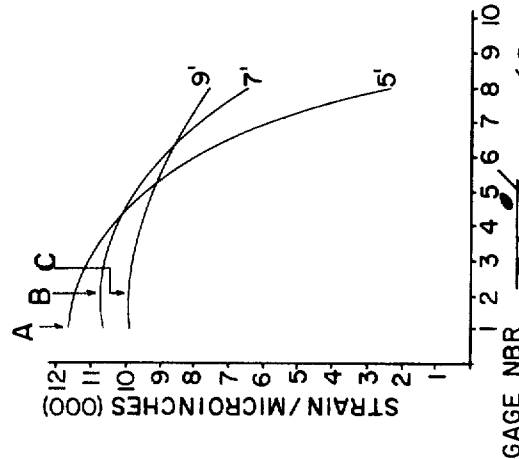


Fig. 10

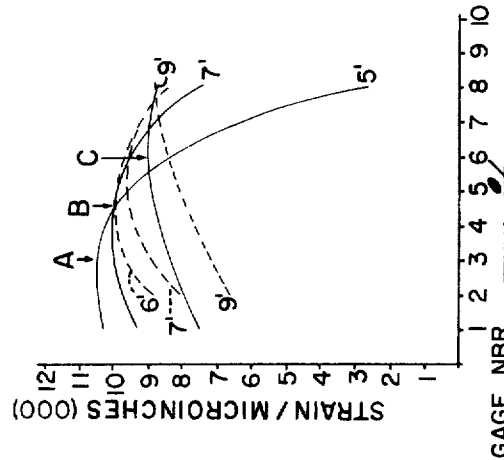


Fig. 11

3.880,422

GYMNASTIC POLE AND PROCESS OF MAKING SAME

This invention relates to a gymnastic amusement device, and more particularly, the invention relates to a flexible, fiberglass pole having one end mounted in a socket, the other end adapted to support a gymnast for various acrobatics, the invention being an improvement in the poles disclosed in U.S. Pat. Nos. 3,246,893 and 3,480,274.

A representative pole to which the present invention is directed is about 13 feet long and about 1 inch in diameter. The pole is mounted in a socket to a depth of about one foot and is retained in the socket by upper and lower elastomeric bushings. The 12 foot portion which projects above the bushings is quite flexible, being capable of being bent at least through about 90° and has sufficient resiliency to support a gymnast and to spring back from a stressed condition with the body of the gymnast, thereby permitting the gymnast to perform a wide variety of acrobatics.

The original poles were formed from a bundle of fiberglass fibers compressed together and adhered by a suitable binder. The poles performed satisfactorily from the standpoint of being flexible, resilient and giving the gymnast a good ride.

An objective of the present invention has been to provide a pole structure which constitutes improvements over the state of the art up to the time of the present invention. These improvements are directed toward increasing the life of the pole, increasing the energy which can be stored in the pole when it is deflected under stress by a gymnast to improve the efficiency, that is, the energy per pound of material used in the formation of the pole, and to improve the capability of supporting weight as far toward the end of the pole as possible so as to give a gymnast of any given weight a greater radial distance from the base of the pole about which to gyrate.

As indicated above, the original poles performed satisfactorily, but to be commercially acceptable the poles would have to have a satisfactory resistance to fatigue, that is to say, they should be capable of being ridden more or less continuously over an 8 hour day and last for over a year so as to be acceptable for use at schools and commercial establishments. Whereas a fiberglass vaulting pole might be used 500 times in its life, for example, it is contemplated that the present invention will be subjected to a million or more comparable flexures.

It has been determined that there are a number of factors which must be taken into consideration in improving the life of the pole. In the original pole, the severest strain on the pole has been at the location of the upper bushing by which the pole is mounted in a socket. One objective of the present invention has been to design the pole so that the maximum strain is above the bushing and, hence, minimizing the contribution to the fatigue failure of that bushing bearing against the pole.

It is contemplated that a pole would be used by persons of varying weights. Persons of varying weights will normally grasp the pole at different points along its length, the heavier the person the closer to the base that he finds it necessary to grab the pole in order to be properly supported by the pole for a good ride. An objective of the present invention has been to design the pole so that the point of maximum strain varies along

the length of the pole depending upon the point at which the pole is grasped. Thus, as different persons use the pole, the point of maximum strain varies; hence, no single point is continuously subjected to maximum strain which would tend to cause the pole to fail earlier at that single point.

Another objective of the invention has been to provide a pole structure specifically including a thin, outer wrap of plastic material which is resistant to ultraviolet light. The wrap not only improves the appearance of the pole, but prevents the scuffing and thus rupturing a few fiberglass fibers, and further tends to reduce the degradation of the binder for the fiberglass fibers when subjected to the sun.

Another objective of the invention has been to improve the energy-storing characteristics of the pole. This objective of the invention has been attained by designing a taper characteristic into the pole which tends to make the strain, along the length of the pole, more uniform when the pole is flexed. With a uniform taper, the maximum strain is close to the base of the pole. Toward the end of the pole, the detected strain is less than half the maximum. Since the strain is directly related to the stress and the stress is directly related to the energy stored in the pole, it can be appreciated that in uniformly tapered pole, considerably less energy is stored near the tip than near the base of the pole. By making the strain along the length of the pole more uniform, not only can a greater energy be stored in the pole, but it also provides for a more stimulating ride by the gymnast out toward the end of the pole.

Another objective of the invention has been to improve the energy efficiency of the pole, the energy efficiency being the energy stored divided by the weight of the pole or volume of material used in the pole, thereby making the pole more economical. Stated another way, it might be possible through the use of additional material to improve the energy storage characteristic of the pole, but if the energy storage characteristic of the pole can be improved without greatly increasing the amount of material in the pole, then a more economical pole has been designed.

Another objective of the invention has been to provide a pole design by which the radial distance from the base of the pole at which a gymnast can achieve a good ride is increased.

These objectives of the invention have been achieved in part by providing an improved method step in designing of the pole, the improved step consisting of the utilization of strain gages spaced along the length of the pole whereby the strain distribution can be determined under differing loading conditions, and whereby the energy storage conditions can be ascertained; all very rapidly after an empirical change has been made in the configuration of the pole.

The foregoing objectives are also achieved in part by several design improvements in the configuration of the pole.

As indicated above, the first poles were solid, of uniform diameter, and were constructed of a bundle of fibers joined together by a binder. It is, of course, known that in a solid pole the central portion of the pole contributes little to the characteristics of the pole as compared to the outer portion of the pole. Hence, a first step in the design of the pole has been to form a hollow pole preferably by wrapping a fiberglass fabric about a mandrel.

A second step has been to introduce a taper into the pole so that near the base, where maximum strain had been occurring, a greater strength would be provided; whereas, out near the tip where greater flexibility was desired, the pole is thinner.

A third step in the redesign of the pole has been to tailor the taper of the pole to improve its characteristics along the lines discussed above. In the preferred embodiment, the tailored taper provides a lesser taper at the base of the pole, an intermediate taper at the central portion of the pole and the greatest taper at the end of the pole.

The tailored taper could of course be achieved by configuring a single fabric wrap about a mandrel, but it is preferred, for reasons of economy, ease of manufacture and improved structural characteristics, to tailor the taper through the utilization of several pieces of fiberglass fabric, one of the pieces being a "shim," the major portion of which is at the central portion of the pole.

Another feature of the invention relating to the design of the pole relates to the orientation of at least the outer fabric as it is applied during the wrapping of the fabric about the mandrel. Heretofore, it has been customary to begin the wrapping of a cut fiberglass fabric with the selvage edge as the starting edge, for the selvage edge gives the operator much greater control and ease of application. Here the "selvage edge" means that edge which has been cut parallel to the longitudinal fibers as contrasted to a bias cut. In accordance with the present invention, where several pieces of cut fabric are employed, the innermost are started in the customary fashion. However, at least the outermost fabric is started at its bias cut edge even though this is a more difficult procedure, for it leaves the outermost edge as the selvage edge of the fabric. It has been found that where the selvage edge is the outer edge, the tendency of a defect to start along the edge of the outer fabric is greatly reduced.

The several objectives of the invention will become more readily apparent from the following detailed description taken in conjunction with the accompanying drawings in which:

pole length for the poles of FIGS. 3, 4 and 5, each curve showing a pole load at a different point along the length of the pole.

In the following description of the pole, it should be understood that the absolute numbers for length of the pole, diameter of the pole, rate of taper of the pole are exemplary only and can be varied within limits, although approximate proportional relationships of the units in the exemplary poles should be maintained when the size of the pole is altered.

Referring to FIG. 1, the pole is indicated generally at 10 and has a tip 11 and a butt end 12. The butt end is mounted in a socket generally of the tube described in U.S. Pat. Nos. 3,246,893 and 3,480,274. Steps 13 may be provided as described in U.S. Pat. No. 3,480,274 to make it easier to mount the pole and to provide an upper step which is used by the gymnast to support himself from time to time during his acrobatics.

The pole is adapted to flex or bend in any direction in a 360° circle around the pole, as indicated generally by the broken lines 14.

Since there is no particular acrobatic advantage to be gained from bending the pole clear to the ground, as a standard of reference and desirability, it is preferred that the acrobat bend the pole only as far as his shoulder. As a standard for pole design, it is assumed that the height of the user's shoulder is 5 feet above the ground.

The pole of the present invention is hollow and is formed by wrapping a fiberglass fabric, impregnated with a binder, about a mandrel which is rotated between three elongated rollers. After the fabric is applied and while the binder is still in the plastic state, the mandrel is subjected to inwardly directed pressure applied by an air bag surrounding the pole to tightly compress the fibers and binder and heat is applied, thereby completing the formation of the pole. The process steps and apparatus described above are generally known and do not form part of the present invention.

All of the poles discussed hereinafter are 13 feet long, except for the final pole to be discussed, that one having originally been made as a 13 foot pole and then having 1 foot of its butt end removed.

The remaining dimensions are set forth in the following tabulations:

Pole	ID Taper	OD	ID	Point of change of taper from butt	OD at point of change of taper	OD Tip	ID
X	.038"/ft.	1.400"	1.080"	—	—	.800"	.590"
Y	.038"/ft.	1.440"	1.080"	60"	1.270"	.805"	.590"
Z	.038"/ft.	1.460"	1.080"	36"	1.330"		
				72"	1.190"	.680"	.590"

FIG. 1 is an elevational view of a pole as constructed in accordance with the present invention;

FIG. 2 is a diagrammatic plan view of the general configuration of the pieces of fiberglass fabric and sheath which are used to form the pole;

FIG. 3 is a curve of a weight-supporting characteristic of a straight tapered pole;

FIG. 4 is a similar curve of a pole having a double taper;

FIG. 5 is a similar curve of a preferred pole having a triple taper;

FIGS. 6, 7 and 8 are diagrammatic illustrations of the tapers of the poles of FIGS. 3, 4 and 5, respectively; and

FIGS. 9, 10 and 11 are curves of the strain versus

The three principal poles differ from each other in only one major respect. The first pole X has a uniform outside taper of .045 inch per foot, the second pole Y has two different outside tapers, the first being .035 inch per foot from the butt to point A which is 5 feet from the butt and a taper of .055 inch per foot over the remaining portion of the pole.

The third pole Z has three outside tapers, the first being .035 inch per foot in the lowermost 3 feet, the second being .045 inch per foot in the second or intermediate 3 feet, and .070 inch per foot in the remaining 7 feet. The inside dimensions and tapers are identical on all poles.

A first comparison of the capabilities of the three poles is illustrated in FIGS. 3, 4 and 5.

Each curve is a plot of the weight of the gymnast against the radius of the pole. The term "radius of the pole" is defined as the distance from the base of the pole horizontally and radially out to the point at which the gymnast stands. For example, in FIG. 3 point A is at a 5½ foot radius and point B is at a 7½ foot radius. At the 5½ foot radius, a gymnast weighing 116 pounds is supported just weightless when the pole has been pulled to his shoulder. A 75 pound gymnast can move two feet farther out and be just weightless as he stresses the pole to the 60 point.

By referring to FIG. 4, the improvement created by the change in the pole taper can be observed. In FIG. 4, the 116 pound gymnast is weightless at more than 1 foot farther away from the base of the pole so that theoretically he can gyrate over a 6½ foot radius as contrasted to the 5½ foot radius as permitted by the pole of FIG. 3. An even greater improvement is provided for the 75 pound gymnast, for he can go all the way out to the 9 foot radius before he becomes weightless.

The third pole which has the greatest improvement in the taper provides substantially the same weight-varying characteristic as the pole of FIG. 4, but other characteristics of the pole have been markedly improved, as will be seen from the discussion below.

FIGS. 9, 10 and 11 show curves of a strain on the respective poles as measured when the pole was deflected to 60 at 5 foot, 7 foot and 9 foot radiuses, respectively. The abscissa is calibrated in gage numbers which correspond to the length of the pole, it being understood that the lower strain gage nearest the butt, which is number 1, is 14 from the butt and all the remaining gages are 1 foot apart toward the tip.

The area under each curve is a measure of the energy stored in the pole under the condition of bending at the location indicated. In the first pole, the energy stored in the pole is very great close to the butt and considerably less out toward the end of the pole where it is gripped. This reflects a rather poor utilization of the pole material. That situation is improved in the double taper pole of FIG. 10 and comes closer to being optimized in the triple taper pole of FIG. 11.

It will be noted that on the pole of FIG. 9, the approximate points of maximum strain A, B and C are rather close together, being separated by a distance of about 1½ feet. On the pole of FIG. 10, the points of maximum strain are even closer together, being separated by about a foot. As to these two poles, the most wear or fatigue on the pole occurs in a very small area even when the pole is used by differing people who would grasp the pole at different positions.

On the three tapered pole of FIG. 11, the points of maximum strain are widely separated over a distance of approximately 3 feet which tends to greatly enhance the life of the pole for the total amount of use.

The broken line curves of FIG. 11 are those of a pole identical to that of the solid line curves except that 1 foot has been removed from the butt end of the pole. This fore-shortening of the pole had the effect of shifting the maximum strain points toward the right. This tends to demonstrate further how the distribution of the strain can be changed by varying the configuration of the pole and suggests the possibility of changing characteristics of the pole for different users. For instance, on a pole for a small child, it is desirable to have a pole relatively short so that he will not be too far from the ground and feel more secure. This makes a stubbier

pole which ordinarily will be subjected to higher strains, but by increasing the taper of the pole, it is possible to put more curvature in it and change the strain levels although a different shape of pole is used.

For certain maneuvers of the pole where the user rides on top of the pole, an extreme curvature would occur and this would be undesirable. Therefore, on an adult size pole where the user is more apt to do this maneuver, it would be more desirable to have less taper in the top of the pole and a straighter pole. To offset the higher strains incurred, it is possible to make the pole longer in proportion to its diameter and thus control the strain in this way.

While the pole may be formed of a single wrap of fiberglass fabric, it is preferred, for reasons of improvement of strength, ease of manufacture and the like, to fabricate the pole from a plurality of wraps, as illustrated in FIG. 2.

The first wrap, indicated at 20, is a trapezoidal section in which the dominant structural fibers are oriented in a transverse direction, as indicated by the lines 21. That wrap has a width dimension sufficient to make two turns around the mandrel which has a .038 inch/foot taper. This wrap provides the necessary radial strength for the pole.

The next wraps are provided by two of the four fabric sections 22, 23, 24 and 25 cut from the rectangular fabric 26. The fabric 26 is cut along the lines 27, 28 and 29, the cut lines 27 and 29 being bias cut and the line 28 being a selvedge cut in that it is parallel to the longitudinally directed fibers indicated at 30.

For convenience of the operator in applying the fabric, for example, the fabric 22, it is preferred to begin the wrap at the selvedge edge 31, for the selvedge edge is much easier to line up in the forming apparatus than the cut edge 27. Similarly, the fabric 23 could be started at the selvedge edge 28, the longitudinal direction of the fabric being reversed so that the wider end indicated at 32 is applied to the butt end of the pole.

After the application of the first two sections, a shim section indicated at 33 is applied, beginning at the selvedge edge 34. The opposed edge 35 provides and determines the final refined tailoring of the pole taper. The illustrated configuration of the shim section, in conjunction with the angles of the bias cuts on the other applied fabrics, provides the three tapered pole whose characteristics are illustrated in FIGS. 5, 8 and 11. Again, the principal structural fibers are longitudinally oriented, as indicated by the lines 37. Following the application of the shim fabric, the fabric 24 is applied beginning at the selvedge edge 28. Section 25 constitutes the last fiberglass fabric to be applied, and it is preferred that it be started at the bias cut edge 29 so that the outermost fiberglass edge on the pole is a selvedge edge, as indicated at 38. It has been determined that there is markedly less fraying of the fiberglass, or stated another way, the fiberglass begins to fray after a great many more cycles of operation if the final fabric edge is a selvedge edge.

After the fabrics have been applied, the pole is treated in a conventional manner which includes the radially inwardly compressing of the pole by placing it in a bag and subjecting it to uniform air pressure and to heat to cure the resin.

It is preferable to wrap the sections 23, 24 and 25 in opposite directions because they tend to spiral slightly, the last fiber having approximately a 2½° angle to the

axis of the pole. By wrapping them in opposite directions, those slightly spiral, longitudinal fibers will cross each other to provide uniform characteristics throughout 360° of use. Further, by the use of multiple sections, the spiral of the final fiber is held to 2½° whereas if a single piece were used, the spiral of the final fiber would be 10°. The inner wrap contributes approximately 10 mils thickness per wrap. The remaining sections contribute 12.5 mils per wrap, between 10 and 15 wraps being applied.

Before the pole has been cured, it is enclosed in a plastic sheath 39 which is preferably of a 1 mil thick polyvinyl fluoride, for example Tedlar by du Pont, material having been treated to be resistant to ultraviolet rays. In the preferred form of the invention, the sheath is formed on the pole by spirally or helically first wrapping a small width, for example, 2 inches, slightly overlapped around the length of the pole. A second 1 inch wrap, preferably of a different color, is wrapped over the overlap to complete the application of the sheath.

In one embodiment of the pole, the fiberglass fabric has a green pigment. The first wrap of polyvinyl fluoride is preferably pigmented white to cover up the green pigment of the fiberglass. The binder tends to leak slightly through the overlap of the first layer and, hence, the second layer, of a different color, covers up the binder.

It should be understood of course that the colors and

pattern of the plastic sheath are subject to wide variation without departing from the scope of the invention.

The tip end of the pole may be provided with a wrap of plastic, substantially thicker than the sheath to provide an enlarged diameter hand grip as indicated at 45 in FIG. 1.

Having described our invention, what we claim is:

1. A fiberglass pole having a butt end adapted to be mounted in a socket and a tip at the end of said pole opposite said butt end, said pole comprising, an elongated pole of circular cross section, the outside surface of said pole being tapered from butt end to tip, the outside surface of said pole at the lower portion adjacent said butt end having a taper of approximately .035 inch per foot, the central portion having a taper of approximately .045 inch per foot, the upper portion of said pole having a taper of approximately .070 inch per foot, the inside diameter of said pole having a uniform taper of approximately .038 inch per foot.
2. In a fiberglass pole having a plurality of predominantly longitudinally oriented fibers joined by a curable binder, the improvement comprising, a plastic sheath surrounding said pole, said sheath being a very flexible, ultraviolet-absorbent, polyvinyl fluoride.

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