United States Patent [19]

Behrendt

[11] **3,789,401**

[45] **Jan. 29, 1974**

[54] **FRAME FOR LOW FREQUENCY SOURCE**

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[22] Filed: **Feb. 16, 1971**

[21] Appl. No.: **115,355**

[52] **U.S. Cl.** ..... **340/8 S,** 310/9.1

[51] **Int. Cl.** **H04b 13/00**

[58] **Field of Search**..... 340/8, 8 S, 9, 10; 310/9.1, 310/8.7

[56] **References Cited**

UNITED STATES PATENTS

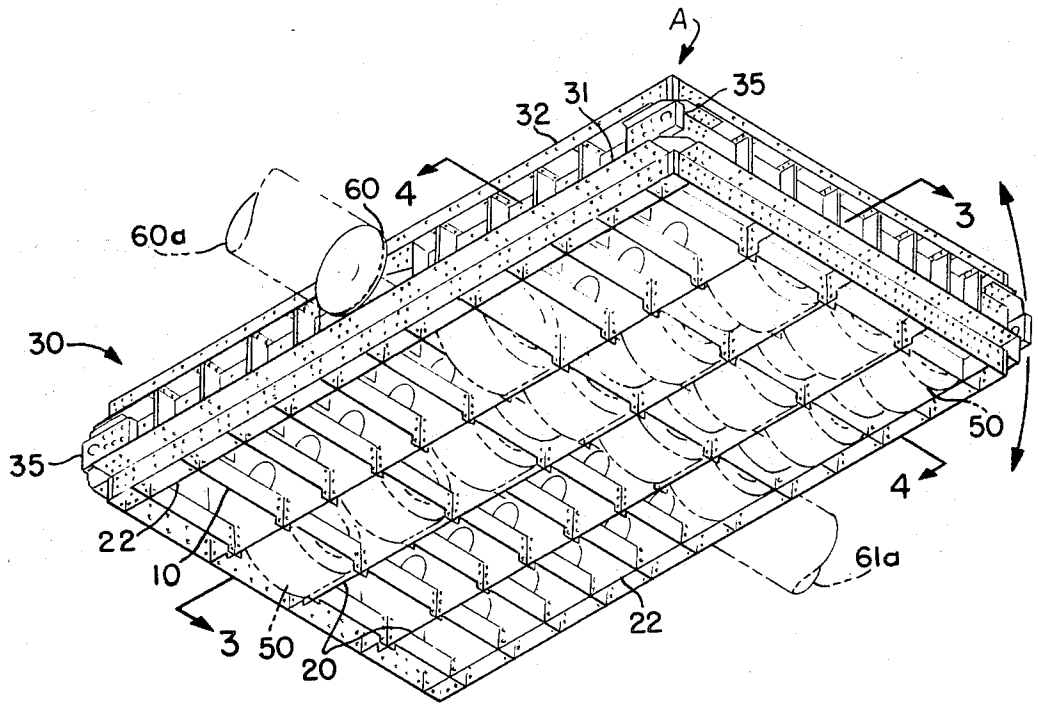
2,844,809	7/1958	Batchelder	340/9 UX
2,610,018	9/1952	Rettinger	340/8

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[57] **ABSTRACT**

A transducer array is supported by a plurality of interconnected longitudinal and lateral fiber-glass members which terminate in a rigid, rectangular frame work defining the limits of a transducer mounting area. All points of juncture between the fiber glass members and the rigid framework are frictionally secured to induce no coupling-induced internal stresses at the juncture points. By mounting the high-energy transducer elements on the fiber-glass members, a tendency for resonance and sympathetic vibration within the supporting structure is dampened to within tolerable limits. Contemporary, rigid frameworks, especially those frameworks that are welded together, resonate with the projection of high-energy acoustic power and tear themselves apart.

8 Claims, 8 Drawing Figures



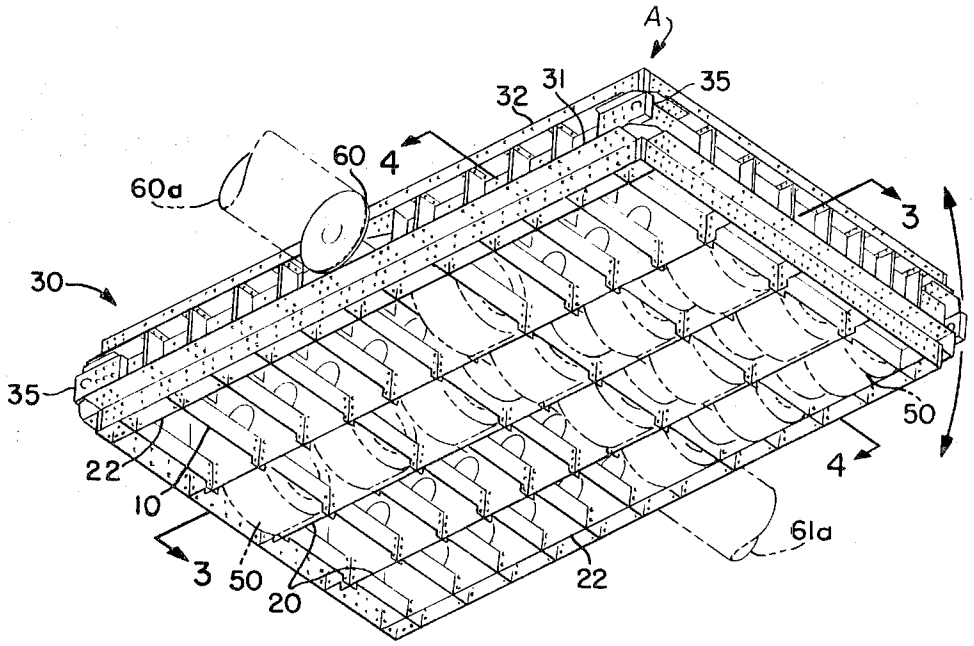


FIG. 1

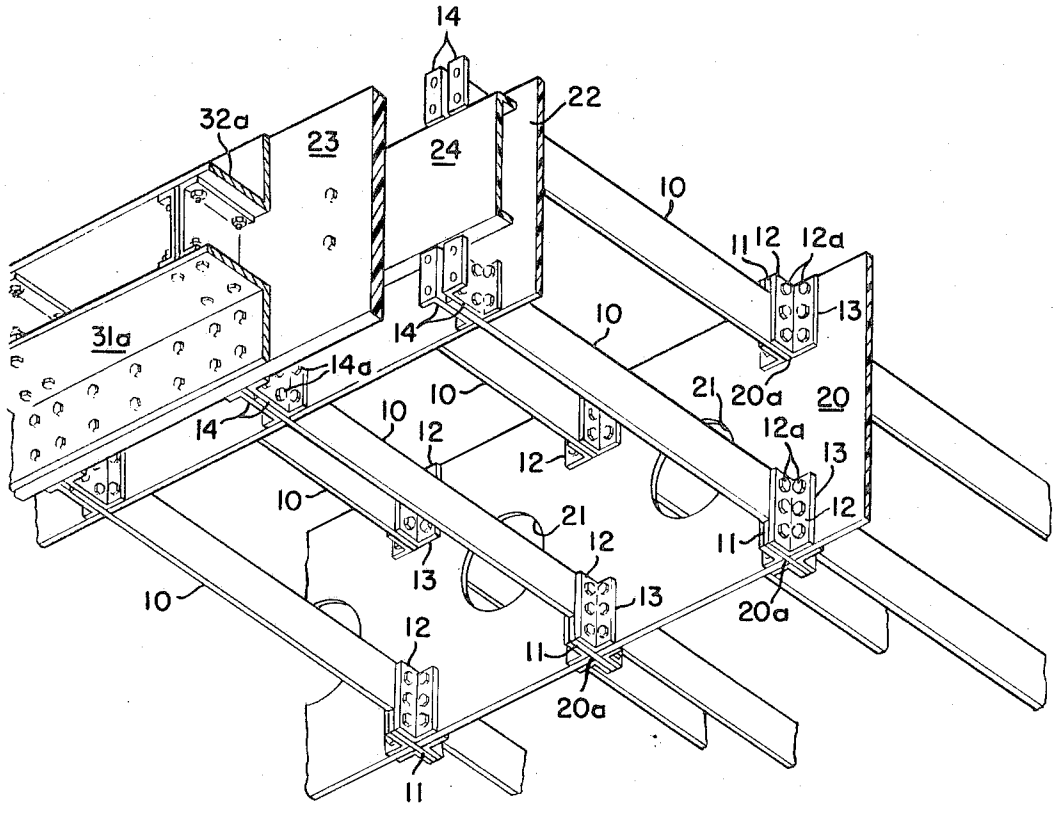


FIG. 2

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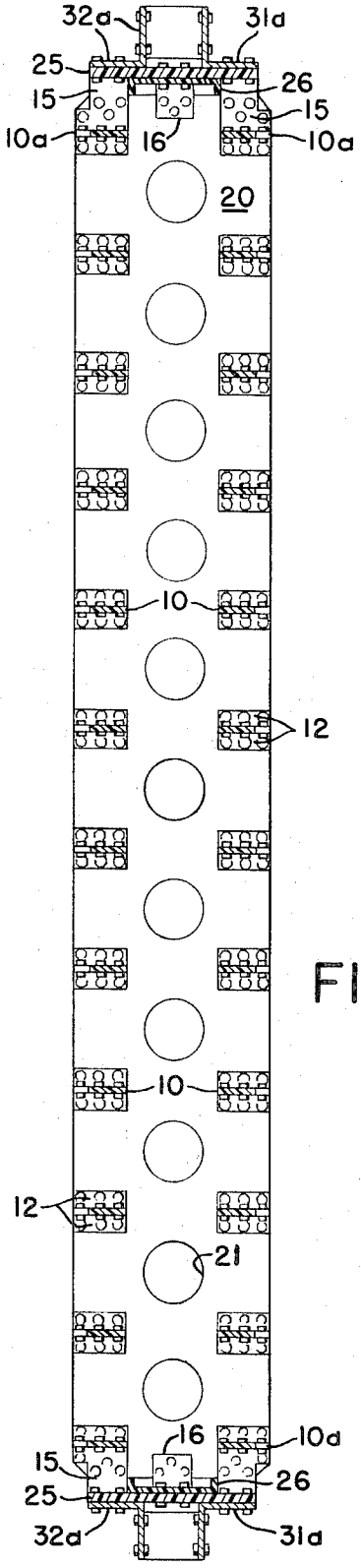


FIG. 3

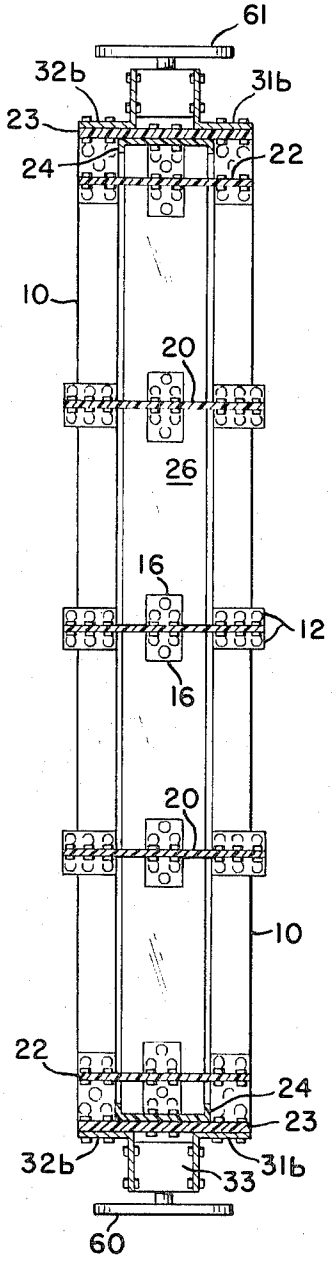


FIG. 4

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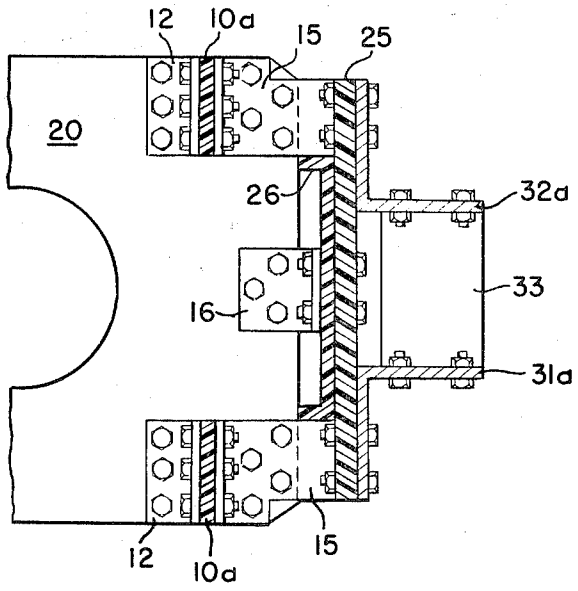


FIG. 3a

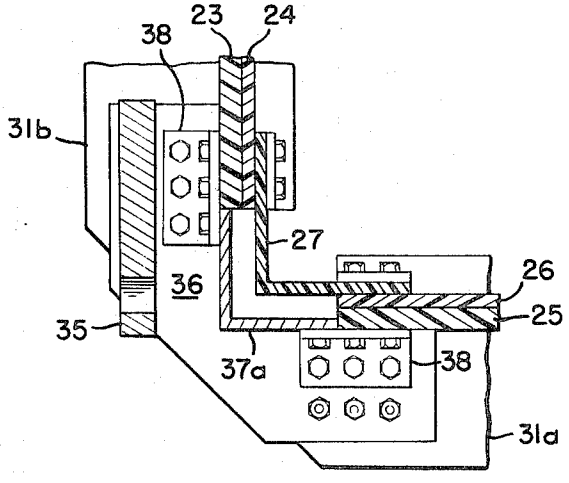


FIG. 6

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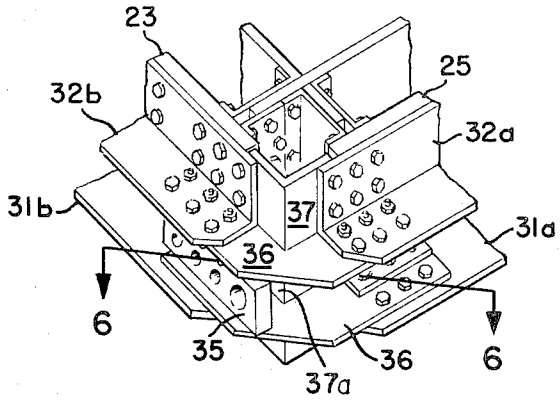


FIG. 5

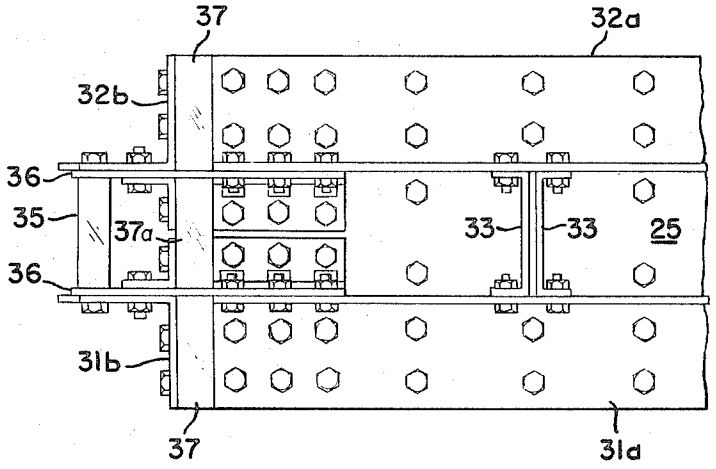


FIG. 7

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FRAME FOR LOW FREQUENCY SOURCE

STATEMENT OF GOVERNMENT INTEREST

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

BACKGROUND OF THE INVENTION

With the increased interest in undersea communications and navigation, higher and higher-power sonar systems are being developed. Individual projection elements, driven in excess of one kilowatt, are common and, when a multielement array is transmitting simultaneously, driving powers in the 20 to 30 kilowatt range are common place. Further technological advances predict the fabrication of arrays driven at much higher energy levels. Prior to these recent advancements in sonar technology, the supporting frameworks for a single transducer element or an array of such elements have been structurally sound. However, as the higher driving powers are applied, conventional supporting structures are inadequate, especially when the arrays are driven at the lower frequencies. This is because the rigid, supporting members of these arrays have lengths equaling a sub-integral-multiple of the projected energy wavelength which resonates with the transmitted energy. Such resonance has two main, intolerable effects, those being, the pattern of projected acoustic energy is distorted or muddled, and self-destructive internal stresses are set up within the supporting members. While phasing techniques of the discrete elements forming the transducer array tend to nullify the distortion patterns, the destructive internal stresses remain to tear the supporting members from one another due to the fact that the members are usually welded together. Welding the members together creates high internal stresses at their points of juncture. When the condition of resonance exists within the framework, the additive forces attributed to the welding stresses and the induced resonant stresses often greatly exceed the tensile strength of the welded joints between structural members and they tear themselves apart.

SUMMARY OF THE INVENTION

The present invention is directed to providing an assembly for supporting a high-energy transducer array and includes a right, rectangularly-shaped framework defining an array mounting area. A plurality of longitudinal, fiber-glass members reaches across the mounting area and orthogonally intersects a plurality of lateral fiber glass members extending across the array mounting area to define a plurality of cavities for each receiving an element of the transducer array. Having all points of juncture among all members of the supporting assembly coupled in a frictionally engaging manner, eliminates the possibility of self-destructive resonance within the supporting assembly and does not introduce points of structural weakness.

The prime object of the invention is to provide a supporting assembly for a high energy transducer array.

Another object is to provide a supporting assembly connected to induce minimal internal stresses in the structural members.

Yet another object is to provide a supporting assembly formed of relatively flexible, acoustically decoupling fiber-glass support members which dampen sympathetic vibration and resonance.

Still another object is to provide a supporting structure having all points of juncture frictionally coupled.

A further object is to provide a supporting assembly having integral supporting members acoustically severed by including a series of spaced, frictional connections creating a series of nodes to avoid low-frequency resonance.

These and other objects of the invention will become more readily apparent from the drawings when taken with the ensuing description.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is an isometric depiction of the invention.

FIG. **2** is an isometric view showing the frictional engagement between longitudinal and lateral members.

FIG. **3** is a cross-sectional view generally taken along lines **3—3** in FIG. **1.**

FIG. **3***a* is an enlargement of a detail of FIG. **3.**

FIG. **4** is a cross-sectional view generally taken along lines **4—4** in FIG. **1.**

FIG. **5** is an isometric close-up of corner "A" in FIG. **1.**

FIG. **6** is a cross-sectional view generally taken along lines **6—6** in FIG. **5.**

FIG. **7** is an end view of corner "A."

DESCRIPTION OF THE PREFERRED EMBODIMENT

In the ensuing description, reference will be made to flexible members and rigid elements. Be it understood that the designation "flexible," i.e., flexible members or structural components, in whatever configuration, means that the particular member is formed of epoxy or polymer, resin-impregnated glass fibers, or, an equivalent material. These flexible materials exhibit a tendancy for attenuating sound throughout their length and in this respect are said to possess a capability for acoustically decoupling the transmission of sound among interconnected flexible members. The thickness of the members and other critical dimensions are sufficient to provide an adequate static support and to hold up when the approximately 50 transducers, identified below, are simultaneously actuated. All of the flexible members possess a certain degree of "give" and, when not connected to one another, are capable of moderate degrees of flexure when subjected to torsional forces.

On the other hand, the elements having the designation "rigid," are either steel, an alloy, or aluminum, having strength characteristics for supporting and directionally orienting the 50-odd element transducer array. Thus, the flexible members and the rigid elements differ from one another in distinct, readily apparent characteristics to each functionally assist the supported array in reliably, projecting, discrete acoustic-energy patterns.

Referring now to the drawings, the supporting assembly for the transducer array is shown in **FIG. 1** to include three primary groups of elements. Those being, lateral, flexible members **10,** longitudinal, flexible members **20,** and a rectangularly shaped, rigid framework **30** which defines, together with the lateral and longitudinal members, a mounting area in which a transducer array **50** is supported.

The transducers are of a type described in U.S. Pat. No. 3,624,429 entitled: "Free Flooded Deep Submergence Transducer" by John W. Behrendt, issued Nov. 16, 1971. These transducers, only a few being shown in place in FIG. **1** to avoid cluttering the drawings, are carried in cavities defined by the intersecting, longitudinal and lateral members and are capable of projecting acoustic energy at the 135 decibel level. The weight of these transducers is approximately 80 pounds apiece, and thus, the supporting assembly must be substantially constructed to bear the aggregate weight of all the transducer elements.

On opposite, lateral extremes on the outside of the rectangular, rigid framework, mounting flanges **60** and **61** are joined a suitable rotation-imparting structure **60***a* and **61**a carried on a supporting vessel to direct the orientation of the array. In FIG. **1**, a downward orientation is depicted to allow, for example, illumination of the ocean's bottom with beamed, acoustic energy, and from which reflected energy provides signals representative of its topography.

The laterally extending, flexible members reach across the framework in pairs and pass through appropriately sized slots **20***a* provided in the longitudinal members. The lateral, flexible members are shaped as elongate strips having appropriately spaced coplanar extensions **11** including spaced holes for receiving self-locking bolts.

The longitudinal, flexible members are more substantially built than the lateral, flexible members to bear the aggregate weight of the array. Acoustic ports **21** are provided at strategically spaced locations to allow a free circulation of water through the array and to enhance the array's mutual acoustic coupling effects. The longitudinal, flexible members also include traverse holes on both sides of its slots **20***a* for mechanical engagement with additional structure to be discussed below.

Joined between the lateral, flexible members and the longitudinal, flexible members calls for including a plurality one flexible connector angle **12,** having a plurality of lateral bores disposed to align with the lateral member's spaced holes and the longitudinal member's traverse holes for receiving self-locking bolts **12***a*. Tightening the bolts frictionally holds the members together, but does not introduce objectional internal stresses at the juncture areas.

Such objectionable internal stresses are created in conventional frameworks when metal supporting structures are welded together, there being tensile stresses created as the melted welding material cools. In addition, welded structures acoustically appear as elongate, integral members which resonate with high-energy, low-frequency, acoustic transmissions. This resonance, while distorting the transmitted signal, additionally, internally generates resonant stresses within the conventionally welded structures. These resonance-created stresses, additively considered with the welding stresses, rip the welded structures apart and render the entire array inoperative. The bolted connector-angle connections introduce no such internal-welding stresses and break up the integral elongate nature of welded frameworks by creating a series of dampened nodes along the reaches of the lateral and longitudinal members.

Experience has demonstrated that four such flexible connector angles securing each lateral-longitudinal intersection adequately prevent structural failure. The connectors also serve to retain separate transducers within each of the cavities defined by the matrix of lateral and longitudinal members.

Sandwiching a bonding agent **13,** such as epoxy, between the flexible connector angles and the orthogonally disposed, flexible members strengthens their frictional interconnection and also enhances the creation of the aforementioned series of nodes. Inclusion of the bonding agent does not cause internal stresses to be developed.

The opposite, lateral extremes of all the flexible, lateral members pass through appropriately aligned slots provided in slightly modified, longitudinal, flexible members **22,** the modification being a reduction in each member's breadth. The lateral extremes continue on, and are finally clamped between opposing pairs of flexible C-shaped connector members **14.** A plurality of self-locking bolts **14***a*, reaching through aligned holes, frictionally joins the lateral, flexible members to a left or right heavy duty, flexible panel member **23.** A flexible left or right channel member **24** is frictionally secured onto a flexible panel member by bolts to reinforce its load bearing capacity.

In a similar manner, the longitudinal, flexible members are frictionally anchored onto an upper and a lower flexible panel member **25,** reinforced with an upper or lower flexible channel member **26** by modified, flexible C-shaped connector members **15.** The modified, flexible C-shaped connector members also frictionally engage end, lateral, flexible members **10**a onto the longitudinal, flexible members, see FIG. **3**a.

Additional structural integrity and bearing capacity is ensured by including an L-shaped connector member **16** at opposite ends of each longitudinal, flexible member bolting it to the upper and lower flexible panel members through their respectively associated upper or lower flexible channel members.

FIG. **6** shows that frictionally connecting the left and right flexible channel members to the upper and lower flexible channel members at the corners with a bolted, flexible channel-connector angle **27** strengthens the flexible member interface.

Thusly arranged, the lateral and longitudinal, flexible members, frictionally interconnected and frictionally joined to the flexible panel members, acoustically decouple the mounted transducer array from any rigid, resonating framework. Any internally generated sympathetic vibrations are effectively dampened and nullified by the frictional couplings and no additive stresses are generated created which may otherwise approach the self-destructive magnitudes.

Because pivotal support and protection of the heavy weight array is required, inclusion of a rigid, steel or aluminum framework is a necessary evil. The rectangularly-shaped, rigid framework **30** includes two rectangularly-shaped, rigid sections **31** and **32** disposed in a back-to-back relationship. Each of the sections includes a pair of rigid, lateral elements **31***a* and **32***a* and a pair of rigid, longitudinal elements **31***b* and **32***b*. The rectangular sections are held in an essentially parallel relationship by a plurality of C-shaped, flexible spacer elements **33** which serve the dual purpose of maintaining the parallel spaced relationship as well as acoustically decoupling the two rectangularly-shaped, rigid sections from one another.

At each corner of the supporting assembly, the two rectangularly shaped rigid sections are secured to a bearing support block **35** which is bolted between the outwardly extending portions of each of the rigid sections. The bearing blocks provide a support surface for receiving chains or wire ropes when the entire supporting assembly is positioned by a crane and mounted onto rotation-imparting structures **60***a* and **61***a*. The bearing blocks also add structural integrity to the rigid framework, especially when corner mounting plates **36** are included in the bolted interconnection.

Of primary concern for the inclusion of the mounting plates is the linking together of the rigid, lateral elements and the rigid, longitudinal elements. A plurality of bolts reaching through the mounting plates and the outward extension of each of the rigid elements allows their connection, and when a rigid connector angle **37**, three of which being used at each corner, is also bolted to a separate, rigid, lateral element and a separate, rigid, longitudinal element, the peripheral framework is securely interconnected. Middle rigid connector angle **37***a*, not embracing either of the lateral or longitudinal elements, frictionally engages the outwardly facing surfaces of the flexible panel members via a flexible connector angle **38** bolted onto a corner mounting plate, a flexible panel member, and the rigid connector angle, see FIG. **6**.

Inclusion of the matrix of frictionally, interconnected, flexible members, frictionally anchored to the peripherally containing rigid elements, acoustically decouples the supported transducer array from nonyielding, rigid elements which would otherwise resonate or be torn apart. In all the bolted, frictionally held joints, inclusion of the bonding agent, e.g., an epoxy resin, is an optional expedient to ensure secure interconnections, the addition of which introduces no internal stresses to the members involved.

Obviously, many modifications and variations of the present invention are possible in the light of the above teachings, and, it is therefore understood that within the scope of the disclosed inventive concept, the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. An assembly for supporting a high acoustic energy transducer array comprising:

a framework including rigid load bearing members having means for frictionally connecting said load bearing members together to define an array mounting area;

a plurality of longitudinal members reaching across said array mounting area, each fashioned from a flexible acoustically decoupling material having means for frictionally securing said longitudinal members between a first pair of said load bearing members; and

a plurality of lateral members reaching across said array mounting area, each fashioned from a flexible acoustically decoupling material having means for frictionally securing said lateral members between a second pair of said load bearing members and further having means for frictionally joining said lateral members to said longitudinal members to form a plurality of cavities each cavity having a transducer mounted therein, upon transmitting said high acoustic energy, said longitudinal and said lateral members, being frictionally secured and frictionally joined, are acoustically decoupled from said transducer array thereby preventing the creation of self-destructive resonance within the assembly.

2. An assembly according to claim **1** further including:

a panel member formed of a flexible acoustically decoupling material having means for frictionally securing said panel member to said load bearing members, said panel member being disposed around the periphery of said array mounting area and including means for being frictionally secured to said longitudinal members and said lateral members for further preventing the creation of self-destructive resonance within the assembly.

3. An assembly according to claim **2** in which all the means for frictionally joining said longitudinal members and said lateral members cooperate to create a series of dampened nodes along the longitudinal and lateral members preventing the sympathetic vibration and resonance of the members when said transducer array is projecting said high acoustic energy.

4. An assembly according to claim **2** in which said load bearing members are at least one set of four elongate rigid elements arranged in a rectangular configuration and said means for frictionally connecting is a plurality of bolt-nut combinations reaching through coinciding holes provided in portions of the rigid elements thereby ensuring said rectangular configuration free from coupling-induced internal stresses in the rigid elements.

5. An assembly according to claim **4** in which said load bearing members are two sets of four elongate rigid elements each arranged in a rectangular configuration and aligned with one another and said framework further includes,

a plurality of spacer angles formed of a flexible acoustically decoupling material having means for frictionally engaging the periphery of said panel member to each said set of elongate rigid elements.

6. An assembly according to claim **5** further including:

first and second means each affixed to both said sets of elongate rigid elements at laterally opposite extremes for mounting said assembly and defining a lateral axis about which said assembly is rotated.

7. An assembly according to claim **6** in which said means for frictionally joining said longitudinal members to said lateral members include,

at least one connector angle element disposed at each longitudinal-lateral-member-intersection formed with bores disposed to coinciding with similarly disposed holes at each said intersection, and

a self-locking bolt element extending through each of the coinciding bores and holes to ensure the frictional joining of the lateral and longitudinal members.

8. An assembly according to claim **7** further including:

a bonding agent interposed at all the frictional interconnections to aid in maintaining the structural integrity of said assembly.

* * * * *