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[45] Patented **Sept. 14, 1971**

[73] Assignee **United States Steel Corporation**

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*Primary Examiner*—J. Karl Bell  
*Attorney*—Robert J. Leek, Jr.

[54] **COMPOSITE BLAST-ABSORBING STRUCTURE**  
 7 Claims, 6 Drawing Figs.

[52] U.S. Cl. .... 109/81,  
 52/618, 89/36 R, 109/49.5, 161/404

[51] Int. Cl. .... F41h 5/04,  
 B32b 3/12

[50] Field of Search ..... 109/78-85,  
 49.5; 52/615, 618; 89/36; 296/31; 161/41, 404;  
 114/10-14

[56] **References Cited**

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**ABSTRACT:** This invention relates to a protective panel for the blast protection of a structure.

The protective panel has an impact member, a honeycomb member disposed opposite the impact member, distensible side members defining with the impact member and the honeycomb member a cavity, and a fluid hermetically sealed in the cavity. The honeycomb member is secured to the panel. The impact member is operable when a localized high-intensity force of an explosion contacts the impact member to transmit the localized high-intensity force of the explosion to the fluid. The fluid is operable to convert the localized high-intensity force to a uniform low-intensity force on the honeycomb member and the side members. The honeycomb member is subjected to accordion-type crushing, and the sidewalls deflect outwardly in bending and fracturing, thus allowing the impact member to contact and deform the honeycomb member and minimally deform the panel.

Alternatively, a second honeycomb member or a multiplicity of honeycomb members is substituted for the cavity.

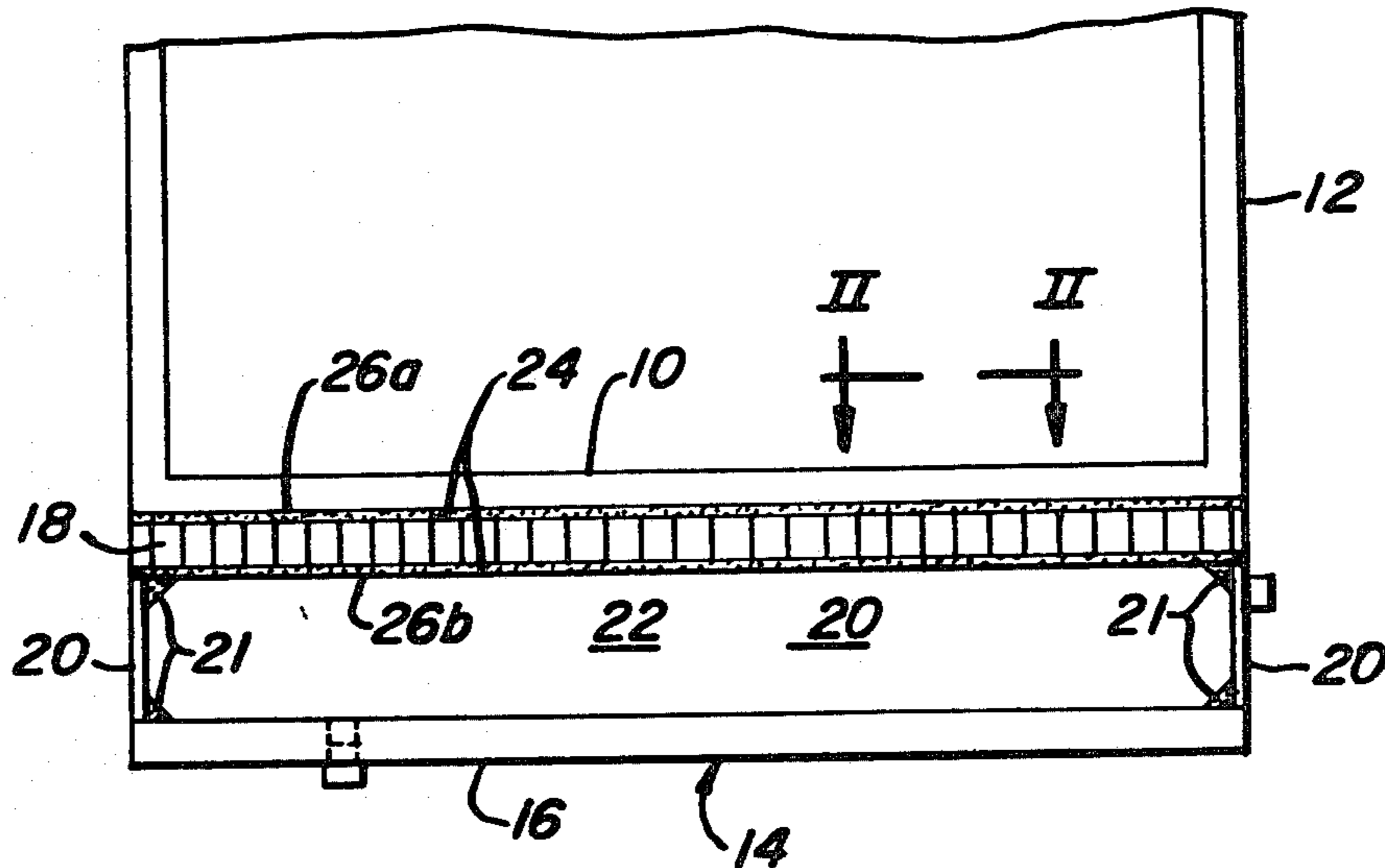


FIG. 1

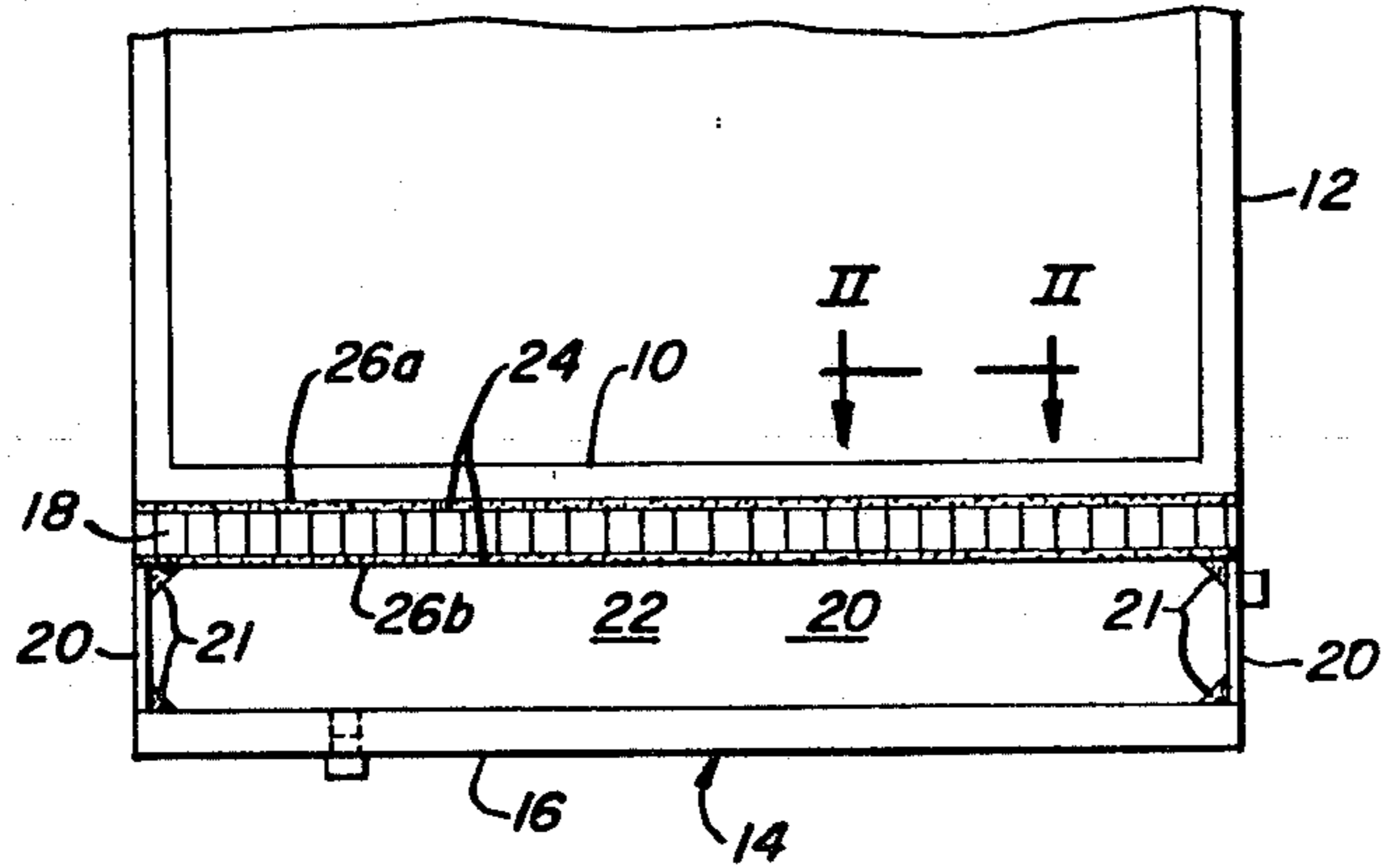


FIG. 1A

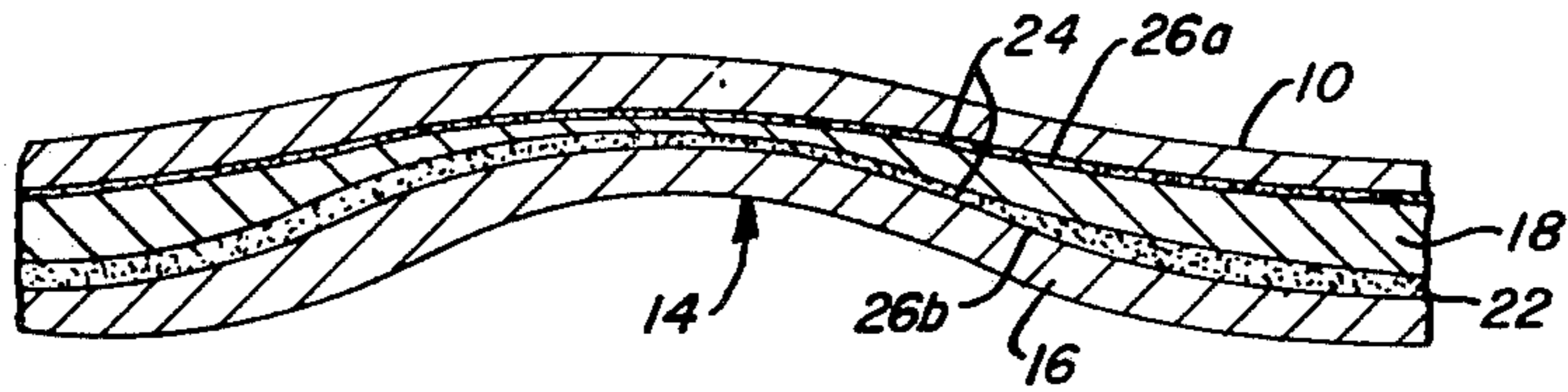


FIG. 3

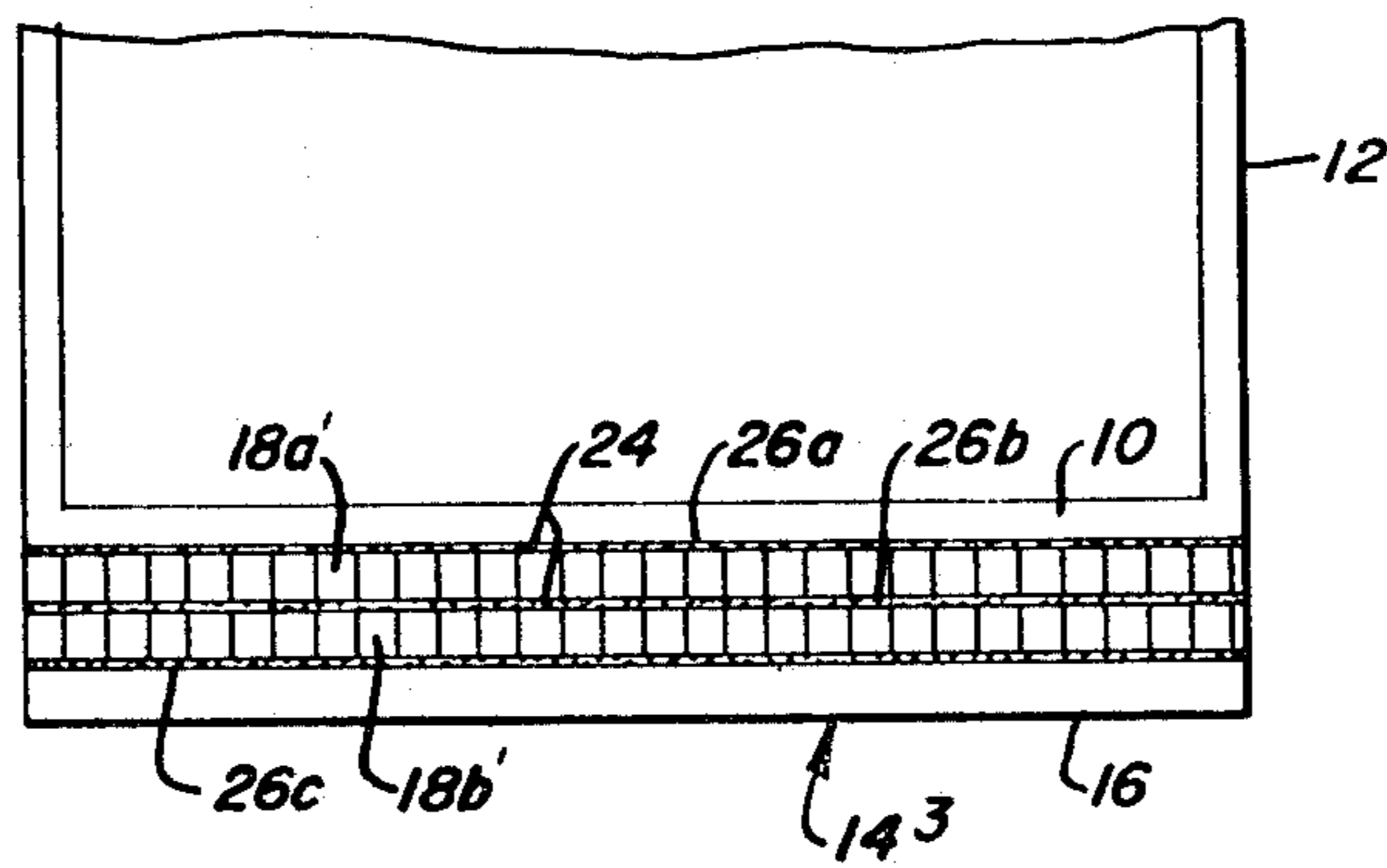
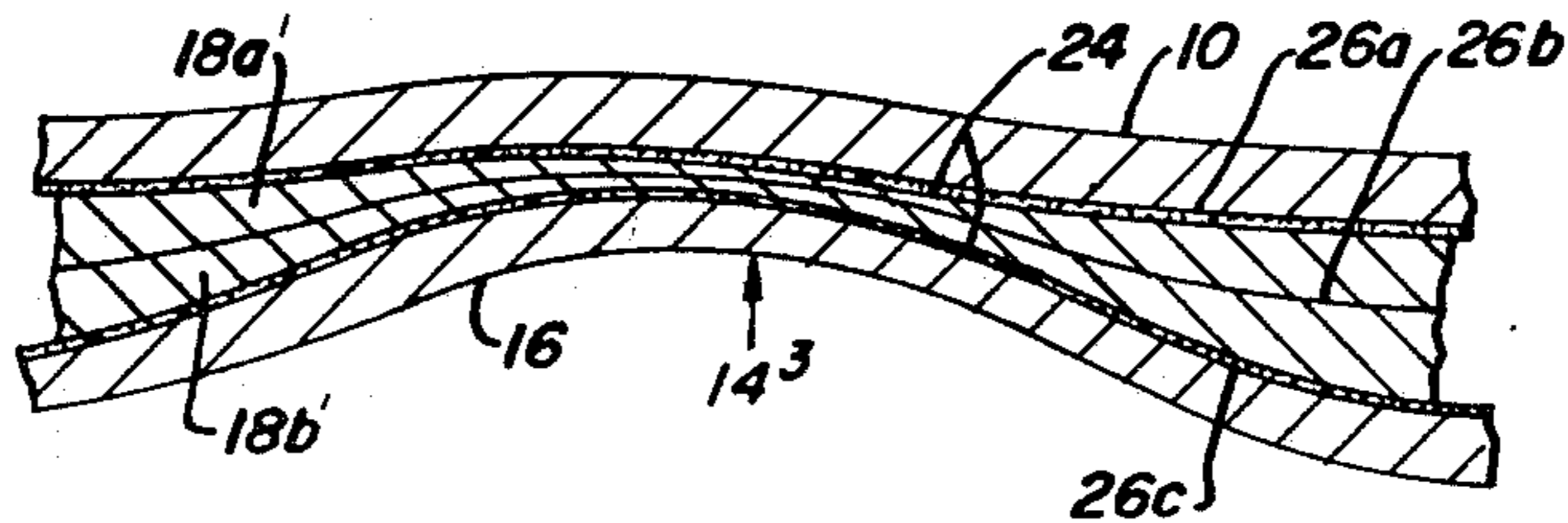


FIG. 3A



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FIG. 2B

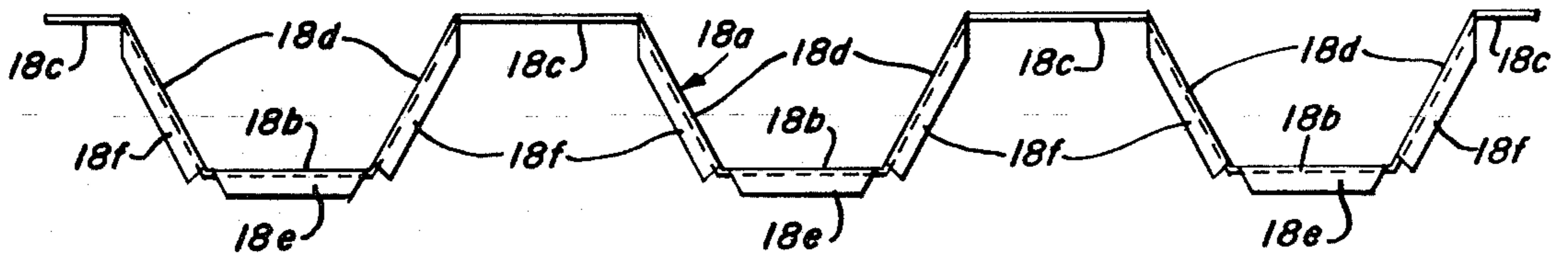
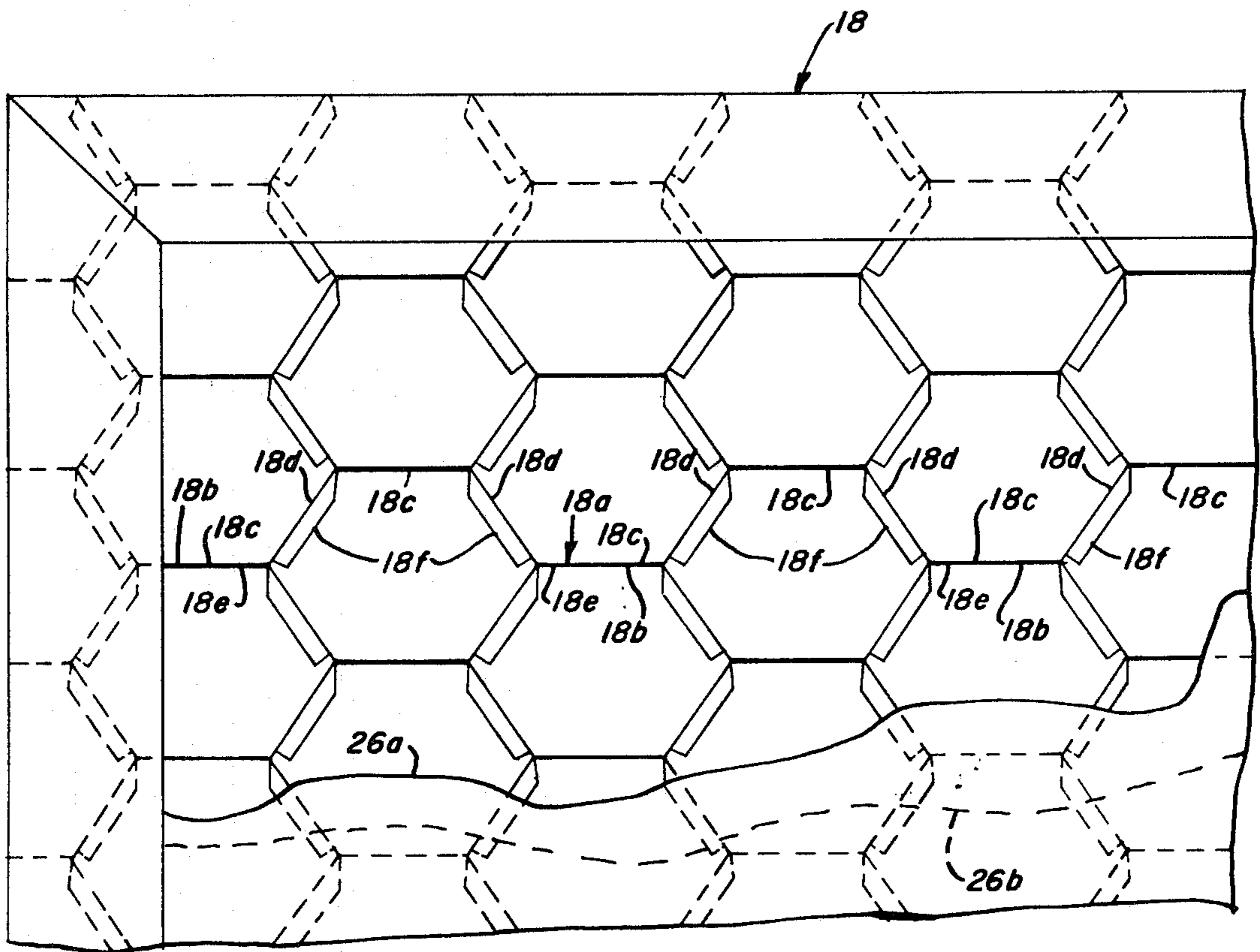


FIG. 2A



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## COMPOSITE BLAST-ABSORBING STRUCTURE

## BACKGROUND OF THE INVENTION

Heretofore, armored vehicles or the like have been protected by conventional plate, construction, panels and the like shown in the following U.S. Pats.: No. 2,733,177, to Meyer, issued Jan. 31, 1956; No. 3,157,090, to Ballu, issued Nov. 17, 1964; No. 3,243,898, to Lewis et al., issued Apr. 5, 1966; No. 3,324,768, to Eichelberger, issued June 13, 1967; and No. 3,351,374, to Forsyth et al., issued Nov. 7, 1967.

## OBJECTS OF THE INVENTION

It is the general object of this invention to avoid and overcome the foregoing and other difficulties of and objections to prior art practices by the provision of a protective structure for an armored vehicle which protective structure:

- a. improves blast protection for a panel,
- b. is readily affixed to the panel to be protected, and
- c. is strong but light enough to permit manual handling.

## BRIEF SUMMARY OF THE INVENTION

The aforesaid objects of this invention and other objects which will become apparent as the description proceeds, are achieved by providing a protective panel for the blast protection of a structure. The protective panel has an impact member, a honeycomb member disposed opposite the impact member, distensible side members defining with the impact member and the honeycomb member a cavity, and a fluid hermetically sealed in cavity. The honeycomb member is secured to the panel. The impact member is operable when a localized high-intensity force of an explosion contacts the impact member to transmit the localized high-intensity force of the explosion to the fluid. The fluid is operable to convert the localized high-intensity force to a uniform low-intensity force on the honeycomb member and the side members. The honeycomb member is subjected to accordion-type crushing, and the sidewalls deflect outwardly in bending and fracturing, thus allowing the impact member to contact and minimally deform the honeycomb member and the panel.

Alternatively, a second honeycomb member or a multiplicity of honeycomb members is substituted for the cavity.

## BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

For a better understanding of this invention, reference should be had to the accompanying drawings, wherein like numerals of reference indicate similar parts throughout the several views and wherein:

FIG. 1 is a fragmentary side view of a bottom panel and associated side panels of an armored vehicle and showing the protective panel of this invention for the bottom panel before the explosion;

FIG. 1A is a view similar to FIG. 1 showing the parts after an explosion;

FIG. 2A is an enlarged fragmentary view of a portion of a core strip of the honeycomb member;

FIG. 2B is a plan view of a corrugated core strip;

FIG. 3 is a view similar to FIG. 1 of an alternative embodiment wherein a second honeycomb member is substituted for the cavity; and

FIG. 3A is a view similar to FIG. 3 showing the parts after an explosion.

Although the principles of this invention are broadly applicable to protective panels for protecting structures and the like from explosions and the like, this invention is particularly adapted for use in conjunction with the protection of the bottom panel of an armored vehicle and hence it has been so illustrated and will be so described.

## DETAILED DESCRIPTION

With specific reference to the form of this invention illustrated in the drawings, and referring particularly to FIG. 1, a protective panel for the blast-protection of a bottom panel 10 (FIGS. 1, 1A, 3, 3A) of an armored vehicle body 12 (FIGS. 1, 3) is indicated generally by the reference numeral 14 (FIGS. 1, 1A).

This protective panel 14 has an impact member 16 (FIGS. 1, 1A, 3, 3A), suitably a MIL-S-12560 class II armored steel plate or the like. A honeycomb member 18 (FIGS. 1, 1A, 2A) is disposed opposite the impact member 16. Distensible side members 20 (FIG. 1), suitably CRDQ (cold rolled drawing quality) carbon steel sheet or the like, are welded together at 21 (FIG. 1), (FIG. 1) to the impact member 16 and to the honeycomb member 18 to define a cavity 22 (FIG. 1) hermetically containing therein an incompressible fluid, such as water or the like. The honeycomb member 18 is secured to the bottom panel 10 by an adhesive 24, such as one of the following:

Trademark or Trade Name	Manufacturer
FM	American Cyanamid Co.
EPON	Shell Chemical Co.
Scotch-Weld Brand	3M Company
USS Nexus PQE-1	U.S. Steel Corp.
Polymeric Material	

As shown in FIGS. 1, 2A, 2B the honeycomb member 18 is composed, for example, of corrugated core strips 18a (FIGS. 2A, 2B) suitably AISI steel 1010 to 1015, 40,000 to 50,000 yield, about 0.010 inches thick and about 1-7/64 inches wide or the like. Each core strip 18a (FIGS. 2A, 2B) has crimping sections 18b, connecting sections 18c and bonding sections 18d. Each crimping section 18b is provided with a crimping tab 18e (FIGS. 2A, 2B) at the top and bottom which crimping tab 18e is crimped over the adjacently positioned connecting section 18c (FIG. 2A) to secure the core strips 18a together. The above adhesive 24 is applied to the bonding tabs 18f on the top and bottom of the bonding sections 18d for securement of the bonding tabs 18f to a top face sheet 26a (FIGS. 1, 1A, 2A, 3, 3A) and the bottom face sheet 26b (FIGS. 1, 1A, 2A, 3, 3A), suitably the same material as the core strip 18a or the like.

## OPERATION

The impact member 16 is operable when a localized high-intensity force of an explosion contacts the impact member 16 to transmit the localized high-intensity force of the explosion to the fluid in the cavity 22. The fluid in the cavity 22 then converts the localized high-intensity force to a uniformly applied low-intensity force on the honeycomb member 18 and on the distensible side members 20. The honeycomb member 18 is subjected to an accordion-type crushing. The sidewalls 20 deflect outwardly in bending and eventually fracture thus allowing the impact member 16 to contact and deform the honeycomb member 18 and minimally deform the bottom panel 10 as shown in FIG. 1A.

During the above sequence of events the protective panel 14 moves from the position shown in FIG. 1 to the position shown in FIG. 1A.

## ALTERNATIVE EMBODIMENTS

It will be understood by those skilled in the art that, alternatively, as shown in FIGS. 3, 3A, a second honeycomb member 18b' (having a single facing sheet 26b between the first honeycomb member 18a' and the second honeycomb member 18b') is employed in lieu of the cavity 22 (FIGS. 1, 1A). Top facing sheet 26a on the first honeycomb member 18a' and bottom facing sheet 26c on the second honeycomb member

18b' are employed. An adhesive 24 may be employed between the top face sheet 26a of the first honeycomb member 18a' and the vehicle bottom 10 and the bottom face sheet 26c of the second honeycomb member 18b' and the impact member 16.

The impact member 16 (FIGS. 3, 3A) is operable when a localized high-intensity force of an explosion contacts the impact member 16 to transmit the localized high-intensity force of the explosion to the second honeycomb member 18b'. The second honeycomb member 18b' is operable to convert the localized intensity force to a uniform low-intensity force on the first honeycomb member 18a' and the bottom panel 10. The first honeycomb member 18a' and said second honeycomb member 18b' are subjected to accordion-type crushing, thus allowing the impact member 16 to deform the second honeycomb member 18b', the first honeycomb member 18a' and minimally deform the bottom panel 10 as shown in FIG. 3A.

SUMMARY OF THE ACHIEVEMENT OF THE OBJECTS OF THE INVENTION

It will be recognized by those skilled in the art that the objects of this invention have been achieved by providing a protective structure 14 (FIG. 1), 14<sup>3</sup> (FIG. 3) for panel 10 of an armored vehicle body 12 which protective structure 14, etc. provides improved blast protection for the panel 10, is readily affixed to the panel 10 to be protected, and is strong but light enough to permit manual handling.

While in accordance with the patent statutes a preferred and alternative embodiment of this invention has been illustrated and described in detail, it is to be particularly understood that the invention is not limited thereto or thereby.

We claim:

- 1. A protective panel for the blast protection of a panel, said protective having:
  - a. an impact member,
  - b. a honeycomb member disposed opposite said impact member and having a cover member,

- c. distensible side members defining with said impact member and said cover member a cavity, and
- d. a fluid hermetically sealed in said cavity,

- 1. said honeycomb member being secured to said,
- 2. said impact member being operable when a localized high-intensity force of an explosion contacts said impact member to transmit said localized high-intensity force of said explosion to said fluid,
- 3. said fluid being operable to convert said localized high-intensity force to a uniform low-intensity force on said honeycomb member and said side members,
- 4. said honeycomb member being subjected to accordion-type crushing by the uniform low-intensity force, and
- 5. said side members permitting the buildup of said uniform low-intensity force on said honeycomb member before deflecting outwardly in bending and fracturing, thus allowing said impact member to contact and deform said honeycomb member and minimally deform said panel.

2. The protective panel recited in claim 1 wherein said honeycomb member has a plurality of corrugated core strips, each having a crimping section joined to an adjacent connecting section.

3. The protective panel recited in claim 2 wherein said crimping section has a crimping tab for connecting said crimping section to said adjacent connecting section.

4. The protective panel recited in claim 1 wherein said honeycomb member has a bonding section disposed between a crimping section and a connecting section.

5. The protective panel recited in claim 4 wherein said bonding section has a bonding tab.

6. The protective panel recited in claim 1 wherein said honeycomb member has a top face sheet secured to said structure.

7. The protective panel recited in claim 1 wherein said honeycomb member has a bottom face sheet defining one side of said cavity.

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UNITED STATES PATENT OFFICE  
CERTIFICATE OF CORRECTION

Patent No. 3,604,374 Dated September 14, 1971

Inventor(s) Harold E. Matson, et al

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 4, line 4, after "secured to said" should read -- structure --.

Signed and sealed this 17th day of October 1972.

(SEAL)  
Attest:

EDWARD M. FLETCHER, JR.  
Attesting Officer

ROBERT GOTTSCHALK  
Commissioner of Patents