Jan. 6, 1970 R. C. STEPHENSON ET AL 3,488,623

SELF-ALIGNING CONNECTOR

Filed May 18, 1967 2 Sheets-Sheet 1

Fig. 2.

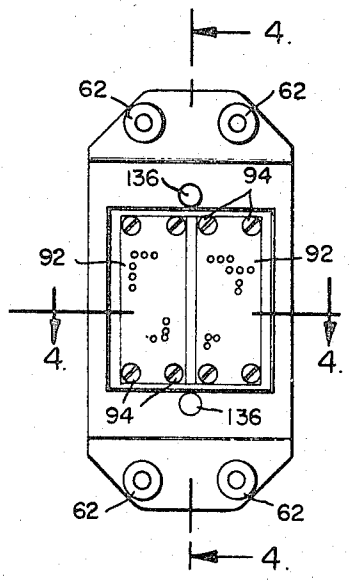
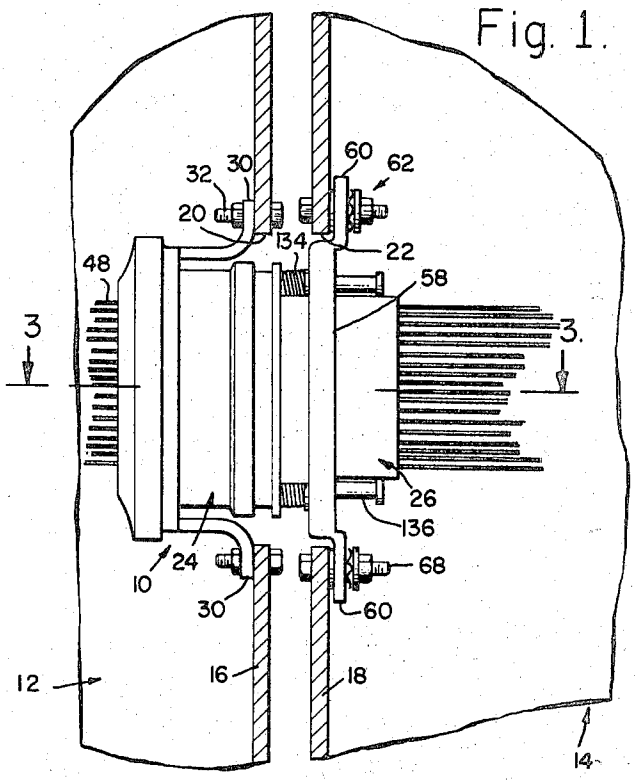


Fig. 1.



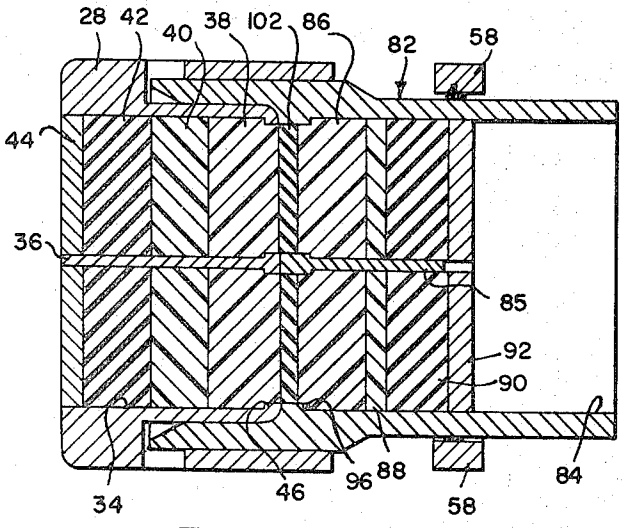


Fig. 3.

Roger C. Stephenson
Jack D. Stiller,
INVENTOR.
BY.

ATTORNEY.

Jan. 6, 1970 R. C. STEPHENSON ET AL 3,488,623

SELF-ALIGNING CONNECTOR

Filed May 18, 1967 2 Sheets-Sheet 2

Fig. 4.

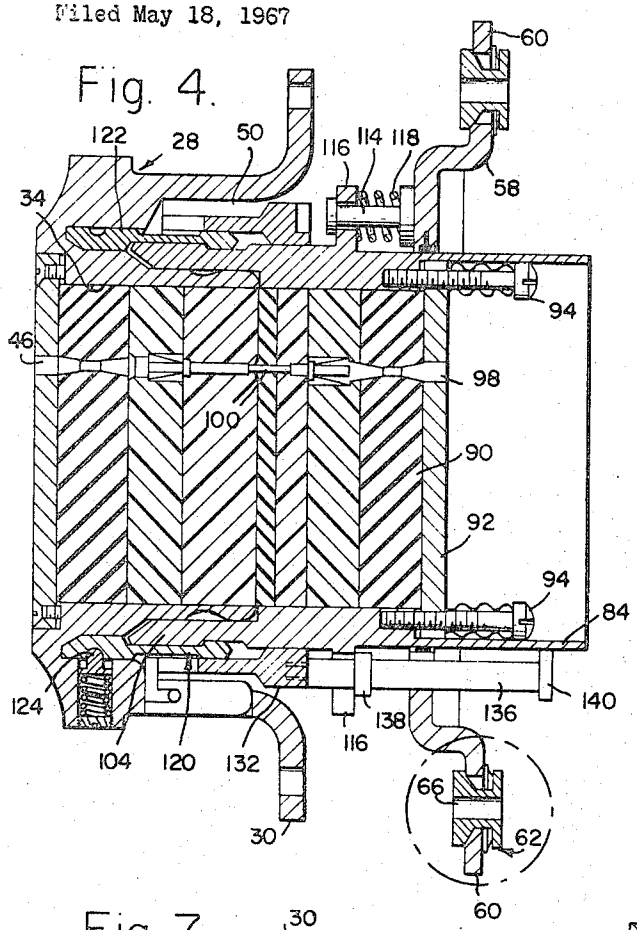


Fig. 5.

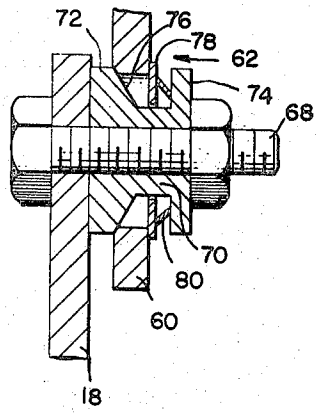


Fig. 7.

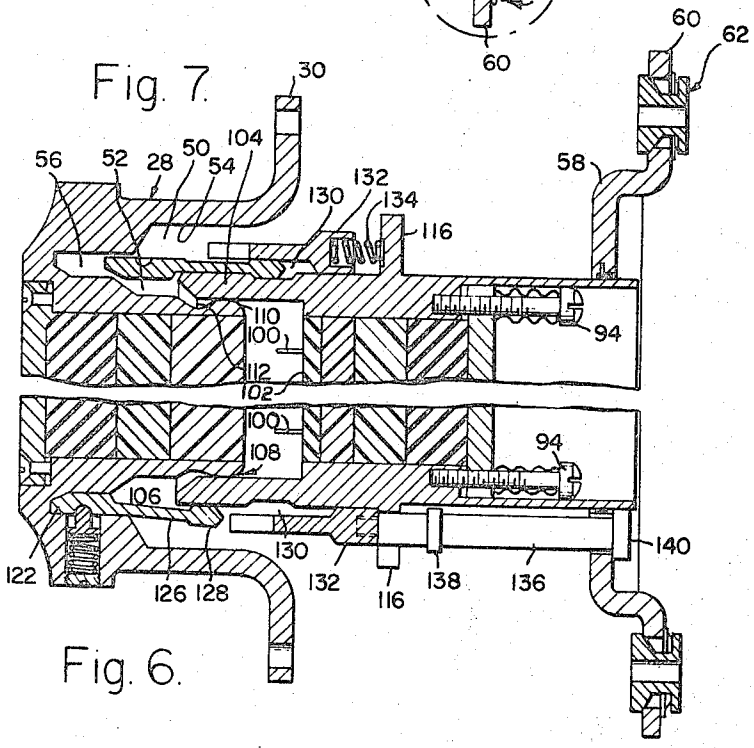


Fig. 6.

United States Patent Office 3,488,623 Patented Jan. 6, 1970

3,488,623

SELF-ALIGNING CONNECTOR

Roger C. Stephenson, Van Nuys, and Jack D. Stiller, Santa Monica, Calif., assignors to Gray & Huleguard, Santa Monica, Calif., a corporation of California

Filed May 18, 1967, Ser. No. 639,551
Int. Cl. H01r 21/28
U.S. Cl. 339—64 7 Claims

ABSTRACT OF THE DISCLOSURE

The present invention relates to so-called umbilical connector assemblies for temporarily interconnecting a large number of electrical circuits on one structure with a large number of electrical circuits on another structure. The assembly includes separable connectors which are mounted on the structures so as to mate when the structures are joined together and to separate when the structures separate. At least one of the connectors includes a floating alignment that allows the connector to move on its supporting structure. As a consequence even though the two structures are misaligned the two connectors can be mated and separated without any material interference. Moreover, in the event the two structures move relative to each other while the connectors are mated, the connector assembly will not be mechanically damaged and the electrical interconnection will not be disrupted.

Background of the invention

Under some circumstances a connector assembly may be utilized for temporarily interconnecting a large number of electrical circuits at one location with a large number of circuits at an another location. For example, it may be desirable to interconnect the "on-board" circuitry carried by vehicles such as aircraft, ships, missiles, etc. with various ground based support equipment, such as power supplies, controls, etc. as long as the vehicle remains stationary. When the vehicle moves the "on-board" equipment becomes self-contained and is disconnected from the support equipment. A large number of so-called umbilical connectors have been provided for such purposes. However, in order to withstand the severe environments sometimes encountered by the vehicles, the connectors must be of a precision nature having closely fitting parts to insure adequate sealing, mating etc. As a consequence connectors of this type must be precisely aligned at the time they are joined together and/or are separated from each other. When one of the connectors in the assembly is merely mounted on the end of a flexible cable there is no particular problem in maintaining the assembly properly aligned.

However, under some circumstances it is necessary for both parts of the connector assembly to be mounted on fairly large rigid structures connected to each other in a predetermined relation. For example, the connector assembly may be provided between two stages of a missile for interconnecting the circuitry in the two stages. If the two stages are always maintained precisely aligned and positioned relative to each other no particular difficulties are experienced in mating or separating the two parts of the assembly nor in maintaining the two parts properly electrically connected. However, as a practical matter it has been found that when two relatively large structures, such as the stages of a missile are joined, a certain amount of misalignment is inherent as a result of mispositioning, variations in size, thermal expansion, etc. Very frequently this is of sufficient magnitude to cause a material interference with efficient operation of the connector assembly. It has also been found very frequently vibrations occur and adjacent portions of the

two structures move relative to each other over a sufficient range to materially interfere with the electrical connections in the connector. It will thus be seen connector assemblies of the umbilical type available heretofore have not been entirely suitable for all types of operations and particularly when the separable portions of the assembly are mounted on relatively large structures which cannot be mated in precise axial alignment.

The present invention provides means for overcoming the foregoing difficulties. More particularly, the present invention provides a connector assembly especially useful on large structures which may be connected together and/or separated. The assembly includes a floating alignment whereby all portions of the assembly will be maintained properly aligned with each other irrespective of the misalignment of the supporting structures and/or vibratory movement therebetween.

In the single embodiment of the invention disclosed herein this is accomplished by providing a connector assembly having two separable parts such as a plug and a receptacle. The plug and the receptacle include housings which contain sets of contacts and are arranged to mate with each other whereby all of the contacts in the two sets are properly electrically interconnected. At least one of the housing is supported by a mounting means which allows the housing to "float" on the supporting structure whereby a predetermined amount of movement may occur between the supporting structure without interfering with the mated connectors. In addition detent means are provided which insure the connectors in the assembly being locked together and will not release during the normal amount of movement between the two structures but will reliably release when the two structures are separated from each other.

These and other features and advantages of the present invention will become readily apparent from the following detailed description of a single embodiment thereof, particularly when taken in connection with the accompanying drawings wherein like reference numerals refer to like parts and wherein;

FIGURE 1 is a fragmentary cross sectional view of a pair of structures having a connector assembly, which includes one form of the present invention mounted thereon;

FIGURE 2 is an end view of the connector assembly of FIGURE 1;

FIGURE 3 is a cross sectional view of the connector assembly taken substantially along the plane of line **3—3** in FIGURE 2;

FIGURE 4 is a cross sectional view taken at substantially right angles of FIGURE 3 and substantially along the plane of **4—4** of FIGURE 2;

FIGURE 5 is a cross sectional view, on a greatly enlarged scale, of one portion of a mounting means;

FIGURE 6 is a fragmentary cross sectional view of the connector assembly during a normal separation thereof, and

FIGURE 7 is a fragmentary cross sectional view, similar to FIGURE 6, showing the separation of the connector assembly during an abnormal separation.

Description of the preferred embodiment

Referring to the drawings in more detail the present invention is particularly adapted to be embodied in a connector assembly **10** for temporarily interconnecting a large number of electrical circuits in a first location with a large number of electrical circuits in another location. For example, the connector assembly **10** may be used for interconnecting the "on-board" circuitry of an aircraft, ship, rocket, etc. with ground based support equipment, such as control circuits, power supplies, etc.

However, the present connector assembly **10** has been found especially useful for joining the circuits on two large structures which may be adjacent to or connected to each other particularly when they may be separated. By way of example, the present connector assembly has been particularly useful for interconnecting the circuits in one stage **12** of a rocket with the circuits in another stage **14** of the rocket. Each of the structures includes a bulkhead **16** and **18**. When the two structures are mated the two bulkheads **16** and **18** are substantially parallel to each other and separated by some predetermined distance. The assembly **10** is disposed in openings **20** and **22** through the bulkheads which are aligned with each other when the structures are mated.

It can be appreciated when two large structures, such as the stages **12** and **14** of a rocket, are mated it is extremely difficult if not impossible for all portions of the structures to be accurately aligned with each other. For example, certain tolerances are necessary when manufacturing the structures, a certain amount of limited mispositioning and misalignment of the structures inherently occurs when they are joined. It has also been found that under some circumstances the shape and/or size of one or both structures may change as a result of changes in temperature, etc. Very frequently during operation various portions of either or both structures may be subjected to vibrations of considerable magnitude.

As a result the amount of spacing between the two bulkheads **16** and **18** and their parallelism may vary. In addition the alignment of the two openings **20** and **22** may vary. In order to prevent this interfering with the operation of the connector assembly **10** a floating alignment is provided to accommodate this movement.

The connector assembly **10** includes a first connector or plug **24** adapted to be mounted on one of the structures **12** and a second connector or receptacle **26** adapted to be mounted on another structure **14**. The plug **24** is mounted on the bulkhead **16** so as to be disposed in the opening **20** whereby its front or face is exposed therethrough. The connector **26** is mounted on the other bulkhead **18** so as to be disposed in the other opening **22** whereby its front or face is exposed therethrough.

The plug **24** includes a housing **28** having a mounting flange **30** which extends across the top and bottom. This flange **30** is secured to the inside of the bulkhead **16** by any suitable means, such as bolts **32**. Although the present housing **28** has a generally square or rectangular configuration it should be noted it may have any other shape, such as circular. The housing **28** includes a passage **34** which extends completely therethrough. Although this passage **34** may be of any desired configuration, in the present instance it is substantially rectangular. A partition **36** may be provided to divide the passage **34** into two separate parts.

Each part of the passage **34** includes dielectric front inserts **38**, back inserts **40**, grommet seals **42** and compression plates **44**. The front of the insert **38** rests on an internal flange **46** whereby it cannot come out of the passage **34**. By tightening the compression plate **44** all of the members will be tightly compressed together and sealed against moisture.

A plurality of electrical contacts **46** are provided in the inserts **38** and **40**. (For purposes of simplification only one is shown in FIGURE 4.) In the present instance the contacts **46** are of the so-called socket variety. The sockets **46** are accessible through openings in the face of the insert **38**. A plurality of electrical conductors **48** extend from the rear of the connector through the compression plate **44** and form a bundle or harness. These conductors **48** are interconnected with the various portions of the electrical circuit contained within the structure.

A clearance pocket **50** is provided in the front of the housing **28** for receiving the various portions of the second connector **26**. The pocket **50** includes an enlarged section formed by a pair of surfaces **52** and **54** generally parallel to the surface of the passage **34** and a restricted section **56**. The surface **52** and passage **34** form a core **106**.

The receptacle connector **26** includes a mounting plate **58** having brackets **60** which extend along the inside of the bulkhead **18**. The brackets **60** may be formed so as to position the main portion of the plate **58** in substantial alignment with the bulkhead **18**.

The brackets **60** are secured to the bulkhead **18** by any suitable means. In the present instance a lost motion mounting connector **62** is provided which, as best seen in FIGURE 5, includes an eyelet **64** having a passage **66** extending therethrough. A bolt **68** extends through this passage **66** and secures the eyelet **64** to the bulkhead **18**. The eyelet **64** includes a reduced diameter center section **70** and two enlarged ends **72** and **74**. One end is joined to the center section by a tapered or conical surface **76** which rides on the bracket **60** on the end of the mounting plate **58**.

A flat washer **78** and a conical or spring washer **80** are provided between the second enlarged end **74** of the eyelet **64** and the backside of the bracket **60**. By tightening the nut, conical washer **80** will be compressed and the bracket **60** firmly clamped against bulkhead **18**. However, it will be possible for the bracket **60** to move upon the bulkhead **18**. First of all the mounting plate **58** can move away from the bulkhead **18** by compressing the conical washer **80**. In addition the bracket **60** can move parallel to the bulkhead **18** by moving relative to the reduced center section **70**. Since there are a plurality of lost motion connectors **62**, four in the present instance, the mounting plate **58** can move around within the opening **22** and angularly with respect to the plane of the bulkhead **18**.

A receptacle housing **82** is provided upon the mounting plate **58** for movement therewith. The receptacle housing **82** has the same general rectangular configuration as the plug housing **24** and it includes a rectangular passage **84** which extends axially therethrough. This passage **84** has the same dimensions as the passage **34** in the plug housing **28** and it is divided into two separate portions by a partition **85**.

Front inserts **86**, rear inserts **88**, grommet seals **90** and a compression plate **92** are provided in both portions of the passage. A plurality of spring biased screws **94** are provided for forcing the compression plate **92** against the seal **90** whereby the inserts **86** and **88** are clamped in position against the flange **96**. A plurality of contacts **98** are provided in the inserts **86** and **88** for mating with the contacts **46** in the first set. These contacts **98** have a pin **100** which project beyond the front insert so as to extend into the inserts **38** and sockets **46**. In addition an interface seal **102** may be provided on the front insert **86** for being compressed between the front inserts **38** and **86**. In the event the seal **86** is compressed excessively the inserts **86** and **88** can move back against the spring screws **94** and reduce the pressure to an adequate level for sealing.

The housing **82** includes an extension **104** on the front end thereof. The portion of the passage **84** within the extension **104** is enlarged whereby the extension **104** can fit into clearance pocket **50** and slide along the surface **52** of the core **106**. In order to insure a smooth and easy mating of the extension **104** upon the core **106**, guide means **108** are provided for aligning the receptacle housing **82** with the plug housing **28**. By way of example the inner end of the extension **104** is beveled or tapered. Thus, during mating, the receptacle housing **82** and the mounting plate **58** will be moved into alignment. In addition guide means of the type disclosed and claimed in co-pending application Ser. No. 385,108 may be employed.

Such a guide means includes a rounded off nose or end surface **110** and a recessed clearance space **112**. When the extension **104** initially engages the core **106** of the plug housing **28** it will be forced into substantially axial alignment. However, if there is initially some misalign-

ment the end of the extension **104** can pass through the clearance space **112** formed by the recess. The rounded end surface **110** cannot bind or jamb in the enlarged portion of passage **84** even though the extension **104** is substantially out of alignment with the core **106**. After the end of the extension **104** has passed over the clearance recess **112** a sufficient amount of the extension is disposed on the core **106** to insure axial alignment and prevent any binding regardless of any initial misalignment.

The pins **100** in the receptacle **26** are so positioned that they will not mate with the socket contacts **46** until after the end of the extension **104** has passed over the clearance space **112** whereby the plug **24** and receptacle **26** are aligned. This will insure a proper and precise mating of the pins and sockets.

The receptacle housing **82** may be mounted on the mounting plate **58** by any suitable means. However, in the present instance a plurality of retainer pins **114** are mounted on the flange **116** and retained in position by means of override springs **118**. The pins **114** include enlarged heads that are effective to engage the mounting plate **58**. Normally the receptacle housing **82** is free to slide through the mounting plate **58**. However, when the two structures are brought too close together and the receptacle housing is forced backwardly through the plate, the enlarged ends of the pins **118** engage the plate **58** and the housing **82** rides against the override springs **118**. As the springs **118** are compressed they absorb the over travel without imposing any undue forces upon either of the housings **28** or **84** or any other portions of the connector assembly **10**.

When the two structures are joined it is desirable for the mated connectors **24** and **26** to be firmly locked together by means of a latch mechanism **120**. As can be seen in FIGURE 1 there is very little clearance space between the two bulkheads **16** and **18** and the connector assembly **10** is relatively inaccessible from the outside. Accordingly, the latch mechanism **120** must be self operating both as to its locking and unlocking.

In the present instance the latch mechanism includes a collet **122** which fits into the restricted section **56** at the bottom of the pocket **50** in the plug housing. This collet **122** is firmly secured in position by means of one or more spring biased detents **124**. Normally the collet **122** is retained in this position. However, in the event of any unusually large forces the collet **122** can be torn loose from the spring detents **124** and removed from its position.

The collet **122** includes one or more resilient spring fingers **126** which are effective to extend over the outside of the extension **104**. The ends of the fingers **126** include enlargements **128** adapted to drop into an annular channel **130** on the outside of the extension **12** when the receptacle housing **82** is in the fully mated position and the electrical contacts **46** and **98** are fully joined. The ends of the fingers and the extension **104** may be chamfered or beveled whereby the fingers **126** will spread apart when the extension **104** is traveling along the core **106**.

A release sleeve **132** is slideably disposed on the outside of the extension **104**. A plurality of springs **134** are provided between the radial flange **116** and the sleeve **132** so as to bias the release sleeve **132** toward the extended or locked position. When the sleeve **132** is in the extended or locked position it will fit over the enlargements **128** on the ends of the spring fingers **126** and maintain them compressed into the channel **130**. Thus, as long as the release sleeve **134** is fully extended the housing **82** will be locked to the collet **122**.

When the two connectors **24** and **28** are being mated and the fingers **126** are moving inwardly along the outside of the extension **104** they will engage the end of the release sleeve **132** and force it back on the housing **82** until such time as the ends of the fingers drop into the channel **130**.

A plurality of release shafts **136** are slideably disposed in the radial flange **116** and the mounting plate **58**. The ends of the shafts **136** are secured to the released sleeve **132**. A pair of spaced enlargements **138** and **140** are provided on the opposite sides of the mounting plate **58**. This limits the outward travel of the sleeve **132** to the lock position. It also allows the receptacle housing **82** to move a predetermined distance relative to the mounting plate **58** without effecting the position of the release shaft **136**. However, if the mounting plate **58** retreats a sufficient distance it will engage the enlarged end of the shaft **136** whereby the release sleeve **132** will commence moving with the plate **58**. The sleeve **132** is then withdrawn from the locked position and the fingers **126** are released from the channel **130** whereby the receptacle can separate from the plug.

In order to utilize the present connector assembly the two structures **12** and **14** are brought together in a generally axially direction, i.e. the two bulkheads **16** and **18** are parallel. The initial engagement between the plug **24** and receptacle **26** occurs when the beveled end of the extension **104** contacts the rounded end **110** of the plug housing **28**. As the extension **104** rides over the rounded end **110** and is guided onto the surface the receptacle housing **82** is brought into axial alignment with the plug housing **28**. During this aligning phase the housing **82** may move on the mounting plate **58** and/or the mounting plate **58** may move on the bulkhead **18**. By the time the end of the extension **104** has traveled beyond the clearance recess **112** and begins sliding on the outer surface **52** of the core **106**, the two housings **28** and **82** and the contacts **46** and **98** are precisely aligned. Accordingly the electrical contacts can come into complete engagement without any damage from binding, bending etc.

At some point in the mating operation the beveled end of the extension **104** will engage the beveled ends of the fingers **126** and force them outwardly whereby they ride along the extension **104**. The ends of the fingers **126** then engage the release sleeve **132** and force it back against its springs **134** until the enlargements **128** drop into the channel **130**. The release sleeve **132** will then travel over the fingers **126** and lock the receptacle **26** to the plug **24**. In the event the two structures **12** and **14** continue to advance together after the connectors are fully mated any over travel of the connectors is accommodated by the override springs **118** between the flange **116** and the mounting plate **58**. Also, if the seal **102** is too highly compressed the inserts and grommet seal are all shifted back against the spring screws **94**.

Once the connectors are fully locked together the electrical contacts **46** and **98** are maintained fully and uniformly mated whereby there are no discontinuities in any of the electrical circuits. In the event any further movement occur between the two bulkheads **16** and **18**, for example as a result of thermal expansions, shifting of the structures and/or vibrations, the relative movement will be accommodated by the mounting plate **58** shifting. on the bulkhead **18** and/or the flange **116** moving against the override springs, and/or the receptacle housing **82** working back and forth through the opening in the plate **58**.

When the two structures are separated they move axially away from each other. During the initial phase of the separation the receptacle housing **82** remains locked to the plug housing **28**. The mounting plate **58** retreats along the housing **82** and the release shafts **136**. After the separation has progressed beyond the initial stage, i.e. in excess of any normal mated movement, the plate **58** engages the enlarged heads **140** of the released shaft **136**. Further travel causes the release shafts **136** to move with the mounting plate **58** and the release sleeve **132** is withdrawn from around the fingers **126**. Eventually the sleeve **132** comes into engagement with the flange **116**. At this point the receptacle housing **82** is released from the plug housing **28** substantially as shown in FIGURE 6. Accordingly it will be carried with structure **14**.

If for any reason the foregoing sequence of events does not occur and the release sleeve **132** is not removed from the fingers **126**, the plug housing **82** remains locked to the plug housing **28**. Continued separation causes a substantial force to be imposed on the collet **122**. Eventually this causes the collet **122** to overcome the force of the spring detents **124** whereby the collet **122** will be carried free of the plug housing **28** substantially as shown in FIGURE 7.

While only a single embodiment of the present invention has been disclosed and described herein, it will be readily apparent to persons skilled in the art that numerous changes and modifications may be made thereto. For example, the arrangement of the various lost motion connections and the manner in which they function may be modified to fit any particular application. Also, the various latching mechanisms and their function may be modified to satisfy the requirements of any particular installation. Accordingly the foregoing drawings and description thereof are for illustrative purposes only and do not in any way limit the scope of the invention.

We claim:

1. A connector adapted to be mounted on a first structure for mating with a second connector on a second structure said connector including the combination of:

a mounting member,

fastening means for securing said member on said first structure, said fastening means being effective to allow said mounting member to move with respect to the first structure,

a housing adapted to mate with the second connector,

means securing said housing on said mounting member whereby said housing is free to move relative to said mounting member whereby said housing may remain mated with the second connector even though the first and second structures move relative to each other, and

a set of electrical contacts in the housing adapted to mate with a set of complimentary contacts in the second connector.

2. The connector of claim **1** wherein:

the contacts in one of said sets are pins and the contacts in the other set are sockets whereby said contacts must be joined and separated by traveling in straight lines parallel to the axis of the connectors, and

guide means on said housing effective to mate with the second connector and move the housing and mounting member into alignment with the second connector whereby the housing is free to travel only in a straight line before the contacts in said sets join.

3. The connector of claim **1** including:

latch means on said housing for engaging complimentary latch means on said second connector, said latch means being effective to engage and become locked together when forced together whereby said housing is secured to said second connector when said connectors are mated,

first lost motion means effective to allow said structures to move toward each other after said housing is mated with the first connector and said latch means are locked together,

second lost motion means disposed between said housing and the latch means thereon, said second lost motion means being effective to allow said structures to separate a predetermined distance without effecting said latch means, said second lost motion means being effective to actuate and release said latch means when the structures separate beyond said predetermined distance whereby said housing is released from the first connector.

4. The connector of claim **1** including:

a recess on said housing, said recess being adapted to receive a plurality of spring fingers when said connector mates with the first connector,

a keeper on said housing moveable between a first position effective to fit over said fingers and retain them in said recess and a second position wherein said fingers are released from said recess,

lost motion means coupled between said keeper and said housing, said lost motion means being effective to allow said keeper to normally remain in said first position while said structures are within a predetermined distance of each other, said lost motion means being effective to move said keeper into the second position when said structures separate beyond said predetermined distance.

5. The connector of claim **4** wherein:

the contacts in one of said sets are pins and the contacts in the other set are sockets whereby said contacts must be joined and separated by traveling in straight lines parallel to the axis of the connectors,

guide means on said housing effective to engage coacting guide means on the second connector when said connectors are mating, said guide means being effective to move said housing relative to said first structure to align said housing with the second connector before the contacts in said sets join whereby the housing can only travel in a straight line when said contacts are being joined and separated.

6. An electrical connector assembly for use on a pair of juxtaposed structures, said assembly including the combination of:

a plug,

mounting means for securing said plug to one of said structures,

a set of electrical contacts in said plug,

a receptacle for mating with said plug,

first guide means on said receptacle and second guide means on said plug,

mounting means for securing said receptacle to the other of said structures,

a second set of electrical contacts in said receptacle, the contacts in said second set being effective to mate with the contacts in said first set when said plug and said receptacle are mated,

said guide means and said contacts being positioned so that the extensions extend across said clearance space when the contacts in said sets are separated,

latch means effective to lock said plug and receptacles together when they are mated, and

lost motion means, coupled to said latch means, said lost motion means being effective to allow said structures to move a predetermined distance without releasing said latch means, said lost motion means being effective to release said latch means whenever said structures move more than a predetermined distance relative to each other.

7. An electrical connector assembly including the combination of:

a first connector for being mounted on a first structure,

a first set of electrical contacts in said first connector, and a guide means,

a second connector for being mounted on a second structure,

a second set of electrical contacts in said second connector for electrically engaging the contacts in the first set, the contacts in one of said sets comprising sockets and the other said sets comprising pins which must be joined with and separated from the sockets by traveling in a straight line parallel to the axis of the connectors,

mounting means for mounting said second connector to the second structure whereby said second connector is free to move relative to the second structure, said mounting means including a mounting member, means for securing said mounting member in a first structure, said means being effective to allow the mounting member to move relative to the structure in a plane parallel thereto and to move oblique to

said plane, and means for securing said second connector on said mounting means for moving normal to the plane,

guide means in said second connector for co-acting with the first guide means on the first connector when the first and second connectors are being mated, said mounting means enabling the second connector to move on said second structure when said guide means is aligning the second connector with the first connector, and said guide means moving said second means on the mounting means to align the pins in the first set with the sockets of the second set and insuring the second connector traveling only in a straight line before the contacts in said set join, and

latch means on said connector for securing said connector together, said latch means including a recess of one of said connectors, a plurality of spring fingers effective to fit into said recess for securing said connectors together, a keeper on the other of said connectors movable between a first position effective to fit over said fingers and retain them in a recess and

a second position to release said fingers, and lost motion means on said connector coupled to said keeper to allow said connector to move on said mounting means without moving said keeper into the second position.

References Cited

UNITED STATES PATENTS

2,289,541	7/1942	Mastney et al.	248—20
2,871,457	1/1959	Jencks et al.	339—75
3,094,364	6/1963	Lingg	339—64
3,152,850	10/1964	Nava et al.	339—89

FOREIGN PATENTS

184,354	8/1922	Great Britain.

RICHARD E. MOORE, Primary Examiner

RICHARD H. McGLYNN, Assistant Examiner

U.S. Cl. X.R.

339—91, 132