

[54] **HOLLOW SPHERE-LIKE STRUCTURES**

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June 14, 1971 Japan..... 46/49700

[52] U.S. Cl. **16/45**

[51] Int. Cl. **A47b 91/00**

[58] Field of Search 16/18, 45, 26, 25,
16/121, 118

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[57] **ABSTRACT**

A first hollow semisphere having therein a cup-like part with a socket and a second hollow semisphere having therein a hollow journal cylinder for receiving an axle are joined together along their peripheral rims to form a hollow spherical structure, one end of the journal cylinder, which is integrally formed with the second semisphere, being fitted in the socket of the first semisphere, and a passageway is provided to communicate the hollow interior of the structure with the journal bore. This spherical structure may be used as it is or it may be enveloped in an outer layer to form a hollow spherical article such as a spherical wheel in a caster.

11 Claims, 21 Drawing Figures

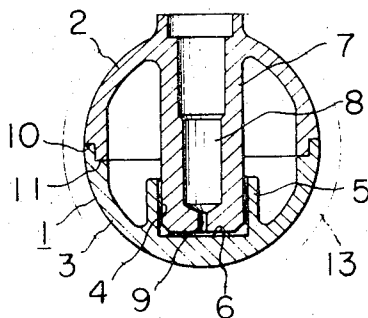


FIG. 1

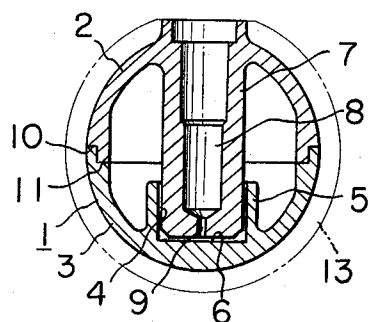


FIG. 2

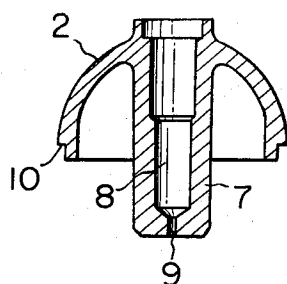


FIG. 4

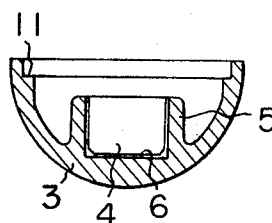


FIG. 3

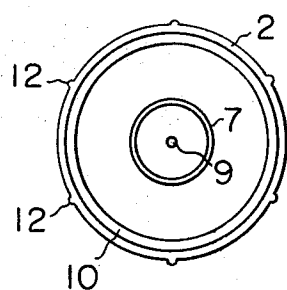


FIG. 5

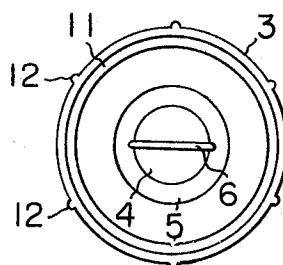


FIG. 6

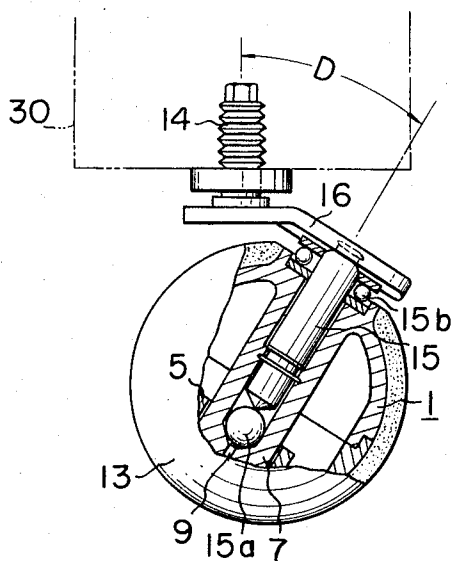


FIG. 7

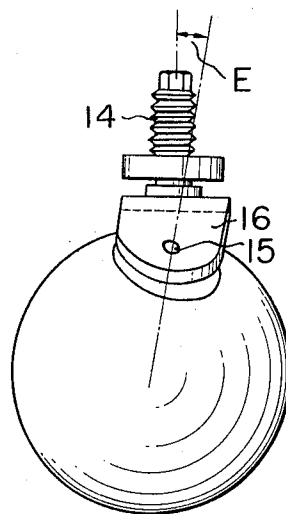


FIG. 8

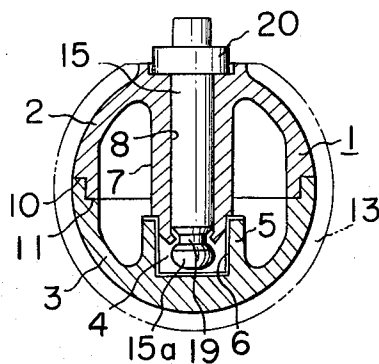


FIG. 9

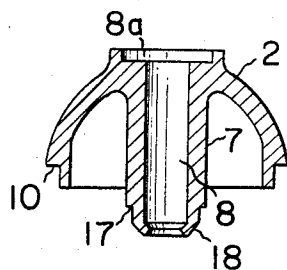


FIG. 10

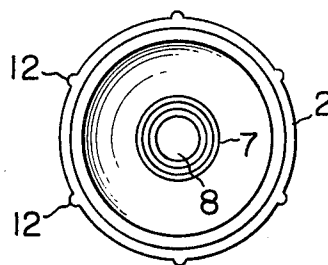


FIG. 11

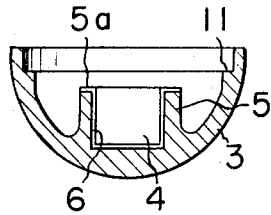


FIG. 12

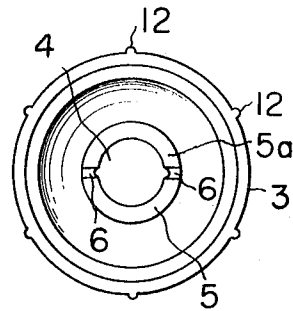


FIG. 13

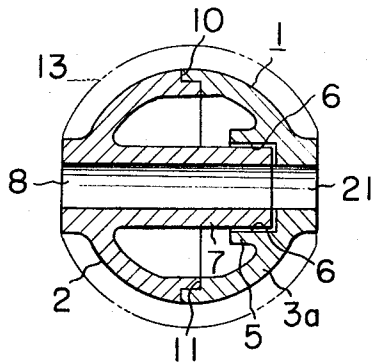


FIG. 14

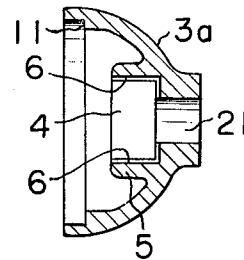


FIG. 15

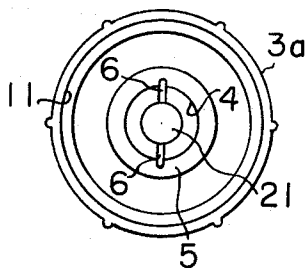


FIG. 16

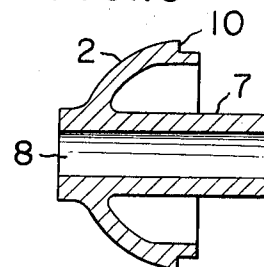


FIG.17

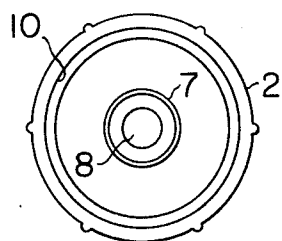


FIG.18

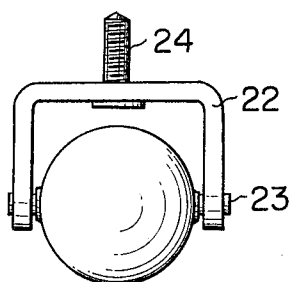


FIG.19 (a)

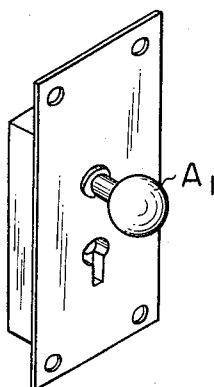


FIG.19 (b)

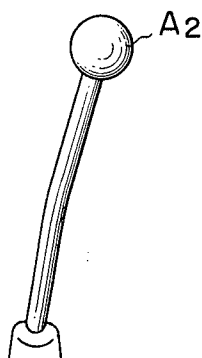
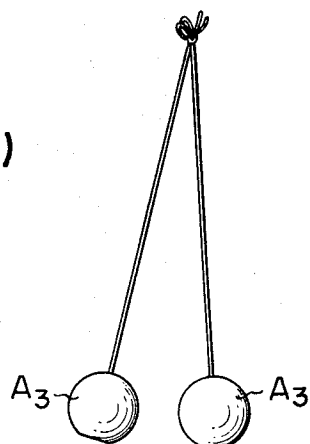


FIG.19(c)



HOLLOW SPHERE-LIKE STRUCTURES

BACKGROUND OF THE INVENTION

This invention relates generally to sphere-like structures to be rotatably or fixedly supported on other structures. More particularly, the invention relates to new and advanced sphere-like structures of high strength, durability, and excellent appearance for caster wheels, other wheels, door knobs, control lever knobs, toys, and various other uses.

The term "sphere-like" is herein used to designate spheres and figures which are not too far removed from spheres, examples of such figures being ellipsoids, other spheroids, ovals, and ovaloids.

There is a recent trend in modern casters toward the use of spherical wheels because of the universality of their direction of rolling and because of their relatively small surface loads. Spherical wheels known heretofore, however, have been of solid internal construction, being molded of materials such as synthetic resins. Accordingly, large quantities of these materials were required and gave rise to high material costs and great weight of each sphere. Furthermore, there have been various problems with these wheels, such as concavities in the inner wall surface of their axle bearing or journal bores due to contracting action caused by shrinkage during injection molding of these wheels.

Moreover, when a wheel made of a hard synthetic resin is used on a soft floor surface, the floor surface is easily damaged. Even when the wheel is made of soft synthetic resins, it still requires a core of a sphere as described above, whereby the above described problems still remain and give rise to difficulties in fabrication.

Furthermore, the rotatable connection between a spherical wheel and the axle to support the wheel presents many difficulties. A common conventional arrangement for this purpose comprises a journal bore having an open end and a closed bottom and provided centrally in the wheel, a steel ball inserted into this bore and rotatably resting on the bottom thereof, the axle rotatably fitted into the journal bore with its tip resting rotatably on the steel ball for smooth low-friction rotation under load, and means such as a clip ring for retaining the axle in the journal bore.

In an arrangement as described above, however, there are many difficulties such as the necessity of using numerous parts such as the steel ball and a clip ring, the necessity of much labor in fabrication, and the resulting high manufacturing cost.

The above described difficulties are encountered in the case of solid spherical wheels with journal bores for receiving cantilever axles and also in the case of solid spherical wheels with through holes or bores for receiving axles therethrough supported at their two ends. These difficulties are also encountered in the case of solid knobs of sphere-like shape for doors, control levers, and the like.

SUMMARY OF THE INVENTION

It is an object of this invention to provide sphere-like hollow structures using a minimal quantity of material and having a minimal number of parts which structures are easily fabricated, undergo no deformation after forming, have high mechanical strength and light weight, can be produced to sell at a low price, have excellent exterior appearance, and can be adapted to be

supported on cantilever shaft structures or through shaft structures supported at the two ends thereof.

According to this invention in one aspect thereof, briefly summarized, there is provided a hollow sphere-like structure comprising a first hollow semishell having therein a journal seat formed integrally therewith and having a socket and a second hollow semishell having therein a journal cylinder formed integrally therewith and having a journal bore formed coaxially therethrough for receiving a shaft structure, the semishells being joined together along peripheral rims thereof, an end of the journal cylinder being fitted in the socket of the journal seat, and a passageway communicating the hollow interior of the sphere-like structure with the journal bore.

According to this invention in another aspect thereof, there is provided a finished sphere-like article comprising the combination of the above described sphere-like structure and an outer layer enveloping the structure.

The nature, principles, and utility of this invention will be more clearly apparent from the following detailed description with respect to a number of examples of sphere-like structures constituting preferred embodiments of the invention when read in conjunction with the accompanying drawings, in which like parts are designated by like reference numerals.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

FIG. 1 is a sectional elevation taken along a plane passing through the axle journal axis of a hollow spherical core structure of a spherical caster wheel according to the invention;

FIGS. 2 and 4 are similar sectional views respectively showing the upper and lower semispheres of the structure shown in FIG. 1;

FIGS. 3 and 5 are planar views respectively of the semispheres shown in FIGS. 2 and 4 as viewed from their open ends;

FIG. 6 is an elevation, with parts cut away and parts shown in section, showing one example of assembly of a spherical wheel having a core structure as illustrated in FIGS. 1 through 5 in a caster;

FIG. 7 is another elevation of the same caster as viewed from a direction perpendicular to the direction of the view of FIG. 6;

FIGS. 8 through 12, inclusive, are views similar to FIGS. 1 through 5, respectively, showing the details of another example of the core structure of a spherical structure according to the invention;

FIGS. 13 through 17, inclusive, are views also similar to FIGS. 1 through 5, respectively, showing the details of still another example of the core structure of a spherical structure of the invention, in which a through hole is provided to function as an axle journal;

FIG. 18 is an elevation showing one example of assembly of the spherical structure having the core structure illustrated in FIGS. 13 through 17 as a wheel in a wheel and mounting assembly; and

FIGS. 19(a), 19(b), and 19(c) are a perspective view, a perspective view, and an elevation, respectively, illustrating a few examples of use of sphere-like structures according to the invention in applications other than wheels.

DETAILED DESCRIPTION

Referring first to FIGS. 1 through 5, the spherical structure generally designated therein by reference numeral 1 constitutes a core structure for a spherical structure and comprises an upper hemisphere 2 and a lower hemisphere 3 both of a synthetic resin molded into hollow hemispherical shape and combined to form the hollow core structure.

The lower hemisphere 3 has therein in central alignment a journal seat 5 having a journal socket 4 and formed integrally with the lower hemisphere. The bottom and side wall surfaces of this journal socket are provided with a continuous groove 6 for venting. The upper hemisphere 2 has therein in central alignment a journal sleeve or cylinder 7 having a journal bore 8 and formed integrally with the upper hemisphere. The lower end of the journal cylinder 7 has outer dimensions and a shape such that it will fit snugly into the socket 4 of the journal seat of the lower hemisphere when the two hemispheres are assembled.

The journal bore 8 of the journal cylinder 7 is open at its upper end and has at its lower end a concave conical bottom having a through vent hole 9 of small diameter communicating with the above mentioned groove 6 when the end of the cylinder 7 is fitted into the socket 4.

The peripheral rims of the upper and lower hemispheres 2 and 3 are provided respectively with stepped shoulders 10 and 11 formed therearound to fit in mutual engagement to form an annular rebated joint or socket-and-spigot joint when the two hemispheres are assembled together and thereby to form a core structure 1 having a smooth surface at the joint between the two hemispheres. Each of the upper and lower hemispheres 2 and 3 has on its outer spherical surface a number (six in the example shown) of reinforcing ridges or ribs 12.

After the two hemispheres 2 and 3 have been assembled as described to form the core structure 1, the core structure is enveloped with an outer layer 13 of uniform thickness of a material such as a soft resilient synthetic resin or rubber so as to form a spherical structure with an elastic property.

A spherical structure of the above described hollow construction according to this invention can be adapted to serve as a wheel in a caster as illustrated by one example in FIGS. 6 and 7. In this application, the spherical structure is rotatably supported on a cantilever axle 15 inserted into the journal bore 8 and bearing at its extreme inner tip on a steel ball 15a previously placed on the conical bottom of the bore 8.

The outer end of the axle 15 is rigidly and perpendicularly fixed to the outer part of a swivel bracket 16 for wheel mounting, between which and the spherical wheel, bearing means such as a ball bearing 15b encircling the root part of the axle 15 is provided. The swivel bracket 16 is rotatably supported at its inner part by a swivel mounting member 14 for attachment to a structure 30 to be casted. The mounting member 14 in this example is a threaded pin screwed vertically into mating internal threads (not shown) in the structure 30. The swivel bracket 16 is thus free to swivel about a swivel axis which, in this example, is vertical and coincident with the axis of the pin 14.

The axle 15 is at suitable angles of inclination for casting relative to the axis of the mounting pin 14 as viewed in FIGS. 6 and 7, and the swivel bracket 16 is

bent accordingly so that its parts connected to the shaft 15 and the pin 14 are respectively perpendicular thereto.

More specifically, FIG. 6 is an elevation as view in a direction perpendicular to a vertical plane passing through the axis of the mounting pin 14 and through the root part of the axle 15 fixed to the swivel bracket 16, while FIG. 7 is an elevation orthogonal to FIG. 6, i.e., an elevation of the caster assembly as viewed from the right side in FIG. 6. The axle 15 is so orientated that its axis is at a carefully designed inclination angle D relative to the axis of the pin 14 as viewed in FIG. 6 and at a carefully designed inclination angle E relative to the axis of the pin 14 as viewed in FIG. 7.

This double casting inclination of the axle 15 eliminates dead-center situations in the operation of the caster and affords reliable casting. One method of providing this orientation of the axle 15 is to use an originally flat plate for the swivel bracket 16 and to bend it along a creasing line which is at an angle other than zero relative to a line joining the pin 14 and the root end of the axle 15 as viewed in plan view.

In the production of the spherical structure of the above described organization according to this invention, the upper and lower hemispheres 2 and 3 are separately molded and then assembled, the journal cylinder 7 of the hemisphere 2 being fitted into the socket 4 of the journal seat 5 of the hemisphere 3, and stepped shoulders 10 and 11 being fitted together, thereby to form the core structure 1. In the case where this spherical structure 1 is to be used directly, as it is without an outer layer, the peripheral rebated joint along the shoulders 10 and 11 is bonded by means of an adhesive.

In the case where this structure 1 is to be used as a core structure, it is enveloped by an outer layer 13 of a soft resilient material by any suitable process such as molding or casting. During such a process, the air in the hollow space between the outer walls of the hemispheres 2 and 3 and the combination of the journal cylinder 7 and journal seat 5 will become pressurized to cause deformation of the spherical structure if it cannot escape.

A feature of this invention is the provision of the groove 6 and the vent hole 9 whereby this air can expand and escape into the bore 8 and hence to outer atmosphere, and whereby deformation of parts of the core structure and of the spherical structure is prevented. While the groove 6 is formed in the inner wall surface of the journal seat 5 in the above described example, it will be obvious that this groove may be alternatively formed on the outer surface of the lower end part of the journal cylinder 7.

The above described organization of the spherical structure according to this invention affords several other advantageous features. In the construction of the structure, the central journal cylinder 7 fits snugly in the socket 4 in the journal seat 5 to form a firmly rigid central structure for receiving an axle, shaft, or lever, and the peripheral parts of the hemisphere are joined securely by an annular rebated joint and form an integral outer shell, which is integral with the rigid central structure. Accordingly, this hollow structure has high strength but is much lighter and entails a lower material cost than a solid structure.

Furthermore, the fabrication of the core structure from two semispherical parts greatly facilitates the manufacturing process of forming a hollow spherical

structure, which process is difficult by most other methods. Thus, hollow spherical structures of excellent exterior appearance without deformations can be easily produced.

In a modification, as illustrated in FIGS. 8 through 12, of the preceding example of this invention, the general construction of the spherical structure 1 is similar to that of the preceding example except for the parts relating to the joint between the journal cylinder 7 and the journal seat 5.

More specifically, the lower end part of the journal cylinder 7 is reduced in diameter to form a stepped shoulder 17 for engagement with the upper rim surface 5a of the journal seat 5, the lower reduced-diameter end of the journal cylinder fitting snugly into the socket 4 in the journal seat 5, when the two hemispheres 2 and 3 are joined together. An annular rebated joint is thus formed between the cylinder 7 and the seat 8.

The lower extremity of the cylinder 7 has an inwardly extending frustoconical flange 18 having a lower rim defining the lower opening of the journal bore 8 centrally formed in the journal cylinder 7. The lower rim of this flange 18 is adapted to fit into an annular groove 19 formed around an axle, (shaft, or lever) 15 near the end thereof when it is inserted into the journal bore 8.

The lower part of the axle 15 below the groove 19 is of bulbous shape with a cone-like wedge tip 15a for facilitating the forceful passage of this tip past the lower rim of the constricted opening in flange 18 of the journal cylinder 7, the rim being elastically and temporarily dilated during this passage of the axle tip and contracting thereafter into engagement with the annular groove 19. The end of the axle 15 is thereby locked and prevented from being extracted. When necessary, the flange 18 may be provided with cuts made outward from the lower rim thereby to facilitate the above mentioned elastic dilation thereof.

To prevent further axial movement of the axle 15 into the journal bore 8, that is, to provide the axle 15 with thrust bearing means, the axle 15 is provided with an enlarged diameter part 20 adapted to abut against and slidably bear on an open end surface 8a formed on the upper hemisphere 2 at the upper end of the journal bore 8.

Thus, the above described construction affords a simple assembly procedure wherein the spherical structure is merely fitted onto the axle 15 and snapped into place, and wherein there is no necessity for using a steel ball as in the preceding example. Accordingly, this organization affords simple and low-cost fabrication and assembly.

In the above described core structure 1, also, a groove 6 is provided in the journal seat 5 for relieving internal air pressure during the molding of an outer layer 13 on the core structure thereby to prevent deformation of the spherical structure. In other respects, the details and features of this core structure are similar to those of the structure of the preceding example.

In still another embodiment of the invention as illustrated in FIGS. 13 through 18, the spherical structure of this invention is adapted to be rotatably supported on a through axle 23 which, in contrast to the cantilever axles 15 of the preceding two examples, is supported at its two ends. The spherical structure, itself, has essentially the same construction as those in the preceding examples, comprising a core structure 1 of hollow construction made up of two hemispheres 2 and

3a and an outer layer 13 of a material such as a synthetic resin or a rubber.

As in the preceding examples, particularly the first example, one hemisphere 2 has a central journal cylinder 7 snugly fitted at its end into a journal socket 4 in a journal seat 5 formed in the other hemisphere 3a and has a vent groove 6.

This other hemisphere 3a, however, differs from the lower hemispheres 2 of the preceding examples in that it has a through hole 21 opening out to the exterior and constituting a coaxial extension of the journal bore 8 formed through the journal cylinder 7. The through hole 21 and the journal bore 8 are of equal diameter and, in the assembled state of the core structure, form an integral journal constituting a bearing for the axle 23 extending therethrough.

The through axle 23 is supported at its two ends by the straddle or fork arms of an axle holding frame 22, which is secured to a structure (not shown) such as a chair or some other article of furniture. This spherical structure, also, has the various advantageous features set forth with respect to the preceding examples.

While the invention has been described above with respect to examples thereof wherein spherical structures are designed principally to function as wheels, it is to be understood that the teachings of the invention can be applied with high effectiveness to sphere-like structures other than wheels. A few examples of such applications are illustrated in FIG. 19 (a) showing a sphere-like structure. A₁ according to the invention used as a door knob, in FIG. 19(b) showing a sphere-like structure A₂ used as a knob at the distal end of a control lever, and in FIG. 19 (c) showing spherical structures A₃ of the invention used in a percussion toy.

Furthermore, as mentioned hereinbefore, the hollow sphere-like structures according to this invention can be used directly as assembled without added material such as an outer layer, or they can be used as core structures enveloped by outer layers.

I claim:

1. A hollow sphere-like structure comprising a first hollow hemisphere-like semishell having therein a journal seat formed integrally therewith on the inner surface thereof and having a socket extending radially centrally of the semishell, a second hollow hemisphere-like semishell having therein a journal cylinder formed integrally therewith on the inner surface thereof and having a journal bore extending radially therethrough centrally of the second semishell for receiving a shaft structure from outside said structure, the semishells being joined together along the peripheral rims thereof and the free end of the journal cylinder coaxially fitted in the socket of the journal seat, and means forming a passageway between the hollow interior of the sphere-like structure and the journal bore.

2. A hollow sphere-like structure according to claim 1 further comprising an outer layer, the joined semishells constituting a core structure of the hollow sphere-like article.

3. A hollow sphere-like structure according to claim 2 which is spherical.

4. A hollow sphere-like structure according to claim 2 which is ellipsoidal.

5. A hollow sphere-like structure according to claim 2 which is spheroidal.

6. A hollow sphere-like structure according to claim 2 which is ovaloidal.

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7. A hollow spherical structure according to claim 2 further comprising a cantilever axle in the journal bore, a caster swivel bracket to which the upper root end of said axle is fixed, and means on said bracket for mounting said bracket to swivel about a swivel axis, the axis of the axle being inclined with respect to the swivel axis as viewed in elevation in two mutually orthogonal directions.

8. A hollow sphere-like structure according to claim 1 in which the end of the journal cylinder has an inwardly extending flange thereon terminating at a rim and adapted to snap into locking position in an annular groove formed around an end of a shaft structure inserted into the journal bore.

9. A hollow sphere-like structure according to claim 15

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3 further comprising an outer layer, the joined semishells constituting a core structure of the hollow sphere-like article.

10. A hollow sphere-like article according to claim 1 in which the first hollow semishell has a central journal bore from the bottom of the socket to the outside of said semishell and aligned coaxially with the journal bore through the journal cylinder, whereby a through hole for journalling a shaft structure is formed by the journal bores.

11. A hollow sphere-like structure according to claim 5 further comprising an outer layer, the joined semishells constituting a core structure of the hollow sphere-like article.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,757,383 Dated September 11, 1973

Inventor(s) Shuichiro IIYOSHI

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

On the Title Page, Item [73] Assignee: "Yugen Kaisha
Tiyoshi Seisakusho" should be -- YUGEN KAISHA IIYOSHI
SEISAKUSHO.

Signed and sealed this 1st day of October 1974.

(SEAL)

Attest:

McCOY M. GIBSON JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents