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(71) Applicant: **CINCH CONNECTORS, INC.** [US/US];
865 Parkview Boulevard, Lombard, IL 60148-3230 (US).

(72) Inventor: **HOPFER, Albert, N.**; 2210 S. Goebbert Road,
Arlington, Heights, IL 60005 (US).

(74) Agents: **AUGUSTYN, John, M.** et al.; Leydig, Voit &
Mayer, Ltd., Suite 4900, Two Prudential Plaza, 180 North
Stetson, Chicago, IL 60601-6780 (US).

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(54) Title: ELECTRICAL CONNECTOR

(57) **Abstract:** An electrical connector (20) for connection to a device or a second connector is provided. The electrical connector (20) includes a housing (32) and a contact (22) arranged in a contact passageway (34) in the housing. The contact (22) has a center portion (46) and an upper and lower spring arms (42, 44) extending in a cantilevered relation from the center portion (46). An inwardly extending finger (52, 54) is arranged at a free end of each of the spring arms (42, 44). The finger (52) on the upper spring arm (42) and the finger (54) on the lower spring arm (44) are in mutual engagement in an overlapping relationship such that when the upper and lower spring arms (42, 44) deflect inwardly toward each other, the fingers (52, 54) slide over each other. The contact passageway (34) includes a retention slot (60) and the contact (22) includes a retention member (58) which upon insertion of the contact (22) into the contact passageway (34) deflects and engages a wall (72) of the retention slot (60) so as to retain the contact (22) in the contact passageway (34).



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ELECTRICAL CONNECTOR**FIELD OF THE INVENTION**

The present invention relates generally to
5 electrical interconnection and, more particularly to an
electrical contact and connector for establishing
electrical interconnection between electrical components.

BACKGROUND OF THE INVENTION

10 Interface devices for electronic coupling are
available in a wide variety of different configurations.
One such interface device employs wadded conductor
contacts retentively mounted in corresponding holes in an
insulated board (see, e.g., U.S. Patent 4,581,679 and
15 U.S. Patent 4,574,331). The ends of the wadded contacts
are exposed and typically protrude beyond the respective
surfaces of the insulated board. Such a device typically
provides direct coupling and physical separation between
electronic circuits formed on adjacent electrical
20 components, such as a circuit board and an integrated
circuit package.

In an application such as interconnecting an
integrated circuit package with a circuit board, it is
generally preferable that the contacts and connector have
25 a very low profile in order to utilize space efficiently.
Moreover, in order to reduce the total connection force
for all of the contacts, it is desirable that the
contacts deflect upon the application of relatively
minimal force.

30

OBJECTS AND SUMMARY OF THE INVENTION

A general object of the present invention is to provide an electrical contact and connector which provide reliable electrical and mechanical performance.

5 A further object of the present invention is to provide an electrical contact and connector which has a relatively low profile.

Another object of the present invention is to provide an electrical contact and connector which requires
10 relatively minimal force to operate.

These and other features and advantages of the invention will be more readily apparent upon reading the following description of the exemplary embodiments of the invention and upon reference to the accompanying drawings.
15

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of an illustrative electrical connector having at least one contact element according to the present invention.

20 FIG. 2 is a top plan view of the electrical connector of FIG. 1.

FIG. 3 is an enlarged partial plan view of the electrical connector of FIG. 1 showing one of the contact openings with an exemplary contact element inserted
25 therein.

FIG. 4 is an enlarged partial side sectional view of the electrical connector of FIG. 1 with the contact element of FIG. 3 inserted into a contact opening and interconnecting an adjoining integrated circuit package
30 and circuit board.

FIG. 5 is a perspective view of the contact element of FIG. 3.

FIG. 6 is a side elevation view of the contact element of FIG. 3.

FIG. 7 is a rear elevation view of the contact element of FIG. 3.

FIG. 8 is a front elevation view of the contact element of FIG. 3.

5 FIG. 9 is a plan view of the contact element of FIG. 3.

While the invention will be described and disclosed in connection with certain preferred embodiments and procedures, it is not intended to limit the invention to
10 those specific embodiments. Rather it is intended to cover all such alternative embodiments and modifications as fall within the spirit and scope of the invention.

DESCRIPTION OF THE EMBODIMENTS

15 Referring now to the drawings, there is shown in FIG. 1 an illustrative electrical connector 20 having at least one conductive contact element 22 in accordance with the present invention. The illustrated electrical connector 20 is particularly adapted for connecting an integrated
20 circuit package 24 to a circuit board 26. Specifically, the electrical connector 20 has, in this case, a plurality of contact elements 22 (one of which is shown in FIG. 4) that can be used to electrically interconnect a plurality of contact pads or lands 28 on a lower side of the
25 integrated circuit package 24 with conductive traces 30 on the upper or mounting surface of the circuit board 26.

The illustrated electrical connector 20 generally comprises a dielectric housing 32 having a plurality of openings 34 for receiving the electrical contacts 22 as
30 shown in FIGS. 2-4. The contact openings 34 extend through the housing 32 from an upper surface 36 to an opposing, lower surface 38 thereof. The upper surface 36 of the connector includes a socket receiving area, in this case defined by four positioning members 40 for receiving
35 the integrated circuit package 24 (see, e.g., FIG. 1).

Consequently, the connector 20 is configured so as to be mountable to a circuit board 26 with the lower surface 38 of the housing facing the upper surface of the circuit board 26.

5 While the present invention is described in the context of providing electronic coupling between an integrated circuit package and a circuit board, it will be readily appreciated that the invention is equally applicable to electronic coupling between other types of
10 electrical components.

 To engage the corresponding contact areas of the mating electrical components, in this case the integrated circuit package 24 and the circuit board 26, each contact element 22 includes an upper and a lower spring arm 42,
15 44 as shown in FIGS. 4-6. The upper and lower spring arms 42, 44 extend in cantilevered relation from respective upper and lower ends of a center portion 46. The upper and lower spring arms 42, 44 diverge from each other as they extend outwardly from the center portion 46
20 towards apex portions 48, 50 at their respective free ends.

 An inwardly extending finger 52, 54 is arranged at the free end of each of the spring arms 42, 44. The fingers 52, 54 extend inwardly at different relative
25 angles such that the free ends of the fingers engage each other in an overlapping relationship. This overlapping configuration of the fingers 52, 54 shortens the electrical path through the contact element.

 When the contact element 22 is inserted in its
30 respective contact opening 34, the center portion 46 is contained entirely within the contact opening and the portions of the spring arms 42, 44 adjacent the apex portions 48, 50 protrude from either end of the contact opening as shown in FIG. 4. Thus, the portions of the
35 upper and lower spring arms 42, 44 which extend beyond

the upper and lower surface 36, 38 of the housing 32 are available to mate with the corresponding electrical contacts of another electrical component.

When the apex portions 48, 50 of the spring arms 42, 44 engage the mating contact surfaces on, in this instance, the integrated circuit package 24 and the circuit board 26, the spring arms 42, 44 deflect inwardly toward each other and produce a sliding or wiping motion between the overlapping fingers 52, 54. The contact element 22 thereby establishes an electrical connection between the integrated circuit package 24 and the circuit board 26.

As will be appreciated, the contact elements 22 can be either formed or stamped from any suitable material that will produce the desired spring action. Upon selection of an appropriate material, the configuration of the contact element 22 of the present invention is such that the spring arms 42, 44 will deflect upon the application of a relatively minimal force.

In order to concentrate or focus the contact force produced by the spring arms 42, 44, a raised protrusion or bump 56 can be arranged on the apex portion 48, 50 of each of the spring arms as shown in FIGS. 6 and 9. The raised bump 56 can be arranged on each spring arm 42, 44 so as to provide the mating surface which engages the contact surface of, in this case, the trace 30 or contact pad 28 and establishes the electrical connection between the two components. By concentrating the contact force, the raised bump 56 helps ensure that a reliable long-term electrical connection is established between the integrated circuit package 24 and the circuit board 26. Alternatively, as opposed to the raised bump 56, a concentration of the contact force can be achieved by forming a plurality of pin holes in the apex portions 48, 50 of the spring arms 42, 44 so that the raised edges of

the pin holes provide the concentration of the contact force.

To secure the contact element 22 within its respective opening in the housing 32, the illustrated
5 contact element includes a pair of retention members 58 which are adapted to engage corresponding retention slots 60 in the contact opening 34 in the housing as shown in FIGS. 3 and 4. Each retention member 58 extends
10 laterally away from a respective one of the opposing sides of the center portion 46 of the contact element 22. Prior to insertion into a contact opening 34, each of the retention members 58 has a generally C-shaped configuration that includes upper and lower beams 62, 64 that extend away from the center portion 46 in generally
15 the same direction as the spring arms 42, 44 as shown in FIGS. 5 and 6.

The retention slots 60 in the illustrated connector housing 32 are provided in opposing side walls 66, 68 of the contact opening 34 and extend from, in this case, the
20 upper surface 36 of the connector housing towards the lower surface 38 as shown in FIGS. 3-4. The retention slots 60, however, do not extend completely through the housing 32 to the lower surface 38, but instead terminate at an end wall 70 which is spaced a distance above the
25 lower surface of the housing 32. Accordingly, when viewed from the top of the housing 32 (FIG. 3), the contact opening 34 has a generally T-shaped outline, while it has a generally rectangular outline when viewed from the bottom of the housing.

30 To allow the retention members 58 to retentively engage the slots 60, the length of the retention slots is less than the length of the upper and lower beams 62, 64 of the contact retention members. Thus, when the contact element 22 is inserted in the contact opening 34 the
35 upper and lower beams 62, 64 deflect in the direction

opposite of the insertion direction as shown in FIG. 4. When fully inserted in the contact opening 34, the contact element 22 is prevented from moving downward by the engagement of the lower beams 64 with the end walls 70 of the slots 60 and from moving upward by the engagement of deflected upper and lower beams 62, 64 with the side wall 72 of the retention slot. Specifically, the deflected upper and lower beams 62, 64 apply a spring force on, as well as dig into, the side wall 72 of the retention slot 60 so as to secure the contact element 22 within the opening 34.

All of the references cited herein, including patents, patent applications, and publications, are hereby incorporated in their entireties by reference.

While this invention has been described with an emphasis upon certain embodiments, it will be obvious to those of ordinary skill in the art that variations of those embodiments may be used and that it is intended that the invention may be practiced otherwise than as specifically described herein.

WHAT IS CLAIMED IS:

1. An electrical connector for connection to a device or a second connector comprising:

a housing having a contact passageway therein, and

5 a contact arranged in the contact passageway, the contact including a center portion, an upper spring arm and a lower spring arm extending in cantilevered relation from the center portion,

10 an inwardly extending finger arranged at a free end of each of the spring arms wherein the finger on the upper spring arm and the finger on the lower spring arm are in mutual engagement in an overlapping relationship such that when the upper and lower spring arms deflect inwardly toward each other the fingers slide over each
15 other.

2. The electrical connector of claim 1 wherein the spring arms produce a contact force when they are deflected inwardly toward one another and further
20 including a raised bump arranged on one of the spring arms for engaging a mating electrical contact and for focusing the contact force provided by the one spring arm.

25 3. The electrical connector of claim 2 wherein a raised bump is arranged on each of the spring arms.

4. The electrical connector of claim 1 wherein the spring arms diverge from each other as they extend away
30 from the center portion.

5. The electrical connector of claim 4 wherein the spring arms extend to respective apex portions which protrude through respective openings in the contact passageway.

5

6. The electrical connector of claim 1 wherein the contact passageway includes a retention slot and the contact includes a retention member which upon insertion of the contact into the contact passageway deflects and
10 engages a wall of the retention slot so as to retain the contact in the contact passageway.

7. The electrical connector of claim 6 wherein the retention member extends laterally away from the center
15 portion of the contact.

8. The electrical connector of claim 7 wherein the retention member has a C-shaped configuration with upper and lower beams.

20

9. The electrical connector of claim 8 wherein the upper and lower beams of the retention member extend in substantially the same direction as the spring arms.

25 10. The electrical connector of claim 8 wherein the retention slot extends from a surface of the housing to an end wall of the slot.

11. The electrical connector of claim 10 wherein
30 the lower beam engages the end wall of the retention slot

when the contact is fully inserted in the contact passageway.

12. The electrical connector of claim 10 wherein
5 the retention slot has an opening at the surface of the housing which is smaller than the retention member.

13. The electrical connector of claim 6 wherein the retention member digs into the wall of the retention slot
10 when the contact is inserted into the contact passageway.

14. An electrical connector for connection to a device or a second connector comprising:

a housing having a contact passageway therein, the
15 contact passageway including a retention slot, and

a contact arranged in the contact passageway, the contact including a retention member which upon insertion of the contact into the contact passageway deflects and engages a wall of the retention slot so as to retain the
20 contact in the contact passageway.

15. The electrical connector of claim 14 wherein the retention member extends laterally away from the center portion of the contact.

25

16. The electrical connector of claim 15 wherein the retention member has a C-shaped configuration with upper and lower beams.

17. The electrical connector of claim 14 wherein the retention slot extends from a surface of the housing to an end wall of the slot.

5 18. The electrical connector of claim 17 wherein the lower beam engages the end wall of the retention slot when the contact is fully inserted in the contact passageway.

10 19. The electrical connector of claim 17 wherein the retention slot has an opening at the surface of the housing which is smaller than the retention member.

15 20. The electrical connector of claim 14 wherein the retention member digs into the wall of the retention slot when the contact is inserted into the contact passageway.

20 21. An electrical contact comprising:
a center portion,
an upper spring arm and a lower spring arm extending in cantilevered relation from the center portion,
an inwardly extending finger arranged at a free end of each of the spring arms wherein the finger on the
25 upper spring arm and the finger on the lower spring arm are in mutual engagement in an overlapping relationship such that when the upper and lower spring arms deflect inwardly toward each other the fingers slide over each other.

22. The electrical contact of claim 21 wherein the spring arms produce a contact force when they are deflected inwardly toward one another and further including a raised bump arranged on one of the spring arms for engaging a mating electrical contact and for focusing the contact force provided by the one spring arm.

23. The electrical contact of claim 22 wherein a raised bump is arranged on each of the spring arms.

24. The electrical contact of claim 21 wherein the spring arms diverge from each other as they extend away from the center portion.

15

25. The electrical contact of claim 24 wherein the spring arms extend to respective apex portions.

26. The electrical contact of claim 21 wherein the contact includes a retention member for engaging a corresponding slot in a contact passageway.

27. The electrical contact of claim 26 wherein the retention member extends laterally away from the center portion of the contact.

28. The electrical contact of claim 27 wherein the retention member has a C-shaped configuration with upper and lower beams.

30

29. The electrical contact of claim 28 wherein the upper and lower beams of the retention member extend in substantially the same direction as the spring arms.

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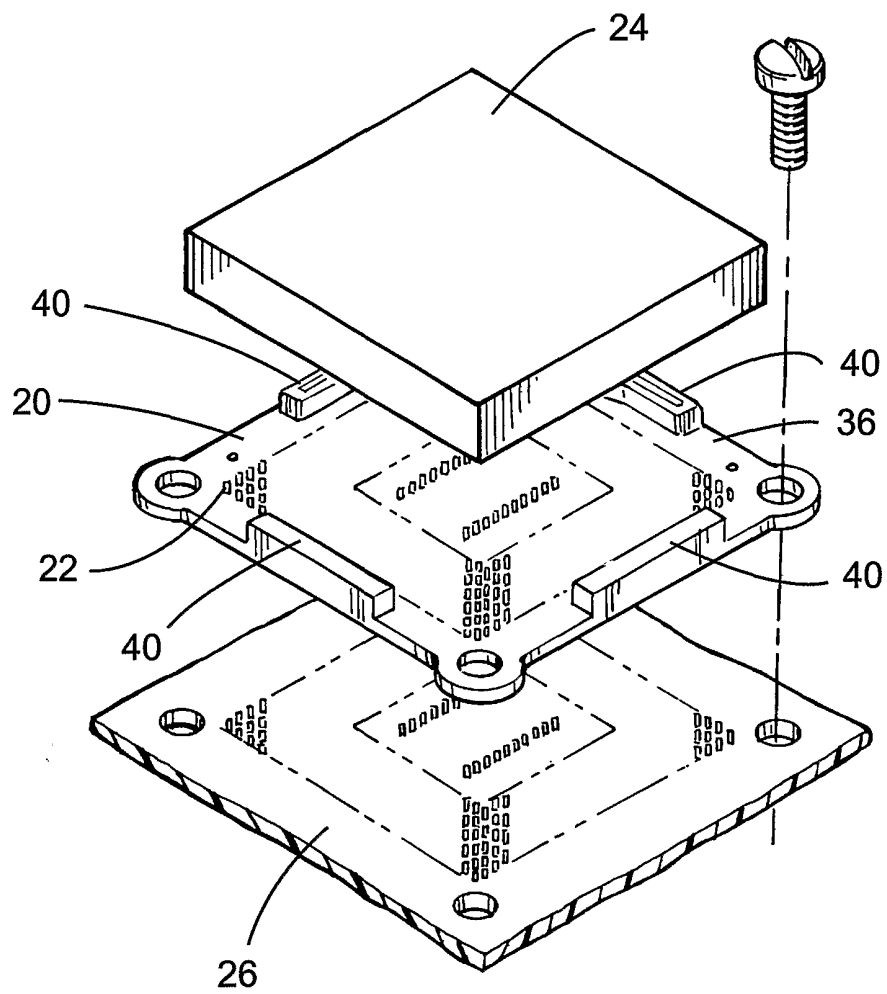


Fig. 1

2 / 4

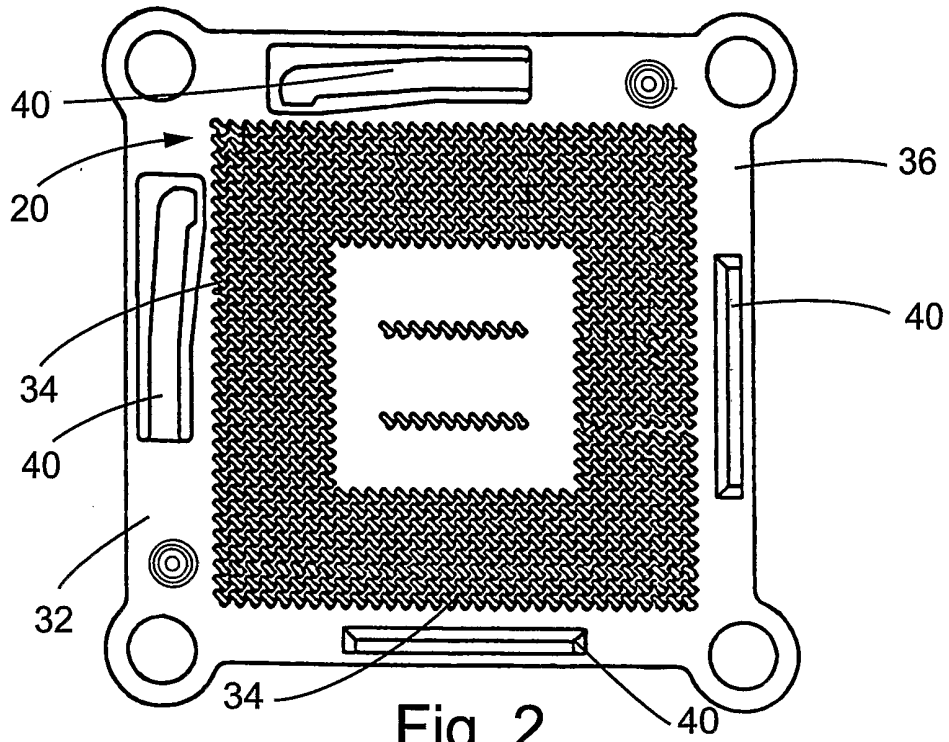


Fig. 2

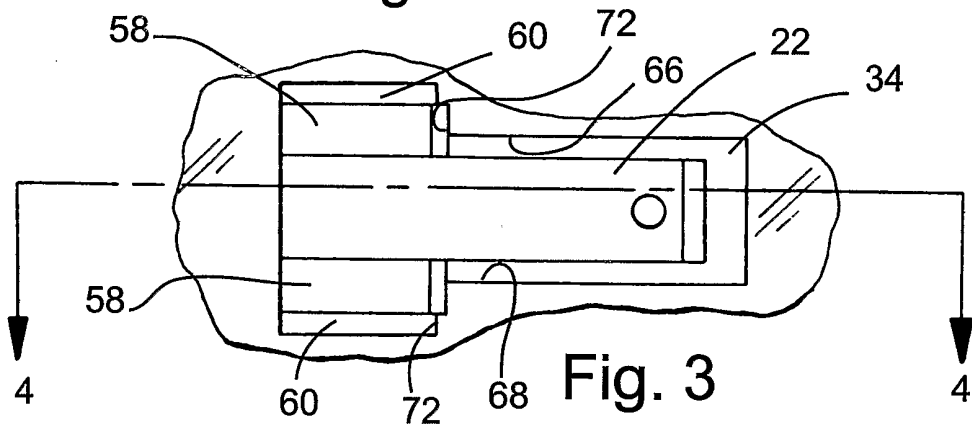


Fig. 3

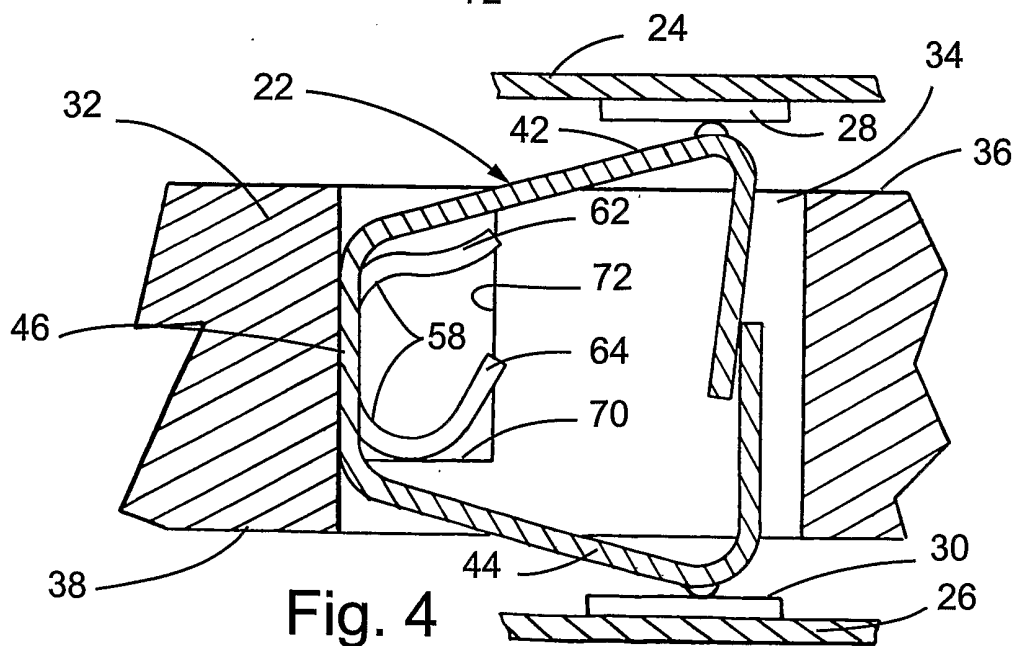


Fig. 4

3 / 4

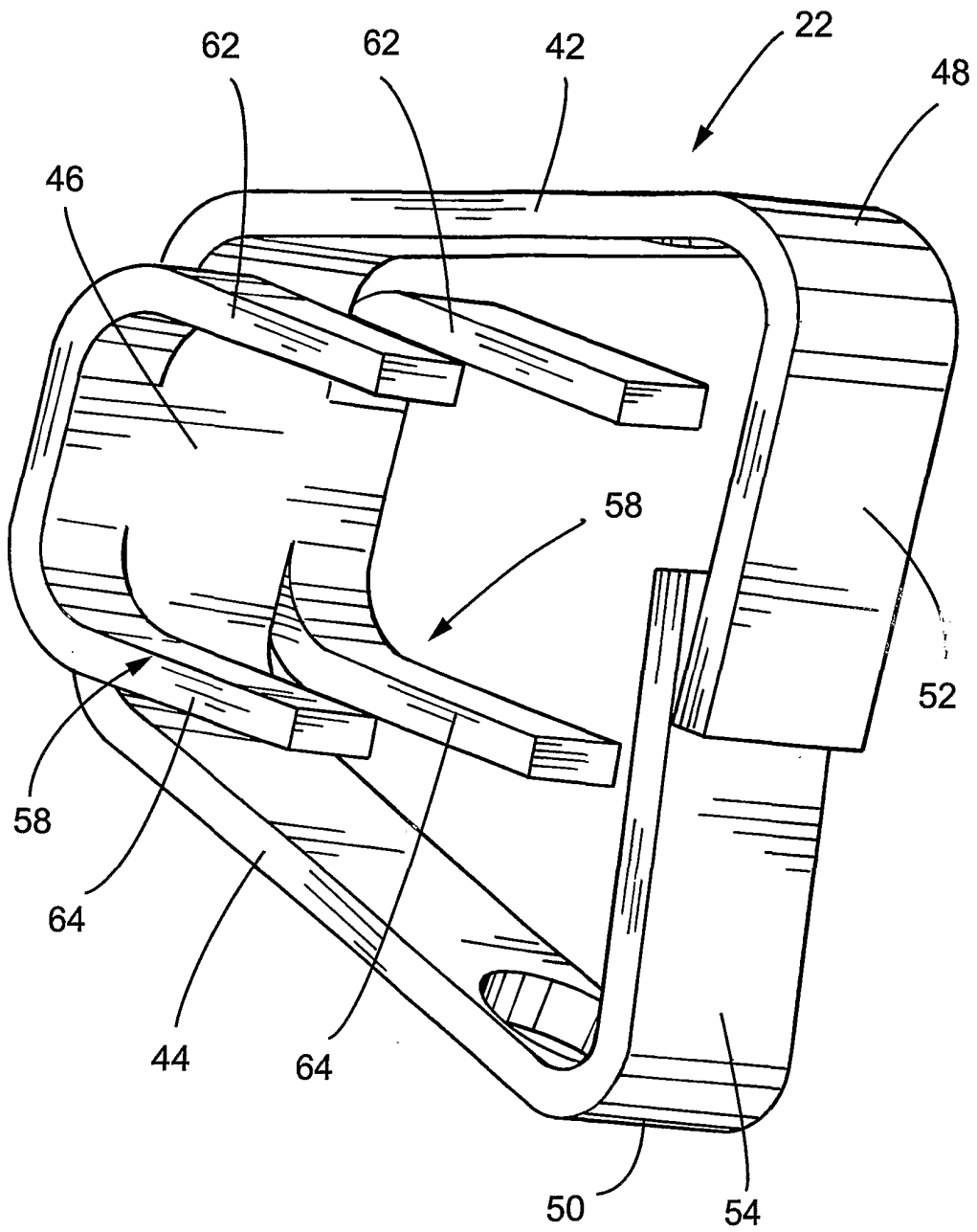


Fig. 5

4 / 4

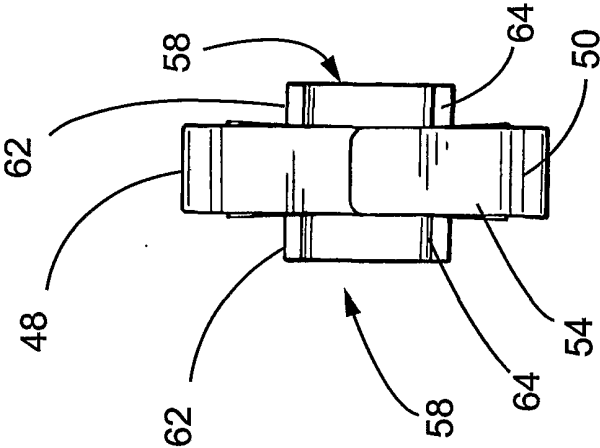


Fig. 8

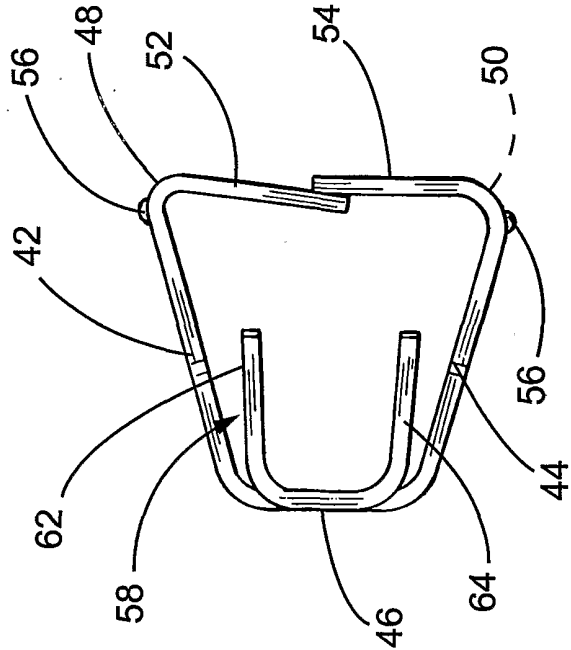


Fig. 6

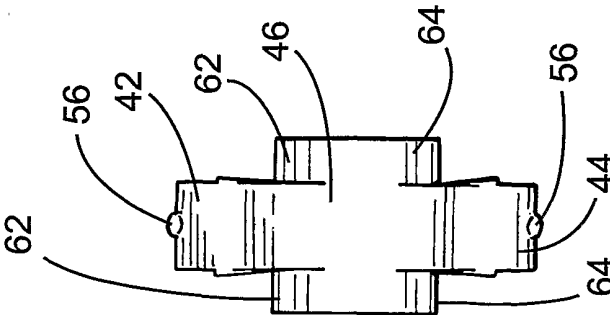


Fig. 7

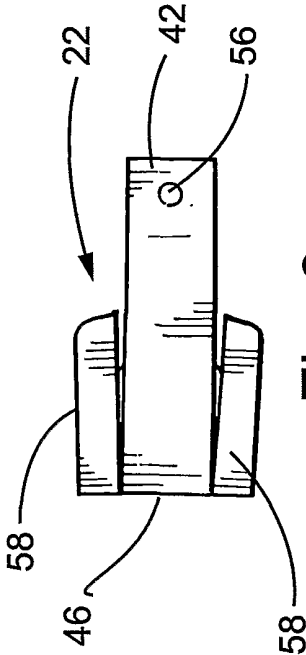


Fig. 9