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METHOD AND APPARATUS FOR MAKING FUSED
BUNDLES OF ENERGY-CONDUCTING FIBERS
Filed March 31, 1971

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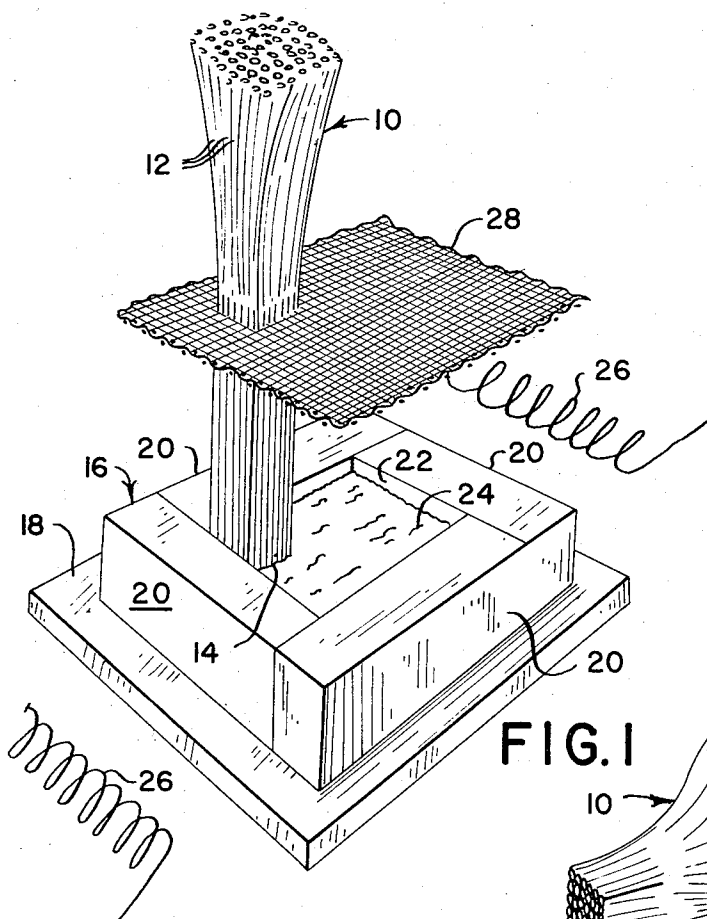


FIG. 1

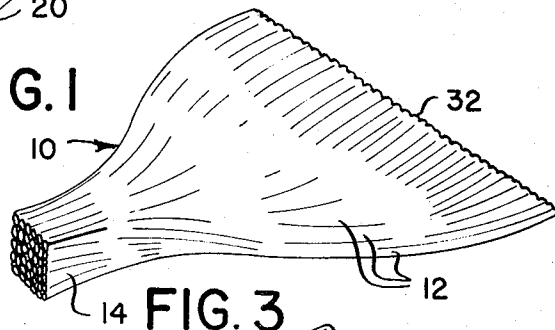


FIG. 3

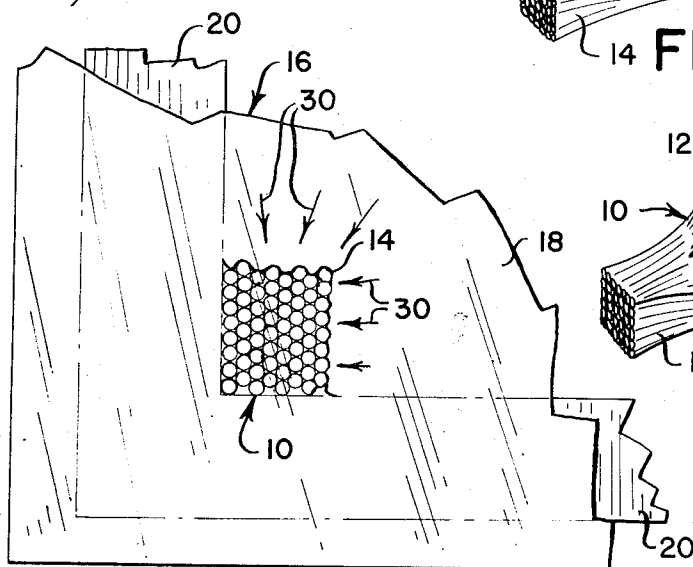


FIG. 2

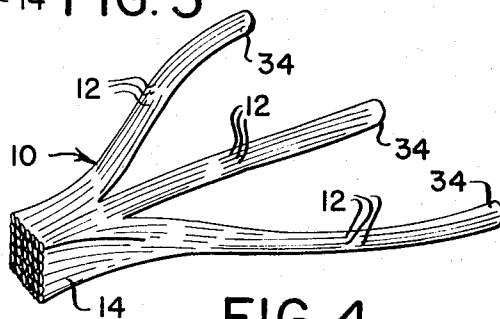


FIG. 4

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METHOD AND APPARATUS FOR MAKING FUSED BUNDLES OF ENERGY-CONDUCTING FIBERS

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3 Claims

ABSTRACT OF THE DISCLOSURE

A bundle of fibers is inserted endwise into a pool of fiber non-wetting, preferably heavy, liquified metal in an open container adjacent a corner thereof wherewith the displaced metal effects tight bundling and fluid clamping of the fibers against the container walls for fusion thereof with applied heat.

BACKGROUND OF THE INVENTION

Field of the invention

Fiber optics with particular reference to method and apparatus for making tightly fused bundles of energy-conducting fibers.

Description of the prior art

In cases requiring bundles of energy-conducting fibers to be assembled in close-packed orderly relationship with each other along a short length of one end of the bundle and differently geometrically arranged at the opposite end, e.g. bundled into a plurality of separate smaller branches or arranged in individually side-by-side relationship with each other along a line or circle or other similar geometrical configuration, there arises the problem of having to handle large numbers of usually exceptionally thin and flexible fibers which continually tend to entangle and resist orderly packing.

Various schemes for aligning and packing fibers in bundles have dealt with apparatuses and methods for vibrating the bundles and/or dipping them in wetting solutions for straightening upon their withdrawal. All such schemes, however, are attended by secondary problems of retaining whatever alignment and close packing has been achieved during subsequent fusing or cementing operations used to permanently connect the fibers together. Mechanical clamps or sleeves and the like which have been used for this purpose are all subject to the effects of human fumbling in their application and/or mechanical failure leading to disruption of fiber alignment and not infrequent fiber breakage. These and other attending problems render conventional fiber aligning and clamping schemes notably tedious, time consuming, costly to perform and generally considerably less than optimum in their manner and means of accomplishing the intended result.

The present invention is directed to a fiber aligning, packing and fusing system which, in overcoming the aforementioned and related difficulties of the prior art practices, makes possible the assembly, alignment and fushion of fibers into orderly tightly packed arrays with a single, simple and economical operation.

Details of the invention will be more clearly understood by reference to the following description when taken in conjunction with the accompanying drawing.

IN THE DRAWING

FIG. 1 is a diagrammatic illustration, in perspective, of a preferred embodiment of the present invention;

FIG. 2 is a greatly enlarged fragmentary plan view of the underneath side of the fiber aligning and bundling apparatus illustrated in FIG. 1; and

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FIGS. 3 and 4 are illustrations, in perspective, of fiber optical devices of the types whose fabrication is facilitated by the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

An exemplary bundle 10 of fibers 12 intended to be assembled in orderly, tightly packed connected together side-by-side relationship with each other adjacent an end 14 thereof is processed according to principles of the present invention as follows; it being understood that all reference to fibers herein is intended to include glass or plastic fibers, clad or unclad and monofilaments or multifibers of any and all types known and used in the field. Also, the term "energy-conducting" is intended to include not only light-conducting fibers but also those which perform the analogous function when subjected to electro-magnetic wave forms having properties equivalent to those of visible light notwithstanding the fact that such wave forms are outside the range to which the human eye is sensitive.

Referring more particularly to FIGS. 1 and 2, the fiber aligning, fluid clamping and fusing apparatus of the present invention comprises a fluid-tight container 16 having a flat transparent bottom 18 (e.g. a quartz or high temperature glass plate) and side walls 20 preferably formed of high temperature ceramic tile or furnace brick or the like.

In the illustrated embodiment of container 16, its bottom 18 and walls 20 form a rectangular inner compartment 22 (FIG. 1) within which is provided a pool 24 of liquid, fiber non-wetting, heavy metal (e.g. molten tin, mercury or a suitable low temperature alloy having a melting temperature substantially below that of fibers 12) into which the bundle 10 of fibers 12 is inserted endwise in one corner of compartment 22. In cases where the material of pool 24 requires melting for achieving the aforementioned liquidity thereof heat is applied to container 16 by suitable heating elements such as electrical heating coils 26 which are diagrammatically illustrated in FIG. 1. The expression "heavy material" is intended to refer more particularly, but not exclusively, to substances having a specific gravity of approximately 5.0 or higher.

Facilitating orderly side-by-side packing of fibers 12 in the corner of compartment 22 is a closely woven screen 28 (FIG. 1). Therewith, a rectangular array of the fibers 12 is automatically produced by inserting fibers 12 into the screen and combing them through its foramina. Screen 28, for purposes of illustration only, is shown as being spaced a considerable distance away from the top of container 16. It may, however, be positioned immediately over compartment 22 or closely adjacent thereto if desired. Other forms of foraminous sheet material may be substituted for screen 28, e.g. punched, drilled or otherwise perforated sheet metal, plastic or cardboard.

With fibers 12 thus combed into orderly side-by-side relationship with each other at the corner of container 22 and with their corresponding adjacent ends abutting plate 18, as illustrated, the liquid heavy metal of pool 24, being displaced by the bundle 10 of fibers, exerts the force of its weight laterally against sides of the bundle as illustrated by arrows 30 (FIG. 2). This causes fibers 12 to push into tightly interfitted relationship with each other substantially as is also illustrated in FIG. 2. The bundling effect can be observed through the transparent bottom of container 16. Thus, should optimum alignment and packing not take place immediately upon first insertion of the bundle into pool 24, it can be immediately detected and slight lifting, shaking and reinsertion into the pool may be effected to assure the desired packing arrangement.

Once the end 14 of bundle 10 is automatically clamped in the corner of compartment 22 by the fluid clamping action of the heavy metal of pool 24 forcing itself against

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bundle 10, the fusing of fibers 12 together at end 14 is accomplished by raising the temperature of the whole container 16 to the fusing temperature of materials of fibers 12. This temperature rise can be accomplished by increasing the electrical current applied to heating coils 26 or with supplemental heating devices such as additional similar heating coils, gas jets or combinations thereof.

The fusion of fibers 12 being accomplished in situ obviates handling problems between alignment and fusing operations wherewith highly desirable results are accomplished straightforwardly and economically.

It is to be understood that all uses of the term "fused" and its variations in this specification are intended to cover any form of uniting fibers 12, i.e. in addition to the usual superficial melting and blending together of the materials of fibers 12, the expression "fused" and "fusing" herein are intended to encompass the melting together or adhering of cement or epoxy coatings applied to fibers 12 prior to their assembly in bundle 10. In the latter case, lower than glass fusing temperatures should be applied to container 16 for curing (fusing) such cements or epoxies. Thus, the material of pool 12 may comprise mercury or an equivalent relatively heavy liquid material. For glass-to-glass fusion, however, pool 24 would preferably comprise molten pure tin or a low melting temperature alloy of tin, lead and/or other suitable metallic constituents.

Upon fusion of end 14 of bundle 10 in container 16, it is simply lifted from the container and unfused lengths of the fibers 12 are combed out of screen 28. These free ends are then disposed as desired, e.g. along a line 32 as shown in FIG. 3 or bundled together in separate groups 34 as shown in FIG. 4. Line 32 (FIG. 3) may be in the form of a circle, semi-circle or other non-linear shape and/or the bundled ends (FIG. 4) 34 may be of equal or different sizes. It is also pointed out that should it become desirable to cement or fuse fibers 12 together at each of ends 34, these ends 34 may be individually proc-

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essed according to the process described above for end 14 of the bundle.

What is claimed is:

1. A method of orderly compacting and fusing together corresponding ends of a bundle of fibers comprising the steps of:

inserting said fiber ends as a group into a pool of a heavy high specific gravity liquid with at least one side of said bundle pressed by the weight of said liquid against a fixed wall of a predetermined regular shape; and

heating said liquid and said ends of said bundle while in said pool to the fusing temperature of materials of said fibers for fusing said fiber ends together.

2. The method according to claim 1 further including the step of combing said ends of said fibers into substantially parallel side-by-side relationship with each other prior to said insertion thereof into said pool and inserting said combed ends of said group into said pool.

3. The method according to claim 1 further including bringing corresponding end faces of said fiber ends into substantially flush relationship with each other within said pool prior to said step of heating said liquid and said ends of said bundle.

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