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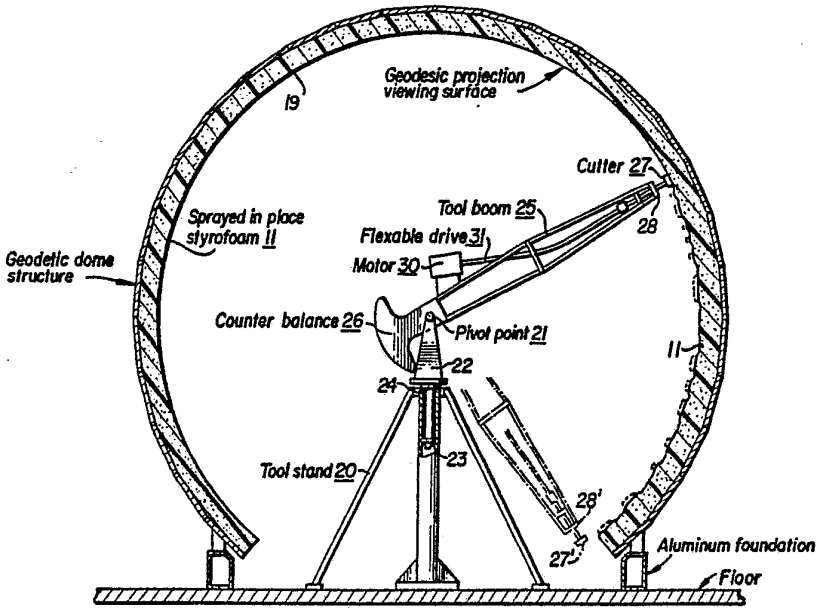
With amended claims.

(54) Title: PROCESS FOR PRODUCING A SPHERICAL PROJECTION - TYPE SCREEN FOR USE IN A VEHICLE SIMULATOR

(57) Abstract

A geodesic dome structure (10), i.e., a structure (10) having a mathematically-derived surface. This dome structure (10) is formed of a single, one-piece layer of synthetic material (11) and provides a one-piece, seamless screen to permit the viewing of a scene in a vehicle simulator in order to achieve a maximum of realism matching substantially real world conditions. One form of the structure (10) for this geodesic dome is described with the single, one piece layer of synthetic material (11) bonded to a generally dome-shaped geodetic structure (12) in order to provide sufficient strength for a free-standing structure. However, another form of the geodesic dome (10) is described with synthetic material (11) formed of sufficient thickness to be strong enough to provide a free-standing structure, and the synthetic material (11) may even be reinforced if desired. The method described of achieving this geodesic dome (10) includes erecting a generally dome-shaped geodetic structure (12) and applying a coating of a predetermined thickness of synthetic material (11) to the inner surface of sucha structure (12). Thereafter, this synthetic material (11) is smoothed to provide the seamless screen for viewing a scene from a vehicle simulator. The method described also includes the use of a tool stand (20) erected in order to locate positively a pivot point (21) from which a tool boom (25) is movable in order to achieve the accuracy described for the inner, smooth, one-piece, seamless screen surface (19).



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PROCESS FOR PRODUCING A SPHERICAL PROJECTION – TYPE SCREEN FOR USE IN A VEHICLE SIMULATOR

BACKGROUND OF THE INVENTION

Field of the Invention

This invention, generally, relates to vehicle simulation and, more particularly, to a new and improved geodesic dome structure and a method of manufacturing same, such dome structure especially being useful in flight simulation.

Background Art

The need for more extensive and specialized training has increased with the increase in today's high performance aircraft that have become more and more complex. To obtain such training, a student pilot must either be provided with actual training and experience in the aircraft which he is to fly, or he must be provided with training in a simulator of such aircraft.

However, there are certain emergency procedures and maneuvers that simply can not be accomplished by training in the actual aircraft because of the dangers of the actual real life environment. This is especially true for single pilot aircraft. Therefore, for such maneuvers or emergency procedures, training in a simulator of the aircraft is particularly advantageous.

Furthermore, with the increase in expense of flight fuel in recent years, the time required in training within such an actual aircraft makes this form of training costs excessive, particularly when taken in consideration

with the wear and tear on the actual aircraft. Consequently, aircraft simulators are being called upon to take on more and more of the aircraft training missions. For such training to be effective, the aircraft simulator must reproduce faithfully the environment that the trainee would face in an actual flight.

For those aircraft types in which a pilot, co-pilot, navigator, and the like view the outside real world through relatively small windows, the visual part of the simulator is customarily accomplished through the use of a suitable cathode ray tube (CRT) positioned at each window. However, this manner of reproducing the scenes to be simulated by the use of CRT's becomes impractical when a trainee pilot is in the type of aircraft using a larger window, such as a bubble-type of clear dome. This type of scene depicts nearly 360° of view.

Much attention has been given to an appropriate structure for creating a screen that is virtually a complete dome to provide a viewing surface on the inside.

DESCRIPTION OF THE PRIOR ART

In the prior art, numerous training and simulator apparatus have been constructed which embody a position from which a trainee or a pilot can manipulate controls and observe a response in a projected visual image. For example, the trainee or pilot is positioned in a mockup of a boat, submarine, airplane, military tank or other vehicles, in which he manipulates controls, such as a wheel, stick or throttle, the observed visual scene responds in a manner which simulates corresponding movement of an actual vehicle in the real world.

The prior art patents which are known to have relevant disclosures are as follows:

2,273,074; 3,607,584; 3,718,989; 3,998,522 and 4,124,277.

However, not withstanding the extensive efforts that have been made in this field, there has not yet been shown a structure for the manufacture of a satisfactory, low cost, yet effective dome structure. There is much work being done today to accomplish such a dome type structure which has the degree of accuracy in its curvature that is required in the simulator field in order to develop the required realizm in a projected scene. Moreover, from the prior suggestions to divide a mirror surface into a "series of mirrors" or that a "screen is composed of a number of small screen surfaces", there is not one disclosure of how it can be done or how to do it inexpensively.

SUMMARY OF THE INVENTION

It is a principal object of the invention to provide a new and improved structure for exhibiting projected images with sufficient realism for use in a projected-image visual system of a simulator.

It is also an object of the invention to provide such a dome structure that is inexpensive to manufacture, yet it maintains an unusually high degree of accuracy in the curvature of the inner surface to admit of the realism required in visual systems of a simulator.

Such a dome which is manufactured for use as a spherical projection-type viewing surface in a vehicle

simulator which admits of a maximum of realism matching substantially real world conditions has a generally geodetic dome having sufficient strength to be a free-standing structure with a curved, substantially dome-shaped, projection screen formed of a single, one-piece layer of synthetic material attached to the geodetic dome. The innermost portion of this dome-shaped structure is formed to a substantially smooth mathematically-derived surface which provides the seamless screen for viewing a scene in the vehicle simulator.

In another aspect of the invention, the geodetic dome having sufficient strength to be a free-standing structure is removed after the synthetic material is formed with the inner surface as defined hereinabove. While it has been found that styrofoam provides a sufficiently strong synthetic material for this type of use, any suitable synthetic material having the required strength as will be described hereinafter would suffice.

In still another aspect of the invention a method of manufacturing the dome is described in detail as included in the following steps: erecting a geodetic generally dome-shaped structure having an inner surface, applying a coating of a preselected thickness of a suitable synthetic material to this inner surface, and then smoothing the inner portion of the coating of the synthetic material to form a substantially smooth, one-piece, seamless screen.

DESCRIPTION OF THE DRAWINGS

The forgoing, other and further objects, features and advantages will appear more fully from the detailed description of the presently preferred embodiments of

the invention and from the appended claims, both viewed in conjunction with the accompanying drawings, in which:

Fig. 1 is a view, partly in cross section of a dome-shaped structure, constructed in accordance with the principles of the invention;

Fig. 2 is a perspective view of a cutting element used in connection with the construction of the dome-shaped structure shown in Fig. 1;

Fig. 3 is an enlarged view of a portion of the cutting element shown in Fig. 2 in cutting position relative to the synthetic material; and

Fig. 4 is a view of a part of a dome-shaped structure showing a modified form of the invention.

PRESENTLY PREFERRED EMBODIMENTS

As used hereinafter the term "geodetic" shall mean a thing which determines size and shape generally. The term "geodesic" identifies a mathematically-derived surface.

Referring now to Fig. 1 of the drawings, the reference numeral 10 identifies generally a geodesic dome formed of a sprayed in place styrofoam or other suitable synthetic material. The styrofoam 11 is sprayed in place against a geodetic dome structure, such as any of those available from Spitz Space Systems, Inc., Chadds Ford, Pennsylvania 19317.

The styrofoam, or other suitable synthetic material identified by the reference numeral 11, is of a predeter-

mined thickness, i.e., if the geodetic dome structure 12 is to remain in place, the thickness of the styrofoam 11 may be somewhat less than if the structure 12 is to be removed. In those instances when the dome structure 12 is to be removed after manufacture of the synthetic material dome 11 is completed, the thickness of the material 11 is determined by that which is sufficient to render it of sufficient strength to be a free-standing structure.

Referring now to Fig. 4 of the drawings, an enlarged view of a portion of the dome structure 10 reveals the geodetic structure 12 and the synthetic material 11 more clearly. If a customary strength analysis reveals that reinforcement is necessary or is desirable, a reinforcing wire mesh 13 is located by, for example, a plurality of pins 14 spaced apart in any desired pattern, and each pin has a threaded end 15 to receive a nut 16 to permit quick disconnect of the sections of the dome 12 from each of these pins 14, so that after completion of the synthetic material 11, the sections 12 may be removed.

In accordance with one aspect of the invention, the respective sections of the dome structure 12 are removable more easily if, before the synthetic material 11 is applied thereto, the inner surface of each section of the dome structure 12 is provided with a suitable layer or other coating 17, which may be of foil or paper, or any desired substance, to permit the sections of the structure 12 to be separable from the synthetic material 11 easily.

Referring again to Fig. 1 of the drawings, the reference numeral 18 identifies the initial rough surface of the synthetic material 11 as it exists right after it is applied to the dome structure 12. Another aspect of

the invention is to obtain the smoothed geodesic projection viewing surface 19 from the initial, rough surface 18.

This is accomplished, in accordance with this invention, by, first erecting a suitable tool stand 20. One of the functions which the tool stand 20 accomplishes is to locate, structurally, a pivot the point 21 which is the center of curvature of the completed viewing surface 19.

The pivot point 21 is located a pivotable structure 22 supported by suitable bearings 23 and 24 on the tool stand 20. The structure 22 is bifurcated and is of sufficient height to locate the pivot point 21 sufficiently high above the bearing 24 so that it can support a tool boom 25 pivotally at the pivot point 21.

The tool boom 25 has an appropriate counter-balance weight 26 which is shaped to swing easily and readily between the bifurcations of the structure 22.

The tool boom 25 supports a cutter 27 at its outermost end 28 in any appropriate manner so that it may be indexed radially and accurately from a position as shown by the reference numeral 21 and the cutter 21 so that it will remove only the high points 29 first from the initial rough surface of the synthetic material 11.

A motor 30 is supported on the tool boom 25 as close to the pivot point 21 as possible, in order to reduce the effect of its weight, and the motor 30 is connected to rotate the cutter 27 through a flexible drive shaft 31. Of course, the motor 30 could be positioned on a direct

line, if desired, between the pivot point 21 and the cutter 27, but it is shown positioned to one side of the pivot point 21 for greater ease in connecting the air supply to it in order to drive it.

Referring now to Fig. 2 of the drawings, a disk 32 has an abrasive surface 33 around the periphery of the disk 32. Such a cutter is readily available commercially.

In Fig. 3 in the drawings, the relationship of the abrasive surface 33 of the disk 32 relative to the synthetic material 11 is shown in better detail, because the view is enlarged.

Article of Manufacture

The geodesic dome manufactured in accordance with the present invention is uniquely adapted for use as a spherical projection-type viewing surface in a vehicle simulator, because it substantially maximizes realism matching those in the real world. Such a dome involves a curved, substantially dome-shaped, projection screen formed of a single, one-piece layer of snythetic material with sufficient strength to be a free-standing structure. This strength is obtained in any one of several different ways.

One way of maintaining sufficient strength in the geodesic dome structure is to erect, first, a geodetic dome structure which is readily available commercially, and then, to have the synthetic material supported from such a dome. Another way, is to make the thickness of the synthetic material 11 sufficient so that it will be a free-standing structure, once it is completed.

A third way, in accordance with the invention, is to have the geodesic dome of synthetic material 11 formed initially with a suitable reinforcing material 13 embedded therein.

After the synthetic material 11 is formed in its free-standing position, the inner portion of this dome-shaped structure of synthetic material is formed to a substantially smooth mathematically-derived surface 19, so that the inner portion forming the viewing surface 19 is a one-piece, seamless screen for viewing various preselected scenes in a vehicle simulator.

A dome manufactured with this structure would be exceeding light in weight and unusally durable because it is largely of a synthetic material.

A geodesic dome manufactured with these features, identified above, will have a one-piece, seamless inner surface 19 which is uniquely adapted for a screen to view a scene, and it will avoid the slow, painstaking assembly that is presently required to assemble hundreds of pieces to make a perfectly aligned and fastened dome structure. Moreover, it avoids the approximately 1,500 linear feet of seams that would be generated in a 35 foot diameter dome which requires filling and surfacing, which is all done by hand.

It has been estimated that a dome which is manufactured with the features identified above will have approximately 67% lower production cost. There are no seams to finish, and the geodesic dome of the invention admits of unusal thermal stability, yielding accompanying dimensional stability.

Due to the superior insulating properties provided by the synthetic material lining the inside of the geodesic dome manufactured in accordance with the principles of the present invention, environmental stability and control of the interior space will be easier and far less costly to maintain.

Method of Manufacture

The method of manufacturing the geodesic dome of the invention involves certain unigue steps also. The method in accordance with the invention will produce the geodesic dome described above in substantial detail for use as a spherical, projection-type viewing surface in a vehicle simulator to present to an observer a maximum of realism which matches substantially real world conditions.

This method involves erecting, first, a geodetic generally dome-shaped structure having an inner surface, and then, applying a coating of a predetermined thickness of synthetic material to this inner surface.

Next, the inner portion of the coating of synthetic material is smooth to form a substantially smooth, one-piece, seamless screen. The coating step, of course, includes spraying, which is a present day acceptable method of applying a suitable synthetic material, such as styrofoam, and the step of smoothing includes grinding, of course.

As described above, the step of erecting a geodetic structure includes the step of assembling a plurality of sections having predetermined size and shape and being formed of a material so that the structure is of sufficient strength to be free-standing. So that each

of these sections is readily removable after the styrofoam or other synthetic material is set in place, the inner surface in each section is formed with a predetermined facing material.

If a relatively light weight geodesic dome is required, it can be obtained in accordance with the invention by removing the geodetic structure. If additional strength is needed for the relatively light weight geodesic dome structure, an additional step may be added to the method of manufacturing such a structure, that of reinforcing the predetermined thickness of synthetic material.

The geodetic dome which is purchased from any suitable vendor, such as the one named hereinabove, may be preferably of such materials as aluminum, fiberglass, fireproof wood or any combination thereof. These domes are assembled easily and quickly without the need of special tools or knowhow.

Styrofoam synthetic material is applied, perferably by spraying, over the entire interior surface of the geodetic dome structure in sufficient thickness to produce the strength desired. Such a thickness may vary from one inch to one foot, if desired. The tool stand 20, then, is placed in the dome structure and is secured to the floor at a point where the polar axis of the dome and the floor intersect. The tool stand 20 has a pivot point 21 at its top end that is coincident with the center of curvature of the dome surface structure.

Next, the tool boom 25 is placed on the tool stand 20 at the pivot point 21. This tool boom 25 will have a special cutter 27 at its outer end that will be precisely

located at the 17 feet, 6 inch radius required to produce a 35 foot diameter spherical screen, for example.

The cutter 27 is rotated rapidly by a motor 30 at the opposite end of the tool boom 25, and a flexible shaft 31 interconnects the motor 30 with the cutter 27.

The tool boom is counter-balanced by a weight 26 so that little or no effort is required to lift or move it about as will be described. The cutter 27 is turned at a high speed by the motor 30, and with the cutter 27 turning at this high speed, the outer end of the tool boom 25, is traversed over the entire interior surface 19 permitting the cutter to generate the spherical surface 19 desired by machining. The resulting surface 19 will be completely free of seams, cracks and the like.

With the finishing of the surface 19 as described, the tool boom 25 is removed and a somewhat shorter painting boom is placed in position on the tool stand 20 to be pivoted at the same point 21. Such a step permits spraying on the screen surface-fillers and coats of paint as desired to completely finish the surface 19. Such a painting boom will hold the spray guns at a specific distance from the surface to enable a uniform coating to be applied.

The painting boom and the tool stand 20 now are completely removed from the dome structure because it is completed, and now the dome surface 19 may be inspected by inserting the simulator, visual system and other equipment as desired.

In view of the detailed description hereinabove, verious modifications of the perferred form of the in-

vention will occur to one skilled in this art. Accordingly, the description and modifications are to be considered as illustrative only, the true spirit and scope of the invention being that as defined by the claims appended hereto.

CLAIMS

1. A method of manufacturing a geodesic dome for use as a spherical, projection-type viewing surface in a vehicle simulator to present to an observer a maximum of realism which matches substantially real world conditions, comprising:

erecting a geodetic generally dome-shaped structure with an inner surface.

applying a coating of predetermined thickness of synthetic material to said inner surface, and

smoothing the inner portion of said coating of synthetic material to form a substantially smooth, one-piece, seamless screen.

2. The method of claim 1 wherein said step of applying a coating to said inner surface includes spraying.

3. The method of claim 2 wherein said synthetic material is styrofoam that is sprayed in place.

4. The method of claim 1 wherein said step of smoothing includes grinding.

5. The method of claim 1 wherein said step of erecting a geodetic generally dome-shaped structure includes the step of assembling a plurality of sections with predetermined size and shape, and said sections being formed of a material having sufficient strength to be a free-standing structure.

6. The method of claim 5 wherein said step of assembling

a plurality of sections includes providing each section with a predetermined facing material to form said inner surface.

7. The method of claim 1 or 6 including the step of removing said geodetic structure, so that said synthetic material with the smooth inner portion forming the one-piece, seamless screen provides a relatively light weight geodesic dome.

8. The method of claim 1 or 6 including the step of reinforcing said predetermined thickness of synthetic material.

9. The method of claim 1 including the step of setting up a tool stand with a pivot point to locate the predetermined center of curvature of the geodesic dome, so that all of said step of smoothing the inner portion of said coating of synthetic material is performed about such pivot point to achieve said maximum of realism.

10. The method of claim 9 including the step of positioning a tool boom to pivot about said pivot point for greater accuracy in performing said smoothing step.

11. The method of claim 10 wherein said step of smoothing the inner portion of said coating of synthetic material includes grinding performed with said tool boom to achieve said greater accuracy.

12. The method of claim 10 including the step of removing said tool boom and said tool stand after said substantially smooth, one-piece, seamless screen is achieved, so that space is available for said vehicle simulator.

13. A geodesic dome manufactured for use as a spherical projection-type viewing surface in a vehicle simulator to present a maximum of realism matching substantially real world conditions, comprising:

a curved, substantially dome-shaped, projection screen formed of a single, one-piece layer of synthetic material with sufficient strength to be a free-standing structure, and

the inner portion of said dome-shaped structure being formed to a substantially smooth mathematically-derived surface, so that the inner portion forming said surface provides a one-piece, seamless screen for viewing a scene in said vehicle simulator.

14. The geodesic dome in accordance with claim 13 including a generally dome-shaped geodetic structure with said single, one-piece layer of synthetic material bonded thereto to achieve sufficient strength to provide said free-standing structure.

AMENDED CLAIMS

[received by the International Bureau on 25 April 1984 (25.04.84); original claims 1–12 amended; claims 13 and 14 unchanged]

1. A method of manufacturing a geodesic dome for use as a spherical, projection-type viewing surface in a vehicle simulator to present to an observer a maximum of realism which matches substantially real world conditions, comprising:

erecting a geodetic generally dome-shaped structure with an inner surface.

applying a coating of predetermined thickness of synthetic material to said inner surface, and

smoothing the inner portion of said coating of synthetic material to form a substantially smooth, one-piece, seamless screen with a mathematically-derived surface for viewing a scene in said vehicle simulator with a maximum of realism which matches substantially real world conditions.

2. The method of claim 1 wherein said step of applying a coating to said inner surface includes spraying.

3. The method of claim 2 wherein said synthetic material is styrofoam that is sprayed in place.

4. The method of claim 1 wherein said step of smoothing includes grinding.

5. The method of claim 1 wherein said step of erecting a geodetic generally dome-shaped structure includes the step of assembling a plurality of sections with predetermined size and shape, and said sections being formed of a material having sufficient strength to be a free-standing structure.

6. The method of claim 5 wherein said step of assembling a plurality of sections includes providing each section with a predetermined facing material to form said inner surface.

7. The method of claim 1 or 6 including the step of removing said geodetic structure, so that said synthetic material with the smooth inner portion forming the one-piece, seamless screen provides a relatively light weight geodesic dome.

8. The method of claim 1 or 6 including the step of reinforcing said predetermined thickness of synthetic material.

9. The method of claim 1 including the step of setting up a tool stand with a pivot point to locate the predetermined center of curvature of the geodesic dome, so that all of said step of smoothing the inner portion of said coating of synthetic material is performed about such pivot point to achieve said maximum of realism.

10. The method of claim 9 including the step of positioning a tool boom to pivot about said pivot point for greater accuracy in performing said smoothing step.

11. The method of claim 10 wherein said step of smoothing the inner portion of said coating of synthetic material includes grinding performed with said tool boom to achieve said greater accuracy.

12. The method of claim 10 including the step of removing said tool boom and said tool stand after said substantially smooth, one-piece, seamless screen is achieved, so that space is available for said vehicle simulator.

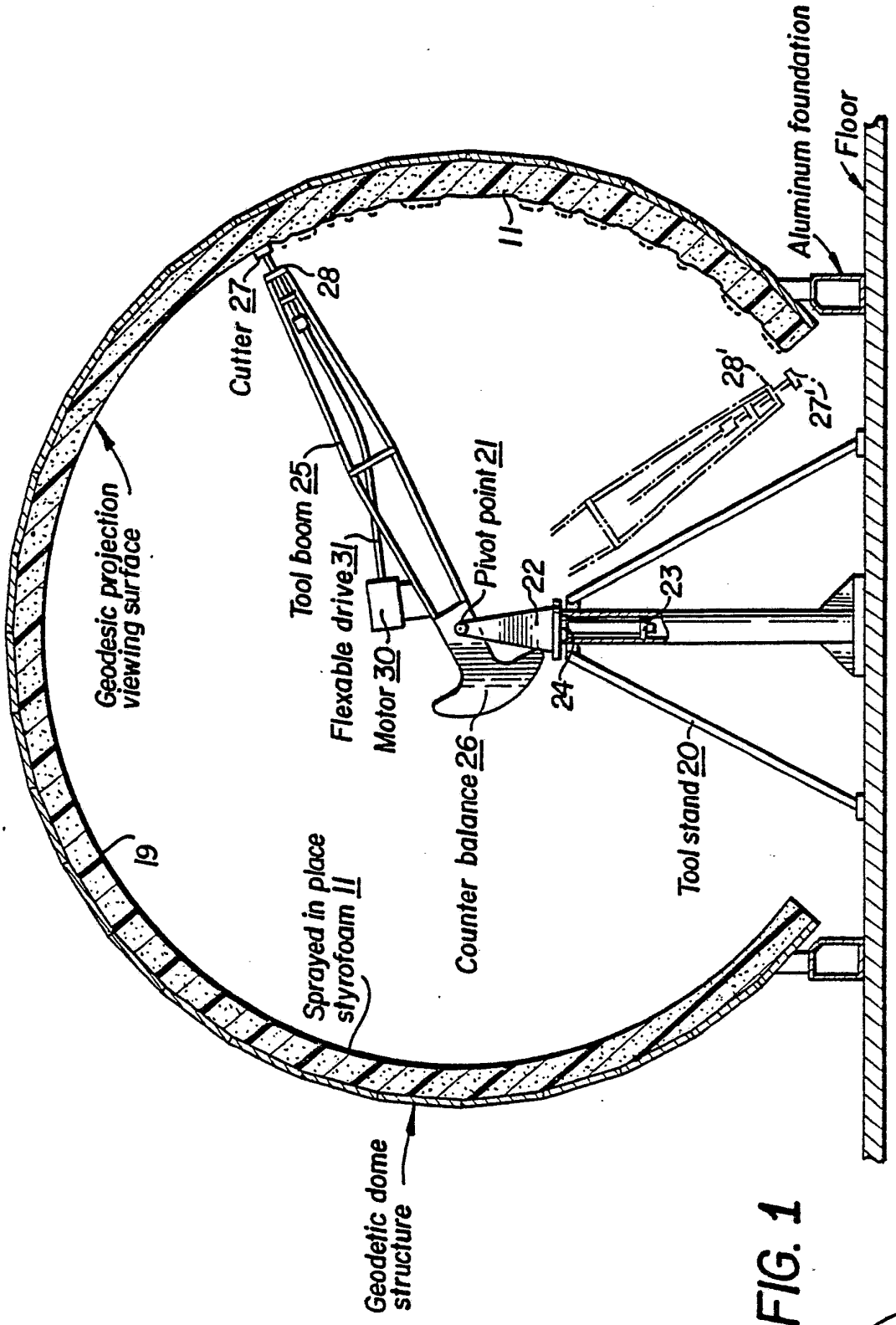


FIG. 1

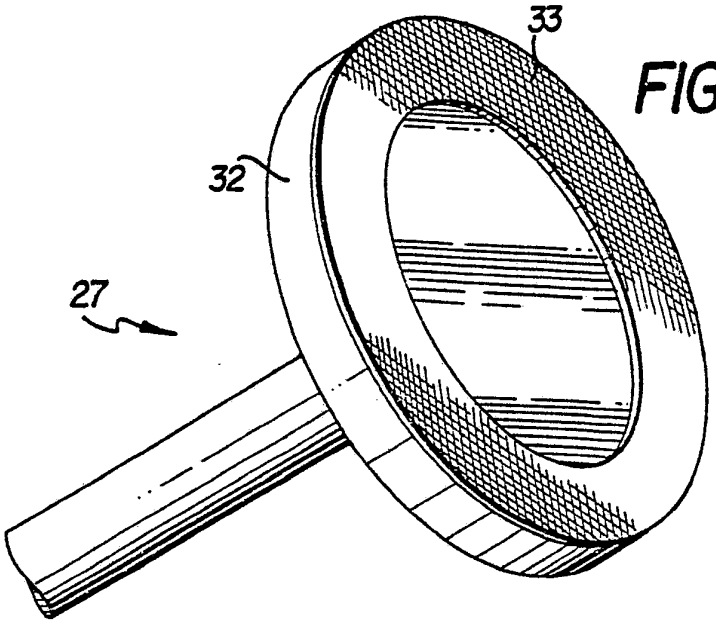
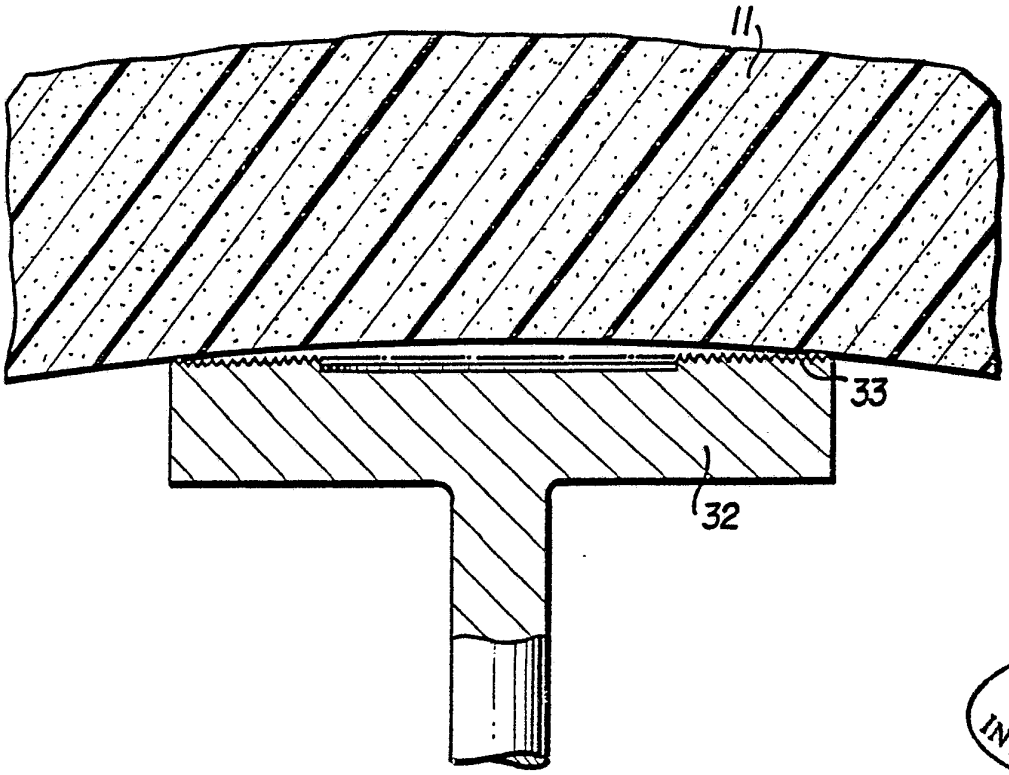


FIG. 2

FIG. 3



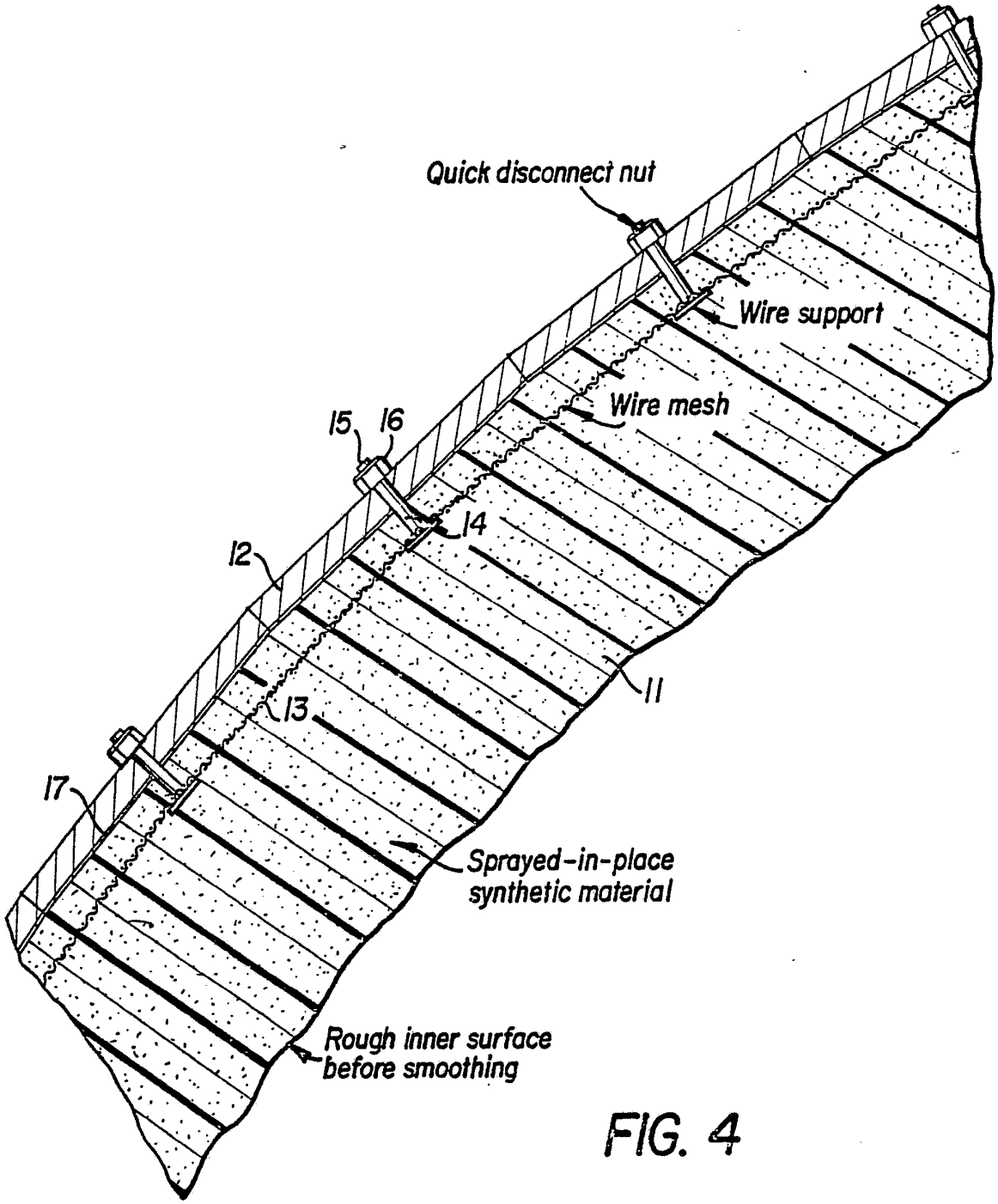


FIG. 4

INTERNATIONAL SEARCH REPORT

International Application No PCT/US83/01911

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [3]

According to International Patent Classification (IPC) or to both National Classification and IPC

INT. CL.[3] E04 B 1/16, B 29D 27/04

U.S. CL. 264-32

II. FIELDS SEARCHED

Minimum Documentation Searched [4]

Classification System	Classification Symbols
U.S.	51/2R,2H,2M,2US,2Y,126,166R,166FB,166 MH,166TS, 166T,330 52/80,81 264/32,45.2,46.9,162;434/40

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [5]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [14]

Category *	Citation of Document, [16] with indication, where appropriate, of the relevant passages [17]	Relevant to Claim No. [18]
X	US, A, 3,763,608 PUBLISHED 9 OCTOBER 1973 CHAMLEE COLUMN 3, LINES 39-56	1-12
X	US, A, 3,590,448 PUBLISHED 6 JULY 1971 BRYANT COLUMN 3, LINES 31-32; COLUMN 7, LINES 55-61	1-12
X	US, A, 4,146,997 PUBLISHED 3 APRIL 1979 DIETHORN COLUMN 6, LINES 34-36	1-12
X	N, TOOL RESEARCH AND ENGINEERING CORP. BULLETIN ISSUED ABOUT 27 MAY 1963 DOME: ANCIENT CONCEPT WITH MODERN APPLICATIONS, 5 PAGES	1-12
X	US, A, Re. 28,689 PUBLISHED 20 JANUARY 1976 TURNER COLUMN 2, LINES 29-40	1-12
X	US, A, 3,803,277 PUBLISHED 9 APRIL 1974 BASSETT COLUMN 5, LINE 40	1-12
X	US, A, 1,520,703 PUBLISHED 30 DECEMBER 1924 ERICSSON PAGE 2, LINES 56-57	1-12

* Special categories of cited documents: [15]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search [2]	Date of Mailing of this International Search Report [2]
FEBRUARY 7, 1984	06 MAR 1984
International Searching Authority [1]	Signature of Authorized Officer [20]
ISA/US	Philip E. Anderson PHILIP E. ANDERSON

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category *	Citation of Document, 16 with indication, where appropriate, of the relevant passages 17	Relevant to Claim No 18
A	US, A, 4,350,489 PUBLISHED 21 SEPTEMBER 1982 GDOVIN COLUMN 2, LINE 53 TO COLUMN 3, LINE 26	1-12
A	US, A,2,821,813 PUBLISHED 4 FEBRUARY 1958 DEGLER COLUMN 3, LINES 59-75	1-12
A	US, A, 2,273,074 PUBLISHED 17 FEBRUARY 1942 WALLER PAGE 2, COLUMN 1, LINES 21-55	1-12
A	US, A, 3,203,144 PUBLISHED 31 AUGUST 1965 FULLER COLUMN 3, LINE 42 TO COLUMN 8, LINES 21-55	1-12
A	US, A, 3,562,975 PUBLISHED 31 AUGUST 1965 MOSS COLUMN 3, LINE 42 TO COLUMN 8, LINE 22	1-12
A	US, A, 4,287,690 PUBLISHED 16 FEBRUARY 1971 BERGER ET AL COLUMN 3, LINES 25-72	1-12
A	N, RCA TECHNICAL NOTES, RCA TN NO. 431, ISSUED JANUARY 1961, THICK-WALLED LOW DENSITY BUILDING STRUCTURE 2 SHEETS	1-12

FURTHER INFORMATION CONTINUED FROM THE SECOND SHEET

X	US, A, 2559,295 PUBLISHED 3 JULY 1951 GROSSENBACHER COLUMN 1, LINE 50 TO COLUMN 3, LINE 40	1-12
X	US, A, 3,284,969 PUBLISHED 15 NOVEMBER 1966 WALTERS ET AL COLUMN 2, LINES 49-51	1-12
X	N, ENCYCLOPEDIA OF POLYMER SCIENCE AND TECHNOLOGY, VOLUMN 13, ISSUE 1970, STYRENE POLYMERS (SPECIAL PRODUCTS): EXTRUDED RIGID POLYSTYRENE FOAM, SEE PAGES 428-430	1-12

V. ☐ OBSERVATIONS WHERE CERTAIN CLAIMS WERE FOUND UNSEARCHABLE [10]

This international search report has not been established in respect of certain claims under Article 17(2) (a) for the following reasons:

1. ☐ Claim numbers....., because they relate to subject matter [12] not required to be searched by this Authority, namely:

2. ☐ Claim numbers....., because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out [13], specifically:

VI. ☐ OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING [11]

This International Searching Authority found multiple inventions in this international application as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims of the international application.

2. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims of the international application for which fees were paid, specifically claims:

3. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claim numbers:

4. ☐ As all searchable claims could be searched without effort justifying an additional fee, the International Searching Authority did not invite payment of any additional fee.

Remark on Protest

☐ The additional search fees were accompanied by applicant's protest.

☐ No protest accompanied the payment of additional search fees.