July 18, 1967 A. J. AMDAHL 3,331,145

GLOBE STRUCTURE

Filed Aug. 5, 1965 3 Sheets-Sheet 1

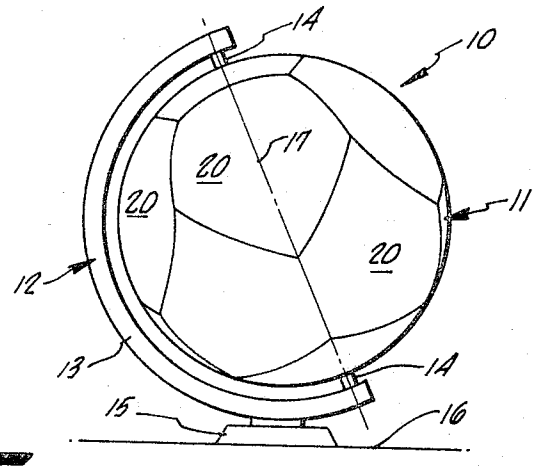


FIG. 1

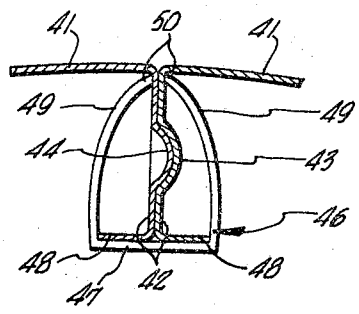


FIG. 9

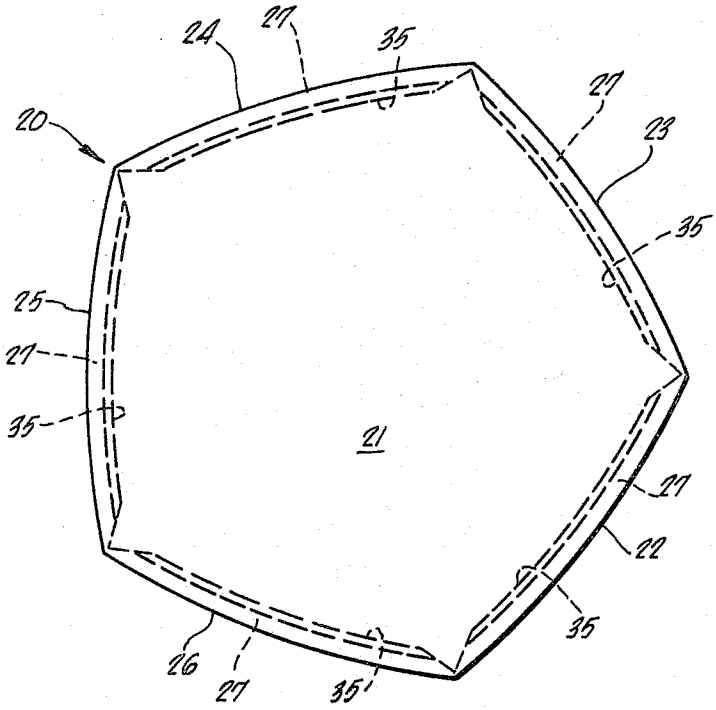


FIG. 2

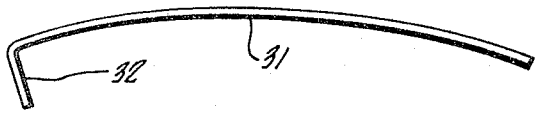


FIG. 7

INVENTOR.
ALTON J. AMDAHL

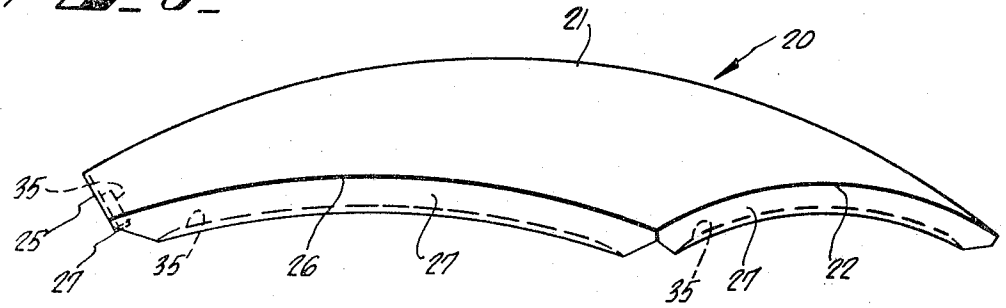
BY Christie, Parker & Dale
ATTORNEYS.

July 18, 1967 A. J. AMDAHL 3,331,145

GLOBE STRUCTURE

Filed Aug. 5, 1965 3 Sheets-Sheet 2

FIG. 3



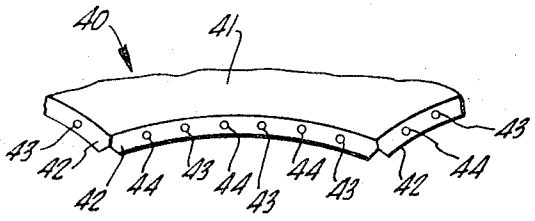


FIG. 8

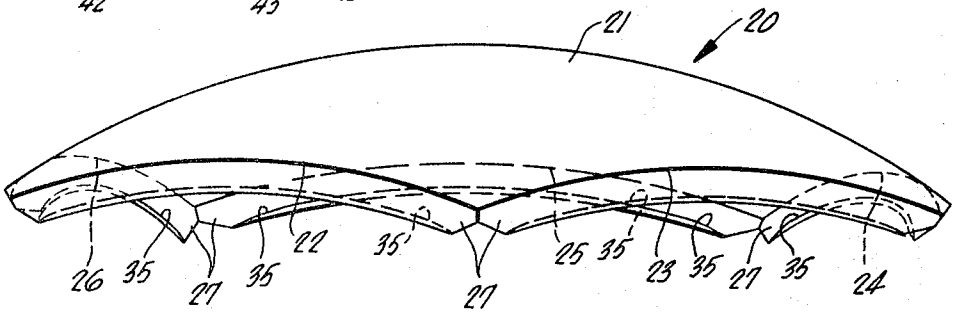
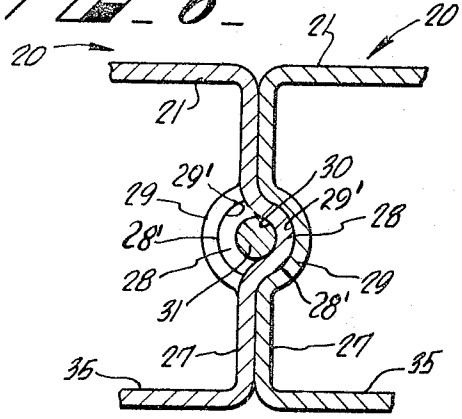


FIG. 4

FIG. 6



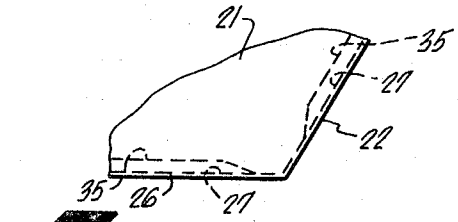


FIG. 5

INVENTOR.
ALTON J. AMDAHL

BY

Christie, Parker & Hale
ATTORNEYS

July 18, 1967 A. J. AMDAHL 3,331,145

GLOBE STRUCTURE

Filed Aug. 5, 1965 3 Sheets-Sheet 3

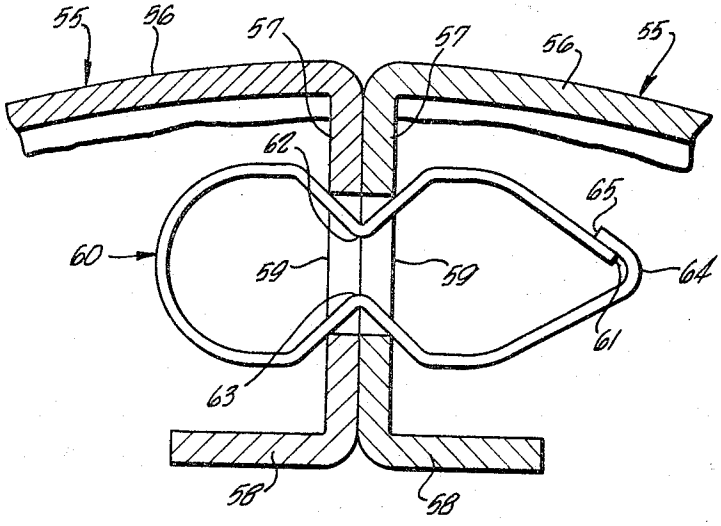


FIG. 10

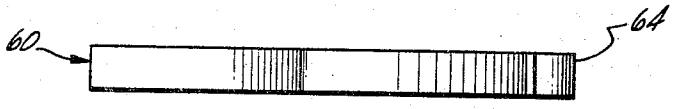


FIG. 11

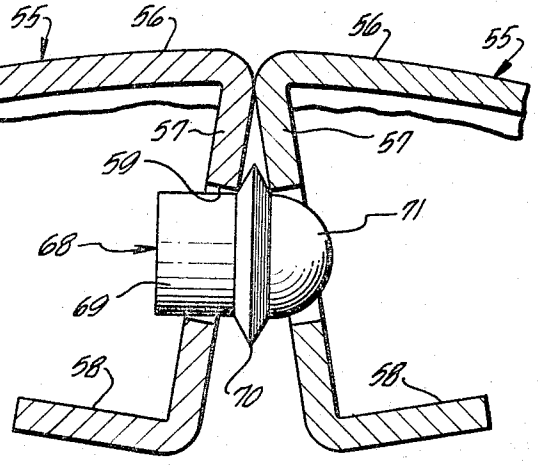


FIG. 12

INVENTOR.
ALTON J. AMDAHL

BY Christie, Parker & Hale
ATTORNEYS.

United States Patent Office 3,331,145 Patented July 18, 1967

3,331,145

GLOBE STRUCTURE

Alton J. Amdahl, Hacienda Heights, Calif., assignor to Trace Tooling Corporation, El Monte, Calif., a corporation of California

Filed Aug. 5, 1965, Ser. No. 482,018
1 Claim. (Cl. 35—46)

This application is a continuation-in-part of my copending application Ser. No. 389,906, filed Aug. 17, 1964, now abandoned, for Globe Structure.

This invention relates to spherical structures, and more particularly to spherical structures fabricated of a plurality of spherical polygons.

World globes are widely used as educational tools. To be effective for such use, the globe should carry an accurate depiction of the earth's geographical features. Such depictions are usually provided in the form of a paper print adhered to the surface of a spherical support, or are printed on a sheet of metal or plastic before the sheet is formed into, in the usual case, a hemispherical part of the finished globe.

Each of the types of globes mentioned above are subject to certain disadvantages. The paper covered globes must be shipped in a fully assembled condition. Such articles are extremely bulky and require considerable space in a carrier's vehicle, on the shelves of the vendor, and, when not in use, in the storage area of an owner. Globes fabricated of hemispherical shells may be shipped from the manufacturer to the vendor in a knock-down condition, the vendor thereafter permanently assembling the globe. In the usual case, however, metal globes are shipped by the manufacturer in a fully assembled condition because the average vendor is not equipped to assemble the globes.

Moreover, sheet metal globes fabricated of a pair of hemispherical metal shells do not always, in the finished state, carry an accurate depiction of the earth's geographical features. It is a difficult, if not impossible, task to accurately print a single design over the entire extent of a hemispherical surface. Accordingly, the usual process of manufacturing sheet metal globes proceeds from the assumption that a flat sheet of metal will always deform in a predetermined manner as the sheet is formed by specific apparatus into a hemispherical shell. A distorted representation of the earth's surface is printed on the sheet before it is drawn into a hemispherical shell, the intent being that the representation will be deformed into the desired final form as the metal is deformed in the predetermined manner during formation of the shell. In actuality, however, the metal does not always deform as desired with the result that the representation of the earth's surface is distorted, often grossly, from what is desired. Moreover, the print on the sheet often fades as the metal is drawn, stamped, or otherwise formed into a hemispherical shell. Moreover, the metal often wrinkles as it is formed.

This invention provides a globe structure which is fabricated from a plurality of preferably identical parts, preferably twelve parts. The parts may be formed economically from sheet metal without requiring extensive deformation or drawing of the metal. Accordingly, the metal deforms almost exactly in accord with a predetermined pattern of deformation so that as distorted representation of the earth's surface printed on the flat sheet is deformed in a desired manner as the part is formed. Moreover, the globe may be shipped in a knocked-down condition. The globe is so easily assembled that the ultimate user of the globe can readily assemble or dismantle it. To this end, the invention includes novel means for connecting together the component parts of the globe shell.

Generally speaking, this invention provides a hollow spherical structure comprised of a plurality of shell elements. Each shell element has a spherically curved convex surface and a peripheral edge. When the outline of the shell element is projected on a sphere concentric to the convex surface of the shell element, the periphery of the shell element defines a plurality of intersecting straight lines. The structure also includes means for connecting the shell elements together so that the convex surfaces of the shell elements cooperate to define a spherical surface.

Preferably the shell elements define a regular pentagon so that when twelve of the shell elements are assembled together a spherical dodecahedron is formed. Since the pentagonal shell elements have a spherically curved surface, the shell elements may be referred to as spherical pentagons.

The above mentioned and other features of the invention are more fully set forth in the following detailed description of the invention taken in conjunction with the accompanying drawings wherein:

FIG. 1 is an elevation view of a world globe constructed in accord with this invention;

FIG. 2 is a top plan view of a shell element of the globe shown in FIG. 1;

FIG. 3 is a side elevation view of the shell element shown in FIG. 2;

FIG. 4 is an end elevation view of the shell element shown in FIG. 2;

FIG. 5 is a true projection view of a corner of the shell element shown in FIG. 2;

FIG. 6 is an enlarged cross sectional view through a pair of shell elements showing the connection of the elements;

FIG. 7 is an elevation view of a connector pin in accord with this invention;

FIG. 8 is a fragmentary elevation view of a shell element showing another manner in which the elements may be located relative to one another;

FIG. 9 is a cross-sectional elevation view of the connection of a pair of elements according to FIG. 8;

FIG. 10 is across-sectional elevation view similar to FIG. 9 showing another manner of securing the shell elements together;

FIG. 11 is a top plan view of the clip shown in FIG. 10; and

FIG. 12 is a cross-sectional elevation view similar to FIG. 10 showing the maner in which the last shell element of the type shown in FIG. 10 is secured in place in an assembled globe.

FIG. 1 shows a world globe assembly **10** which includes a spherical globe **11** and a base **12** to which the globe is rotatably mounted. The base includes a semicircular arm **13** which carries a pair of coaxially aligned axles **14** at its opposite ends which engage the globe at its north and south poles, respectively. A pedestal **15** is connected to the arm so that the globe assembly may be mounted on a horizontal supporting surface **16**. The arm is mounted to the pedestal so that, when the pedestal is engaged with surface **16**, the axis of rotation **17** of the globe is inclined at an angle of 23½° from a vertical reference line so that the globe assembly accurately depicts the angular deviation of the earth's axis of rotation from normal to the plane of the elliptic.

A globe structure according to this invention is fabricated of a plurality of shell elements. The shell elements each have a convexly curved spherical surface and a periphery configured so that when the outline of the element is projected on a sphere concentric to convex surface, the periphery describes a plurality of intersecting straight lines. In other words, the periphery of each shell

element defines a geometrical figure, such as a triangle, a quadrilateral, a pentagon or some other polygon. Preferably the shell elements are identical.

As seen in FIG. 1, globe **11** is fabricated from a plurality of shell elements **20** which preferably are identical except insofar as the two shell elements which are located at the poles of the globe define means (such as holes, not shown) which cooperate with axles **14** for mounting the globe to base **12**. A single shell element is shown in detail in FIGS. 2–4. Each shell element **20** has a convexly curved spherical surface **21** and five edges **22–26** which define the periphery of the shell element. Preferably edges **22–26** are equal in length. Accordingly, the shell element is a regular spherical pentagon, i.e., when the planform configuration of the shell element (as viewed in FIG. 2) is projected upon the surface of a sphere to which surface **21** of the shell element is concentric, a regular pentagon is defined. Twelve such shell elements are provided to compose globe **11** and therefore the assembled shell elements define a spherical dodecahedron. Preferably the shell elements are stamped or otherwise suitably formed from sheet metal.

As shown in FIGS. 2–4, each shell element defines a flange **27** along the entire elongate extent of each of edges **22–26**. The flanges are disposed normal to spherical surface **21** of the shell element. Adjacent the intersections of edges **22–26**, each flange is cut back on itself to allow for deformation of the flange toward the center of the shell element.

Each flange **27** defines means for connecting the shell element to five other shell elements. As shown in FIG. 6, each flange defines a plurality of generally cylindrical semicircularly configured detents, bosses or lobes **28** and **29** which extend out of the plane of the flange and are oriented along the length of the flange. Lobes **28** extend away from the center of the shell element out of the plane of the flange, and lobes **29** extend toward the center of the shell element. The outer convex surface **28'** of each lobe **28** on one shell element is curved to mate with the concave surface **29'** of lobe **29** each of the other shell elements. The lobes on each flange are coaxially aligned parallel to surface **21**, and the lobes on all of the shell elements are spaced a predetermined distance from the intersections of flanges **27** with surfaces **21** on all twelve of the shell elements. Lobes **28** and **29** alternate with each other along the length of each flange **27**.

Globe **11** may be assembled commencing with the shell element which defines the South Pole. The five shell elements which carry depictions of areas of the Southern Hemisphere are selected and are engaged with the South Pole element so that the depictions of the five elements continue the depiction carried by the South Pole element. Each of the five elements is engaged with the South Pole element by engaging lobes **28** of its appropriate flange **27** with lobes **29** of the corresponding flange of the South Pole element. When this is done, an arcuately curved circular passage **30** of generally circular cross-section is formed along the engaged flanges between the concave surfaces of lobes **28** as shown in FIG. 6. An elongated arcuately curved wire connector pin **31** (see FIG. 7), having a length substantially equal to the length of each flange **27**, is passed along passage **30** to connect the shell elements together. One end of pin **31** is laterally bent to define a handle **32**. Twenty-five pins **31** are provided to connect the shell elements of the globe.

After each of the five Southern Hemisphere shell elements have been connected to the South Pole element, the five elements are connected together along the flanges which extend north and south relative to the South Pole element. This requires the use of five connector pins.

Five Northern Hemisphere shell elements are then connected to the proper Southern Hemisphere elements and to each other after being properly arranged relative to the previously assembled elements. This operation requires the use of fifteen connector pins. The pins are positioned so that the pin handles extend into the interior of the globe.

The shell elements preferably are fabricated of sheet metal, a material which has inherent resiliency. Accordingly, flanges **27** may be resiliently deformed relative to their shell elements. This resiliency is relied upon to connect the North Pole shell element to the eleven elements assembled according to the above described procedure. The North Pole element is placed in the proper relation to the pentagonal opening formed by the assembled elements and is snapped into place. That is, the North Pole element is forced into position by deforming its flanges **27**, and the flanges of the adjacent elements, so that the North Pole element may move into position. Once in position, it is held relative to the pinned elements by engagement of its lobes **28** in lobes **29** of the adjacent elements, lobes **28** and **29** functioning as detents to hold the shell element in place.

As mentioned above, the North and South Pole elements have holes at their centers to receive axles **14** of the base. The hole in the North Pole element provides means whereby the element may be grasped and pulled relative to the other elements to remove the element from the globe.

From the foregoing, it is seen that the globe may be assembled and disassembled with ease without the use of special tools. When assembled, the spherical surface of each shell element cooperates with the corresponding surfaces of the adjacent elements to define a single spherical surface.

Each flange **27** defines an inturned lip **35** at its lower edge, i.e., the edge spaced from the curved portion of the shell element, as shown in FIG. 6. Lips **35** are provided to prevent scratching of the matter painted on surfaces **21** as the globe is assembled. If desired, however, the lips may be deleted from the shell elements without departing from the spirit of this invention.

FIGS. 8 and 9 illustrate an additional flange and detent configuration which has utility in securing together shell elements according to this invention. Each shell element **40** has a convexly curved spherical surface **41** and a flange **42** formed along each straight line edge of the periphery of the shell element. Each flange lies normal to the convex surface of the shell element. A plurality of dimpled shell element locating and detent bosses are formed in each flange. As shown, these bosses comprise recessed bosses **43** and projecting bosses **44** which alternate with each other along the length of each flange. The projecting bosses on each flange are configured to mate within the recessed bosses of a cooperating flange, as shown in FIG. 9.

A globe structure may be formed by assembling the shell elements in the sequence described above. The shell elements are located relative to one another by mating the projecting bosses of one element in the recessed bosses of an adjacent element. The shell elements are secured together by a plurality of clips **46** (see FIG. 9) which are engaged along the mated flanges. Clip **46** is fabricated of a resilient material, such as spring steel, and is essentially U-shaped in configuration. Each clip has a base **47**, at least as long as the combined width of lips **48** inturned from the edge of each flange **42** opposite from surface **41**, and a pair of curved legs **49** which come together at tips **50**. The clips are engaged with the mated flanges in a manner such that the flanges lie between the clip legs and are engaged by the tips of the clip legs just adjacent to surfaces **41**. Such an engagement of the flanges by the clips assures that the flanges are intimately mated adjacent surfaces **41** and that no substantial gap exists between the convex surfaces of adjacent shell elements.

The last shell element **40** to be assembled into the globe structure is snapped into place, as described above, and is maintained in place by the mating of its detent

bosses with the detent bosses of the adjacent shell elements.

FIGS. 10, 11 and 12 illustrate another configuration of shell elements according to this invention. A pair of shell elements **55**, of which twelve are provided, each have a convexly curved spherical surface **56**. Preferably each shell element defines a regular spherical pentagon. A flange **57** is formed by each element **55** along each edge thereof substantially normal to surface **56**. Each flange forms an interned lip **58** along its extent opposite from surface **56**. Each element is identical to the other.

A plurality of circular openings **59** are formed through each flange **57** at spaced locations along the flange between surface **56** and lip **58**. The openings are located so that they register with the openings in the flange of the adjacent element of the assembled globe.

A clip **60** is passed through each registered pair of openings of the first eleven elements assembled together. Each clip is fabricated of a strip of spring metal bent into a shape resembling the numeral "8." As shown in FIG. 10, the spring metal strip of each clip extends from a first end **61** near one end of the "8" toward the middle of the "8" to a V-shaped portion **62** at the middle of the "8." The strip extends along a generally circular path around the other end of the "8" to a second V-shaped portion **63** at the middle of the "8." V-shaped portions **62** and **63** have their apexes disposed toward each other. From V-shaped portion **63**, the spring metal strip extends to the first end of the "8" where it defines a return bend **64** terminating in end **65**. The portion of the spring metal strip adjacent end **65** overlies the portion of the strip adjacent end **61** to prevent the ends of the strip from moving apart from each other. As shown in FIG. 10, it is preferred that the strip on the side of the return bend opposite end **65** is straight for a short distance.

The clip is sized so that when it is not engaged in two registered openings **59** and ends **61** and **65** are engaged, the surfaces of the strip at the apexes of portions **62** and **63** which face away from each other are spaced apart a distance as great as or only slightly less than the diameters of openings **59**. Also, it is preferred that end **65** be spaced laterally of a line between the ends of the clip a distance less than the radius of the openings.

As shown in FIG. 10, each clip is used to secure two adjacent elements **55** together by forcing return bend **64** through the registered openings of the flanges of the openings until the clip snaps into position in a relation where flanges **57** lie in V-shaped portions **62** and **63**. When the clip is in place, the apexes of portions **62** and **63** are deformed toward each other against the bias of the spring metal strip. The reverse surfaces of the flanges around openings **59** are engaged with the legs of portions **62** and **63**. The tendency of the clip to move the V-shaped portions apart wedges the flanges together as shown. Each registered pair of openings in abutted flanges has a clip **60** engaged therein.

It is apparent that clips **60** may be used to secure together the first eleven of the twelve elements **55** provided in a globe according to this invention. The twelfth and last spherical pentagon shell element **55** is secured in place by means of detent plugs **68** as shown in FIG. 12. As many detent plugs are required as there are holes or openings through all of the flanges of the last element. Each detent plug has a cylindrical body **69** having a length at least as great as the thickness of the sheet metal from which the shell elements are formed. The body has a diameter slightly less than the diameter of openings **59**. At one end of the body the detent plug defines a circumferential, radially extending lip **70**. Preferably the lip has a triangular cross-sectional configuration. The detent plug also has a rounded head **71**, the lip lying between the body and the head. Head **71** is hemispherical and is aligned with the axis of body **69**.

The last shell element **55** is secured in place by disposing a detent plug in each opening **59** of each flange **57**.

The plugs are positioned so that plug lips **70** are disposed adjacent the flange surfaces which are opposite from flange lips **58**. The last shell element is properly oriented relative to the assembled shell elements with which it is to be engaged. The last shell element is then engaged with the assembled elements by pushing it into place. As the last element is pushed into place, the rounded heads of detent plugs **68** ride against the exposed surfaces of the adjacent flanges until the heads are engaged in the openings in the adjacent flanges. Because of the presence of lips **70** on plugs **68**, the juxtaposed flanges **57** cannot be parallel to each other. That is, the presence of lips **70** causes the mated flanges to be deformed away from each other as shown in FIG. 12 against the resilient bias of the metal from which the respective shell elements are fabricated. Accordingly, the last shell element is held securely in place.

The globe may be disassembled merely by sharply rapping the globe with the side of the hand adjacent the shell element which carries detent plugs **68**. The remaining shell elements may be disassembled by removing clips **60** from between the remaining elements.

It will be observed that the degree of "dishing" of each shell element described above is considerably less than in a hemisphere. The maximum arc across each shell element is approximately 69°. Accordingly, a blank of sheet metal need not be deformed to a great extent as a shell element is formed, preferably by stamping and then by forming in a sheet metal brake. Since the degree of deformation of the metal is small, the pattern of deformation during formation is very accurately reproducible. A design printed on the blank will be deformed in a predictable manner. It is therefore possible, through the use of this invention, to provide a world globe in which the geographical features of the earth's surface are accurately represented.

Moreover, the cost of manufacturing a spherical pentagon of the type described above is considerably lower than the cost of tooling required for the manufacture of hemispherical shells of a large size, for example 12 inches.

The invention has been described in the context of a world globe. It will be apparent, however, that the globe structure described above may be used for other purposes without departing from the spirit of this invention. For example, the shell elements described may be fabricated of a suitable plastic material of proper dimensions to provide an enclosure for a radar antenna. Such a structure may be assembled rapidly from parts which do not require large volumes of cargo space during transportation thereof.

While the invention has been described above in conjunction with specific apparatus, this has been by way of example only and is not to be considered as limiting the scope of this invention.

What is claimed is:

A hollow spherical world globe structure comprised of a plurality of essentially identical thin-walled shell elements each fabricated of a unitary piece of sheet metal, each shell element having a spherically curved convex outer surface, an essentially parallel concave inner surface, and a periphery which, when the outline of the element is projected on a sphere concentric to the convex surface of the element, defines a regular pentagon, the convex surface of each element carrying a graphical representation of a selected part of the earth's geography, and means for connecting the shell elements together so that the convex surfaces thereof cooperate to define a spherical surface, the connecting means including an integral flange defined by each element along each peripheral edge thereof in substantially fixed relation to the element and extending substantially normally away from the convex surface of the shell element, detent means carried by each flange for mating with similar means on the flange of a shell element juxtaposed thereto to key the juxtaposed elements in a predetermined relation, the de-

tent means comprising a plurality of bosses formed in each flange, alternate ones of the bosses extending in opposite directions from the flange, the bosses which extend in one direction from the flange being configured to mate within the bosses extending in the other direction from the flange of said juxtaposed shell element, and means for maintaining the bosses in said mated engagement including a plurality of resilient clips engaged with the flanges defining said mating bosses at spaced apart locations along the flanges, each clip defining a pair of legs biased toward each other, each clip being engaged with a pair of juxtaposed flanges by disposing the flanges between the clip legs so that legs engage the flanges and urge the flanges toward each other.

References Cited

UNITED STATES PATENTS

2,181,831	11/1939	McLaughlin	52—582 X
2,424,601	7/1947	Crouch	35—46
2,875,866	3/1959	Hess	52—588 X
3,091,487	5/1963	Gallagher et al.	52—584 X

FOREIGN PATENTS

1,164,405	5/1958	France.
161,045	4/1921	Great Britain.
560,186	3/1944	Great Britain.
57,244	8/1945	Netherlands.

JEROME SCHNALL, *Primary Examiner.*