

FORM 1

APPLICATION ACCEPTED AND AMENDMENTS

SPRUSON & FERGUSON

ALLOWED.....20.2.91.....

COMMONWEALTH OF AUSTRALIA

610325

PATENTS ACT 1952

APPLICATION FOR A STANDARD PATENT

Minnesota Mining and Manufacturing Company, incorporated in Delaware, of 3M Center, Saint Paul, Minnesota 55144-1000, UNITED STATES OF AMERICA, hereby apply for the grant of a standard patent for an invention entitled:

Catalytic Converter

which is described in the accompanying complete specification.

Details of basic application(s):-

<u>Basic Applic. No:</u>	<u>Country:</u>	<u>Application Date:</u>
155,086	US	11 February 1988

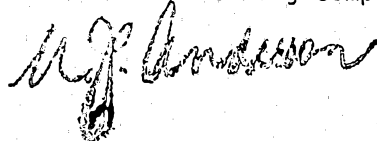
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DATED this FOURTH day of JANUARY 1989

Minnesota Mining and Manufacturing Company

By:



Registered Patent Attorney

TO: THE COMMISSIONER OF PATENTS
OUR REF: 82909
S&F CODE: 58400

004571 04/01/89

5845/2

THE PATENTS ACT 1952
DECLARATION IN SUPPORT OF A
CONVENTION APPLICATION FOR A PATENT

In support of the Convention Application made for a patent for an invention entitled:

Catalytic Converter

Title of Invention

I/We Donald Miller Sell, Chief Patent Counsel

Full name(s) and address(es) of Declarant(s)

of Minnesota Mining and Manufacturing Company
3M Center, Saint Paul, Minnesota 55144-1000
United States of America

do solemnly and sincerely declare as follows:-

Full name(s) of Applicant(s)

1. I am/We are the applicant(s) for the patent
(or, in the case of an application by a body corporate)

1. I am/We are authorised by
MINNESOTA MINING AND MANUFACTURING COMPANY

the applicant(s) for the patent to make this declaration on its/their behalf.

2. The basic application(s) as defined by Section 141 of the Act was/were made

Basic Country(ies)

in United States of America

Priority Date(s)

on 11 February 1988

Basic Applicant(s)

by RICHARD P. MERRY

Full name(s) and address(es) of inventor(s)

3. I am/We are the actual inventor(s) of the invention referred to in the basic application(s)
(or where a person other than the inventor is the applicant)

3. RICHARD PAUL MERRY

care of Minnesota Mining and Manufacturing Company
3M Center, St. Paul, Minnesota, 55144-1000
United States of America

(respectively)-

Set out how Applicant(s) derive title from actual inventor(s) e.g. The Applicant(s) is/are the assignee(s) of the invention from the inventor(s)

is/are the actual inventor(s) of the invention and the facts upon which the applicant(s) is/are entitled to make the application are as follows:

The said Company is the assignee of the actual inventor.

4. The basic application(s) referred to in paragraph 2 of this Declaration was/were the first application(s) made in a Convention country in Saint Paul, Minnesota, the subject of the application.

Declared at U.S.A. this 3rd day of November 19 88

Donald Miller Sell

Signature of Declarant(s)

Donald Miller Sell, Chief Patent Counsel

To: The Commissioner of Patents

11/81

(12) PATENT ABRIDGMENT **(11) Document No. AJ-B-27718/89**
(19) AUSTRALIAN PATENT OFFICE **(10) Acceptance No. 610325**

(54) Title
CATALYTIC CONVERTER

International Patent Classification(s)
(51)⁴ **F01N 003/28 B01D 053/36 C04B 035/14**

(21) Application No. : **27718/89** (22) Application Date : **04.01.89**

(30) Priority Data

(31) Number (32) Date (33) Country
155086 11.02.88 US UNITED STATES OF AMERICA

(43) Publication Date : **17.08.89**

(44) Publication Date of Accepted Application : **16.05.91**

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(56) Prior Art Documents
US 4693338
GB 2171180

(57) Claim

1. A catalytic converter 10 having a metallic casing 11, a unitary, solid catalytic element 20 disposed within said casing 11, and resilient means 30 disposed between said catalytic element 20 and said metallic casing 11 for positioning said catalytic element 20 and for absorbing mechanical and thermal shock, characterized by; said resilient means 30 being a resilient, flexible, fibrous mat 31 of shot-free (as herein defined) ceramic fibers having a stitchbonded compressed thickness in the range of 4 to 25 mm wrapped about the lateral surface of said catalytic element 20 to a mount density of about 0.25 to about 0.50 g/cm³.

S & F Ref: 82909

FORM 10

COMMONWEALTH OF AUSTRALIA

PATENTS ACT 1952

COMPLETE SPECIFICATION

610325

(ORIGINAL)

FOR OFFICE USE:

Class Int Class

Complete Specification Lodged:
Accepted:
Published:

This document contains the amendments made under section 49 and is correct for printing

Priority:

Related Art:

Name and Address
of Applicant:

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Saint Paul Minnesota 55144-1000
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Sydney, New South Wales, 2000, Australia

Complete Specification for the invention entitled:

Catalytic Converter

The following statement is a full description of this invention, including the best method of performing it known to me/us

Abstract

A catalytic converter 10 utilizing a resilient, flexible shot-free ceramic fiber containing mounting mat 30 for mounting a monolith 20 within a metallic casing 11 is disclosed. The mounting mat 30 may be comprised of shot-free ceramic fibers 31 alone or preferably is comprised of a composite of shot-free ceramic fibers 31 in combination with an intumescent sheet material 32.

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CATALYTIC CONVERTERBackground of the Invention

5 The present invention relates to a catalytic converter for an automotive exhaust system comprising a metallic casing with a catalyst support (monolith) securely mounted within the casing by a resilient, flexible ceramic fiber containing mounting mat. The mounting mat may be
10 comprised of ceramic fiber alone or preferably is comprised of a composite of ceramic fiber in combination with an intumescent sheet material.

Catalytic converters are universally employed for oxidation of carbon monoxide and hydrocarbons and reduction
15 of the oxides of nitrogen in automobile exhaust gases in order to control atmospheric pollution. Due to the relatively high temperatures encountered in these catalytic processes, ceramics have been the natural choice for catalyst supports. Particularly useful supports are
20 provided by ceramic honeycomb structures as described, for example, in U.S. Patent Re 27,747.

More recently, catalytic converters utilizing metallic catalyst supports (metallic monoliths) have also been used for this purpose. (See, for example, UK Patent
25 1,452,982, U.S. Patent 4,381,590 and SAE paper 850131.) The metallic monoliths have better thermal shock resistance and offer lower back pressure due to reduced wall thickness of the monolith forming the gas flow channels.

The metallic monoliths are normally welded or
30 brazed directly onto the outer metallic casing of the catalytic converter which becomes very hot because the heat of the exhaust gas is readily conducted by the metallic monolith to the casing. The high casing temperature can result in undesirable heating of surrounding areas, such as
35 the floorboard and passenger compartment, as well as creating a risk of grass fires when a vehicle is driven

off-road or parked. In addition, when such a catalytic converter is subjected to repeated quenching as, for example, when driving through puddles of water, thermal fatigue of the solder joints holding the layers of the honeycomb structure of the metallic monolith together can result. It is, therefore, desirable to mount the metallic monolith in the metallic casing with a mat which provides thermal insulation.

Catalytic converters with ceramic monoliths have a space or gap between monolith and metal casing which increases during heating because of differences in thermal expansion; in the case of catalytic converters with metallic monoliths, this gap decreases upon heating. This is so, even though the thermal expansion coefficients of the metallic monolith and metal casing are similar since the metallic monolith becomes much hotter than the metallic casing resulting in a decreased gap between the two elements. Conventional intumescent mat mounting materials lack the high temperature resiliency needed to continue to provide support for metallic monoliths as the converter is cycled between high and low temperatures.

Prior efforts to produce catalytic converters having ceramic catalyst supports mounted with ceramic fibrous mats include UK Patent Application 2,171,180 A which relates to ceramic and mineral fibrous materials for mounting ceramic monoliths in catalytic converters. The fibrous material is wrapped and compressed under vacuum and sealed in a substantially air impervious plastic envelope or pouch. In use, the plastic will degrade or burn and release the fibrous material so that it expands to hold the ceramic monolith securely.

U.S. Patent 4,693,338 relates to a catalytic converter comprising a ceramic monolith with a blanket of fibers having high resistance to high temperatures between the monolith and the metallic case, the blanket being substantially devoid of binder and devoid of water of constitution and being highly compressed, and a sealing

element (gas seal) surrounding the end of the ceramic monolith which is adjacent the outlet of the converter.

Summary of the Invention

5 The present invention relates to a catalytic converter comprising a catalyst support resiliently mounted in a metallic casing and which utilizes a resilient, flexible ceramic fiber containing mounting mat for mounting the monoliths. The mounting mat comprises a fibrous mat of essentially shot-free ceramic fibers. Since ceramic fibers, in mat form, tend to be quite bulky, handling is markedly improved by stitchbonding the fibrous mat material with organic thread. A thin layer of an organic or inorganic sheet material can be placed on either or both sides of the mat during the stitchbonding process to prevent the organic threads from cutting through the ceramic fiber mat. In situations where it is desired that the stitching thread not decompose at elevated temperatures, an inorganic thread such as ceramic thread or stainless steel thread can be used.

Brief Description of the Drawings

25 FIG. 1 is a perspective view of a catalytic converter of the present invention shown in disassembled relation;

 FIG. 2 is a plan view of the bottom shell of the catalytic converter of FIG. 1 showing the ceramic fiber containing mounting mat about the periphery of the metallic monolith; and

30 FIG. 3 is a schematic sectional view along the line 3-3 of FIG. 2 of the resilient, flexible ceramic fiber containing mounting mat of this invention.

Detailed Description of the Invention

35 Referring now to the drawings, catalytic converter 10 comprises metallic casing 11 with generally frustoconical inlet and outlet ends 12 and 13,

respectively. Disposed within casing 11 is a monolithic catalytic element 20 formed of a honeycombed monolithic body, preferably a metallic monolith, having a plurality of gas flow channels (not shown) therethrough. Surrounding catalytic element 20 is mounting mat 30 comprising a resilient, flexible, fibrous mat of shot-free ceramic fibers which serves to tightly but resiliently support catalytic element 20 within the casing 11. Mounting mat 30 holds catalytic element 20 in place in the casing and seals the gap between the catalytic element 20 and casing 11 to thus prevent exhaust gases from by-passing catalytic element 20.

Shot-free ceramic fibers useful in forming mounting mat 30 are those commercially available under the tradenames Nextel Ultrafiber 312, Nextel Ultrafiber 440, Nextel Ultrafiber Al_2O_3 , Nextel Ultrafiber $Al_2O_3 - P_2O_5$, Nextel Ultrafiber ZS-11, Fibermax fiber and Saffil fiber. When compressed to a mount density of between 0.21 and 0.50 g/cm³, these mats have the unique ability to repeatedly undergo a reduction in thickness while hot and spring back to substantially their original thickness when cooled, thus continually exerting a substantial holding force to catalytic element 20. Since these fiber materials are generally available in the density range of 0.020 to 0.060 g/cm³, they must be compressed by about a factor of 10 when used to mount catalytic element 20. Mat thicknesses of from 2 to 25 cm are generally compressed by stitchbonding to a thickness of 4 to 25 mm for installation into a 2 to 12 mm gap for mounting monoliths in catalytic converters. In a preferred embodiment, mounting mat 30 is comprised of a layer of ceramic fibers 31 in combination with a layer of intumescent sheet material 32 to enhance the hot holding force of the mounting mat while maintaining its resiliency. Tests have shown that to be effective, the mounted thickness of the intumescent sheet material 32 should not exceed the mounted (compressed) thickness of the ceramic fiber layer.

Only substantially shot-free ceramic fibers, formed by sol gel processes, of greater than 5 cm fiber length and a diameter of 2 to 10 microns, seem to offer the high degree of resiliency needed for mounting monolith 20, especially metallic monoliths. Conventional ceramic fibers formed by melt processes such as are available under the tradenames Fiberfrax or Cerafiber contain shot particles and lack the desired properties as the following tests will show. As used herein, "shot-free" refers to a fiber mass containing essentially no particulate ceramic (shot).

Intumescent sheet material 32 comprises a thin, resilient, flexible, intumescent sheet comprising from about 20% to 65% by weight of unexpanded vermiculite flakes, such flakes being either untreated or treated by being ion exchanged with an ammonium compound such as ammonium dihydrogen phosphate, ammonium carbonate, ammonium chloride or other suitable ammonium compound; from about 10% to 50% by weight of inorganic fibrous material including aluminosilicate fibers (available commercially under the tradenames Fiberfrax, Cerafiber, and Kaowool), asbestos fibers, glass fibers, zirconia-silica fibers and crystalline alumina whiskers; from about 3% to 20% by weight of binder including natural rubber latices, styrene-butadiene latices, butadiene acrylonitrile latices, latices of acrylate or methacrylate polymers and copolymers and the like; and up to about 40% by weight of inorganic filler including expanded vermiculite, hollow glass microspheres and bentonite. The thin sheet material is available in a thickness of from 0.5 to 6.0 mm under the tradename Interam mounting mat.

Because of the low density and bulky nature of shot-free ceramic fibers and the fact that they must normally be compressed by about a factor of 10 to get the desired mount density, it has been found useful to sew or stitchbond these materials with an organic thread to form a compressed mat that is closer to its ultimate thickness in use. When a layer of intumescent material is included, it

is stitchbonded directly to the fiber mat. In addition, it is sometimes useful to add a very thin sheet material as a backing layer to both sides of the mounting mat as it is being sewn in order to prevent the stitches from cutting or being pulled through the ceramic fiber mat. The spacing of the stitches is usually from 3 to 30 mm so that the fibers are uniformly compressed throughout the entire area of the mat.

A mounting mat of shot-free ceramic fiber (Nextel Ultrafiber 312) approximately 45 mm thick was stitchbonded both with and without an additional 1.5 mm thick layer of intumescent sheet material (Interam mat Series IV). The mat was stitchbonded (sandwiched) between two thin sheets (about 0.1 mm thick) of nonwoven high density polyethylene (CLAF 2001). The mat was stitchbonded using 150 denier polyester thread consisting of 36 ends although any thread having sufficient strength to keep the materials compressed could be used. A chain stitch 34 consisting of 30 stitches per 10 cm was used with a spacing of about 10 mm between stitch chains. The material was compressed to a thickness of 6.2 to 6.5 mm during stitching. The resulting stitchbonded thickness of mat was about 7.0 mm without the intumescent sheet material and about 8.1 mm with the intumescent sheet material. In the latter case the intumescent sheet material comprised about 7% of the overall thickness of the stitchbonded composite.

A test to determine the resilient pressure exerted by various monolith mounting mats against metallic monoliths was performed. The apparatus consisted of two stainless steel anvils containing cartridge heaters so that temperatures actually encountered by catalytic converters could be simulated. The gap or distance between the anvils can also be set to actual converter use conditions (decreased with increasing temperatures). Various mounting mats were placed between the anvils with both anvils at room temperature (R.T.). They were then closed to a 4.24 mm gap and the pressure recorded. The anvils were

then heated so that the top anvil was at 800 C and bottom one at 530 C and the gap simultaneously reduced to 3.99 mm. Pressure was again recorded. Finally, the heaters were shut off and both anvils cooled back to room temperature while adjusting the gap back to the original 4.24 mm. Pressure was recorded once more. The data generated from testing various mounting mats is shown in Table 1.

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TABLE 1

Pressure (kPa) Exerted at
Various Temperatures

	Mount Density (g/cm ³)	R.T./R.T. @4.24 mm gap	800 C/ 530 C @3.99 mm gap	Ret. to/ R.T. @4.24 mm gap	
5	<u>Mounting Mats</u>				
10	Ceramic Fiber/ Intumescent Composite (Nextel Ultrafiber 312/Interam Series IV (1.7 mm))	0.416	137.9	227.5	75.8
15	Stitchbonded Ceramic Fiber/Intumescent Composite (Nextel Ultrafiber 312/Interam Series IV (1.4 mm))	0.394	117.2	117.2	41.4
	Ceramic Fiber (Nextel Ultrafiber 312)	0.270	96.5	124.1	55.2
20	Ceramic Fiber (Nextel Ultrafiber 440)	0.329	206.8	268.9	96.5
	Ceramic Fiber (Nextel Ultrafiber Al ₂ O ₃)	0.306	124.1	89.6	41.4
25	Ceramic Fiber (Fibermax Fiber)	0.320	151.6	75.8	55.1
	Ceramic Fiber (Saffil Fiber)	0.284	41.4	62.1	34.5
	Ceramic Fiber (Fiberfrax Fiber)	0.284	96.5	68.9	0
30	Intumescent Mat (Interam Series III)	0.693	34.5	475.8	0
	Intumescent Mat (Interam Series IV)	0.912	55.2	910.1	0
35	Ceramic Fiber (Cerafiber (washed) (5.2% shot))	0.291	172.4	75.8	0
	Ceramic Fiber (Nichias (8% shot))	0.302	186.2	55.2	0

It will be observed that shot-free ceramic fiber containing mounting mats of this invention continued to exert sufficient force at all temperatures, including a return to room temperature, while mats containing only
5 conventional materials did not. The preferred combination of shot-free ceramic fibers (Nextel Ultrafiber) and the intumescent sheet material (Interam mat) produced a very significant increase in holding force at high temperature while still maintaining adequate holding force at room
10 temperature.

Various mat materials were also tested to determine their suitability to securely hold metallic and ceramic monoliths in catalytic converters using a hot shake test. This test involved passing exhaust gases through the
15 converter while simultaneously subjecting it to mechanical vibration. The vibration is supplied by an electromechanical vibrator made by Unholtz-Dickie Corp. An acceleration of up to 40 g's at 100 Hz frequency is applied to the converter. The heat source is a natural gas burner
20 capable of supplying to the converter an inlet gas temperature of 1000 C. The exhaust gas temperature is cycled in order to properly test the mounting materials ability to maintain its resiliency and corresponding holding force while the space it occupies is changing
25 dimension. One cycle consists of 10 minutes at 1000 C and 10 minutes with the gas shut off. Vibration is maintained throughout the thermal cycle. The duration of the test is 20 cycles. The test results are shown in Table 2.

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TABLE 2

	<u>Mat Material</u>	<u>Mount Density (g/cm³)</u>	<u>Results</u>
5	Intumescent sheet (Interam Mat Series IV)	0.64	Fail first cycle
	Intumescent sheet (Interam Mat Series IV)	0.88	Fail first cycle
	Intumescent sheet (Interam Mat Series IV)	1.12	Fail first cycle
10	Intumescent sheet (Interam Mat Series III)	0.64	Fail first cycle
	Ceramic Fiber (Fiberfrax Fiber)	0.48	Fail first cycle
	Wire Mesh	N/A	Fail first cycle
15	Ceramic Fiber (Nextel Ultrafiber 312)	0.20	Fail first cycle
	Ceramic Fiber (Nextel Ultrafiber 312)	0.35	Pass 20 cycles
20	Ceramic Fiber (Nextel Ultrafiber 312)	0.43	Pass 20 cycles
	Ceramic Fiber (Saffil Fiber)	0.33	Pass 20 cycles
	Ceramic Fiber/Intumescent sheet composite (Nextel Ultrafiber 312/ Interam Mat Series IV (1.7 mm))	0.34	Pass 20 cycles
25			
	Ceramic Fiber/Intumescent sheet composite (Nextel Ultrafiber 312/ Interam Mat Series IV (1.4 mm))	0.54	Pass 20 cycles*
30			

*Ceramic monolith. All other conditions identical.

35 It will again be observed that the shot-free ceramic fiber containing mounting mats of this invention passed this practical test while mounting mats made with conventional materials normally used to make mats for

mounting ceramic monoliths did not. It will also be noted that a mounting mat containing melt processed ceramic fibers (Fiberfrax fiber) did not pass this test.

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The claims defining the invention are as follows:

1. A catalytic converter 10 having a metallic casing 11, a unitary, solid catalytic element 20 disposed within said casing 11, and resilient means 30 disposed between said catalytic element 20 and said metallic casing 11 for positioning said catalytic element 20 and for absorbing mechanical and thermal shock, characterized by; said resilient means 30 being a resilient, flexible, fibrous mat 31 of shot-free (as herein defined) ceramic fibers having a stitchbonded compressed thickness in the range of 4 to 25 mm wrapped about the lateral surface of said catalytic element 20 to a mount density of about 0.25 to about 0.50 g/cm³.

2. The catalytic converter 10 of claim 1 wherein said resilient means 30 additionally comprises a layer of intumescent material 32.

3. The catalytic converter 10 of claim 2 wherein said layer of intumescent material 32 has a mounted thickness not greater than the mounted thickness of said ceramic fiber mat 31.

4. The catalytic converter 10 of claim 3 wherein said layer of intumescent material 32 comprises from about 20% to 65% by weight of unexpanded vermiculite flakes, from about 10% to 50% by weight of inorganic fibrous material, from about 3% to 20% by weight of binder and up to about 40% by weight of inorganic filler material.

5. The catalytic converter 10 of claim 4 wherein said unexpanded vermiculite flakes have been ion-exchanged with an ammonium compound.

6. The catalytic converter 10 of claim 4 wherein said inorganic fibrous material is alumina-silicate fibers, asbestos fibers, glass fibers, zirconia-silica fibers or crystalline alumina whiskers.

7. The catalytic converter 10 of claim 4 wherein said binder is a latex of natural rubber, styrene-butadiene copolymers, butadiene-acrylonitrile copolymers, acrylate polymers or methacrylate polymers.

8. The catalytic converter 10 of claim 4 wherein said inorganic filler is expanded vermiculite, hollow glass microspheres or bentonite.



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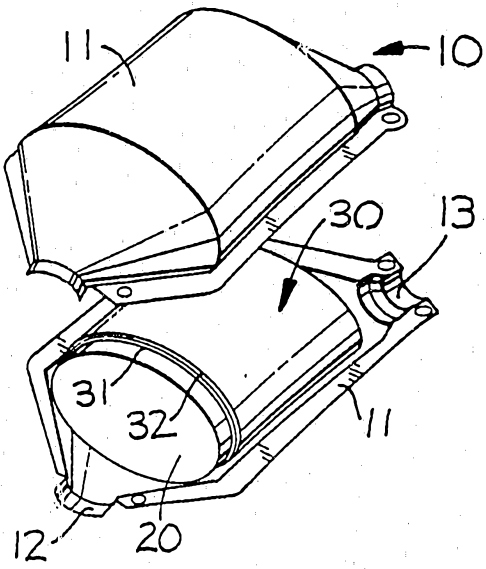


FIG. 1

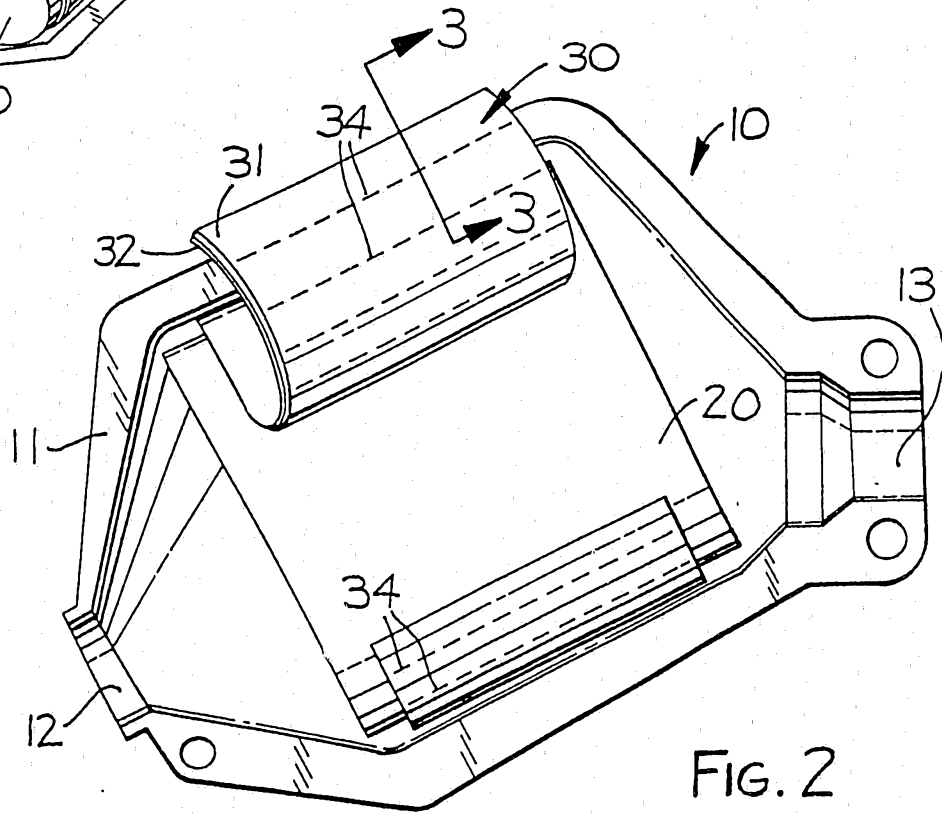


FIG. 2

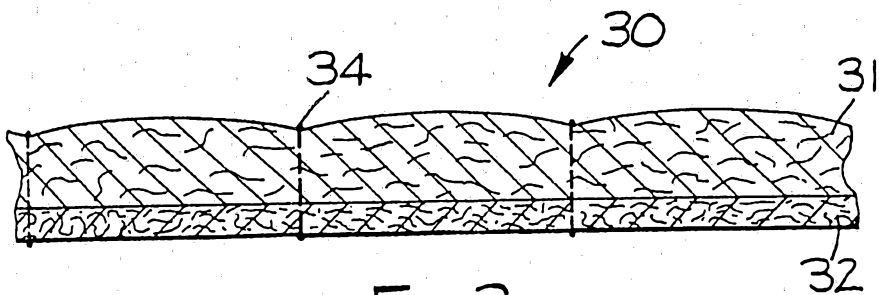


FIG. 3