United States Patent

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[54] **CONSTRUCTION OF LOW-TENSION WIRE ARRAYS**
4 Claims, 4 Drawing Figs.

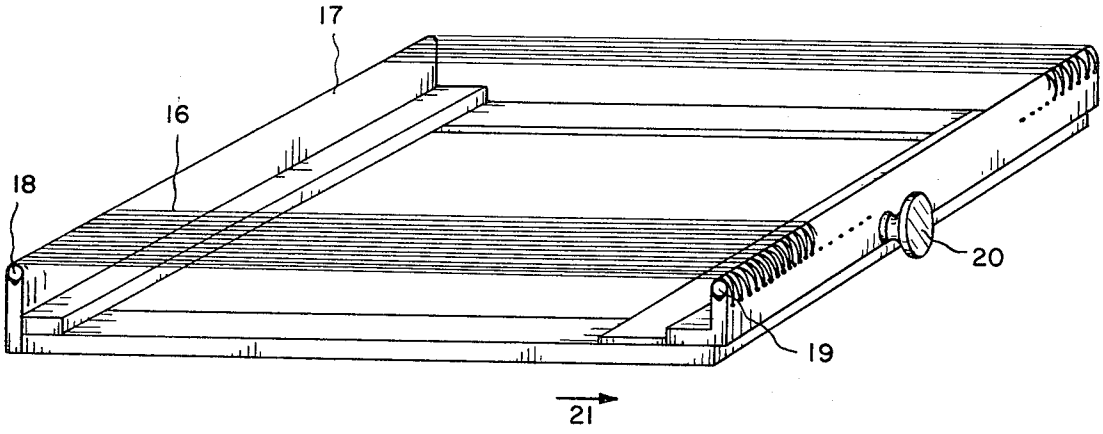
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[51] **Int. Cl.** **H01s 4/00**
[50] **Field of Search** ..... 29/(Inquired); 29/592, 604, 446; 140/92.1; 29/419, 460, 527.1, 610

[56] **References Cited**
UNITED STATES PATENTS

3,049,604	8/1962	Showalter	29/597X
3,057,381	10/1962	Pitts	29/610X
3,091,754	5/1963	Nazarre	340/173
3,206,832	9/1965	Strother	29/572

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ABSTRACT: A method of constructing a low-tension wire array including the steps of arraying wires on an expandable frame expanding the wires past their elastic limit, and releasing the frame tension until each wire hangs in catenary. The wires are then placed onto an epoxied sheet and the ends cut.



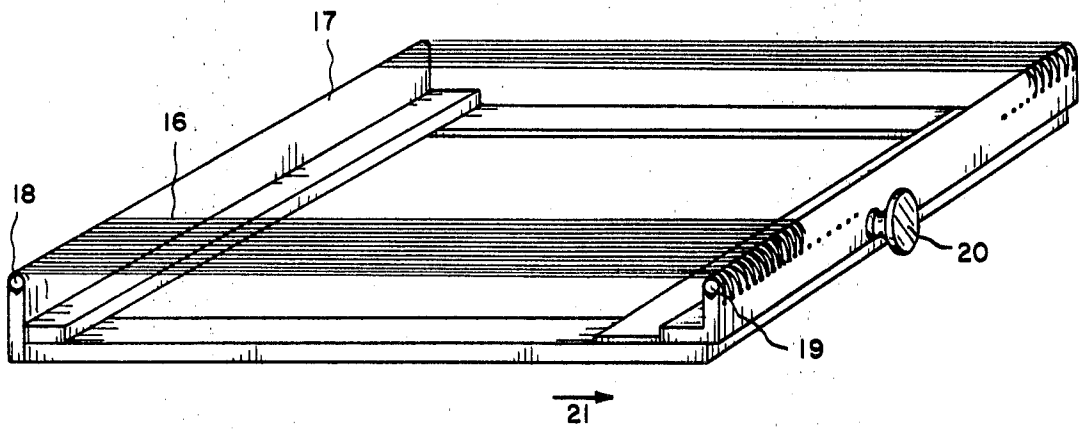


Fig. 3

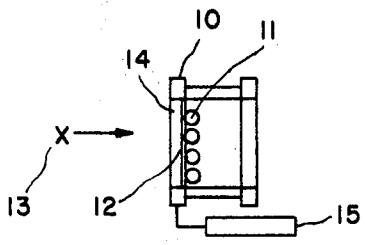


Fig. 1

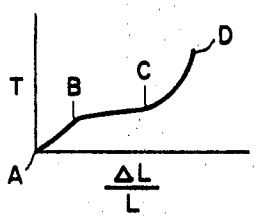


Fig. 2

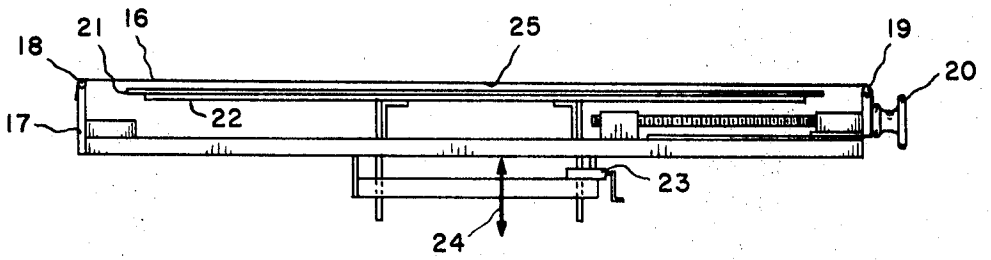


Fig. 4

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CONSTRUCTION OF LOW-TENSION WIRE ARRAYS

This invention relates to wire arrays and particularly to a method of constructing a low-tension wire array.

Wire arrays have been employed successfully in digital spark chambers. Such chambers are data acquisition devices which are used to collect data regarding the nature or movement of high-energy particle or spark in a gaseous environment. The energy path is through a set of chamber plates which are wire array panels in the particle path. The spark which will move through one or more chamber plates, generates a pulse along a wire in each chamber plate which is in turn transported to various types of digital data-recording equipment. Thus, a coordinate picture of the movement of the spark can be obtained.

The chamber plates are commonly constructed of woven wire cloth, the wires alternating with a monofilament acrylic fiber. The cloth is supported by a rigid frame. For purposes of accuracy in readings, it is necessary to maintain each wire in a tensed condition when finally assembled. The strength of the frame construction must be sufficient to allow for the tensioning of each wire without any distortion in the plane formed by the frame. With the greater number of wires in larger frames, the distortion in the frame increases because the variation in tension along the length of the frame increases.

It is therefore the prime object of this invention to provide a method of constructing an array of wires with low tension.

It is a further object of the invention to provide a method of constructing a wire array with minimal distortion.

It is a still further object of the invention to provide a method of construction for wire arrays which permits the construction of larger scale wire arrays in lower tension, lower distortion frames than heretofore achievable.

In accordance with the foregoing objects, the inventive method herein employs the concept of tensioning each wire in an expandable frame until the elastic limit of each wire is exceeded. The tension is then released and the wires permitted to hang in catenary. At this point, each wire will hang with the same droop, regardless of their original tension within the frame. The wires are then epoxied to a thermoplastic film and the ends cut.

More specifically, the wires are stretched horizontally on a rack. The racks are then separated further until the wire exceeds the elastic limit, which can be defined as the point at which the ΔL over L increases rapidly with tension. The racks are then set closer so that the tension is partially removed. The wires then hang in catenary with all tension equal. The wires are now epoxied to a flat plane which is positioned horizontally under the wires and raised vertically until it contacts the wires in the center. It is then raised further until the wires are in contact with the plane over the entire length. When the epoxy is cured, the wires are cut loose from the rack upon which they were positioned. The catenary droop can be set so the wire now exerts near zero tension upon the plane and thus there is no need to build a strong plane with strong supporting frames. That zero tension results may be understood by considering the case where the catenary has a large droop and the case where there is high tension and little droop. If the tension is initially low, i.e., large droop, the wire will come under compression as the plane is raised and so it will not lie straight on the plane. If the initial tension is too great there will be some tension after the plane is completely raised and the plane will have to be stronger to resist distortion. Therefore, an intermediate value for the initial droop exists for which the final tension of the assembled plane is near zero.

The foregoing objects and brief description of the invention will become more apparent from the following more detailed description and appended drawings, wherein:

FIG. 1 is a schematic diagram of the employment of chamber plates utilizing wire arrays;

FIG. 2 is a graphical representation of the elastic characteristics of a typical wire;

FIG. 3 shows an expandable frame for tension stretching the wire array; and

FIG. 4 illustrates the catenary suspension after expansion and shows the manner of assembling the wires onto the chamber plate plane.

Referring now to FIG. 1, there is shown a typical chamber plate construction in expanded cross-sectional form. A frame mount **10**, constructed of any suitable material encases the wire array **11** which is in turn mounted as a plurality of parallel wires on a base of suitable thermoplastic film **12**, such as mylar or the like. An energy particle or a spark **13**, which can be generated by means of a high voltage across a spark gap, passes through the chamber window area **14** and creates a pulse along one of the lines **11**. Each of the lines **11** are connected, as by suitable conductors mounted along the edge of the frame **10**, to a digital data acquisition device **15**. By using a plurality of chamber plates in the path of the particle, and by employing data devices at the initiation of the spark and at each chamber plate, the movement characteristic of the spark can be analyzed.

Clearly the accuracy of the analysis is dependent upon insuring that no extraneous factors enter into the time and position measurement of a spark on a plate. Such factors would include nontensed wires, affecting the interwire positioning, and varying tensions of the wire, affecting nonplanar distortion of the mounting plate **10**. These factors become more pronounced with the size of the plate. A typical construction requires an active area of approximately 1 meter by 1 meter employing 0.005-inch diameter copper wire with a linear wire density of 50 lines per inch (50 mesh).

To construct the chamber plate with minimal distortion caused by tension, the elastic limit characteristic of the wires are utilized. As shown in FIG. 2, the elastic limit curve is the relationship between the change in length to the length, ΔL over L, as a function of tension, T. As a wire is put under tension, as by stretching, the ΔL over L will undergo a proportionate increase from point A to point B with a relationship dependent upon the tensile strength of the wire. When the elastic limit, (the tension of point B) is exceeded, relatively slight increases in tension thereafter produce a disproportionate increase in the ΔL over L. When the point C is reached, the wire has reached the end of its expansion range and shows a marked reduction in expansion with further tension increases. At some point D after point C, the wire will break.

In accordance with this invention, the range of point B to point C is employed. A wire array **16**, with wires positioned in substantially parallel relationship, is suspended in a rack such as the expandable frame **17** shown in FIG. 3. The wire ends are attached to the frame members **18** and **19** respectively. The frame is expandable, as by means of a tension screw **20**. The frame members **18** and **19** are preferably each threaded bars which are independently adjustable and can be employed for laterally adjusting the wire ends with respect to each other to insure that the wires are not only parallel but that they are orthogonal with respect to the threaded bars.

The tensioning screw **20** serves to expand the frame members **18** and **19** in a direction **21** corresponding to the direction of length of the wires. After the wires have been arrayed along the frame members, the frame is expanded and the wires stretched until the elastic limit of each wire is exceeded and each wire is in condition defined between the points B and C of FIG. 2. At this point, the tension of the wires is released as by reversing the direction of turn of the tension screw until each wire hangs in catenary with all tension equal. Because each wire is in the B–C range, each wire at this stage will hang with the same dimensional droop, regardless of their original tension condition. The actual droop selected will depend on the length of the wire and will represent a compromise value.

To assemble the completed chamber plate, the wires are now bonded as by a suitable epoxy, or similar bonding compound, to a dimensionally stabilized flat wire support plane **21** (FIG. 4). The support plane **21** is preferably a sheet of heat-treated epoxy-coated thermoplastic film such as mylar or the like. The plane **21** is in turn supported on a support

surface **22** which is coupled to the frame **17** by means of a vertically adjustable mechanism **23** for imparting vertical motion in the direction **24** to the plane **21**.

The plane **21** is positioned horizontally under the wires **16** and is raised vertically until it contacts the wires in the center **25** of the catenary droop. It is then raised further until the wires are in contact with the plane over its entire length.

The epoxy is now allowed to cure. When the epoxy is cured, the wires are cut loose from the frame members **18** and **19**.

The wires now exert near zero tension on the plane. The near zero tension can be understood by considering the case where the catenary has a large droop and the case where there is high tension and little droop. If the tension is initially low, i.e. large droop, the wire will come under compression as the plane **21** is raised and so it will not be straight on the plane. If the initial tension is too great there will be some tension left after the plane is completely raised, and the plane will have to be stronger to resist distortion. Thus, an intermediate value for the initial droop exists for which the final tension of the assembled plane is near zero.

Subsequent to the positioning and bonding, the wired plane can be assembled as by epoxy bonding to a suitable support frame such as is illustrated in FIG. **1** and connections made to each wire through the frame for subsequent connections to the data acquisition devices.

In this manner, much larger chamber plates can be realized without a concomitant increase in tension or plane distortion. Planes can thus be constructed as large as several meters on each side.

Since certain changes and modifications can be readily entered into in the practice of the present invention without departing substantially from its intended spirit or scope, it is to be fully understood that all of the foregoing description and specification be interpreted and construed as being merely illustrative of the invention and in no sense or manner as being limiting or restrictive thereof excepting as it is set forth and defined in the appended claim.

I claim:

1. The method of assembling a wire array in a low-tension framework comprising the steps of arranging an array of wires in a substantially parallel relationship in an expandable frame with the ends of said wires affixed to the frame members, tensioning each wire of said array simultaneously by expansion of said frame members in the direction of length of said wires until the elastic limit of each of said wires of said array is exceeded, removing said tensioning by contracting said frame members until each of said wires hang in catenary, raising a substantially flat epoxy-coated planar support surface up into said array of wires until the wires contact the surface over its entire length, allowing said epoxy to cure and cutting said wires loose from said frame.

2. The combination of claim **1** wherein said surface is a sheet of thermoplastic material.

3. The combination of claim **1** wherein each of said frame members is a threaded bar which is individually adjustable for positioning the wires relative to said bar.

4. The method of assembling a wire array in a low-tension framework comprising the steps of arranging an array of wires in a substantially parallel relationship in an expandable frame with the ends of said wires affixed to the frame members, tensioning each wire of said array simultaneously by expansion of said frame members in the direction of length of said wires until the elastic limit of each of said wires of said array is exceeded, removing said tensioning by contracting said frame members until each of said wires hang in catenary, raising a substantially flat epoxy-coated planar support surface up into said array of wires until the wires contact the surface over its entire length, allowing said epoxy to cure, cutting said wires loose from said frame, and epoxy bonding said resulting wired plane to a support frame.