United States Patent [19]

McDonald et al.

[11] **3,751,869**

[45] **Aug. 14, 1973**

[54] **WIRE SUPPORT STRUCTURE**

[76] Inventors: **Johnnie F. McDonald,** 1113 W. Mesa Rd.; **Frederick J. Sparber,** R.D. 1, Box 192A, both of Belen, N. Mex. 87002

[22] Filed: **Oct. 4, 1971**

[21] Appl. No.: **186,335**

[52] **U.S. Cl.** **52/650,** 52/643

[51] **Int. Cl.** **E04h 12/10,** E04c 5/06

[58] **Field of Search** 52/650, 643

[56] **References Cited**

UNITED STATES PATENTS

2,670,819	3/1954	Stanley et al.	52/650
3,298,152	1/1967	Lockshaw	52/650

FOREIGN PATENTS OR APPLICATIONS

1,221,815	1/1960	France	52/694
205,023	10/1923	Great Britain	52/650

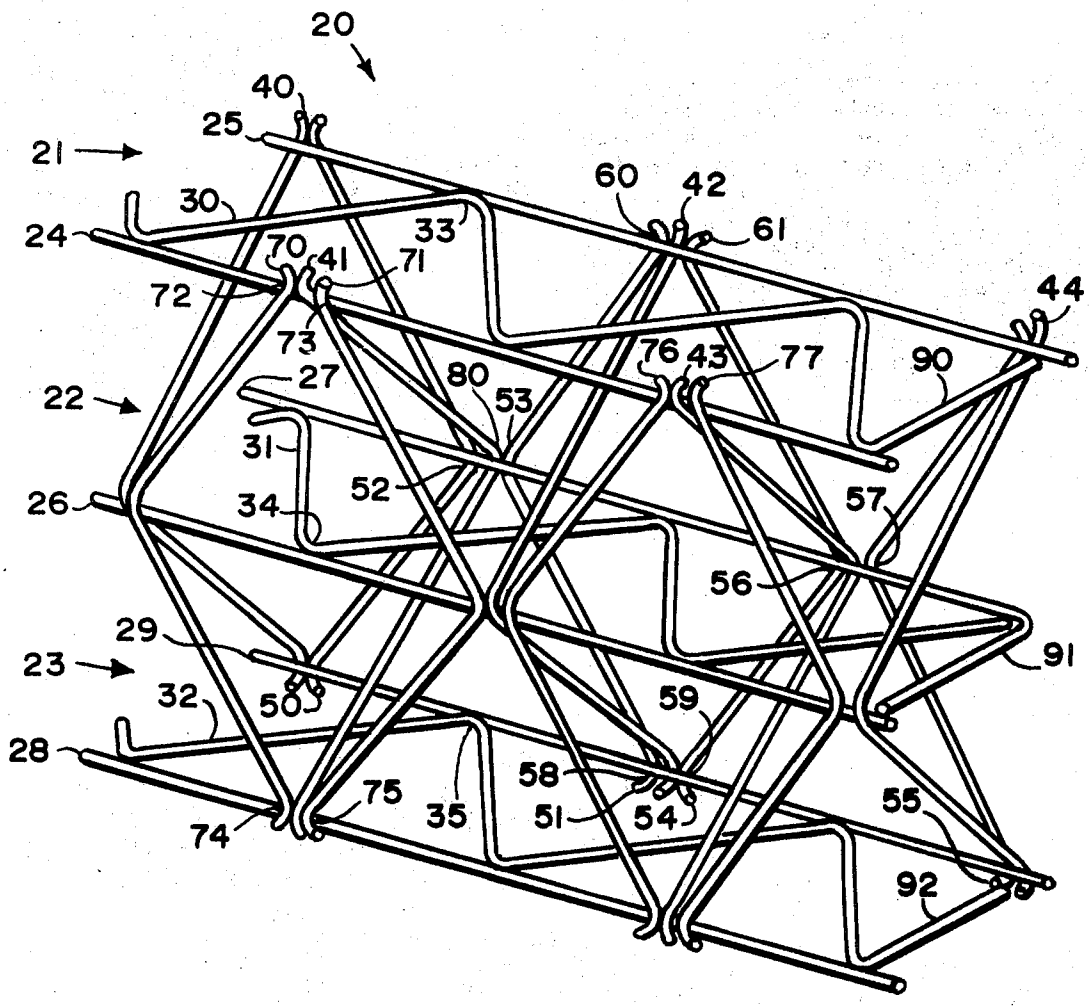
Primary Examiner—Alfred C. Perham

Attorney—Richard A. Bachand

[57] **ABSTRACT**

A wire support structure, one of the continuous repeating patterns of which includes, spot welded together, three parallel sets of two wires, the two wires in each such set being interconnected by a wire configured into a continuous series of V shapes, the V patterns on successive sets being alternately disposed in opposite directions. Opposite wires of successive parallel sets are interconnected at the open ends of the V shapes by wires also configured into a continuous series of V shapes. Finally, another set of V configured wires are fastened onto the faces of the structure adjacent the points at which the wire interconnecting opposite wires of adjacent sets of two wires are attached.

12 Claims, 2 Drawing Figures



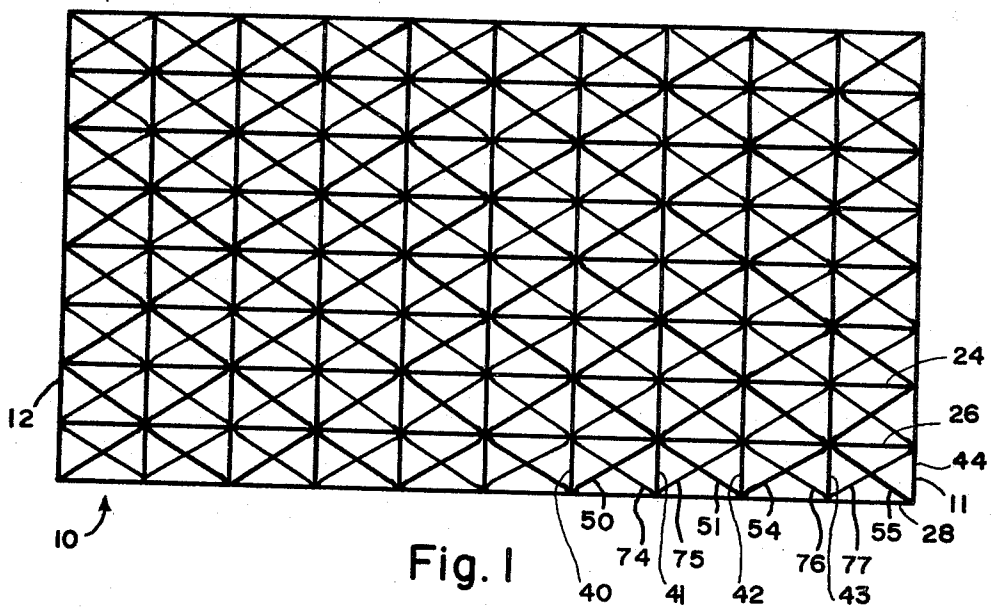


Fig. 1

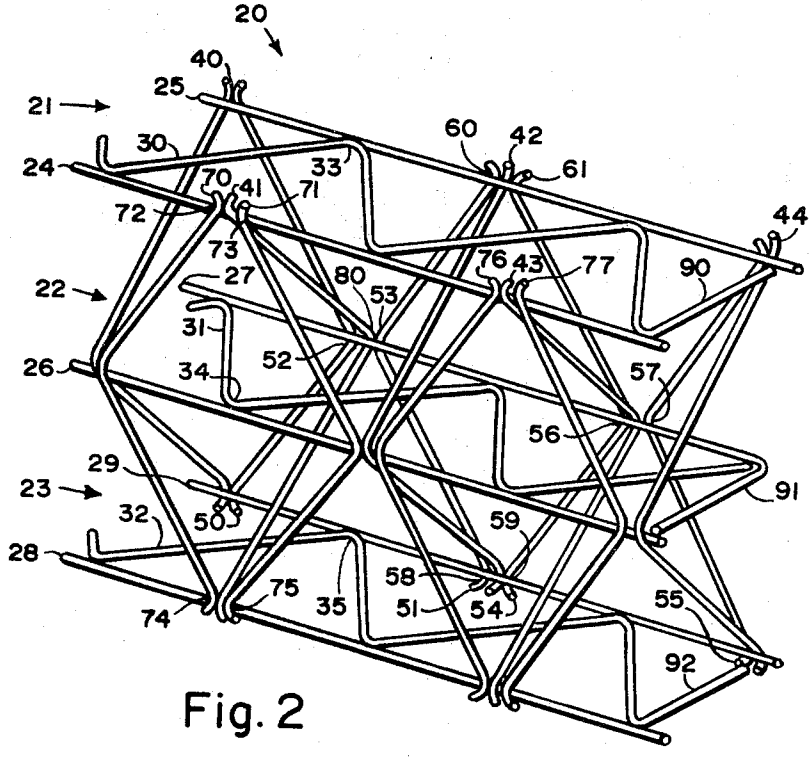


Fig. 2

INVENTORS
Johnnie F. McDonald
BY Frederick J. Sparber
Richard F. Bachand
ATTORNEY

WIRE SUPPORT STRUCTURE

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to improvements in building structures, and more particularly to improvements in wire support structures.

2. Description of the Prior Art

Many varying types of support structures or joist systems have been proposed and advanced, most of which are based upon iron or steel frameworks. Such structures and systems are generally wood, iron, steel, or other heavy material, to achieve a desired necessary strength, and are usually intended as building supports, for example, to support a roof or ordinarily used wooden or other sidewall sub-frameworks. A familiar example is a parallel series of ordinary I beams, which present resistance to torsional or other unusual loads. A variation upon the I beam structure often encountered is one in which the central member (the vertical line of the I) is substituted by a rod formed into a series of V shapes along the length of the beam and welded between parallel flat members. The ultimate heavy beams realized, however, are complete in themselves as a single line-type support, and ordinarily do not incorporate interconnecting members between adjacent beams, except perhaps non-loaded spacers, in some instances.

Recent building trends have been increasingly toward prefabricating as much of the building as possible, for example at a remote factory, and shipping the prefabricated units to the building site for final quick assembly. This practice has now been expanded to include in the prefabrication process even the inside and outside wall frames, usually of wood, frequently embodying vertical studs, where by an entire wall frame may be designed and assembled at a remote factory then shipped to the building site there requiring only location at the desired wall location and affixing the adjacent wall frames. Of course, each wall unit must be individually (and not inexpensively) designed and assembled, since building designs widely vary as to size, location of doors and windows, and so forth.

Some unique and unusual supporting frames have been proposed, but, although widely accepted, such unusual frames are impractical for most building uses, and therefore are rarely employed. The so-called geodesic dome structure, for example, having particular symmetric support characteristics is used for unusually large buildings. Being designed for such special uses, however, such unusual structures are not particularly useful in meeting common or everyday building requirements. Additionally, such specialized frames are not usually amenable to mass production or prefabrication techniques, except perhaps in very small units.

One support structure has been advanced by Nowland in Great Britian Patent Number 184,050, which shows a structure extending over a two-dimensional plane in a cross-hatch configuration of elements held together by individual discrete wire-like loops. This particular structure, although perhaps useful for a roof support or the like, may not be entirely satisfactory for many building purposes, such as a universal wall support or frame. For instance, the interconnecting wire-like loops may not give sufficient rotational fixture to enable the structure to withstand torsional or angular loads and stresses which may be encountered in fastening walls on each side or hanging a door or window in a hole cut through it. Also such wire-like loop joints are not amenable to mass production techniques, the movable joints having to be individually and complexly fastened to the intersections of the members.

It should be noted at this juncture that tower and scaffold structures have been thought or suggested by some to include considerations of building support structures, perhaps in the sense of interconnected beams or other such support structures. However, towers and scaffolds are usually intended for vertical loading along a single line and are not ordinarily designed to support much more than itself (towers, in fact, are generally guyed to enable them to support their own weight if subjected to transverse forces). In the case of scaffolds, permanent side attachments of significant proportions are not usually anticipated to the hollow or solid pipe frame. It can therefore be seen that tower and scaffold structures in general are not substitutable for the ordinary wood frame, for example, of a wall of a building without considerable modification and change.

Of most types of framing structures, even those most widely used, the strength-to-weight ratio is relatively low. This, for any desired building of predetermined characteristics, results in unnecessary expense in handling, shipping, fabricating and assemblying of the frame components, especially if they are prefabricated at a remote factory location. A collateral consideration encountered is the weight per unit volume of the frame structure. For instance, in many buildings, "dead air" spaces are desired between wall facings on either side of a frame, inside to outside, room to room, and so forth. It can be seen that it is desirable to have as lightweight a structure as possible (and of course as strong a structure as possible) for the largest volume.

Thus, although many variations in wall construction have been attempted in search of an ideal frame which may be easily fabricated, preferably prefabricated, with mass production techniques from readily available materials, which has high strength, lightweight per unit volume, and yet is of relatively little cost, it appears that to date such structure does not exist.

BRIEF DESCRIPTION OF THE INVENTION

In light of the above, it is, therefore an object of the invention to provide a wire building structure which is lightweight and which has a high strength-to-weight ratio per unit volume.

It is a further object of the invention to provide a building structure of wire.

These and other objects, features, and advantages will become apparent to those skilled in the art from the following detailed description when read in conjunction with the appended claims and accompaning drawing.

In accordance with the invention in its broad aspect, a wire support structure is presented which includes three parallel sets of two parallel wires. Each of the two parallel wires are interconnected with a wire formed in a generally "V" shaped pattern, the patterns formed between successive sets being alternately oppositely oriented. Two additional wires disposed in parallel planes perpendicular to the two parallel wires are interconnected in a continuous "V" shaped pattern to a wire of each parallel set opposite the connections of the interconnecting wires therebetween, the two additional

wires being generally alternately oppositely oriented. Finally, four wires are included, interconnecting one of the two parallel wires in each set on the faces defined by the three parallel sets, at points adjacent points at which the two additional wires are connected, also in a generally "V" shaped pattern, the patterns of adjacent and opposing wires being generally oppositely oriented.

The structure in accordance with the inventon is fabricated entirely from wire between 0.062 inch and ⅜ inch diameter, and of size such that the length of the two wires in parallel planes perpendicular to the two parallel wires is in a ratio between the length and diameter of at most 50/1.

BRIEF DESCRIPTION OF THE DRAWING

The invention is illustrated in the accompanying drawing, wherein:

FIG. 1 is a plan view of a support structure showing a representative panel fabricated from a plurality of continuous repeating patterns of interconnected wires, in accordance with the invention.

FIG. 2 is a perspective view of two adjacent portions of the panel of FIG. 1 showing the wire interconnections, in accordance with the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The invention is primarily intended to present a support structure having an internal volume extending over an area or expanse, and which has a relatively high strength per unit weight, as described below in detail. The panel may be fabricated into any useful size such as a four by eight foot panel, or other widely accepted construction dimensions, a top view of a representative panel **10** being illustrated in FIG. **1**. The interconnections of the wires and their interrelationship is shown in FIG. **2**, a perspective view of several adjacent repeating sections **20** of the panel **10** of FIG. **1**.

As shown in FIG. **2**, the basic structure includes three parallel sets or panels **21, 22,** and **23,** each including two parallel wires **24** and **25, 26** and **27,** and **28** and **29,** respectively, each pair respectively interconnected by a set of three sawtooth or "V" shaped wires **30, 31,** and **32.** The peaks of the "V" patterns of wires **30–32** are alternately oppositely disposed; for example, peak **33** of wire **30** is disposed at essentially the same location as peak **34** of wire **31** but faces the rearward side of the section **20,** whereas peak **34** faces forward. Likewise, peak **35** of wire **32** is disposed opposite that of peak **34** of wire **31,** but is in the same direction as peak **33** of wire **30.**

Interconnecting alternate wires on successive panels **21, 22,** and **23** are wires **40, 41, 42, 43,** and **44,** wire **40** interconnecting wires **25, 26,** and **29;** wire **41,** interconnecting wires **24, 27,** and **28;** and wire **42** interconnecting wires **25, 26,** and **29,** and so forth. The wires **40-44** are generally "V" or sawtooth shaped, successive wires along the direction of the parallel wires **24–29** being alternately oppositely oriented. For added strength, although connection may be made at an inside point, connection of wires **40–44** is made at an outside point by looping the wire outside the respective opposite ones of wires **24-29** of sets **21-23.** A section **20** of the basic structure of this invention may be defined to include a set of two wires such as **40** and **41** and that a repeated section **20** may include another set of two wires such as **42** and **43,** and so forth.

On the rearward face of the structure **20** defined by wires **25, 27,** and **29,** are additional sawtooth or "V" shaped wires **50, 51, 54,** and **55;** likewise, on the forward face defined by wires **24, 26,** and **28** are "V" shaped wires **70, 71, 76,** and **77.** The wires **50, 51, 54, 55, 70, 71, 76,** and **77** are disposed alternately oppositely, both within and between the forward and rearward faces, with the bend or peak of the "V" shapes adjacent points at which wires **40–44** loop over one of wires **24–29.** Thus, as shown, for example, wires **50** and **51** are fixed to wires **25, 27,** and **29** with their peaks **52** and **53** adjacent to one another on opposite sides of the point **80** at which the wire **41** loops over the wire **27.** Likewise, wires **54** and **55** are affixed to the wires **25, 27,** and **29,** with their peak portions **56** and **57** adjacent opposite sides of the point at which the wire **43** loops over wire **27.** It can be seen particularly in FIG. **1,** the wires **50, 51, 54,** and **55** or the wires **70, 71, 76,** and **77** repeated continuously over a desired expanse, each form a general X pattern, a fact contributing to the particular strength of the resulting overall structure. A section **20** of the basic structure of this invention may be defined to include a set of four wires consisting, for example, of two wires **50** and **51** on the rearward face of the section **20** together with two wires **70** and **71** on the forward face of the same section **20.**

As defined above and as viewed in FIG. **2** section **20** repeats geometrically in a lateral sense with every set of two wires such as **40** and **41.** Inspection of FIG. **2** reveals, of course, that the smallest self-sufficient structure based on the geometry of section **20** so defined will require, for complete support, three consecutive such wires as **40, 41** and **42.** Thus, for example, the self-sufficient structure of FIG. **2** involves two adjacent repeating sections **20** plus a fractional portion of a third such section.

Without in any way altering the structure of FIG. **2** it may alternately be viewed as comprising two parallel sets of three parallel wires, one such set consisting of wires **24, 26** and **28** and the other consisting of wires **25, 27** and **29.** It will be convenient in this context then to refer to wires **24, 25, 28** and **29** as the "outside" wires of these two parallel sets respectively. We may then designate a first set of three wires such as **40, 41** and **42,** each such wire respectively interconnecting two outside wires such as **24** and **28** of one of the two parallel sets with an inside wire such as **27** of the other set, said first set of three wires being alternately oppositely disposed. As before, each of a set of four wires such as **50, 51, 70** and **71** respectively interconnect three connections of the first set of three wires with one of said two parallel sets of three parallel wires. Finally, in this alternate view, each of a second set of three wires such as **30, 31** and **32** respectively interconnects two wires such as **24** and **25** occupying a same respective position in said two parallel sets at points intermediate the connections thereto of the first set of three wires.

At all of the junctions between the various wires, a permanent connection (not shown) is made. It is preferable that the connections be made by spot welding or other similar welding technique, or by resistance welding, since such welding produces a lightweight, permanent, easily made junction between the wires. One of the principle objects of structure being to present an

overall lightweight support structure, if a junction technique such as gas welding or other welding technique which employs addition of a solder or other flux is employed the weight factor of the structure may be significantly and undesirabley increased due to the additional material. Likewise, if wires or other type joining structures are used at the junctions, the weight of the resulting structure may also be significantly increased, and, additionally, the inter-wire strength may be insufficient for many purposes for which the support structure is intended. The resistance or spot welding techniques present the additional advantage of being easily employed in mass production techniques, for which the structure of the invention is particularly well adapted.

With the structure fabricated as above described, it will, on a point basis, support extremely large loads applied from practically any direction. For example, if a point load is applied at the point **80** on the rearward face of the structure **20** in the direction of the forward face, the wire **41** is placed in compression on both sides of the point **80** in the direction of wires **24** and **28.** The wires **50** and **51** are placed in tension in a four sided symmetric outwardly radiating pattern from the point **80** in the direction of the intersections of wires **40** and **42** with wires **25** and **29.** The wire **27** also is placed in tension on either side of point **80.** Furthermore, the wire **31** is placed in compression from the tension in wire **27,** and the wire **26** is placed in tension from the compression of wire **31.** However, since wires **70** and **71** are placed in tension from the compressive forces in wire **41,** the effect is to place wire **26** in compression offsetting or counteracting the tension created therein by the forces of wire **31.** Thus, it can be seen by continuing the analysis that any point load is evenly and symmetrically distributed and, at least partially offset, by and among all of the wires throughout the structure **20** or any continuous repetition from it, to present a maximum support strength to be obtained for any particular wire strength.

It is readily apparent at this point that the choice of length of the interconnecting wires, between connecting points and the final panel dimensions, is of significance. The permissible length of the wires required to present a particular support strength may be determined generally by the formula:

$$P_{Cr} = N \pi^2 E A/2,$$
$$[L/D/4]$$

where

P_{cr} = critical load
N = an engineering factor between 1 and 4
E = modulus of elacticity
A = cross-section area of the wire,
L = length of the wire
$D/4$ = radius of gyration.

It has been found by use of this formula that with a ratio of length between connections to diameter of approximately 50/1 or less for the interconnecting wires **40–44,** that a structure of generally optimum strength capabilities for most wire sizes and materials may be obtained. By choice of the length of the wires **40–44,** assuming the same wire composition and size is used throughout the structure, the sizes of the rest of the wires are predetermined by proportional reference thereto.

The strength of the support **20** may be additionally increased by tying down the ends of the sections **21, 22,** and **23** at the ends of the structure, such as ends **11** and **12** of the panel **10** of FIG. **1.** To facilitate this tie down, the end wires may be joined together (junctions not shown), for example, as shown in FIG. **2,** wires **24** and **25** may be interconnected by wire **90,** wires **26** and **27** may be interconnected by wire **91,** and wires **28** and **29** may be interconnected by wire **92.** The end connection wires, as shown, may be continued from any convenient wire at the end of the structure, for instance, wire **90** continued from wire **30,** wire **91** continued from wire **27,** and so forth. The end wires may then be fastened to whatever available structure exists at that end. For instance, the tie down may be achieved by setting the end of the structure into cement or other such material which will adhere to the wires, or alternatively, by attaching the end wires onto a similar adjacent panel, in turn fastened down.

As above described, the structure of the invention is particularly well adapted to be fabricated of wire. Although wire of any type may be employed, mild steel, perhaps with 0.01 percent carbon is particularly well suited for fabrication of the structure of the invention. The choice of the wire used, of course, will depend upon the desired characteristics of the ultimate structure, but conveniently, it may be of diameter between 0.062 inch and three-eighths or one-half inch. The choice of wire used will naturally affect the weight and size of the structure as well as the strength characteristics, as above described.

For an example of a wire support structure in accordance with the invention, it has been found convenient to fabricate such structure of wire having diameter of approximately three-sixteenths inch. With the wires **40–44** made of length approximately 4 ¼ inches, the structure may be of depth approximately 3 inches, with about 10 points, such as point **80,** at which three wires cross the parallel wires on one face over perhaps 1 square foot area.

The unit weight per unit volume, because of the particular "series of tripod" configurations presented by the structure, appears to be stronger per unit weight in volume than that of commonly used honeycomb type material and, in fact, is lighter per unit volume than styrofoam for a given support strength. The wire structure of the invention, in fact, may find advantageous application in reinforcing styrofoam or cement or other material which may be poured into a pre-existing form.

Although the invention has been described with a certain degree of particularity, it is understood that the present disclosure has been made only by way of example and that numerous changes in the details of construction and the combination and arrangement of parts may be resorted to without departing from the spirit and scope of the invention as hereinafter claimed.

We claim:

1. A wire structure comprising:

three parallel sets of two parallel wires;

a set of three wires each interconnecting the two parallel wires of a respective one of said three parallel sets and forming therebetween a continuous series of generally "V" shaped patterns alternately oppositely oriented among said three parallel sets;

a set of two wires, disposed in parallel planes perpendicular to the two parallel wires of said three parallel sets, each interconnecting in a continuous "V" shaped pattern one wire of each of said set of two parallel wires opposite the connection thereto of

said set of three wires, each alternately oppositely oriented; and

a set of four wires, each interconnecting in a generally "V" shaped pattern one of the two parallel wires of said three parallel sets adjacent the connection of said set of two wires thereto the patterns of adjacent and opposing wires of the four wires being generally oppositely oriented.

2. A structure of claim **1** wherein said structure is repeated in directions perpendicular to and along said three parallel sets of two parallel wires.

3. The structure of claim **1** wherein said wire is of diameter between 0.062 inch and three-eighths inch.

4. The structure of claim **3** wherein the length of each wire in said structure between connections is such that ratio of the length to the diameter of each of said wire is less than 50/1.

5. The structure of claim **4** wherein said wires are welded together at their intersections.

6. The structure of claim **5** wherein said welds are spot welds.

7. The structure of claim **5** wherein said welds are resistance welds.

8. The structure of claim **1** further comprising means to anchor the ends of each of said parallel sets of two parallel wires.

9. The structure of claim **7** wherein said wire is of 0.01% carbon-mild steel.

10. The structure of claim **2** wherein such structure is of a size presenting on one face thereof at least 10 points at which three adjacent wires are affixed to one of the two parallel wires of said three parallel sets.

11. A wire structure comprising:

two parallel sets of three parallel wires;

a first set of three wires, each interconnecting two outside wires of one parallel set with an inside wire of the other parallel set, alternately oppositely disposed;

a set of four wires, each interconnecting three connections of said first set of three wires within one of said parallel sets in a generally "V" shaped pattern;

and a second set of three wires each interconnecting two wires occupying a same respective position in said two parallel sets at points intermediate the connections of said first set of three wires.

12. The wire structure as claimed in claim **11** wherein the connections are spot welds, said wire is of diameter between 0.062 and three-eighths inch, and the ratio of length between connections to diameter of said first three wires is at most 50/1.

* * * * *