United States Patent [19]

Salem

[11] **3,747,261**

[45] **July 24, 1973**

[54] **BALL AND ROD LINKAGE FOR JOINING POLYHEDRAL MEMBERS**

[76] Inventor: **Nasr Salem**, 42 Opera Square, Cairo, Egypt

[22] Filed: **Mar. 27, 1972**

[21] Appl. No.: **237,864**

[52] **U.S. Cl.** **46/26**, 273/155, 46/29

[51] **Int. Cl.** **A63h 33/10**

[58] **Field of Search** 46/25, 26, 28, 29

[56] **References Cited**

UNITED STATES PATENTS

1,958,508	5/1934	Audet	46/25
2,662,335	12/1953	Calverley	46/29 X
3,458,949	8/1969	Young	46/29 X

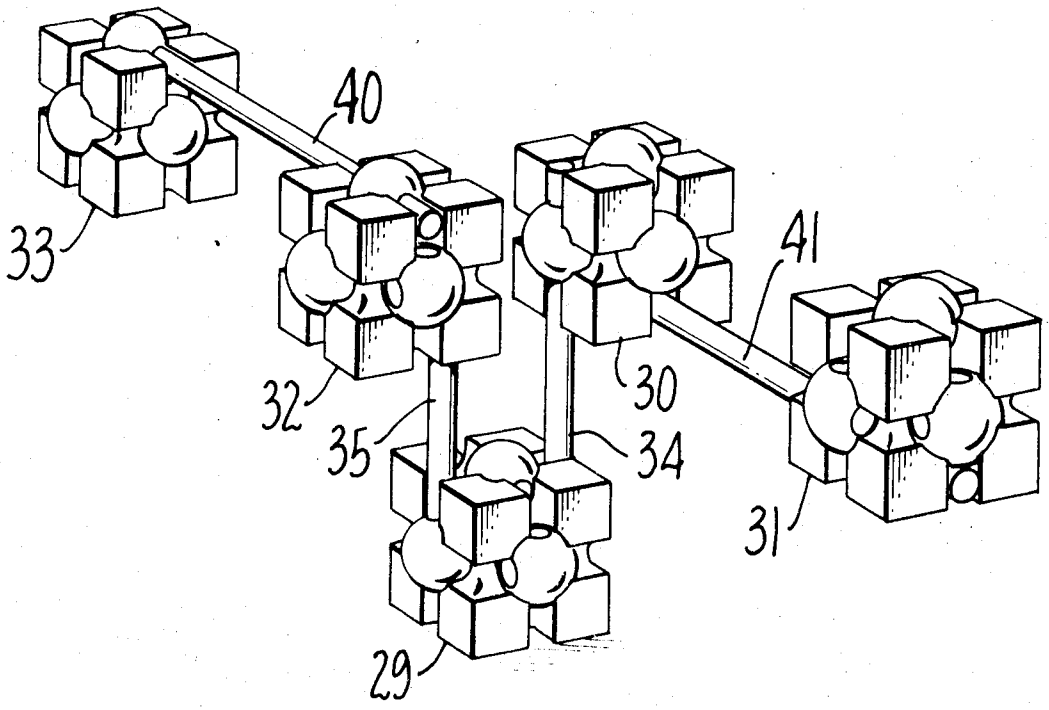
Primary Examiner—F. Barry Shay

Attorney—Mark Mohler et al.

[57] **ABSTRACT**

A ball-and-socket linkage for interconnecting polyhedrel members comprising a pair of balls each having four coplanar flat spots spaced at 90° intervals; a rod for detachably connecting the balls, a spherical, open socket formed in a face of each member for snugly receiving more than one-half of the surface of one of the balls, and four U-shaped grooves formed in said face and extending from the socket opening to the face edge, said grooves being spaced about 90° from each other around the opening and the diameter of the opening being slightly greater than the flat-spot-to-flat-spot diameter of the ball. A plurality of such members and linkages are used as "executive" toys and for constructing artistic assemblages thereof.

9 Claims, 9 Drawing Figures



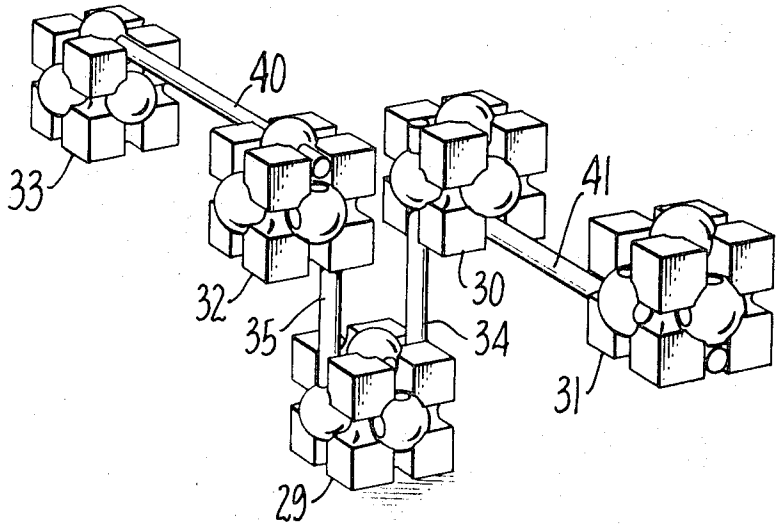


FIG. 1.

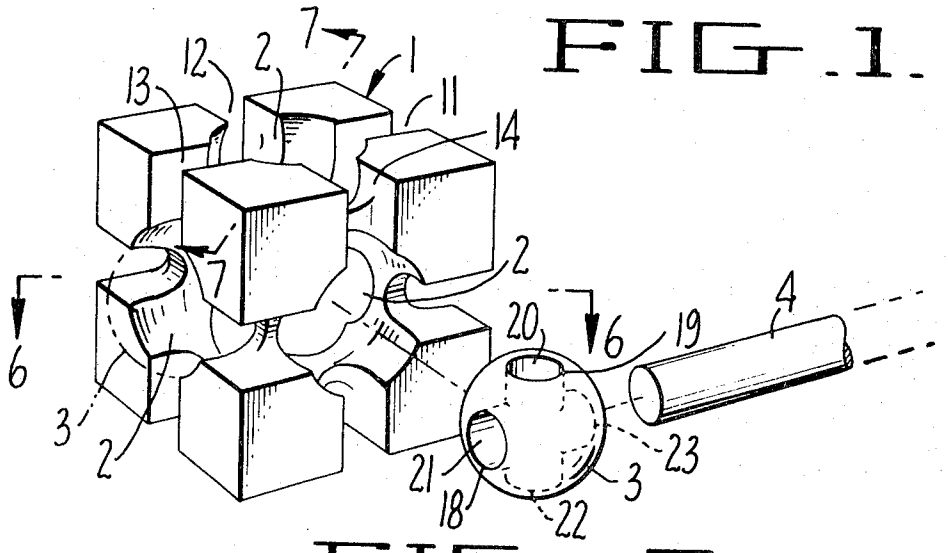


FIG. 2.

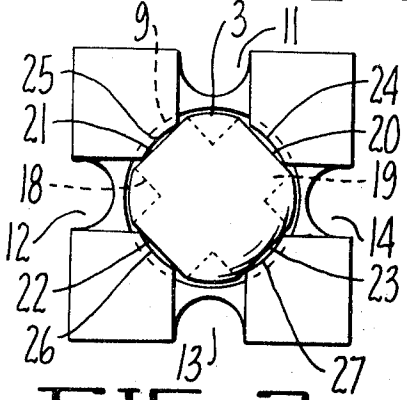


FIG. 3.

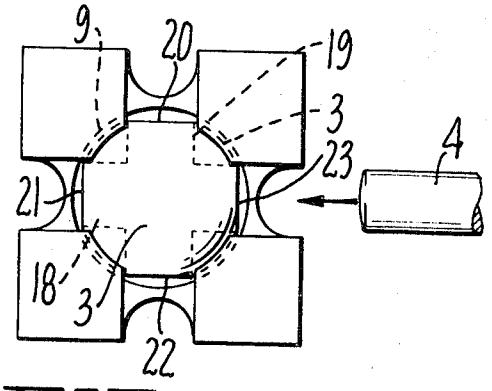


FIG. 4.

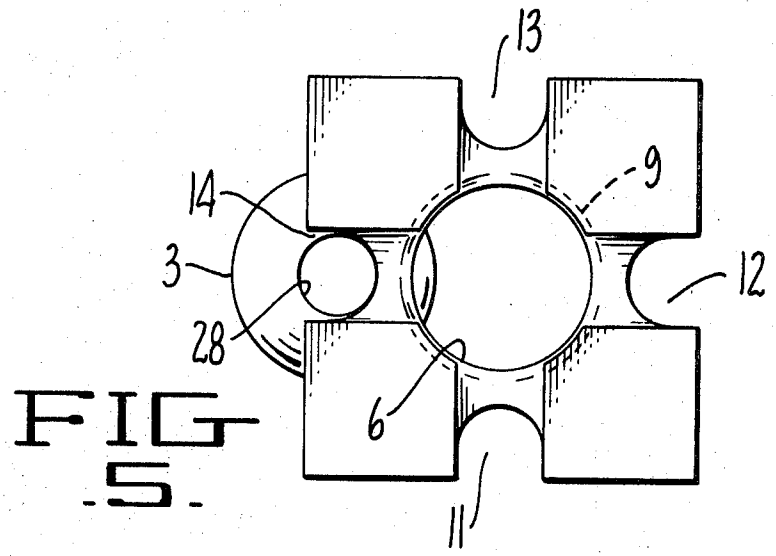


FIG. 5.

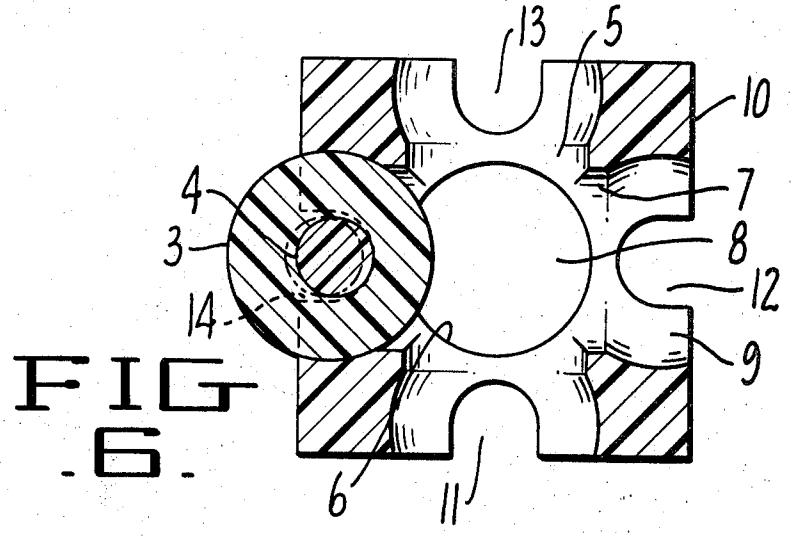


FIG. 6.

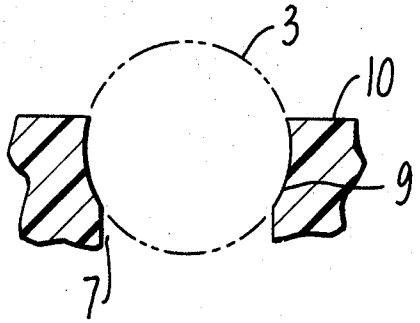


FIG. 7.

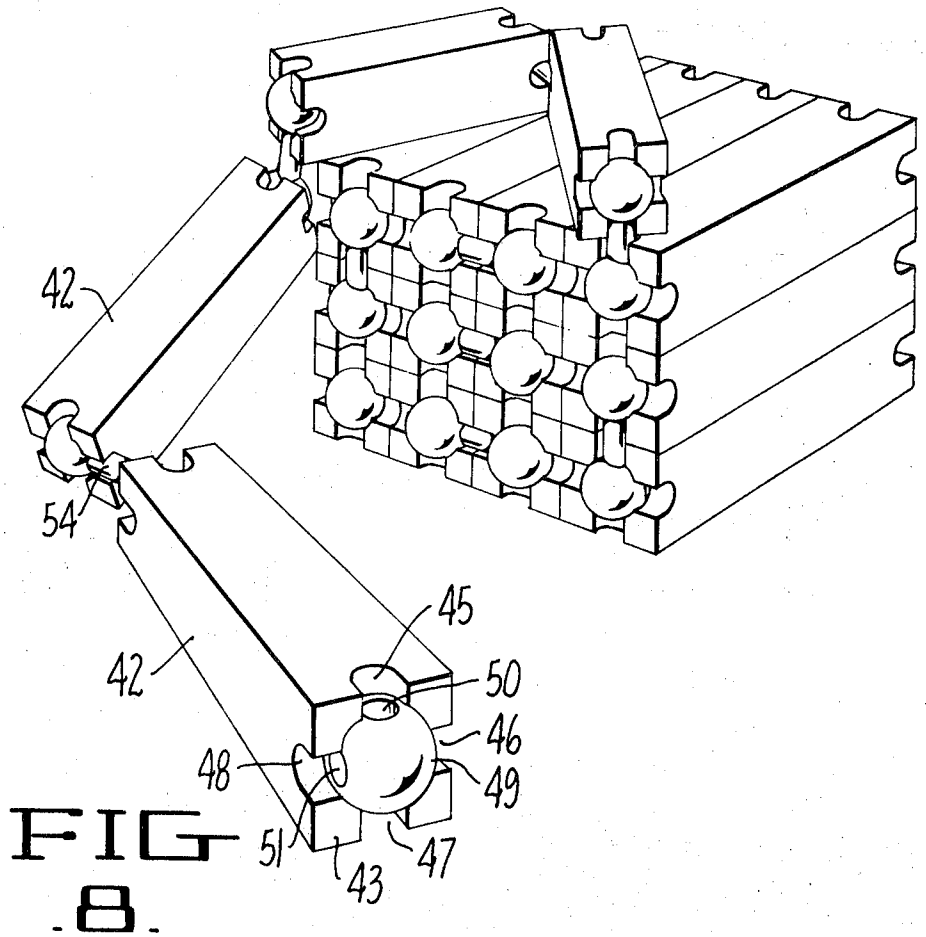

42
54
45
42
50
46
48
49
51
43
47

FIG. 8.

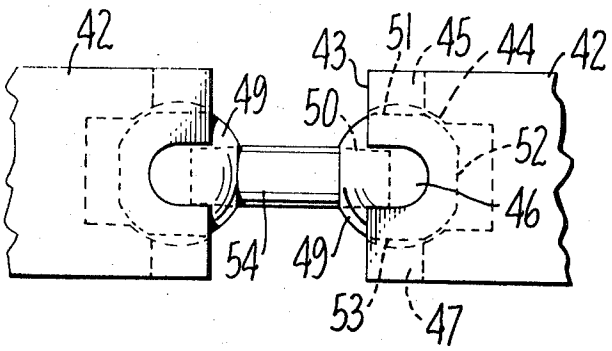

42
43
51
45
44
42
49
50
52
46
54
49
53
47

FIG. 9.

BALL AND ROD LINKAGE FOR JOINING POLYHEDRAL MEMBERS

BACKGROUND OF INVENTION

This invention relates to a novel ball-and-socket type linkage and construction toys utilizing said linkage.

The ball-and-socket linkage of this invention may find use in a wide variety of mechanical applications in which it is desired to join two members together and have such members capable of motion in all directions relative to the joint. Particularly, I have found it useful as a coupler means for "executive" construction toys in which a plurality of members, either of the same shape or different shapes, are detachably interconnected. Since the linkage of this invention permits 360° of rotation of the members relative to one another it enables an almost unlimited variation of assemblages thereof. It thus may be used to provide amusement through mechanical manipulation of the linked members into various assemblies or provide aesthetically appealing designs which may be displayed as art works.

SUMMARY OF THE INVENTION

The ball-and-socket joint of this invention is so constructed that the ball may be removed from the socket when the ball is in one specific position and is locked therein in all other positions. This joint comprises a pair of balls each having four flat spots lying in the same plane and spaced approximately 90° from each other, a shaft or rod detachably interconnecting the two balls and a generally spherically-shaped open socket in a surface of each member to be joined, said socket being sized to snugly receive more than one-half of the surface of the ball. The surfaces of the members in which the sockets are formed also have four grooves formed therein, each groove extending linearly from the opening of the socket to the edge of the surface. The grooves are spaced approximately 90° from each other around said opening and are of sufficient width and depth to accommodate the rod or shaft. The diameter of the socket opening is greater than the diameter of the ball measured from flat spot-to-flat spot. This permits the ball to be removably positioned in the socket when the flat spots are aligned with the edges of the socket opening.

As part of an "executive" construction toy, the above described ball-and-socket forms a joint between faces of regularly shaped, polyhedral members. Such joints may be located on one or more faces of the polyhedron. For instance, if the polygon is a cube, one to six of its faces may be equipped with such a joint.

The rods or shafts interconnecting the balls are detachable to provide greater design capability. They are sized to fit snugly into a hole or bore in the ball. When the rod is withdrawn from the hole, the hole opening provides one of the above described four flat spots which allow the ball to be removed from the socket. In a preferred version of the linkage of this invention, the balls have a pair of generally diametrical cross bores which are substantially normal to each other and extend completely through the ball. The four openings of the cross bores provide the four flat spots required to enable the ball to be removed from the socket. If desired, the balls may be made self-locking in the sockets by making one of the cross bores slightly eccentric relative to a corresponding diameter. When a rod is run through the eccentric bore and one of said grooves and

the ball is rotated, the rod is forced tightly against the bottom of the groove making the rod the axis of rotation of the ball. Further rotation of the ball will force it against the socket thus locking it in place.

Accordingly, a primary object of this invention is to provide a ball-and-socket linkage in which the ball may be removed from the socket in only one position and is locked therein in all other positions.

Another object is to provide construction toys comprising a plurality of members joined by ball-and-socket linkages of this invention which may be assembled in an almost unlimited number of different designs.

A further object is to provide aesthetically appealing assemblages of polyhedral members which are interconnected by the ball-and-socket joint of this invention.

Yet another object is to provide assemblages of polygonal members interconnected by the ball and socket linkage of this invention in which the ball is self-locking in the socket.

Further objects of this invention will be apparent from the following detailed description of the drawings and invention.

DESCRIPTION OF DRAWINGS

FIG. 1 is a perspective view of one possible assembly of one embodiment of this invention in which cubic members having a ball-and-socket joint in each face are interconnected.

FIG. 2 is an exploded view of a cubic member similar to those illustrated in FIG. 1 showing the relative positions between the socket, ball and interconnecting rod.

FIG. 3 is a side view of the member of FIG. 2 in which the ball is positioned in the socket such that it may be removed from the socket.

FIG. 4 is another side view of the member of FIG. 2. However, in FIG. 4 the ball is in a position in which it is locked in the socket and cannot be removed.

FIG. 5 is a top plan view of a cubic member of FIG. 2.

FIG. 6 is a sectional view of a cubiic member of FIG. 2 taken along line 6—6 of FIG. 2.

FIG. 7 is a partial, sectional view of a cubic member of FIG. 2 taken along line 7—7 of FIG. 2.

FIG. 8 is a perspective view of one possible assembly of another embodiment of this invention in which square cross-section, elongated, parallelepipeds are interconnected at their square ends by ball-and-socket joints of this invention.

FIG. 9 is a partial, elevational view of one of the joints of FIG. 8.

DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. 2 shows the basic elements of the joints and toys of this invention: a member 1 (in this instance cubic), six sockets 2 (the rear, bottom and right side sockets are not shown in FIG. 2) formed in the center of each face of the cubic member, a ball 3 adopted to be received within each socket 2 and a connecting rod 4.

Each socket 2 is positioned in the middle of one of the faces of cubic member 1. It is convenient to construct these sockets by first drilling three cylindrical holes through the cube from face to opposing face and then forming a pocket in the shape of a partial sphere near each end of each hole. Such construction is shown

in FIGS. 6 and 7. Referring to FIG. 6 the three cylindrical, face-to-face holes, generally designated 5, 6 and 7, respectively, intersect each other at right angles at the center of the member, forming a central cavity 8 therein. Their diameters are less than the diameters of the balls 3. At each end of each hole 5, 6, 7 is a chamber or recess 9 in the shape of a partial sphere which forms part of the socket 2 for the ball 3. The diameter of chamber 9 is slightly larger than the diameter of ball 3. Chamber 9 truncates outwardly at the face 10 of member 1 and inwardly where it meets cylindrical hole 7. The center of chamber 9 is located at a depth in hole 7 whereby the socket will receive slightly more than one-half of the ball. As illustrated in FIGS. 6 and 7 the ball 3 is seated in the socket with its mid-section engaged by chamber 9, its inner side extending into the hole 7 and its outer side extending out of the end of hole 7. As shown, approximately two-thirds of ball 3 is seated within the socket.

Each face of member 1 has four U-shaped grooves 11, 12, 13, 14 (FIGS. 2, 5 and 6) which extend inwardly on each face from the mid-points of the edges thereof to the socket opening, intersecting the socket at 90° intervals. These grooves serve to engage the connecting rod 4 as described hereinafter.

As illustrated in FIGS. 2, 3 and 4, ball 3 has a pair of substantially diametrical, cylindrical cross bores 18, 19 which intersect each other at right angles and extend com-pletely through ball 3. The diameter of the cross bores is sized to snugly receive and hold the connecting rod 4. The ends or openings of the cross bores 18, 19 form four coplanar flat "areas" 20, 21, 22, 23 on the ball circumference spaced from each other at 90° intervals. By "coplanar" it is meant that the flat areas are all in the same general relation with respect to a diametral plane of the ball. FIG. 3 shows the position of a ball 3 relative to a socket 2 required to insert and remove the ball from the socket. The four flat areas 20, 21, 22, 23 are respectively aligned with the four edges 24, 25, 26, 27 of the socket opening; whereas the four arcuate sections on the ball circumference between the flat areas align with the four U-shaped grooves 11, 12, 13, 14. The diameter of the ball from flat area 20 to flat area 22 (and from areas 21 to 23) is slightly smaller than the diameter of the socket opening from edge 24 to edge 26 (and edges 25 to 27). Therefore, the ball may be slid into or out of the socket when it is in the position shown in FIG. 3. The ball cannot be inserted or removed from the socket when it is in any other position.

FIG. 4 illustrates one position in which the ball 3 is locked with the socket 2. The flat areas 20, 21, 22, 23 are respectively aligned with U-shaped grooves 11, 12, 13, 14, whereas the arcuate sections on the ball between said flat areas are aligned with the edges 24, 25, 26, 27 of the socket opening. Since the ball diameter from the arcuate section to the opposite arcuate section 180° removed is slightly greater than the edge-to-edge diameter of the socket opening the ball is locked within the socket and cannot be removed therefrom unless it is rotated to the position shown in FIG. 3.

As seen in FIGS. 2 and 4 the interconnecting rod 4 is adopted to be inserted into one of the cross bores 18, 19 of the ball. The bottoms of the U-shaped grooves 11, 12, 13, 14 are semi-circular and their depths are such that their bottoms will substantially align with the cross bore openings when the ball is in the socket and the cross bores are aligned with said grooves (FIG. 5). The grooves 11, 12, 13, 14 are sufficiently wide to accommodate the rod 4. When the rod 4 is inserted in one of the cross bores but not completely through the ball and slipped into one of the four grooves, movement of the ball in the plane of the cross bores is restricted. If the rod is extended through the ball and into the opposite groove all movement of the ball within the socket, except perhaps rotation about the rod, will be restricted.

FIGS. 5 and 6 show an embodiment of this invention in which the ball may be completely locked within the socket with even rotation about a connecting rod restricted. In this embodiment one (or both) of the cross bores is not diametrical but is eccentric. When a connecting rod 4 is inserted in the eccentric cross bore 28 and extended along the bottom of groove 14, and the ball rotated in the socket the eccentric bore and rod will move from a position outwardly of the center of the ball (shown in phantom in FIG. 5) towards a position which is inwardly of the ball's center (shown in solid lines in FIG. 5). This forces the rod against the bottom of groove 14 thus making the rod the ball's axis of rotation. Further rotation of the ball in the same direction forces the ball tightly against the inner side of the chamber 9, thereby locking the ball in place. The ball may be dislodged by rotating it in the opposite direction.

FIG. 1 illustrates a possible assembly of cubic members such as the one of FIG. 2. The assembly comprises five cubic members 29, 30, 31, 32, 33 with member 29 acting as a base. Members 30, 32 are attached to base member 29 by rods 34, 35, respectively. Rod 34 extends upwardly from the ball-and-socket (not shown) in the right side of member 29 and connects with the ball-and-socket in the left side of member 30. Rod 35 extends upwardly from the ball-and-socket in the left side of member 29 and connects with the ball-and-socket (not shown) in the right side of member 32.

Membrr 32 is connected to member 33 by rod 40 which extends rearwardly and to the left from the ball-and-socket in the top of member 32 to the ball-and-socket in the top of member 33.

Member 30 is connected to member 31 by rod 41 which extends forwardly and to the right between the ball-and-socket in the bottom of member 30 and the ball-and-socket in the bottom of member 31.

While FIG. 1 shows individual ball-and-sockets being used as a single connection site, it is apparent that any ball-and-socket may function as a site for from one to four interconnections. For instance, in order for a single ball to serve as a site for four connections the cross bore openings are aligned with the grooves (as in FIG. 4) and a rod is inserted along each of said grooves into the cross bores to the mid point of the ball. It is likewise apparent that a connecting rod may be extended through the cross bores of balls in opposite faces of a cubic member and the central cavity 8 thereof, with the rod extending at a right angle outwardly from one or both of said faces. Similarly, other variations in the mode of interconnecting and assembling the members may be readily conceived.

FIGS. 8 and 9 represent another embodient of the invention. Instead of being cubic, the members 42 are elongated parallelipipeds and have square cross sections. Each square end 43 of each member has a socket 44 and U-shaped grooves 45, 46, 47, 48 formed therein which, in all material respects, are identical to the sock-

ets and grooves of the cubic member of FIG. 2. The balls 49, however, only have a single, cylindrical hole 50 which extends to about the mid point thereof. Each ball 49 also has three flat spots 51, 52, 53 on its surface which are coplanar with the opening of hole 45 and are spaced at 90° intervals about the ball's circumference. These flat spots, together with the opening of hole 50, function as the four flat areas 20, 21, 22 and 23 of ball 3 of FIGS. 2–4 and permit the ball 49 to be inserted and removed from the socket 44. Hole 50 is sized to snugly engage a connecting rod 54. Referring to FIG. 9 each end of rod 54 is inserted into the hole 50 in the balls 49, thereby connecting the two members 42. Each member is free to rotate about the ball connecting it to the other member. Movement of a given member in the plane of the flat spots may be restricted by slipping the connecting rod into one of the four U-shaped grooves 45, 46, 47, 48.

FIG. 8 illustrates one possible assembly of the above-described parallelepipeds. There are sixteen members, twelve of which are stacked in a block four members wide and three members high. The remaining four members are shown in various positions illusrating that they may be strung out linearly into various designs as well as placed alongside each other and/or stacked one on top of each other.

The aesthetics of the assemblies of this invention may be enhanced by making the members, balls and connecting rods from different colored plastics. Naturally, other materials such as wood and aluminum may be used if desired.

Further modifications and embodiments of the above described linkage and assemblies which are obvious variants thereof are intended to be included within the scope of the following claims.

I claim:

1. Ball and socket linkage and polyhedral members for joining by said linkage comprising:

a. a pair of balls, each ball having four generally coplanar, flat spots spaced approximately 90° from each other;

b. a rod interconnecting said balls;

c. a generally spherically-shaped, open socket formed in a surface of each of said members and sized to snugly engage the surface of one said balls so as to overlap said ball surface beyond a diametral plane thereof; and

d. four grooves formed in said surface of said member, each groove extending linearly from the opening of said socket to the edge of said surface of said member, said grooves being spaced approximately 90° from each other about said opening and being of sufficient size to accommodate said rod;

e. the diameter of the opening of said socket being slightly greater than the flat-spot-to-flat-spot diameter of said ball thereby permitting said balls to be removably positioned in said socket when the flat spots are aligned with the edges of said opening.

2. The linkage of claim 1 wherein:

f. each of said balls has a pair of generally diametrical cross bores which intersect at right angles and extend through the ball, the openings of which form said flat spots;

g. said rod is cylindrical and its ends are inserted in one cross bore of each ball, thereby interconnecting said balls; and

h. the bottoms of said grooves are substantially semicircular and are deep enough to permit substantial alignment thereof with said cross bores when the ball is seated within the socket.

3. The linkage of claim 2 wherein:

i. at least one of said cross bores is slightly eccentric relative to said ball.

4. A construction toy comprising:

a. at least two balls, each ball having four generally coplanar flat spots spaced approximately 90° from each other;

b. an elongated rod, said rod having means cooperable with said balls to detachably interconnect a pair of said balls;

c. at least two regularly-shaped, polyhedral members, each having a plurality of flat faces;

d. a generally spherically-shaped, open socket formed in at least one of the faces of each of said polygonal members and sized to snugly engage the surface of one of said balls so as to overlap said ball surface beyond a diametrical plane thereof; and

e. four grooves formed in each of said faces having said socket formed therein, each groove extending from the opening of said socket to an edge of said face, said grooves being spaced approximately 90° from each other about said opening and being of sufficient size to accommodate said rod;

f. the diameter of the opening of said socket being greater than the flat-spot-to-flat-spot diameter of said ball thereby permitting said ball to be removably positioned in said socket when the flat spots are aligned with the edges of said opening.

5. The toy of claim 4 wherein:

g. said polyhedral members are cubes; and

h. said sockets and said grooves are formed in each face of each of said members.

6. The toy of claim 5 wherein:

i. each of said balls has a pair of generally diametrical, circular cross-section bores, said bores being substantially normal to each other and extending completely through said balls the openings of said bores forming said four flat spots;

j. said rods have circular cross-sections slightly smaller in area than said bores and are adapted to be inserted into said bores thereby connecting said balls; and

k. the bottoms of said grooves are substantially semicircular and are deep enough to permit substantial alignment thereof with said bores when the ball is seated within the socket.

7. The toy of claim 6 wherein:

l. at least one of said bores is slightly eccentric relative to said ball.

8. The toy of claim 4 wherein:

g. said members are elongated parallelepipeds and have square cross-sections;

h. said sockets and said grooves are formed in each square face of said members.

9. The toy of claim 8 wherein:

i. each ball has a bore extending partially therethrough, the opening of which forms one of said four flat spots; and

j. said rod has a cross-section of slightly smaller area than the cross-sectional area of said bore and is adapted to be inserted into said bore thereby connecting said balls.

* * * * *