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Inventor Scott L. Patton
Robert M. Payton

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1 Navy Case No. 74931

2
3 FIBER OPTIC HANDLING AND COATING FIXTURE

4
5 STATEMENT OF GOVERNMENT INTEREST

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

10
11 CROSS REFERENCE TO RELATED PATENT APPLICATIONS

12 The instant application is related to two co-pending U.S.
13 Patent Applications entitled METHOD AND APPARATUS FOR
14 PHOTOBLEACHING PATTERNS IN IRRADIATED OPTICAL WAVEGUIDES (Navy
15 Case No. 74919); and METHOD AND APPARATUS FOR IRRADIATING
16 PATTERNS IN OPTICAL WAVEGUIDES CONTAINING RADIATION SENSITIVE
17 CONSTITUENTS (Navy Case No. 74968) having same filing date.

18
19 BACKGROUND OF THE INVENTION

20 (1) Field of the Invention

21 This invention relates generally a method and apparatus for
22 handling optical waveguide substrates and, more particularly, to
23 a fixture and a method for handling optical fibers and similar
24 waveguides for processing.

1 (2) Description of the Prior Art

2 Optical waveguides, including fiber and fiber-like
3 substrates such as optical fibers, are known. It is also known
4 to change the useful properties or characteristics of selected
5 areas of an optical waveguide by first exposing the optical core
6 and/or the optically transmissive cladding to permit processing
7 of the core and/or the cladding. For example, United States
8 Letters Patent No. 4,182,664 to Maklad et al., discloses
9 processing by which optical fibers become relatively stable to
10 nuclear radiation loss by pre-irradiating the fibers.

11 United States Letters Patent No. 4,793,680 to Byron
12 discloses the formation of a grating by directing a pulsed high-
13 power laser beam on or near an exposed end of an optical
14 waveguide to create rippled discontinuities on the waveguide.
15 Other processes form optical patterns of varied optical densities
16 or refractive indexes. United States Letters Patent No.
17 4,403,031 to Borrelli et al. discloses a process for forming
18 optical patterns of varied optical densities or refractive
19 indexes by exposing porous glass impregnated with a photolyzable
20 organometallic compound to photolyzing light.

21 Other processing forms Bragg gratings in the core and/or
22 cladding layers of optical fibers. These fibers are particularly
23 adapted for use in strain sensing, stress sensing, temperature
24 sensing, pressure sensing, vibration sensing, and other sensors.
25 In one such method, apparatus directs coherent green light
26 (approximately 488nm wavelength) into both ends of a germania

1 doped optical fiber. The resulting interference pattern
2 photobleaches the core of the fiber and thereby creates a
3 grating.

4 United States Letters Patent Nos. 5,066,133 to Brienza,
5 5,061,032 to Meltz et al., 5,042,897 to Meltz et al., 4,793,930
6 to Blyler, Jr. et al., and 4,725,110 to Glenn et al. disclose
7 apparatus for focusing and directing split beams of coherent
8 light in the ultraviolet region (approximately 244nm wavelength)
9 onto a specific region of a germania doped optical fiber. An
10 analogous process disclosed in United States Letters Patent No.
11 5,104,209 to Hill et al. forms Bragg gratings in europium and
12 alumina doped fibers.

13 In general, such processing of optical waveguides comprises
14 successive steps. When more than one region or segment requires
15 processing, each region is processed successively. Sequential
16 processing frequently introduces other perturbations including,
17 for example, dimensional variations, planar variations, and
18 consistency variations.

19 The consecutive nature of these operations also increases
20 the time needed for the processing of individual fibers.
21 Repeated handling of the fiber increases the potential of
22 breakage in the processed region thereby limiting the amount of
23 processing or requiring extra care in the handling of the fiber.

24 As a final step in processing, it is often desirable to
25 apply or reapply a protective coating over the processed
26 waveguide. Various methods which are known or suggested for

1 applying such protective coatings include extrusion, overmolding,
2 and vapor-phase deposition processes. Extrusion processes
3 generally involve drawing the fiber individually through the
4 coating material and risk fiber breakage. Overmolding processes
5 involve disposing a pre-formed, over-sized covering or tube over
6 the fiber and filling the tube with a molding material which
7 bonds the tube to the fiber. The overmolding process frequently
8 introduces undesirable mechanical properties and also increases
9 the potential for fiber breakage. Vapor-phase deposition
10 techniques typically deposit very thin coatings (i.e., in the
11 micron range) of materials generally not useful for protective
12 coatings for such fibers.

13 United States Letters Patent No. 4,040,691 to David et al.
14 discloses a fixture in the form of a waveguide holder-humidifier
15 comprising a rectangular container and a hinged top. Holes in
16 two sides of the container enable a liquid sample to pass through
17 the container. United States Letters Patent No. 4,793,681 to
18 Barlow et al. discloses a relatively complicated splice cradle
19 for holding fiber optic splice segments in place. United States
20 Patent No. 4,721,586 to Kakii et al. discloses a mold which
21 mounts optical fibers of a cable as part of a method for forming
22 cable plugs. A resin is introduced into the mold to solidify
23 about multiple optical fibers of a single cable which are then
24 cut apart to form two plugs. United States Letters Patent No.
25 4,750,804 to Osaka et al. discloses a jig securing single or

1 plural optical fiber cores for fusion welding with other
2 similarly secured cores.

3 The foregoing references fail to provide a fixture for
4 holding optical waveguides for processing to alter the properties
5 of optical waveguides. They fail to provide a fixture that is
6 relatively simple to use and that reduces the direct handling of
7 optical waveguides during processing and that enables concurrent
8 processing by a variety of techniques of waveguides secured in
9 the fixture. Additionally, the prior art fails to suggest a
10 fixture that is simple to use and that facilitates the formation
11 of a protective coating about exposed portions of the optical
12 waveguide.

13 14 SUMMARY OF THE INVENTION

15 An object of the present invention is to provide a fixture
16 for releasably holding optical waveguides in a secure manner
17 during processing that alters the properties of such waveguides.

18 Another object of the present invention is to provide an
19 optical waveguide processing fixture that is relatively simple to
20 use and that reduces the direct handling of optical waveguides.

21 Still another object of the present invention is to provide
22 a fixture that enables the concurrent processing of optical
23 waveguides secured therein by various techniques.

24 A further object of the present invention is to provide a
25 handling fixture that can be used to improve the consistency of
26 optical waveguide processing and provide a coating fixture for

1 coating exposed portions of optical waveguides with a protective
2 coating.

3 One aspect of the present invention comprises a fixture
4 having a first and a second frame to hold fiber optical cable
5 with a cured molding material for processing. First and second
6 spaced members of the first frame with at least one surface in a
7 common plane define opposite boundaries of a processing aperture.
8 A set of first and second chambers have openings in the planar
9 surfaces of the first and second spaced member, respectively, and
10 align along a support axis spanning the processing aperture.
11 Each of the chambers receives the molding material and positions
12 the fiber optic cable along the support axis spanning the
13 processing aperture. The second frame attaches to the first
14 frame for overlying at least the planar surfaces of the first and
15 second members thereby to close the chambers.

16 17 BRIEF DESCRIPTION OF THE DRAWINGS

18 The appended claims particularly point out and distinctly
19 claim the subject matter of this invention. The various objects,
20 advantages and novel features of this invention will be more
21 fully apparent from a reading of the following detailed
22 description in conjunction with the accompanying drawings in
23 which like reference numerals refer to like parts, and in which:

24 FIG. 1 is a perspective view of a processing fixture,
25 according to the present invention, in a separated form;

1 FIG. 2 is a top plan view of one of the frames of the
2 processing fixture of FIG. 1;

3 FIG. 3 is a top plan view of one unit of a coating fixture
4 that is usable with the fixture of FIG. 1 and is constructed in
5 accordance with another aspect of the present invention; and

6 FIG. 4 is a sectional view of the coating unit of FIG. 3
7 taken along the section line 4-4.

8 9 DESCRIPTION OF THE PREFERRED EMBODIMENT

10 In FIG. 1 a processing fixture 10 constructed in accordance
11 with this invention that captures portions of optical waveguides
12 formed of fiber optic cable in molded plastic. The fixture 10
13 comprises a first frame 11 and a second frame 12 that are shown
14 as being separated with respect to each other and that are
15 adapted for being secured together as a unitary structure.

16 The first frame 11 includes first and second spaced members
17 13 and 14. The members 13 and 14 define opposite boundaries of a
18 processing aperture 15 about a central axis 16 intermediate the
19 members and have surfaces 17 lying in a common plane. A
20 plurality of sets of first and second chambers 20 and 21 are
21 formed in and spaced along the first and second members,
22 respectively. Each chamber has an opening in the planar surface
23 17 and each pair of chambers 20 and 21 in a set lies along one of
24 a plurality of spaced support axes 24. Each of the chambers 20
25 and 21 comprises a central cavity 22 disposed between opposite
26 axially extending elongated slots 23. The cavity 22 and

1 corresponding slots 23 lie along the support axis 24 for that
2 set. The slots 23 have cross-sections that correspond to the
3 cross section of a optical fiber being processed. The support
4 axis 24 is angularly displaced with respect to the central axis
5 16 and spans the processing aperture 15. Normally the support
6 axes 24 will be at right angles to the central axis 16. Two
7 spaced side members 25 and 26 extend between the members 13 and
8 14 and define the remaining boundaries of the processing aperture
9 15. The members 25 and 26 also have surfaces 27 that are
10 coplanar with the surfaces 17 to define a mating surface 30.

11 Still referring to FIG. 1, the second frame 12 for attaching
12 to the first frame 11 and overlying the mating surface 30
13 preferably corresponds in size and form with the frame 11. That
14 is, the frame 12 includes first and second spaced members 33 and
15 34, which define opposite boundaries of a processing aperture 35
16 about a central axis 36 intermediate the members. The members
17 have surfaces 37 lying in a common plane. First and second
18 chambers 40 and 41 in the first and second members, respectively,
19 open at the planar surface 37. Each of the chambers 40 and 41
20 comprises a central cavity 42 disposed between opposed slots 43
21 that lie along a corresponding one of the support axes 24 and
22 register with corresponding chambers 20 and 21 when the frames 11
23 and 12 are assembled. Two spaced side members 45 and 46 extend
24 between the members 33 and 34 to further define the boundaries of
25 the processing aperture 35. The members 45 and 46 also have

1 surfaces 47 which are coplanar with the surfaces 37 to define a
2 mating surface 50.

3 Suitable mating means, such as apertures 53 and locating
4 pins 54 formed in the frames 11 and 12, respectively, position
5 the frames along the mating surfaces 30 and 50. For example,
6 threaded ends of locating pins 54 can extend through the
7 apertures 53 and receive nuts (not shown) to releasably secure
8 the frames 11 and 12 together along the mating surfaces 37 and 47
9 to form a unitary structure in which the processing apertures 15
10 and 35 align. Other securing or locking mechanisms can also be
11 used.

12 In the specific embodiment depicted in FIGS. 1 and 2, the
13 mating surfaces 30 and 50 include six sets of chambers 20 and 21
14 and six sets of chambers 40 and 41, respectively, formed in the
15 parallel members 13, 14, 33, and 34. As previously discussed,
16 each of the chambers 20 and 40 in the parallel members 13 and 33,
17 respectively, align with one of the chambers 21 and 41 in the
18 parallel members 14 and 34, respectively. Likewise, each set of
19 the chambers 20 and 21 in the parallel members 13 and 14 align
20 and register with respective ones of the sets of the chambers 40
21 and 41 in the parallel member 33 and 34.

22 This arrangement provides, upon securing the frames 11 and
23 12 together, segments of a continuous optical fiber that extend
24 between the chambers 20, 21, 40 and 41 along support axes 24.
25 Each segment spans the processing area of the fixture 10 defined
26 by the processing apertures 15 and 35. Each segment also can be

1 spaced from any adjacent segment. When the frames 11 and 12 are
2 separated, the ready access to the chambers 20, 21, 40, and 41
3 facilitates the insertion and removal of optic fiber cables from
4 the fixture 10.

5 In using the fixture 10, the frames 11 and 12 are separated
6 to provide access to one set of chambers, such as chambers 20 and
7 21 in the frame 11 as shown in FIG. 2. depending upon the
8 molding materials, a release agent may be applied to the chambers
9 20 and 21 and corresponding slots. The user then lays along each
10 of the support axes 24 a segment of optical fiber. In FIG. 2, a
11 single optical fiber cable 55 snakes successively through each
12 set of the chambers 20 and 21 in the frame 11. This arrangement
13 positions segments 56a-56f in the processing aperture 15 along
14 the different support axes 24.

15 Continuing to refer to FIG. 2, the user pours a molding
16 material 57 around the portions of the optical fiber cable 61 in
17 the cavities 22 and allows the molding material to cure while
18 maintaining some tension on the ends of each segment 56a through
19 56f outside the frame 11. The molding material 57 should be
20 compatible with the material forming the optical fiber or any
21 protective coating on the cable. Curable resins, such as
22 urethane and RTV silicone are examples of acceptable materials.
23 Once cured, the material 57 secures the optical fiber 55 in the
24 cavities 21.

25 Alternatively, molding material 57 may be added to the
26 cavity 22 first and cured. The fiber cable 55 then can be laid

1 into the chambers 20 and 21 of the frame 11 and secured to the
2 solidified molding material by a suitable bonding agent, such as
3 a cyanoacrylate glue. In any event, the molding material 57,
4 however formed and secured to portions of the cable 55, functions
5 to securely retain the optical fiber cables in the fixture 10
6 without slippage of the segments in the process area.

7 After securing the frames 10 and 12 together, the molding
8 material bears against the walls of the cavities 42 to inhibit
9 movement of the segments 56a-56f. Additional molding material 57
10 can be injected into the cavities 22 and 42 of the registered
11 chambers to improve the securement of the segments 56a-56f in the
12 fixture 10. For example, injection apertures 60, as depicted in
13 FIG. 1, enable injection of the additional molding material into
14 the closed chamber 24. Once secured, the segments are now ready
15 for processing. After processing, separating the frames 11 and
16 12 enables removal of the cable 55 with the segments of molding
17 material 57 at each end of the processed segment.

18 Thus, a fixture constructed in accordance with this
19 invention provides a device for securing one or more optical
20 fiber segments within the fixture. Securing portions of the
21 fiber to the molding material in the cavities together with the
22 sizing of the end slots of the chamber provides a relatively
23 stable and stationary cable segment in the process area.
24 Additionally, it will be appreciated that within the scope of
25 this invention, one of the frames 11 and 12 could be formed with
26 chambers sufficiently deep to receive the fiber optic cable and

1 molding material therein with the other frame formed as a cover
2 without any chambers.

3 The fixture of this invention permits the steps of various
4 method of processing fiber optic cables to be applied to the
5 segments in the process area concurrently or sequentially. This
6 reduces the likelihood of variations, errors and the like in
7 processed segments. The fixture also reduces handling of the
8 segments during processing reducing the likelihood of damage to
9 the optical fiber cables as well as other errors induced by the
10 stretching and twisting of the optical fiber cables.

11 Moreover, once properly positioned in the frame the
12 processing of desired portions can be accomplished without
13 further measuring or reorienting of the optical fiber cables
14 themselves. Even in the case of sequential processing or
15 processing only selected ones of the segments, the fixture
16 reduces the direct handling of the optical fiber cables to reduce
17 the likelihood of breakage, while improving the control over the
18 segments.

19 As seen in FIG. 2, the reduced diameter of regions 61a-61f
20 represent the removal of some layers from the cable 55 in each of
21 these regions. Forming a protective coating over such regions is
22 often desirable. FIG. 3 and FIG. 4 depict a coating unit 70
23 that, with a second mating unit (not shown), forms a coating
24 fixture according to the present invention for use with the
25 unitary structure of fixture 10.

1 Specifically, the unit 70 includes a first surface 71 for
2 positioning along a surface 72 opposite the mating surface 30 of
3 frame 11 (FIG. 1). A central raised portion 73 extends from the
4 surface 71. The portion 73 is sized and shaped to extend into
5 the portion of the processing area 15 of the fixture 10 (FIG. 1).
6 The upper surface 74 of the portion 73 includes a series of
7 grooves 75 that align with and partially surround the individual
8 segments 61a through 61f.

9 The second coating unit (not shown) is positionable on the
10 surface 76 (FIG. 1) opposite the mating surface 30 of the frames
11 12 and it, like the unit 70, includes a raised portion with
12 grooves formed therein for extension into the process area of the
13 fixture 10 defined by the process aperture 15 (FIG. 1). The
14 first unit 70 and the second unit include means for securing the
15 coating units on the fixture 10. In this instance, the unit 70
16 includes apertures 77 formed therein for receiving the locating
17 pins 54 (FIG. 1) of frame 12 to position and secure the unit 70
18 to the fixture 10. Other arrangements for seating and securing
19 the first and second units on the corresponding frame known in
20 the art are contemplated hereby and will not be further
21 discussed.

22 When the first unit 70 and the second unit are operatively
23 positioned on the fixture 10 with the frames 11 and 12 (FIG. 1)
24 secured together, the grooves of both of the coating units
25 register to form cavities that span the process area 15 of the
26 fixture 10 along the support axes 24 (FIG. 1). These cavities

1 envelop any optical fiber cables segments disposed in the process
2 area (e.g., segments 56a-56f of FIG. 2). Injection ports 80 in
3 the coating unit 70 enable introduction of a suitable molding
4 material into each of the cavities. Filling the cavities with
5 the molding material and solidifying it forms a protective
6 coating over the cable segments in the cavities. Detaching the
7 coating units from the fixture 10 and opening the fixture 10
8 enables access to and removal from the chambers 20, 21, 40 and 42
9 the processed optical fiber cable segments with the protective
10 coating formed thereon.

11 The molding material used to form the protective coating
12 should be compatible with the material forming the optical fiber
13 or any protective coating on the cable. Curable resins, such as
14 urethane and RTV silicone are examples of acceptable materials.
15 As previously indicated it may be desirable to coat each cavity
16 surface with a release agent prior to assembling the unit 70 and
17 the mating unit. The cross-section of the ducts preferably
18 conform to the original or desired shape of the protective
19 coating on the optical fiber cables (e.g., cylindrical) so that
20 the molding material solidifies in such shape. The coating
21 fixture, thus, enables coating or re-coating optical fiber cable
22 segments with a protective coating.

23 The advantages of the present invention should now be
24 apparent. For example, multiple processing steps can be
25 performed on segments secured in the fixture without further
26 handling of the optical fiber cable. The fixture enables

1 concurrent processing of multiple segments of a single or plural
2 optical fiber cables, which improves efficiency and reduces
3 variations resulting from variations in the processing steps.
4 Finally, the fixture enable the coating or re-coating of
5 processed optical fiber cables as part of a single continuing
6 process while the cables are positioned within the fixture.

7 In summary, this invention comprises a fixture which secures
8 a plurality of optical fiber cable segments for processing. The
9 fixture includes a structure mounting optical fiber cable
10 segments in a processing area which are readily accessible for
11 processing in accordance with various techniques. The mounting
12 of the optical fiber cable segments in the structure provides for
13 dimensional control over areas being processed. The fixture
14 eliminates much of the handling of the optical fiber cable during
15 processing which often contributes to breakage. An additional
16 feature which may be included with the fixture of the invention
17 is a coating fixture which enables coating of the segments with a
18 the protective coating.

19 This invention has been disclosed in terms of certain
20 embodiments. It will be apparent that many modifications can be
21 made to the disclosed apparatus without departing from the
22 invention. Therefore, it is the intent to
23 cover all such variations and modifications as come within the
24 true spirit and scope of this invention.

2
3 FIBER OPTIC HANDLING AND COATING FIXTURE

4
5 ABSTRACT OF THE DISCLOSURE

6 The invention comprises a fixture and method for holding
7 optical waveguides, such as fiber optic cable, in a relatively
8 stable fashion for processing. The fixture includes a first
9 frame and a second frame, releasably securable to the first frame
10 to form a unitary structure. Chambers disposed in at least one
11 of the frames are adapted for removably receiving optical fiber
12 cable when the first and second frames are released from one
13 another and for securely retaining with molding material optical
14 fiber cables when the first and second frames form the unitary
15 structure. A process area is defined in the unitary structure
16 such that segments of optical fiber cables secured therein are
17 accessible in the process area for processing. An optional
18 coating fixture is securable to said unitary structure for
19 forming with a molding material a protective coating about the
20 cable segments in the processing area.

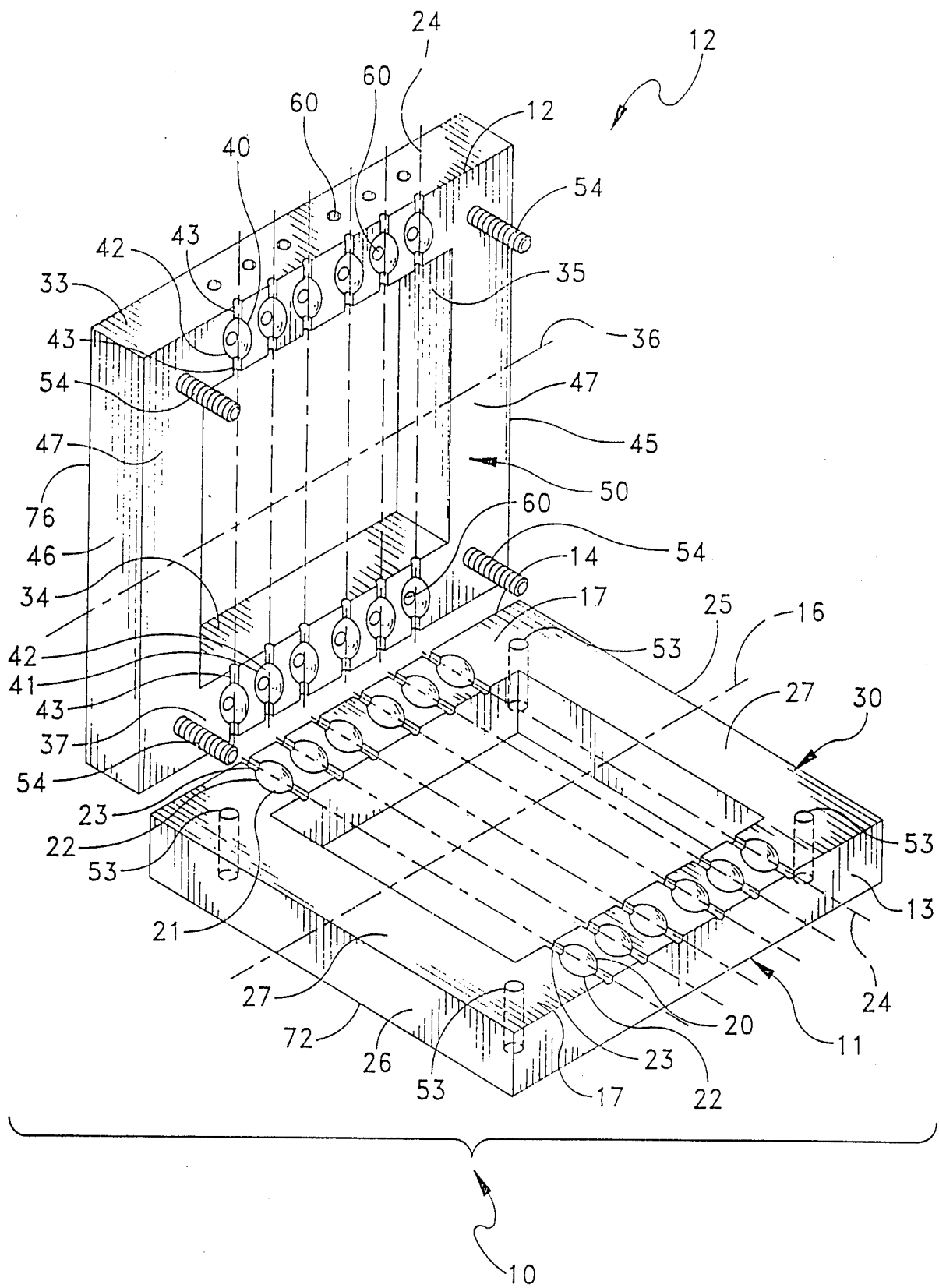


FIG. 1

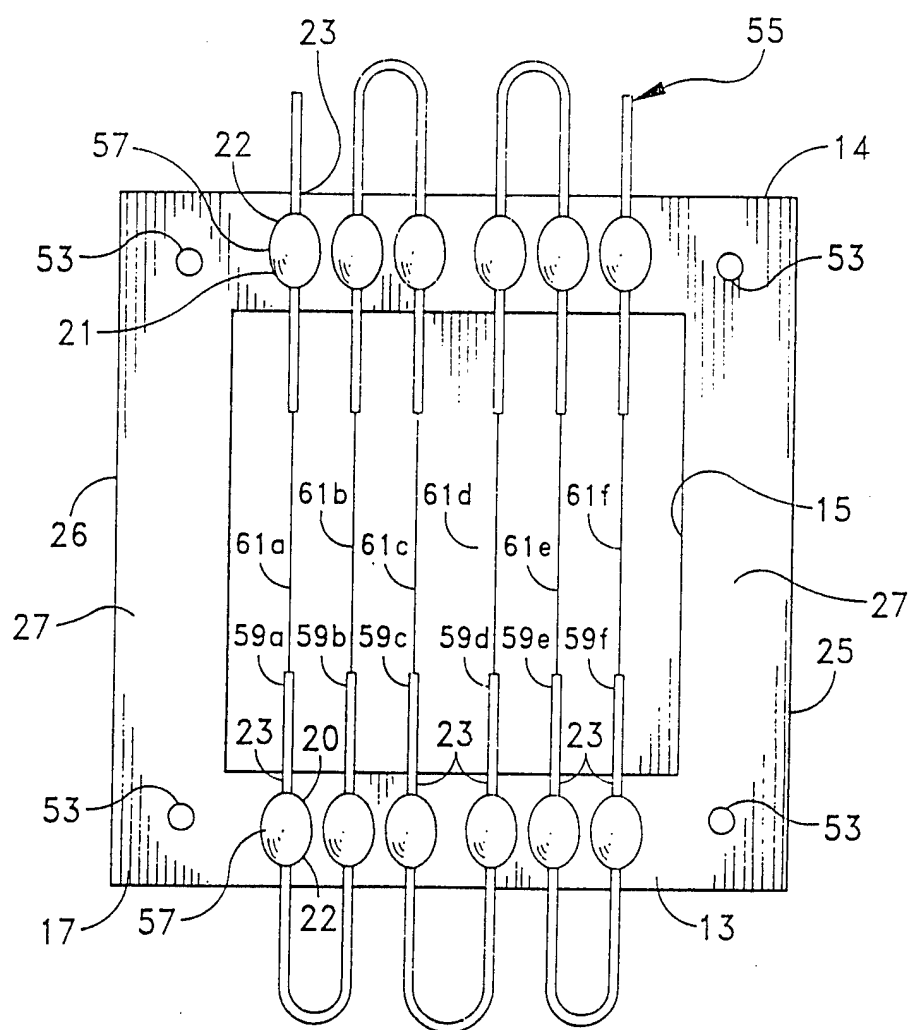


FIG. 2

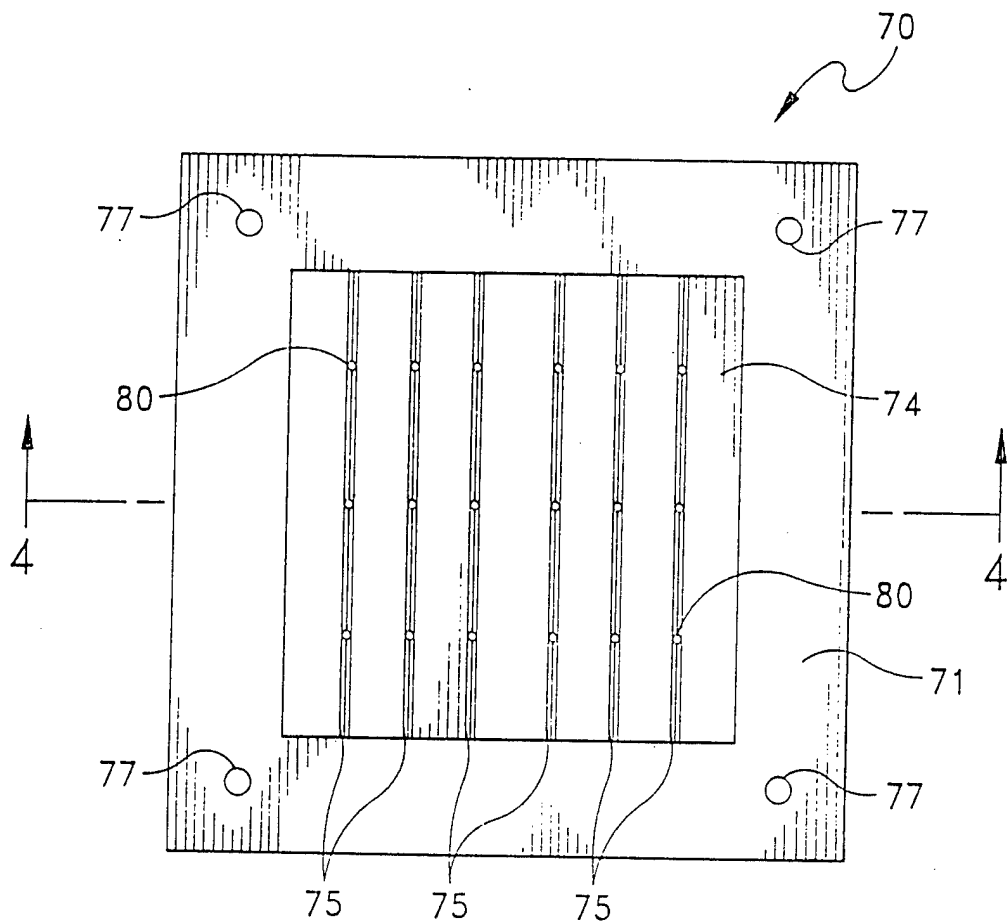


FIG. 3

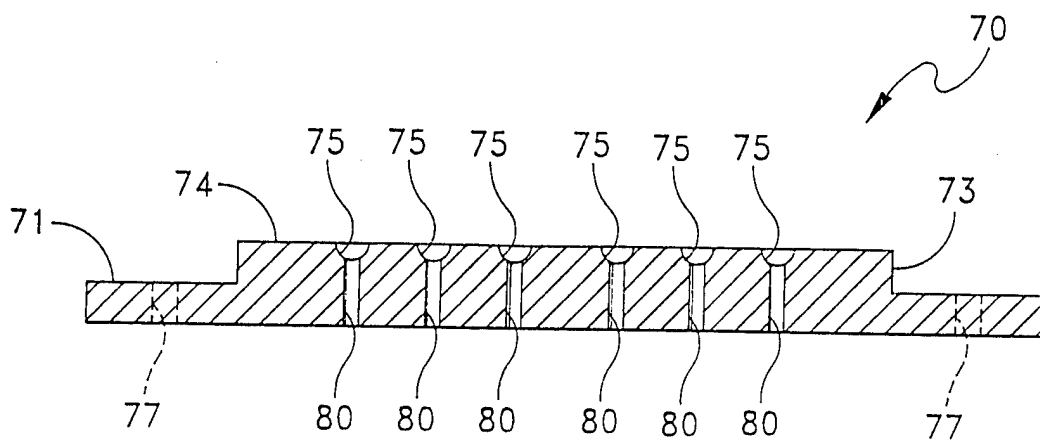


FIG. 4