United States Patent [19]

McCormick

[11] **3,905,669**

[45] **Sept. 16, 1975**

[54] **STRUCTURAL ALIGNMENT PIN AND ELECTRICAL CONNECTOR ASSEMBLY**

[75] Inventor: **Larry L. McCormick,** Los Angeles, Calif.

[73] Assignee: **G & H Technology, Inc.,** Santa Monica, Calif.

[22] Filed: **Dec. 1, 1972**

[21] Appl. No.: **311,303**

[52] **U.S. Cl.** ..... **339/65;** 339/176 M

[51] **Int. Cl.** **H01r 23/16**

[58] **Field of Search** ..... 339/49, 45, 46, 119 R, 339/121, 125 R, 126, 154 R, 156 R, 157 R, 176 R, 176 M, 176 MF, 192 R, 192 RL, 193, 195 M, 196 M, 65, 66

[56] **References Cited**

UNITED STATES PATENTS

2,213,133	8/1940	Brewer	339/65
3,111,355	11/1963	Samburoff et al	339/45 M X
3,566,334	2/1971	Ziegler	339/64 M
3,601,763	8/1971	McNutt	339/65
3,725,849	4/1973	Becke	339/126 J X

FOREIGN PATENTS OR APPLICATIONS

1,320,894	2/1963	France	339/49 R
826,001	12/1951	Germany	339/121

Primary Examiner—James T. McCall
Assistant Examiner—Lawrence J. Staab
Attorney, Agent, or Firm—Dan R. Sadler

[57] **ABSTRACT**

A multi-pin electrical connector is integrated with a structural alignment pin to produce an electro-structural coupling assembly. The assembly is employed for mechanically and structurally aligning and electrically linking a plurality of assemblies with each other.

5 Claims, 4 Drawing Figures

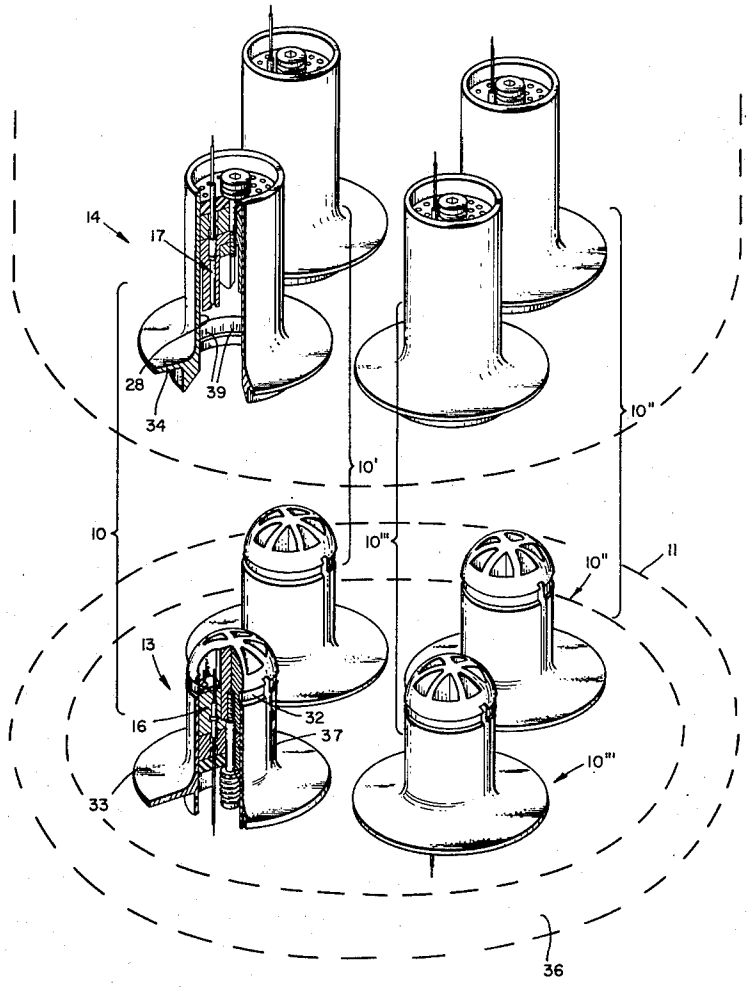


Fig. 1.

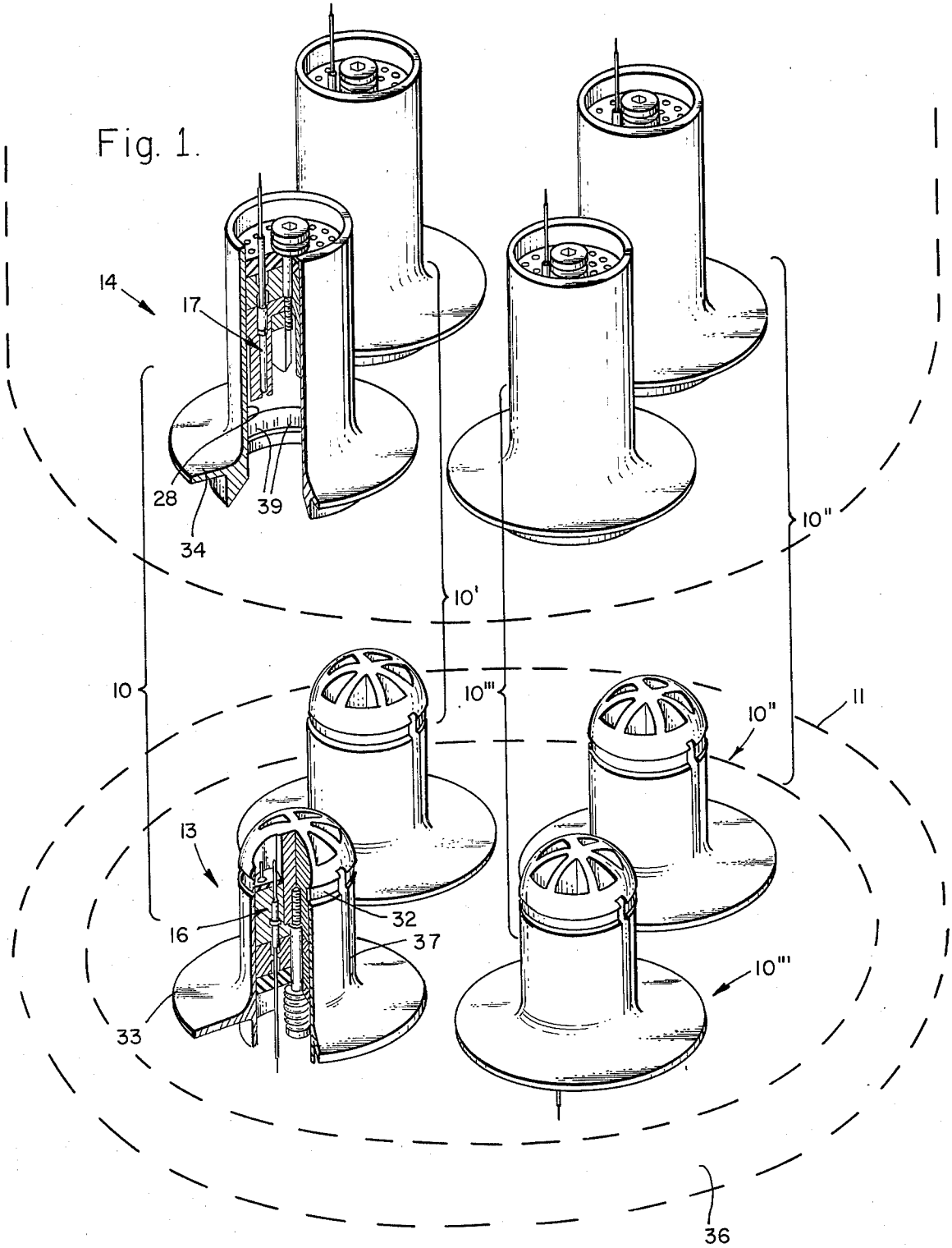


Fig. 4.

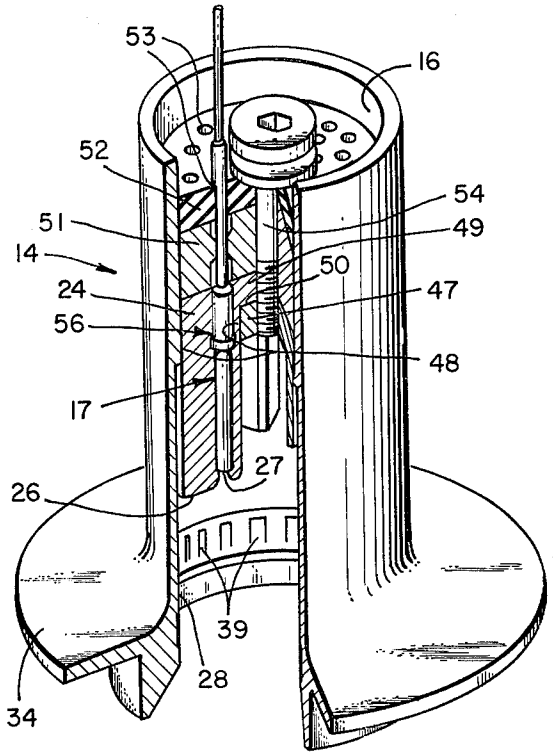
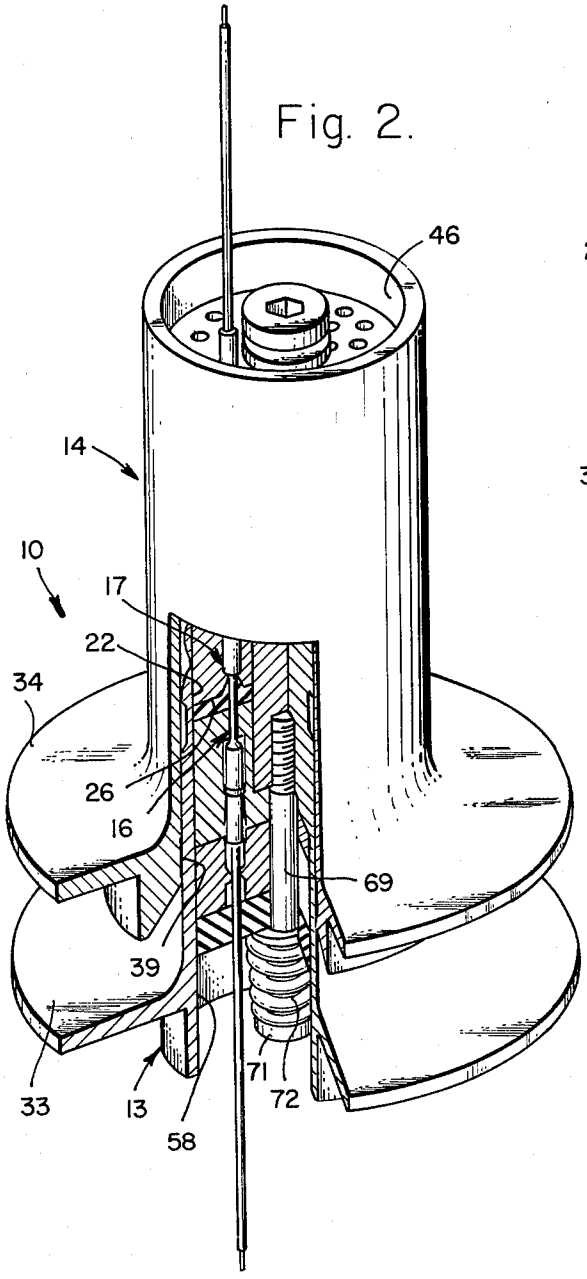


Fig. 2.



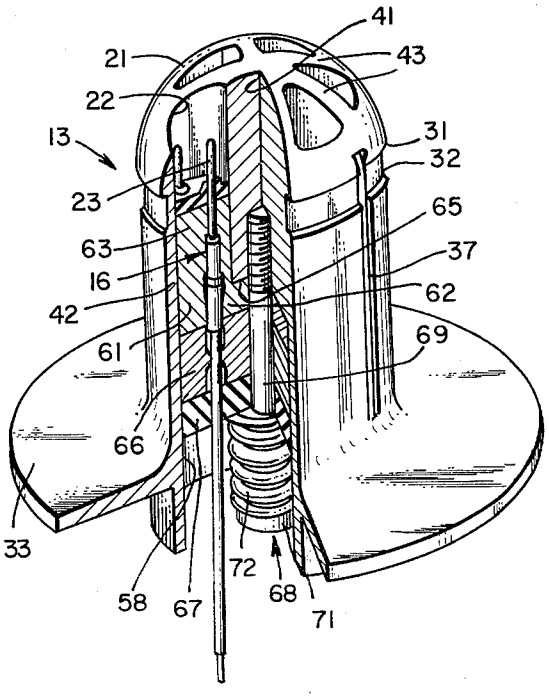


Fig. 3.

STRUCTURAL ALIGNMENT PIN AND ELECTRICAL CONNECTOR ASSEMBLY

BACKGROUND

The present invention relates to electrical connecting and structural aligning devices or assemblies.

In many instances there is a need to both mechanically or structurally align two or more structures and provide electrical signal wiring therebetween. For example, assemblies such as aircraft engines, various types of auxiliary equipment, etc., are frequently mechanically or structurally mounted on a supporting structure whereby they are mechanically readily separatable therefrom for servicing, replacement, etc. When the assembly includes electrical equipment it is also desirable to provide some form of electrical circuitry which can also be readily connected and/or disconnected. This form of electrical connection has usually been provided by some form of readily separable electrical connector.

Heretofore, in order to insure proper mating of the assembly when it is being mounted it has been customary to employ some form of an alignment pin or pins. Such pins are effective to commence engagement even though there may be a substantial amount of initial misalignment. As the assembly advances into the fully mated position the pin guides the assembly into exact alignment.

After the assembly is fully mated the various electrical circuits may be completed by joining the various electrical connectors. This of course requires a separate operation at the time the assembly is mated and at the time it is unmated. In order to avoid this difficulty it has been proposed to provide pairs of electrical connectors which are positioned to mate with each other as the assembly is brought into the mounting position and to separate from each other as the assembly is separated.

Although such an arrangement has been found satisfactory for some purposes it has been found objectionable for many purposes. For example, since the mating electrical contacts must be exposed they are likely to be damaged during handling of the assembly and particularly during the structural mating thereof. One cause of damage is attributed to the lack of the simultaneous alignment or registration between the structural components and the electrical connector components. Since the electrical connectors and particularly the electrical contacts therein are relatively very small and very fragile relative to the large mass of the assembly even a very slight misregistration of connector sections will almost always result in damage, complete destruction and/or failure to electrically mate. Bending of the pin contacts is one common form of damage.

The foregoing type of mating problems are particularly acute when the assembly being mated is a very large bulky and/or heavy structure such as a large aircraft jet engine, the stages of a missile, etc. In addition with structures of this nature the mating is frequently a "blind" operation, i.e., the operator cannot visually observe the mating of the various parts and particularly the electrical contacts. Accordingly adjustments cannot be readily made to avoid any damage. It is only after the mating is completed that a check can be made to determine whether the mating was a successful operation or whether it was a failure.

In addition to the problem of providing physical registration of the electrical contact components in the foregoing environments, the body of the electrical connector must sometimes serve as an environmental seal. For example, when the connector is employed to extend electrical wiring to a jet engine or between missile stages etc., each section of the connector is usually mounted to extend through an exterior wall which is exposed to the environment. Such an arrangement is necessary to permit engagement with a complementary connector section similarly mounted on the other mating structure. Under such circumstance the connector must provide a seal around the electrical contacts to protect the electric wiring from external environmental hazards. The seal must also provide for electrically insulating the various contact terminals. Thus, proper construction of the seal and electrical insulation associated with such connectors is crucial to successful operation.

SUMMARY

The present invention overcomes the foregoing difficulties. More particularly, in the embodiment of the invention disclosed herein a combination, integral structural alignment pin and electrical connector assembly are provided for overcoming the above-mentioned disadvantages associated with prior mechanical alignment and electrical connecting systems. A disengagable coupling assembly is provided including mated structural alignment means which may be mounted on separate assemblies, such as aircraft engines, auxiliary equipment and/or on the various stages of a missile system, etc., for structurally aligning and releasably coupling such assemblies together. Such structural alignment means is embodied in a structural alignment pin and a complementary structural alignment socket which may be individually mounted on the separate structures.

Mated electrical contact means are integrally provided with the structural alignment pin and socket for automatically connecting electrical leads between the structural bodies when coupled. Depending upon the application, a plurality of pin and socket structural alignment means may be employed. Each such means includes a structural pin and socket capable of accommodating a plurality of separate electrical contacts for a multi-wire connection.

The present embodiment provides such electrical contact means in the form of electrical pin and complementary electrical socket terminals. These terminals are arranged within the structural alignment members in a manner which protects the more fragile electrical contacts at all times. The electrical contacts are automatically physically aligned by the structural pin and socket during movement of the structural bodies into and out of coupled alignment. This avoids circumstances which in the past have resulted in damage to the electrical terminals, particularly the contact pins.

Environmental seals together with electrical insulation capable of meeting rigorous specifications are provided in this electrical-structural coupling assembly. The insulator parts are specially formed in the present embodiment of the invention to work with structural alignment members to guide the electrical contacts into proper alignment before they engage.

DRAWINGS

FIG. 1 is a perspective view, partly in section, show-

ing a set of four coupling assemblies in accordance with the present embodiment of the invention for structurally aligning and electrically connecting a pair of missile stages indicated in phantom.

FIG. 2 is an enlarged perspective view, partly in section, illustrating one of the coupling assemblies of FIG. 1, although here shown in an engaged or coupled condition.

FIG. 3 is an enlarged perspective view, partly in section, illustrating the structural pin and associated electrical contact terminals of the assembly shown in FIGS. 1 and 2.

FIG. 4 is an enlarged perspective view, again partly in section, illustrating the complement of the structural pin of FIG. 3, and herein identified as the structural alignment socket and its associated electrical contacts.

DESCRIPTION

The present invention may be embodied in a coupling assembly for structurally aligning and electrically linking two or more structural bodies. Such bodies may be equipped with electrical control wiring adapted to be extended therebetween as electrical control linkage. Primarily, such structures will form components of a larger system and they will be relatively movable into and out of coupling engagement.

The present invention may be utilized with a wide variety of equipment for interconnecting them mechanically and electrically. Although it may be used in connection with aircraft engines, etc., in the present instance the invention is particularly adapted for physically aligning and electrically interconnecting two or more stages of a missile system. A missile system may involve one or more booster or rocket stages connected together for lifting a vehicle stage or satellite into space. The stages must be structurally coupled and aligned with each other while on the launching pad.

The various stages typically include electrical controls, such as sensors, servomechanisms, ignition system, etc. which are operated from a central control point within the missile. This requires the connection of electrical control and power wiring between the various missile stages.

To facilitate the alignment of the missile stages and to provide interstage electrical communication, the coupling assemblies in accordance with the present embodiment each include structural alignment pin and socket members and electrical connector terminals integrally mounted within the structural members. This arrangement is illustrated in the drawings by a plurality of coupling assemblies **10, 10', 10''** and **10'''** mounted as shown in FIG. **1** at abutting axial ends of a pair of missile stages **11** and **12.** Each coupling assembly is provided by a structural alignment pin **13** and a complementary structural alignment socket **14** individually affixed to stages **11** and **12** respectively.

Here a set of four coupling assemblies **10, 10', 10''** and **10'''** are provided. Each assembly includes a structural alignment pin **13** and a complementary structural socket **14.** In some applications a single coupling assembly may be employed such as where no substantial rotational force is applied to the coupling. In this instance, at least 3 assemblies are used to properly align the rocket stages **11** and **12** and prevent relative rotation therebetween.

The coupling assemblies afford smooth, reliable disengagement upon separation of the missile stages during flight. Reliable decoupling in response to stage separation forces, such as provided by rockets, is of course essential to successful operation of the missile.

Integrally incorporated within each of the structural pins and associated sockets of these assemblies are one or more electrical contacts, such as contacts **16** and **17** carried within structural pin **13** and socket **14** respectively. In the present embodiment a plurality of such electrical pin and socket terminals are provided within each coupling assembly. Thus each assembly includes a multi-wire connector for extending the electrical control wires between the coupled rocket stages.

The structural and electrical components of each coupling assembly are constructed to effect structural alignment of the massive missile stages and in so doing automatically physically align the electrical contacts for positive and reliable engagement. In other words, the structural alignment provided by pin **13** and its associated socket **14** serves to guide the electrical components during movement thereof into and out of physical engagement with their counterparts.

With reference to coupling **10,** a rounded head portion **21** of structural alignment pin **13** (FIG. 3) is formed with a plurality of recesses, such as recess **22.** Each of the recesses extends longitudinally or axially inwardly from head portion **21** of the structural pin. One or more electrical contacts, preferably male or pin contact terminals are mounted within each of these recesses. For example pin terminal **16** is mounted within recess **22.**

The electrical contact pins serving as the terminals are protectively mounted within the various recesses and are preferably fully recessed relative to the surrounding surface of head portion **21.** The forward contacting portions, such as portion **23** of pin terminal **16,** extend longitudinally with the body of structural pin **13** so that they may be inserted endwise into similarly longitudinally disposed electrical socket terminals, such as terminal **17,** carried by structural socket **14.**

To provide insultaion for the various electrical terminals and to assist in the guiding of these terminals into registration, structural socket **14** includes an insulating sheath **24** shown in FIG. **4.** Sheath **24** provides a means for both insulating and mounting of each of the electrical socket terminals, such as terminal **17.** It is formed with a plurality of longitudinally extending forward end portions, such as portion **26,** each matingly cooperating with one of the recesses, such as recess **22** of structural pin **13.**

More particularly, the forward end portions of sheath **24** each carry one or more electrical socket terminals lengthwise therein as shown for terminal **17.** These sheath portions are thus matingly removably insertable into the recesses of the structural pin. This disposes the contacting portions of the electrical socket terminals inwardly of the pin **13** recesses for engaging the complementary contacting portions of the recessed pin terminals as shown in FIG. **2.** For example, contacting portion **27** of electrical socket terminal **17** is disposed inwardly of recess **22** for receiving contacting portion **23** of male pin terminal **16.**

Sheath **24** including the plurality of forward end portions, such as portion **26,** is recessed within pin receiving cavity **28** of structural socket **14.** In this manner all of the electrical contact terminals and their supporting insulation are protectively recessed within the structural alignment members.

Moreover, the electrical contacts, such as terminals **16** and **17**, are disposed so that the structural components of the assembly engage first and disengage last upon moving into and out of coupling engagement. This insures that the more fragile electrical pins and sockets are properly aligned before engagement and during disengagement.

The assembly of the missile stages **11** and **12** may entail vertical stacking of the missile sections on the launch pad. For this purpose the massive body of missile stage **12** may be lifted to a position overlying stage **11** and thereupon slowly lowered into place. The set of four coupling assemblies shown here facilitates the structural alignment. The first engagement between the stages will involve the seating of the structural pin head portions, such as portion **21** of pin **13**, within the openings of the structural sockets, such as socket **14**.

A certain amount of forced structural alignment will take place as the structural pins engage and center themselves within the openings to the various socket cavities. However, this structural alignment mode takes place prior to any physical contact between the various electrical contacts. Only after a lower circumferential edge **31** of head portion **21** has fully seated within its associated socket cavity, herein cavity **28**, will there be any engagement of the electrical terminals.

In the present embodiment each of the structural alignment pins is provided with a circumferentially extending recess **32**, sometimes called a "roll-off". This roll-off facilitates the engagement and disengagement of a cylindrical pin having only a slight clearance fit inside a hollow cylindrical body. In effect, rounded head portion **21** of pin **13** may roll or rotate into and out of the cylindrical opening defined by cavity **28** of socket **14**.

Each of the structural pin and socket members of assemblies **10**, **10'**, **10''** and **10'''** may be provided with radially outwardly extending mounting flanges for securing these members to missile stages **11** and **12**. For example, suitable mounting flanges **33** and **34** are shown for structural pin **13** and its associated socket **14** of coupling assembly **10**. The flanges in turn may be fastened to the missile structure by suitable means (not shown) such as by bolts, welding, etc. Generally the pin and socket of the coupling assembly will be mounted in registration with openings formed within the axial end wall of missile stages **11** and **12** through which the lead wires to the various electrical connectors may extend.

In the present embodiment, the structural pin **13** and socket **14** of each of the coupling assemblies do not function to carry any substantial vertical loading. The weight of missile stage **12**, which may be exceedingly heavy, will be substantially if not altogether carried by structural portions of missile stages **11** and **12** other than assemblies **10**, **10'**, **10''** and **10'''**. For example, an upwardly facing annular edge portion **36** of stage **11** may be used to support the weight of stage **12** with the various structural pins and sockets serving to axially align the stages. In other embodiments however, the coupling assemblies may be designed to support axial compression loads as well.

A longitudinally extending keyway **37** may be provided on each of the structural alignment pins for receiving a complmentary key portion (not shown) disposed on an interior wall surface of the cavity **28** of each of the structural sockets. The key and associated keyway **37** may serve to set the angular relationship between the complementary structural and electrical components forming each coupling assembly.

The pin receiving cavity, such as cavity **28**, of each of the structural sockets may be provided with circumferentially disposed inwardly biased spring fingers **39** adjacent the opening to cavity **28**. This increases the frictional holding force between the pin and socket and may be used to take up any play caused by a loose fit therebetween.

As the structural pin and socket must provide an extremely strong mechanical interaction, the provision of the electrical contacts integral with the structural members should not lessen the strength and ruggedness of the structural part. Because of this, the plurality of recesses, such as recess **22**, are symmetrically placed within an intermediate radial region of pin **13**. These recesses thus extend longitudinally of the pin body in this intermediate radial region lying between a solid central region **41** of the pin and a solid outer circumferential region thereof. The solid portions of the pin surrounding the recesses provide a strong structural network including region **41** connected to a solid structural shell **42** by a plurality of radially extending ribs **43**.

In this instance, each of the recesses like recess **22** has a generally triangular cross section narrowing adjacent the solid central region **41** of the pin body and widening adjacent the exterior circumference. Here, each structural pin is formed with six recesses like recess **22**.

Sheath **24** and its plurality of forward end portions, such as portion **26**, is shaped so as to cooperatively mate with these symmetrical recesses. Thus, each socket sheath is here formed with a plurality of six forward end sections or portions, like portion **26** (FIG. **4**). These forward end portions have a generally triangular cross section, each mated to a correspondingly disposed axial recess of the structural pin. As indicated above, the forward end portions of the sheath are constructed to assist in guiding the electrical contacts into registration prior to engagement therebetween.

Additionally, these elongated triangular cross-section portions of sheath **24** serve to enter and completely fill the free space regions defined by the recesses and surrounding the contacting portions of the electrical pin terminals. This function is illustrated in FIG. **2** in which a forward end portion **26** of sheath **24** has been fully inserted within recess **22** so as to seat against an insulating member supporting pin terminal **16** within the structural pin recess. The entire region surrounding the contacting portions **23** and **27** of terminals **16** and **17** is thus filled with an insulating material having a suitably selected dielectric constant. Among other things, this will prevent arcing between adjacent contact terminals, when, as in the case of the present embodiment, two or more electrical contacts are disposed within one recess **22**. Also, electrical breakdown between the contacts and the adjacent walls of the structural members is inhibited.

To retain sheath **24** within structural socket **14**, the socket may be provided with an open axial end **46** at the rear of the socket. A radially extending interior wall section **47** separates open end **46** from cavity **28**. Wall section **47** may be formed with a plurality of triangular shaped openings, such as opening **48** symmetrically spaced about the central axis of the body through which the triangular cross-section forward end portions

of sheath 24 may extend. A rear annular base portion 49 of sheath 24 may fit against a rear surface 50 of wall 47.

To the rear of annular base portion 49, a body of yieldable insulating material may be provided with suitable electrical lead openings formed therein. Finally, a rear pressure plate 52 of relatively rigid material is provided. Pressure plate 52 is provided with a plurality of lead through openings 53. To retain these various structures in place, an axially extending bolt or screw 54 extends through central openings provided in pressure plate 52, insulator body 51, and base 49 of sheath 24 and is threadedly engaged within an axial bore provided in wall 47.

Screw 54 may be employed to apply compressive pressure against insulator body 51 by forcing pressure plate 52 forward of the assembly so as to cause the insulating material of body 51 to crowd around and seal the electrical leads and contacts extending therethrough.

Each of the electrical socket terminals, such as terminal 17, may be retained within sheath 24 by suitable means. Here, a known type of spring biased retention finger assembly 56 is employed for this purpose. Briefly, assembly 56 provides spring biased retention fingers releasably locking on a rearwardly facing shoulder of the electrical terminal.

For structural alignment pin 13, the electrical contact terminals are retained therein in the following manner. An open axial end 58 is provided adjacent the rear of structural pin 13. Each of the longitudinally extending recesses, such as recess 22, is extended inwardly of the pin body so as to communicate with open end 58 as illustrated in FIG. 3.

An insulator structure 61 is provided for insertion into the open axial end 58 of structural pin 13 for retaining the various electrical pin terminals therein. For this purpose insulator structure 61 includes an annular base portion 62 and a plurality of longitudinally and forwardly extending triangular cross-section portions. For example one of these portions is shown as matingly seated within recess 22 of the structural pin. Annular base portion 62 of structure 61 may abut against a rearwardly facing axial wall surface 65 defined by the axial extent of open end 58.

A yieldable electrical insulating body 66 having suitable electrical lead through openings therein may be compressed between a rear pressure plate 67, having similar openings, and the back of insulator structure 61 by a spring bias assembly 68.

Assembly 68 may be provided by an axially extending bolt or screw 69 passing through suitable central openings in rear pressure plate 67, body 66 and structure 61 and threadedly engaged within an axial bore of the solid central region 41 of pin 13. Mounted in compression between a rear surface of pressure plate 67 and a head 71 of screw 69 is a coiled spring 72.

In this manner spring 72 is arranged to provide spring bias means continuously urging insulator means provided by body 66 and insulator structure 61 forwardly and toward the head of structural pin 13. Thus spring 72 may function to subject the yieldable material of insulator body 66 to a constant compressive force.

In addition, and if desired, spring bias assembly 68 may serve to accommodate some axial overrun in the mating of the structural and electrical components. This overrun is provided in the following manner. With reference to FIG. 2 the forward end portions 26 and 63 respectively of structural socket 14 and structural pin 13 may abut before the structural bodies become fully coupled. In the environment of the missile system as shown in FIG. 1, the relative axial coupling is limited primarily by abutment of the actual missile stage structures with one another.

The portions 26 and 63 of the coupling assemblies may however engage before abutment of the structures on which the coupling assemblies are mounted. Accordingly, the electrical contact terminals and their surrounding insulation may become fully engaged and coupled before the axial limit of the structural coupling is attained. In other words, the electrical components may overrun one another before the axial coupling motion is stopped by engagement of the structural bodies, such as the missile stages. The arrangement of insulator structure 61 within structural pin 13 and the provision of spring bias assembly 68 accommodates this overrun.

If forward end portions 26 and 63 respectively of the socket and pin structures engage prior to reaching the axial coupling limit, the insulation means formed by structure 61, body 66 and plate 67 are forced rearwardly of the pin body against the biasing force of assembly 68. This allows the contact terminals, such as terminals 16 and 17, and the surrounding insulation provided by portions 26 and 63 to remain firmly and positively engaged at all times. In the event of an overrun the rearward axial movement afforded by the spring bias assembly 68 prevents any damage to the electrical or insulating parts.

Although the present embodiment of the coupling assembly has been described in conjunction with a multi-stage missile system, it is apparent that it may be employed in other environments. For example, the coupling assembly may be employed to facilitate the mounting and removal of aircraft engines. The massive aircraft engine must of course be structurally aligned with the aircraft frame. Electrical communication between the control center of the aircarft and sensors and other electrically operated devices on the engine is devisable if not essential. It will be appreciated that the present coupling assembly is well suited for structurally aligning the engine with respect to the aircraft frame and connecting electrical leads to and from the engine.

In general, the electrical and structural coupling disclosed herein may be employed for structurally aligning any two or more structural bodies in which electrical signal communication therebetween is required.

Since numerous changes can be made in the above described embodiment of the invention and other embodiments can be realized without departing from the scope of the invention, it is intended that the foregoing descriptive material and accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

I claim:

1. A coupling including:

a structural alignment socket,

a structural alignment pin matingly removably insertable in said socket,

said structural pin having a recess extending axially inwardly of a forward end thereof,

an electrical contact pin mounted within said structural pin recess and extending longitudinally therewith,

a sheath means mounted within said structural socket and having a forward end extending longitudinally

therewith matingly removably insertable into said structural pin recess, and

an electrical contact socket carried longitudinally within said sheath member and matingly receiving said contact pin, whereby a combined structural alignment and electrical connection is achieved,

said structural pin having a forward axial end in the shape of a hemisphere for easy entry into said structural socket, said structural pin having a plurality of said recesses extending inwardly of said head and symmetrically spaced about the center thereof, at least one said electrical contact pin mounted in each of said recesses, said sheath means having a plurality of said forward ends symmetrically spaced about the axis of said socket and matingly removably insertable within separate said recesses, at least one said electrical socket longitudinally carried within each of said forward ends of said sheath means for matingly receiving said electrical pins.

2. The coupling of claim **1,** wherein said pin recesses and mated forward ends of said sheath means are generally triangular shaped in cross section.

3. The coupling of claim **1,** said structural pin having an open axial end at the rear thereof communicating with said recesses, electrical pin insulator means disposed in said open axial end for retaining said electrical pins in said recesses and for passing electrical wire leads thereto, said structural socket having an open axial end at the rear thereof communicating with said sheath means for passing electrical wire leads to said electrical sockets therein.

4. The coupling of claim **3,** said electrical pin insulator means having forwardly extending portions extending into said recesses, and spring bias means continuously urging said insulator means forwardly of said structural pin.

5. The coupling of claim **4,** said insulator means including a pressure plate, and said spring bias means including a screw threadedly engaged with an axially aligned bore in said structural pin and a spring disposed on said screw so as to urge said pressure plate means forwardly in said structural pin.

* * * * *