

April 10, 1962

J. P. FALCONER
ROOF CONSTRUCTION

3,028,706

Filed March 14, 1960

4 Sheets-Sheet 1

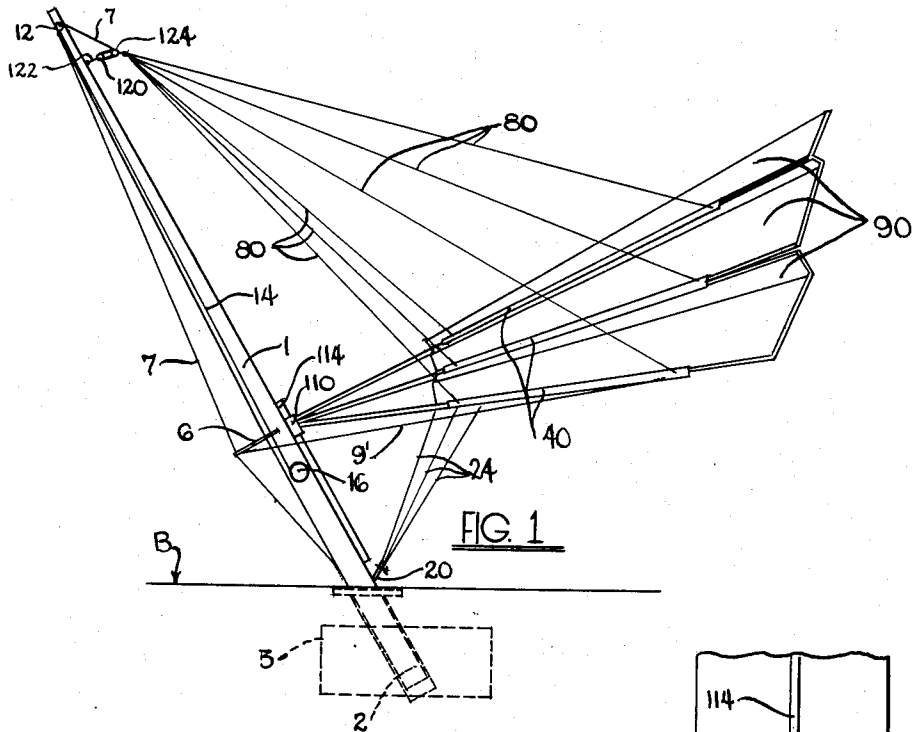
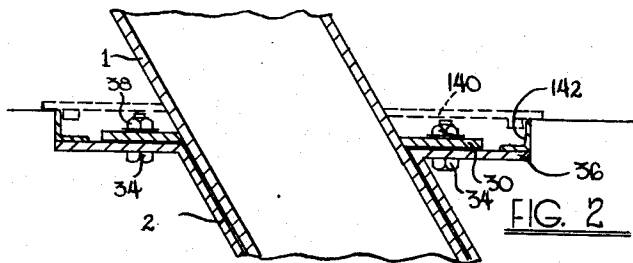
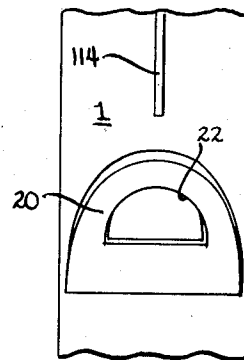
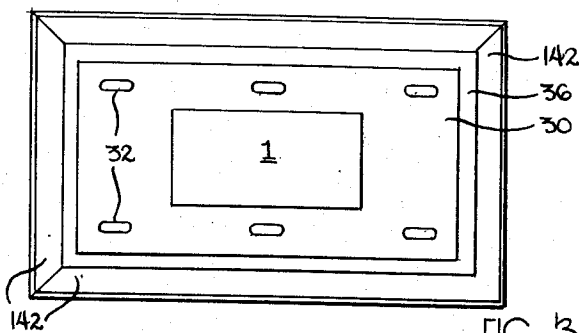


FIG. 4

FIG. 3

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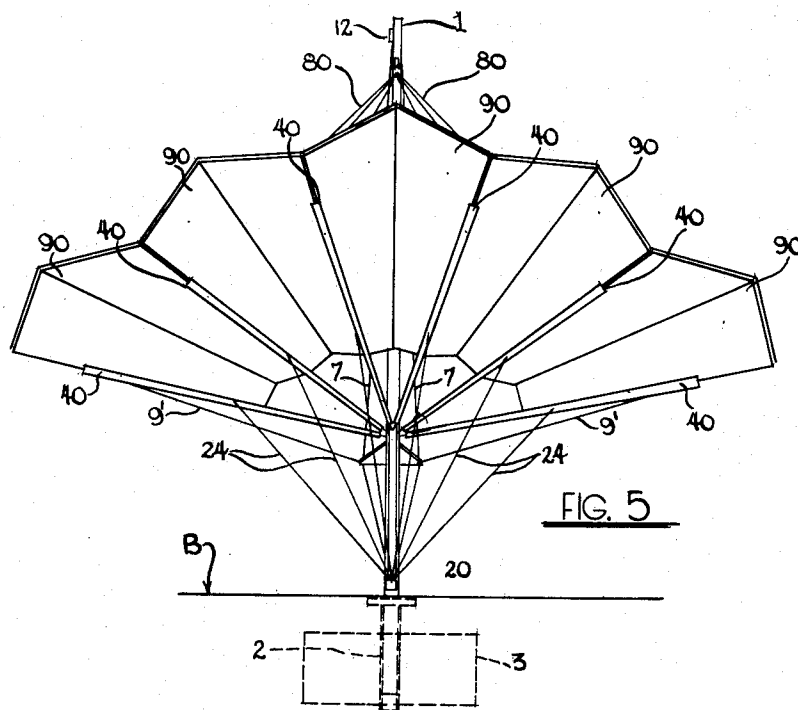


FIG. 5

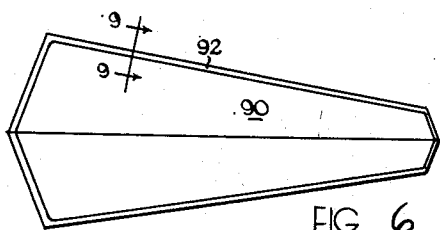


FIG. 6

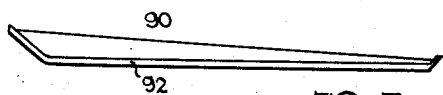


FIG. 7

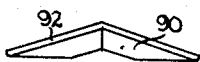


FIG. 8

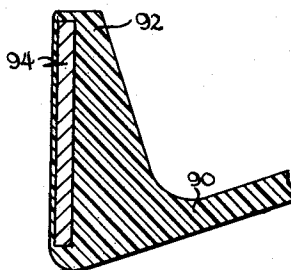


FIG. 9

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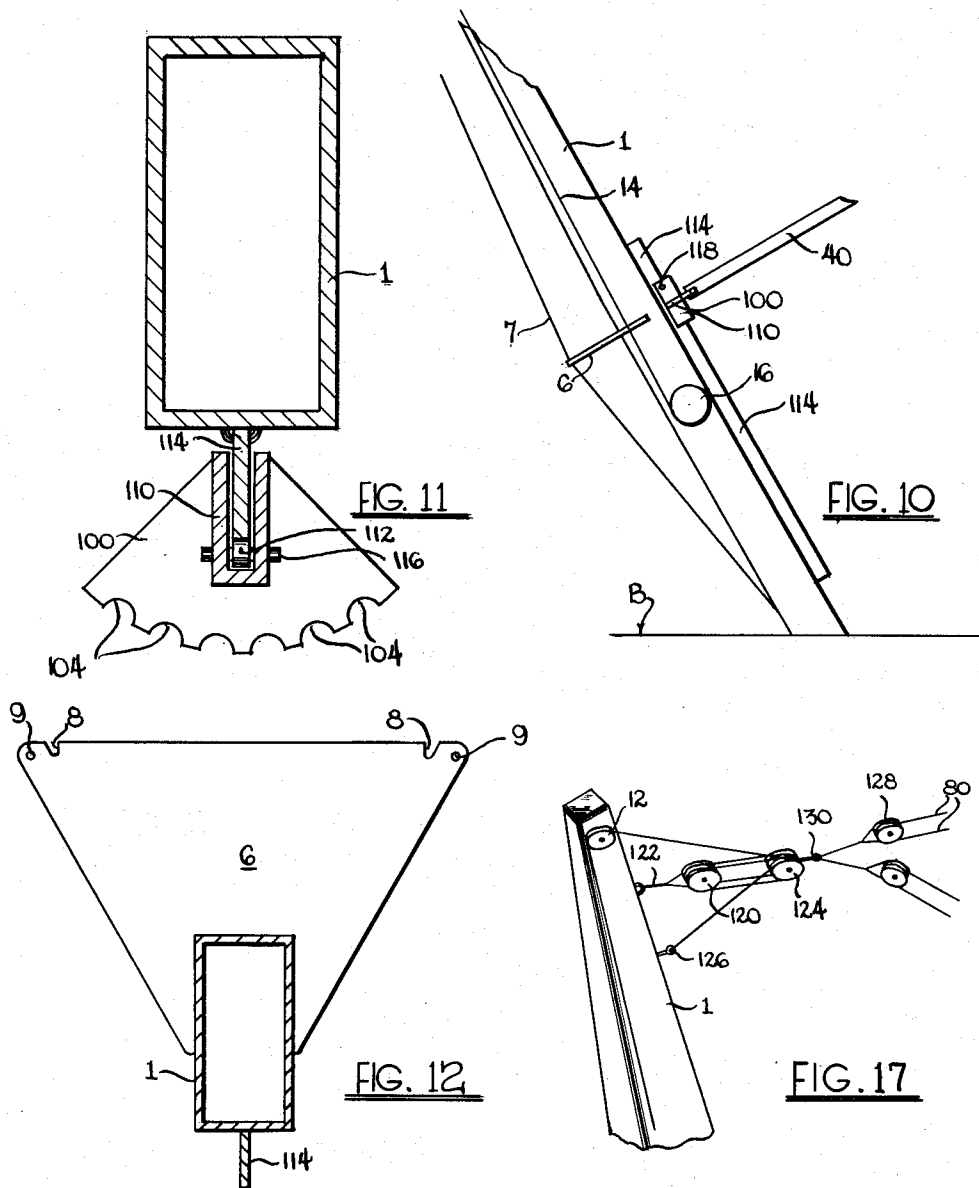
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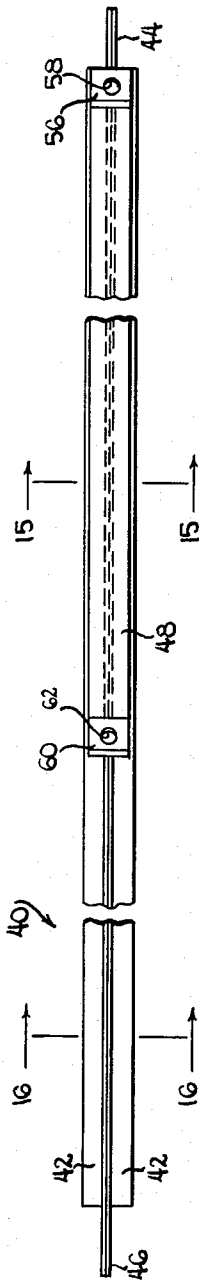


FIG. 13

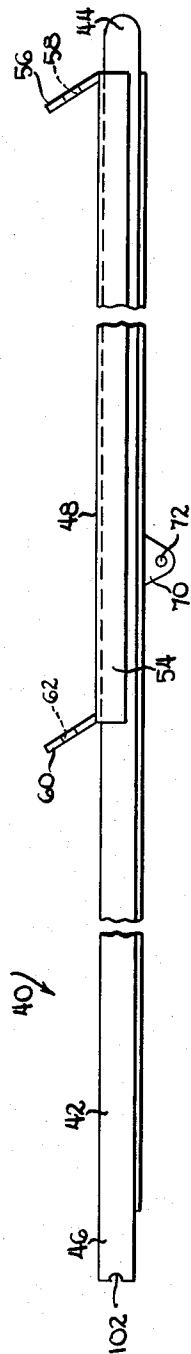


FIG. 14

FIG. 16

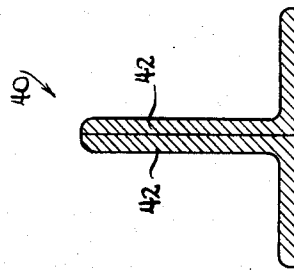
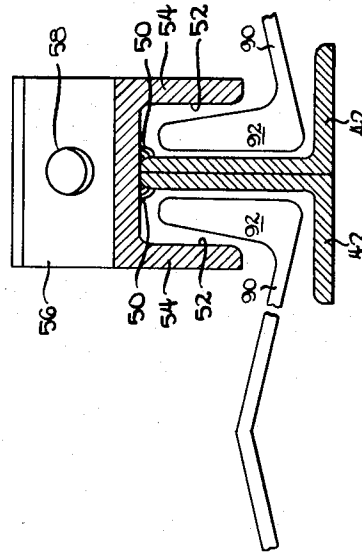


FIG. 15



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ROOF CONSTRUCTION

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2 Claims. (Cl. 50-48)

The present invention relates to new and useful improvements in structural refinements in roof or shell constructions and more particularly relates to roofs or shells adapted for spanning or enclosing or covering areas where few or no intermediate supports can be or are desired to be used, as for instance in the case of a covering over a staging area from which performances by individuals or groups before audiences may be made.

Broadly speaking, the invention envisions a plurality of spaced-apart, flexible, supporting elements which are engageable with and carried by a support means in manner whereby said supporting elements form catenaries adapted to sustain a plurality of joined-together roof-like or shell-like elements in a covering relationship.

The invention resides in the particular arrangement, construction and relationship of the various elements, components and instrumentalities of the construction as exemplified in the detailed disclosure hereinafter set forth wherein the objects of the invention, as defined in the paragraphs below, will be apparent and is particularly directed to an inventively novel and improved roof construction of the type in which a plurality of flexible roof supporting elements are adapted to be secured to a central support, such as a mast, in manner to serve as catenary roof-supporting elements adapted to sustain a multiplicity of roof or shell sections, all whereby an inexpensive, light, durable and readily installed roof or shell is provided.

It is another salient object hereof to provide a construction whereby a variable shape in the arcing or arching of the roof or shell, relative to the ground or base which it overlies, can be attained according to the type of performance to be rendered thereunder, it being appreciated that, for different types of performances, due principally to the acoustical problems attendant thereto, different configurations of arched roof may be desirable. For a performance of chamber music, for example, a different type of roof construction might be preferred to that desirable for a performance of band music, or of choral music, or of a play, or of a lecture.

By means hereof, one using a shell is enabled, by varying the lengths of the boom bridles, to obtain any one of a variety of arched effects. In this manner, the finalized shape of the shell can be modified to suit the requirements of the individual usage.

The size of the performing group, the type of work performed by such group, and the type of equipment which is necessitated in connection with the performance of such group, are essential considerations determining the form or configuration which the shell may be called upon to take for any specific use.

Additionally, the factors of the location of the shell relative to the surrounding terrain, which may include hills and/or valleys, vegetation, rock formations, buildings, or other obstructions not to mention the size and location of the anticipated audience, are other essential considerations in determining the best shape of roof or shell for a specific purpose.

Given the acoustical advantage of a basic shell form, adjustment can be made by means of this invention which will produce optimum acoustic results for groups with individual performance characteristics, as for example, a chamber group. Now a chamber group, it will be readily appreciated, produces a different type and volume of sound than does a choral group, for example. There is, as only experimentation will advantageously show, a preferred shell form for each, taking into full account all

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other of the aforementioned considerations. Best results are determinable by experimentation and the structural design permits such experimentation with a minimum of physical changes or adjustments. A mere change in the lengths of the boom bridles is all that is necessary to effect such changes.

The invention accordingly embraces broadly the concept of a roof or shell structure offering improved acoustical qualities in connection with performances. Basically the changing of the shape of the shell effectuates a control of the projection and spread of the sounds, allowances being easily made for the different audience conditions encountered.

It will be helpful to an understanding of my invention to first briefly consider some of the more important features and aspects thereof, so that same may be kept in mind during the subsequent reading of the detailed description of the practical embodiment of my improvements and of the illustration thereof in the annexed drawings.

My invention offers improved acoustical qualities in connection with performances by allowing an increase in the projection of the sounds and a control of the spread of the sounds for better audience reception and by allowing an improved mixing of the sounds within the performance area per se to the end that the performers themselves are offered an improved presence of the sounds essential to an optimum quality of performance.

Additionally, a roof or shell structure is indicated wherein a light, portable unit is provided which can be readily dismantled for storage during the off-concert season or other non-use periods and/or for transportation to other sites for recreation and reuse.

Other of the chief objects and purposes hereof are to provide advantageous structural and operational features in a construction of the class to which reference has been made so as to provide an invention having the following meritorious characteristics: first, a simplicity in construction and compactness of design and therefore an adaptability to economical manufacture; second, a uniqueness in engineering design of coating parts whereof the components are coordinated for facile assembly; third, a susceptibility to easy installation and/or adjustment with respect to the various purposes to which it is intended; fourth, a high degree of efficiency and dependability in its operational use; fifth, the securement of a higher degree of accuracy and greater degree of variety in the manner of work performed therewith than has heretofore been possible with prior devices known in the art; sixth, the provision of a construction which is well adapted to withstand the usage to which a roof or shell construction is ordinarily subjected, and seventh, the provision of such other improvements in and relating to roof or shell constructions as are hereinafter described and claimed. To the end of attaining these objects and other incidental ends and advantages reasonably appearing, some of which will in part be obvious and apparent and some of which will in part be more fully pointed out in the progress of the disclosure, it will be explained that the invention consists substantially in the combination, construction, location and relative arrangement of parts, as described in detail hereinafter, as shown in the annexed drawings, and as defined with particularity in the appended claims forming a part hereof.

It will be apparent that the physical embodiment delineated is only indicative of but one of the various ways, albeit the preferred exemplification, in which the principles of the invention may be employed and in which the component parts may be combined and arranged. Same is submitted as one best known embodiment of the invention in accordance with the patent statutes and is given with a view to illustrating and explaining the

precise nature of the principles of the invention and their embodiment for practical use, in order that others skilled in the art may be enabled to adapt and modify them in numerous embodiments, variations and modifications, each as may be best adapted to the conditions of any particular use.

In the accompanying drawings, wherein like characters of reference are employed to designate like or corresponding parts throughout the several views:

FIG. 1 is a side elevational view of the structure of my invention;

FIG. 2 is a fragmentary sectional view showing the detail of the mast and the complemental mast socket base plates;

FIG. 3 is a top plan view of the one of the mast socket base plates shown in FIG. 2;

FIG. 4 is a fragmentary front elevational view of a portion of the mast component showing the detail of the boom downhaul connected thereto;

FIG. 5 is a front elevational view of the structure shown in FIG. 1;

FIGS. 6, 7 and 8 are plan, side and end elevational views respectively of a typical plastic shell section;

FIG. 9 is an enlarged sectional view on the line 9—9 of FIG. 6 showing the details of one of the side edges of a typical plastic shell section;

FIG. 10 is a side elevational view of the lower part of the mast above the base or ground level showing the backstay plate, boom track, boom slide, and part of a typical boom;

FIG. 11 is a sectional view through the mast and boom track and boom slide showing the boom connecting plate in plan view;

FIG. 12 is a sectional view through the details of the mast and boom track and showing the backstay plate in plan view;

FIG. 13 is a top plan view of a boom;

FIG. 14 is a side elevational view of the boom shown in FIG. 13;

FIG. 15 is an enlarged sectional view on the line 15—15 of FIG. 13 showing the relationship of adjacent shell edges in place;

FIG. 16 is an enlarged sectional view on the line 16—16 of FIG. 13; and

FIG. 17 is a small scale fragmentary perspective view showing the upper end of the mast and the relationship of the various blocks and halyard thereat.

Before the structure here illustrated is specifically described, it is to be again particularly understood that this invention is not limited to the structural details or arrangement of parts here shown since a construction embodying the present invention may take various forms, it being susceptible of various modifications and alternative constructions.

I do not thereby intend to limit the invention to the specific form disclosed, but rather intend to embrace herein all modifications, variations, alternative constructions, and equivalents falling within the spirit and scope of the invention and within the meaning and preview and range of equivalency of this disclosure.

With continued reference now to the drawings, I have shown an assembly having principal parts including a mast 1, comprising an elongated section of generally rectangular configuration. The dimensions thereof and the material from which same is made may be determined according to the stresses induced by the size and weight of the booms and shell sections supported thereby when the construction is disposed in one of its operative positions.

A mast socket 2 comprises an open-ended sleeve-like member of a size and shape complemental to the outside dimensions of mast 1 so as to receive the lower extremity of said mast therethrough and to hold same rigidly in situ and angularly relative to the horizontal plane of

the ground or base B above and over which mast 1 and its supported elements may be projected.

Mast socket 2 is preferentially firmly encased or embedded in a poured concrete footing 3 (shown in dash lines in FIGS. 1 and 5 for purposes of simplification) which is sunken into the ground or base B at a distance below the surface thereof and functions to aid in the support of the mast 1 and its supported elements and in the resistance thereof to any unwanted overturning movements as possibly induced by dead loads of the unitary structure and/or by live wind loads.

Welded to mast 1 and extending transversely thereto and rearwardly and outwardly therefrom intermediate its opposite extremities is a generally triangular shaped backstay plate 6, as best shown in FIGS. 1 and 10, and as shown in detail in FIG. 12, and which functions in the manner of a spreader to provide an angular disposition to a pair of backstays 7 and 7 relative to and at opposite sides of the longitudinal axis of mast 1.

A pair of spaced recesses 8 are provided in the outer rearward edge of backstay plate 6. Each backstay 7 is receivable in one of said recesses wherefor same are held in spaced relationship as to each other and as to mast 1. The upper and lower ends of each backstay 7 are secured to the head and foot portions respectively of mast 1. Each backstay may be provided with a turnbuckle (not shown) conveniently located along its length to permit easy adjustment of the tension thereof.

The backstays function to strengthen mast 1 in its resistance to forward bending and to obviate excessive forward deflection as induced by the weight of the shell and boom assembly.

Adjacent the outer rearward corners of backstay plate 6, suitable openings or apertures 9 are provided therethrough permitting ready attachment thereto of the rearward extremities of respective stabilizing guys 9' of a pair thereof, as will be observed by reference to FIG. 1.

A pulley or cheek block 12 is fixed to the upper extremity or head of mast 1 and is arranged for accommodating the passage therethrough of a halyard 14 in known manner as same is payed out from or taken up by a winch 16 which is rotatably mounted on one side of mast 1 at a convenient working point therealong. Winch 16 functions to take up or pay out halyard 14 upon the raising of lowering of the assembled structure.

To the forward face of mast 1 at a point closely adjacent and above base B, an outwardly and forwardly projecting connecting plate 20 may be fixed as by a weldment. The plate is apertured at 22 for the passage therethrough of the lower ends of a plurality of boom downhauls 24 whereby said boom downhauls may be secured relative to mast 1.

Below connecting plate 20 and secured to mast 1 as by a weldment or the like, a centrally apertured sleeve-like mast socket upper base plate 30 is provided. See FIG. 3. Upper base plate 30 is sleeved around and fixed to mast 1 and is provided with a plurality of elongated slots 32 therethrough in opposite corners thereof. The slots are adapted to receive bolts 34 therethrough for the securement of base plate 30 to a similarly centrally apertured lower base plate 36 which it overlies. Base plate 36 is sleeved around and fixed to mast socket 2 as by a weldment or the like.

It will be appreciated that opportunity for lateral shifting between mast 1 and mast socket 2 is lessened by virtue of the juxtaposed upper and lower base plates 30 and 36, one being fixed to said mast and the other being fixed to said mast socket, with the base plates being suitably bolted to each other by the bolts 34 extending through the vertically aligned openings and the nuts 38 threadably engageable therewith.

The construction of each of the booms of the plurality thereof will now be described with reference to FIGS. 13—16. The booms of the plurality thereof are identical in construction and are generally indicated by numeral 40.

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Structural sections, called angles 42, such as shown in FIGS. 13-16, may be placed in back-to-back relationship and held fixed to each other as by weldments or the like. Other sections, such as channels or the like, could be used with equivalent results.

As best shown in FIGS. 13 and 14, the vertically extending webs of the angles 42 and 42 are of such length as to overhang at the opposite ends of the section in manner to provide a forwardly extending tail portion 44 and a rearwardly extending tail portion 46.

A generally U-shaped channel section 43 is disposed in inverted relationship to the joined-together angles 42 and 42 and is welded or otherwise fixed to the juxtaposed top planar surfaces of the vertically extending webs thereof as by weldments 50 in manner to provide a pair of longitudinally extending pockets 52 on the opposite sides of said vertically extending webs.

Entrance to a pocket thereto is gained through the respective mouth defined by the horizontally extending web of angle 42 and the related downwardly depending web 54 of the U-shaped channel section 43, as best shown in FIG. 15.

Extending upwardly from the forward extremity of the channel section 43 and disposed angularly relative thereto is a forward bridle connection 56 having an aperture 58 extending centrally therethrough.

Extending upwardly from the rearward end of the channel section 43 and disposed angularly relative thereto is a rearward bridle connection 60 having an aperture 62 extending centrally therethrough.

Depending downwardly from the horizontal webs of the angles 42 and 42, and approximately intermediate the length of the boom 40, a boom downhaul connection 70 is provided having an aperture 72 extending centrally therethrough.

Members 56 and 60 permit the attachment to the boom 40 of the respective forward and rearward legs of a boom bridle 80 and member 70 permits the connection of the boom downhauls 24 to the boom.

A plurality of fan-shaped plastic shell sections 90, detailed in FIGS. 6, 7 and 8, are identical in shape and construction, and are thus capable of being stacked during storage or transporting periods, with a minimum of space being required.

In FIG. 9, I have shown an upstanding side edge 92 of a typical shell section 90, same being of a shape such as to permit the free sliding of said side edge into a pocket 52 of one of the booms 40 for engagement therewith in manner to permit a certain amount of play between the respective shell section and boom.

The side and leading edges of the shell sections may be reinforced for purposes of offering stiffness by the use of a metallic strip 94 laminated into the plastic, as best shown in FIG. 9.

Booms 40 are connected to mast 1 by means of a connecting plate 100, which may be generally triangular in configuration, as shown in FIG. 11.

The rearward extremity of the tail portion 46 of each boom 40 is provided with a semi-circular notch 102 as shown in FIG. 14. Notch 102 is engageable in the appropriate one of a series of complementary semi-circular notches 104 in connecting plate 100 in manner to provide a universal joint between connecting plate 100 and the respective boom 40, particularly when and as said boom is thrust rearwardly upon the raising of the assembly.

A generally U-shaped boom slide 110 extends transversely to the plane of said connecting plate and is receivable in a slot in said connecting plate so as to extend upwardly and downwardly thereof. Said boom slide is fixed to said connecting plate as by a weldment or the like. See FIGS. 10 and 11.

A pair of spaced, parallel-disposed vertically-spaced roller bearings 112, one on each side of member 100 are each rotatably mounted on the boom slide 110 as by a pin 116. The bearings 112 permit boom slide 110 to

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travel vertically relative to mast 1, along a boom track 114 fixed to and extending outwardly therefrom, until the predetermined operating position of the booms is attained. At such point, boom slide 110 is locked to boom track 114 by means of a pin 118 inserted in aligned openings located in both boom track 114 and boom slide 110, as shown in FIG. 10.

All standing and running rigging, comprising backstays 7, stabilizing guys 9', halyard 14, boom bridles 80 and boom downhauls 24, is made from high tensile strength, marine galvanized or stainless steel wire rope of sizes adequate to carry the stresses induced by dead and live loads.

A block 120 is loosely secured to mast 1 downwardly of the cheek block 12 as by a link 122 so as to be loosely articulated relative thereto, as best shown in FIG. 17.

A block 124 spaced outwardly of block 120 rides free as halyard 14 is taken in or payed out, the upper free end of the said halyard 14 being secured relative to mast 1 as by an eye bolt 126 fixed to mast 1 in any known manner and receiving the end of halyard 14 in the eye thereof.

The number of sheaves or pulleys in the respective blocks 120 and 124 may be dependent upon the size and hence the weight of the shell being lifted thereby, there being always one more sheave in the block 124 than in the block 120 all to the end that an adequate mechanical advantage is offered so as to enable winch 16 to raise or lower the assembly through the halyard with ease.

It will be understood that the halyard 14 is passed back and forth around the sheaves of the blocks 120 and 124 in known manner.

A plurality of boom bridles 80 are provided, there being one for each said boom 40. Each boom bridle comprises a pair of legs of a wire rope or the like, which legs are secured at their outer ends to the respective forward and rearward boom bridle connections 56 and 60 on the respective boom 40.

The inner ends of the legs are interconnected and run freely over a boom bridle block 128 which is loosely secured to the block 124 as by a link 130.

In the raising and lowering of the assembly, the boom bridles 80 are self-adjusting. The legs of each boom bridle change in length as the assembly is raised or lowered so as to distribute the strain created by the weight of the assembly between the two points of the boom connections 56 and 60.

Each boom bridle 80 may incorporate a turnbuckle (not shown) for precision adjustment of the length thereof.

The boom bridles will be identical in construction except that their lengths may vary, it being appreciated that the outer boom bridles are necessarily longer than the inner boom bridles.

The several boom downhauls 24 are attached at their lower ends to the boom downhaul connecting plate 20 and at their upper ends to the downhaul connections 70 on each boom, they functioning to resist the possible lifting action of a strong wind directed at the assembly.

Each said boom downhaul may incorporate a turnbuckle (not shown) for precision adjustment of the length thereof.

The boom downhauls will be identical in construction except that their lengths may vary, the inner downhauls being necessarily longer than the outer downhauls.

The pair of stabilizing guys 9' are attached at their forward ends to the two outermost booms at points near the forward bridle connections 56 and at their rear ends to the corners of the backstay plate 6, and function to resist any threatened rotation of the assembly about the mast and to locate the assembly symmetrically about the mast centerline. Each stabilizing guy is provided with a turnbuckle (not shown) for precision adjustment of length. Each is identical in construction and length.

Mast 1 may remain permanently in situ or may be re-

moved for storage or use at other locations where the footing and mast socket 2 are installed.

If mast 1 is removed, a cover plate 140 may be placed over and secured to an angle iron frame 142 attached to the peripheral edges of mast socket base plate 36. See FIGS. 2 and 3.

Assuming that the footing and mast socket are in place, mast socket cover plate 140 may be removed and mast 1 may be raised and slipped in place in the mast socket. The base plates 30 and 36 are then bolted together.

The booms may be laid out on the ground in the rough shape of the shell, and the booms bridles may be attached to the respective booms.

The shell sections may then be slipped into the channel sides of the booms and the boom bridle blocks may be attached to the halyard block 124.

With the boom slide in the lowest position on the track, the rear ends of the booms may be inserted into the connecting plate, working from the center pair of booms progressively outwardly to the outer booms, and raising the assembly slightly with winch 16 as each pair of booms is attached to the connecting plate so that the booms may be forced back and held in place.

When all of the booms are in place in the lowered position, the stabilizing guys may then be attached and the assembly may be winched into the desired operative position.

When the boom slide reaches its upper predetermined location, it may be locked in place relative to the track.

Boom downhauls may then be attached to the booms and mast, and the turnbuckles of the downhauls and stabilizing guys may be adjusted so as to achieve equal firmness in all rigging and to remove all slack.

To lower the construction, this process is reversed.

The structure hereof permits the use of three or five shell sections together with four or six booms respectively.

Five shell sections have been found to give improved acoustics control but in some cases, where the performing group may be small in number, three sections may be adequate.

Inherent in the design is the ability to adjust the vertical pitch of the shell sections so as to produce a maximum control, and quality of the acoustics under varying performance conditions.

The construction achieves its shell like effect because of the fact that the out board bridles attached to the out board booms are on opposite sides of the shell and are longer than the center bridles attached to the center booms, the intermediate bridles being of intermediate lengths therebetween.

Of course, if desired, the exact reverse situation could apply with different results being attained.

The lengths of the bridles being used would depend upon the effect desired to be attained.

Generally, it will be appreciated that as the arching, or curvature of the roof is increased, the horizontal spread is decreased, a feature which may be desirable in the case of smaller performing groups.

The invention is not restricted to said embodiment and same is not intended to be exhaustive of, nor limiting of, the spirit or scope hereof. That is, the precise construction of the figures of the drawing need not be slavishly

followed as, of course, various elements or details thereof may have to be adapted or modified in accordance with any particular use to which it is to be put.

Without further analysis, the foregoing is intended to so fully reveal the gist of my invention and its construction and operation that others can, by applying current knowledge, readily adapt it for various applications without omitting features which from the standpoint of prior art, fairly constitute essential characteristics of its generic and/or specific aspects. The substitution of equivalents and other changes, modifications and alterations as circumstances may suggest or render expedient, are contemplated since the invention is susceptible of such without departing from its real spirit or underlying principles. Stated otherwise, it is not desired to limit this invention to the exact construction shown and described as the objects thereof may be attained by the use of constructions different in certain respects from that disclosed.

The invention is claimed, broadly as well as specifically, as indicated in the appended claims, and same are desired to include within the scope thereof all of said suitable variations, modifications and equivalents by which substantially the results of the invention may be obtained through the use of substantially the same or equivalent devices or means. Accordingly, limitation hereof should only be made as determined by a proper interpretation of the subjoined claims.

What is claimed as new and useful is:

1. An acoustic shell comprising, an elongated mast, a boom track fixed to said mast, a boom slide slidably mounted upon said boom track, a connecting plate fixed to said boom slide, a plurality of channelled booms having inner extremities journaled in said connecting plate and extending in fanlike arrangement in a curved plane substantially transverse to the longitudinal axis of said mast, a plurality of shell sections each supported by two adjacent booms of said plurality thereof, an adjustable halyard payable outwardly over a cheek block mounted on said mast by a winch mounted on said mast and having a block at the outer free end thereof, a plurality of boom bridle blocks each loosely connected to the block of said halyard, a plurality of boom bridles each being movable over one of the boom bridle blocks of said plurality thereof and having opposite legs articulated to the forward and rearward ends of one of the booms of said plurality thereof, and a plurality of boom downhauls each having opposite ends recessed to one of the booms of said plurality thereof and to said mast.

2. In the acoustic shell as set forth in claim 1, including means for varying the angularization of the shell sections of said plurality thereof relative to said mast and comprising means for drawing in and paying out said halyard by means of the winch.

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