

July 22, 1969

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STRUCTURAL ELEMENT  
Filed Oct. 9, 1967

3,456,414

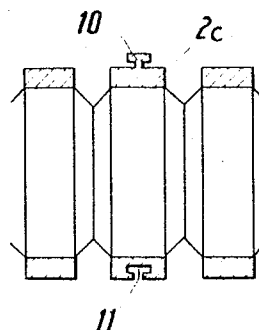
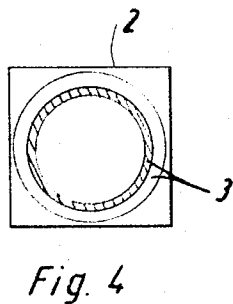
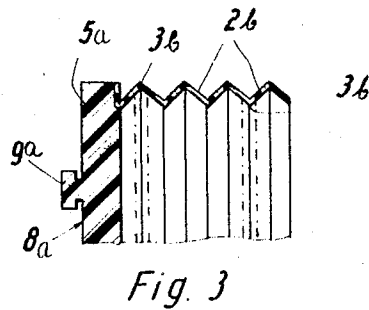
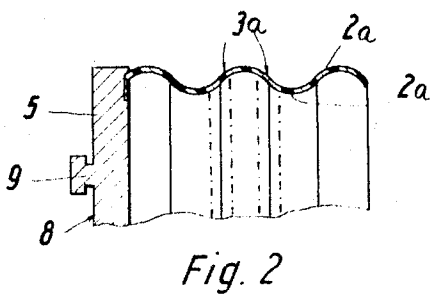
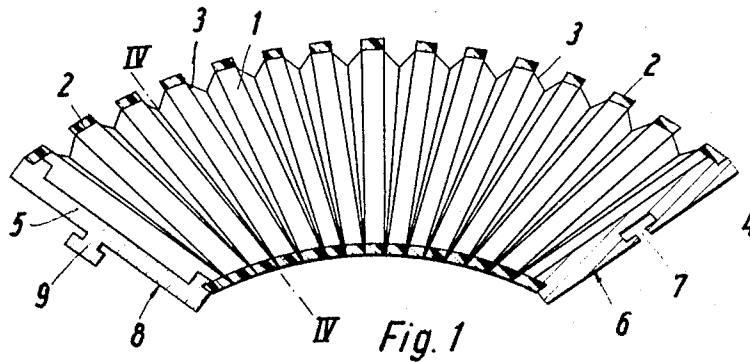


Fig. 5

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Filed Oct. 9, 1967, Ser. No. 674,386

Claims priority, application Germany, Oct. 15, 1966,  
F 50,450

Int. Cl. E04c 3/30

U.S. Cl. 52—726

12 Claims

**ABSTRACT OF THE DISCLOSURE**

A structural element consisting of a plurality of connected relatively movable sections which include a pair of end sections and a plurality of intermediate sections located between the end sections. At least some of the intermediate sections are flexible. Coupling means is provided on at least one of these sections for mating engagement with complementary coupling means provided on other elements to which the structural element is to be connected.

**CROSS-REFERENCE TO RELATED APPLICATIONS**

Other structural elements, in conjunction with which the structural element disclosed can be used herein and to which it can be connected, are set forth in an application filed on Dec. 1, 1966, in the name of Artur Fischer, under the title, "Structural Element," and currently copending under Ser. No. 598,522.

**BACKGROUND OF THE INVENTION**

The present invention relates to structural elements in general and in particular to structural elements which are readily and releasably connectable to other structural elements. Still more particularly, the present invention relates to structural elements which consist of a plurality of connected sections which are movable with reference to one another.

From my aforementioned copending application, structural elements such as building blocks and the like, are known which are particularly suitable for use in construction kits with which a person, usually a child, is to be enabled to construct buildings, vehicles, and objects in general. It is desirable that these construction kits enable the construction of models or replicas of the actual buildings or other objects which are as close to a true representation as possible. Clearly, this will not only lend increased interest to the use of the construction kit but will also enhance the value of the kit as a means of construction in that structural and other principles of objects being copied with the kit will become clearer and find increased understanding on the part of the kit user the more lifelike the replica which can be erected with the kit.

While the structural elements, and construction kits employing such structural elements, which are disclosed in my aforementioned copending application and in other applications to which reference is had in that application, provide these desired advantages to a considerable degree. They do, however, suffer from one drawback, namely the impossibility of utilizing them to create curvatures. This, of course, precludes the copying of arches, of dome-shaped configurations, of vaulted structures, and the like. It is in this area that the present invention provides a significant improvement.

**SUMMARY OF THE INVENTION**

The present invention provides a structural element which enables the erection of structures, models and the like wherein a curvature is required.

More particularly, the present invention provides a structural element which, in conjunction with other al-

ready known structural elements makes it possible to create arches, dome-shaped structures, vault structures, and the like.

The structural element according to the present invention thus makes possible, if used in conjunction with a construction kit, the erection of replicas or models of existing objects which are much more true—true like than was heretofore possible to achieve.

Furthermore, the novel structural element herein disclosed can be readily used in conjunction with, and connected to other structural elements, for instance those set forth in my copending application mentioned above.

In accordance with one feature of my invention I provide a structural element which is adapted to be connected to other elements, and which comprises a plurality of connected relatively movable sections, and coupling means provided on at least one of these sections. The sections include, in accordance with the invention, a pair of end sections and a plurality of intermediate sections which are located between the end sections and at least some of these intermediate sections are flexible so as to permit movement of the end sections relative to one another and to the intermediate sections. The coupling means which, as mentioned before, is provided on at least one of these sections, enables mating engagement of the novel structural element with complementary coupling means provided on other elements to which the novel element is to be connected.

It is clear, of course, that the arrangement of intermediate sections between the end sections, and the stated flexibility of at least some of these intermediate sections, permits movement of the end sections relative to one another and relative to the intermediate sections, in a variety of ways. The direction in which these various sections can be moved with reference to one another, depends to a considerable extent upon the cross-sectional configuration of the various sections. Thus, if it is assumed that both the flexible intermediate sections and the remaining intermediate sections are of polygonal cross-sectional configuration, for instance of quadratic cross-sectional configuration this does not constitute any obstacle to stretching the structural element into an elongated configuration by drawing the end sections away from each other in opposite direction, and to arching the thus obtained elongated structural element to one side of its direction of elongation. However, if it is necessary for any reason to effect such arching in a plane extending diagonally, of the quadratic cross-sectional configuration, the quadratic arching or bending movement will become much more difficult if not entirely impossible. The reason for this is, of course, that despite their flexibility, the flexible intermediate sections must exhibit a certain amount of stiffness because the structural element would otherwise be incapable of self-support and would collapse in whatever position it were to be placed. This, however, can be obtained only by providing the corner areas of the flexible sections of polygonal cross-sectional configuration with a flexibility which is too small to permit ready bending in such diagonal direction as pointed out before. It is therefore a part of the concept of the present invention that where bending of the aforementioned type is necessary a cross-sectional configuration of the flexible sections may be circular or substantially circular rather than polygonal.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawings.

## Brief description of the drawing

FIG. 1 is a longitudinal section through an arched structural element according to the present invention;

FIG. 2 illustrates, in a fragmentary section on an enlarged scale, another embodiment of the invention;

FIG. 3 is a view similar to FIG. 2, but illustrating yet a further embodiment of the invention;

FIG. 4 is a section taken on the line IV—IV of FIG. 1; and

FIG. 5 is a view similar to FIGS. 2 and 3, illustrating yet an additional embodiment of the invention.

## Description of the preferred embodiments

Discussing now the drawings in detail, and firstly FIGS. 1 and 4 thereof, it will be seen that the structural element according to the present invention is identified generally with reference numeral 1. It consists, as is evident from FIGS. 1 and 4, of a pair of end sections 4 and 5, intermediate which there are arranged a plurality of intermediate sections 2 and 3. The cross-sectional configuration of the end sections 4 and 5, as well as that of the intermediate sections 2, is polygonal and more specifically, quadratic in this instance, although this is, of course, only an example of one possible configuration. The intermediate sections 2 alternate with and are connected by flexible intermediate sections 3. The entire structural element may consist of various different materials, which may also be used in conjunction with one another, and advantageously it consists of synthetic plastic material. The sections 3 are suitably secured to the sections 2, for instance by means of an adhesive, by spot welding, or in any other manner which lends itself to this purpose. The cross-sectional configuration of the flexible sections 3 is circular by contrast with the quadratic cross-sectional configuration of the sections 2 and the end sections 4 and 5. By this expedient the structural element illustrated in FIG. 1 can be arched not only in the manner illustrated in that figure, but also in other ways. For instance, the right-hand half of the element could be bent out of the plane of the sheet of drawing at an angle thereto. The versatility of this construction is obvious and requires no special elaboration.

The end section 4 has an end face 6 and the end section 5 has an end section 8. In accordance with the invention, and in order to facilitate connection of the structural element of FIG. 1 with other elements, for instance of the type disclosed in my aforementioned pending application, I provide coupling means for my novel structural element. In the embodiment of FIG. 1 this coupling means is provided on the respective end sections where the end face 6 of the end section 4 will be seen to be provided with an undercut groove 7 which may extend across the entire width of the end face 6. The end face 8 of the end section 5, on the other hand, is provided with an undercut projection head 9 whose configuration is such that it can be received in the groove 7. Thus, the structural element of FIG. 1 can be connected to other structural elements which are provided with grooves corresponding to the groove 7, and/or with coupling heads corresponding to the coupling head 9, it being merely necessary to effect mating engagement of the respective coupling portions. To facilitate entry of a coupling head corresponding to the coupling head 9 into the groove 7 the latter may be provided either with open ends or, if the ends are closed, with a cutout intermediate these ends and so configured as to permit introduction of a coupling head into the groove 7 transversely of the elongation thereof.

In FIG. 1 the sections 2 and 3 are assumed to be synthetic plastic material, whereas the end sections 4 and 5 are to consist of a material other than synthetic plastic material. It is of course evident that this is merely an example and that all sections of the structural element may

consist of synthetic plastic material, that all sections may consist of material other than synthetic plastic material, that the end sections may consist of synthetic plastic material while the intermediate sections consist of other material, or that any other desired and operative combination of materials or even single material can be used for constructing the structural element. This is true not only of the element in FIG. 1, but of all elements herein disclosed.

Another embodiment of my novel structural element is shown in FIG. 2 where only one end section 5 with the associated coupling head 9, is illustrated. The intermediate sections are identified with reference numerals 2a and 3a, and are here all of circular cross-sectional configuration. The intermediate sections 2a have curved circumferential faces and are joined by the sections 3a which constitute transitional zones between adjacent sections 2a and whose axial extent is indicated by the chain lines which are visible in FIG. 2. It will be noticed that the circumferential edge faces of adjacent ones of the sections 2a are alternately radially outwardly and radially inwardly curved and that the provision of the transitional zone sections 3a results in an undulatory configuration which is reminiscent of a bellows. If desired, the sections 3a which constitute these transitional zones may be of lesser wall thickness than the sections 2a although sufficient flexibility will be provided even if this is not the case. The reason for this is that the stiffness requisite in the intermediate sections for providing sufficient self-supporting ability for the structural element is imparted by the curved configuration of the circumferential edge faces so that the wall thickness can be selected thin enough to assure the desired flexibility.

The embodiment of FIG. 3 is largely the same as that of FIG. 2, except for two differences. By way of example the end section 5a with its end face 8a and the coupling head 9a provided thereon is illustrated as consisting of synthetic plastic material, and the sections 2b as well as the sections 3b comprise circumferential edge faces which are not curved but which rather include two mutually inclined facets or portions. The axial extent of the flexible intermediate sections 3b is again indicated by the chain lines just as in the case of FIG. 2.

FIG. 5, finally, illustrates an embodiment which is basically similar to that of FIG. 1, except that coupling means is provided on at least one of the intermediate sections 2c which correspond to the intermediate sections 2 in FIG. 1. This intermediate section 2c is provided with a circumferential edge face and coupling means is constituted by a coupling head 10 whose configuration although not necessarily its size is the same as that of the coupling head 9 in FIG. 1, and of an undercut groove 11 whereof again the configuration although not necessarily the size is the same as of the undercut groove 7 in FIG. 1. This coupling means which is provided on one or more of the intermediate sections 2c can be provided in lieu of, or in addition to coupling means on one or both of the end sections and of course serves the same purpose, namely connection of the structural element disclosed herein to other structural elements.

It is clear, of course, that a variety of modifications in the use of materials, in the type of coupling means employed, in the cross-sectional configuration selected for the end sections and/or intermediate sections is possible.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of structural elements differing from the types described above.

What is claimed as new and desired to be protected by Letters Patent is set forth in the appended claims:

1. An elongated tubular structural element adapted to be connected to other elements and comprising, in combination, a plurality of connected relatively movable tubular sections including a pair of end sections closing said elongated tubular structural element at opposite ends

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thereof and a plurality of intermediate tubular sections each including two mutually inclined wall portions, at least some of said intermediate tubular sections being flexible whereby to permit movement of said end sections relative to one another and to said intermediate sections as well as bending movement of said structural element transversely of its elongation in a plurality of mutually inclined directions; and coupling means provided on the outer surface of at least one of the sections for mating engagement with complementary coupling means provided on other elements to which said structural element is to be connected.

2. An element as defined in claim 1, wherein at least some of said sections are of polygonal cross-sectional outline.

3. An element as defined in claim 1, wherein at least said end sections are of polygonal cross-sectional outline.

4. An element as defined in claim 1, wherein at least some of said sections are of quadractic cross-sectional outline.

5. An element as defined in claim 1, wherein said end sections and alternate ones of said intermediate sections are substantially rigid, and wherein the remaining ones of said intermediate sections are flexible.

6. An element as defined in claim 5, wherein said alternate intermediate sections are of polygonal cross-sectional outline, said remaining intermediate sections being of substantially circular cross-sectional outline.

7. An element as defined in claim 1, wherein the remaining ones of said intermediate sections are also flexible, said plurality of intermediate sections together defining a bellows-shape.

8. An element as defined in claim 1, wherein at least some of said intermediate sections are of circular cross-sectional outline.

9. An element as defined in claim 1, wherein said one section is one of said pair of end sections and is provided

with an end face, said coupling means being provided on said end face for coupling of said structural element to other elements.

10. An element as defined in claim 9, wherein said coupling means is a male coupling portion extending from said end face and adapted to matingly engage with a complementarily configured female coupling portion.

11. An element as defined in claim 10, wherein the other end section of said pair of end sections is also provided with an end face, and wherein said coupling means further comprises a female coupling portion provided in said end face of said other end section and configured complementarily to said male coupling portion for coupling of said structural element to other elements which are provided with similar male coupling portions.

12. An element as defined in claim 9, at least one of said sections having a circumferential edge face, and wherein said coupling means comprises at least one coupling portion provided on said edge face for coupling of said structural element to other elements.

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U.S. Cl. X.R.

46—25; 52—309, 594, 632