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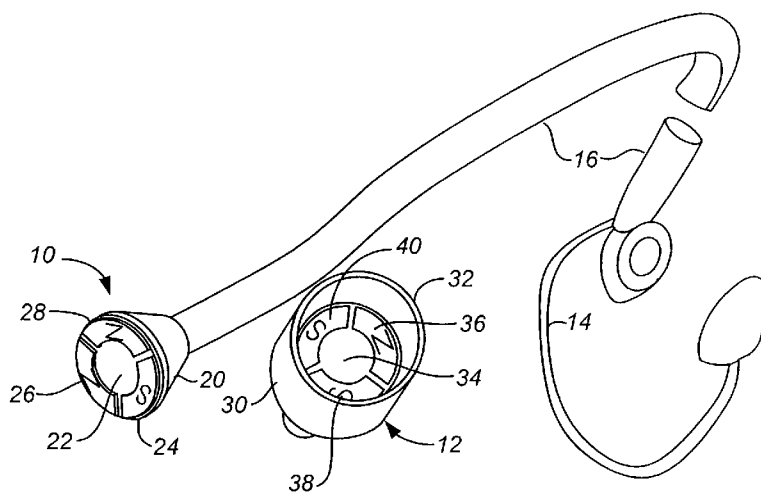
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(57) Abstract: A signal carrying plug and a signal carrying receptacle form a magnetic signal carrying connector are provided wherein electrical terminals of the source and electrical contacts of the load are held against one another by at least one magnet affixed adjacent the source terminals confronting and attracted to magnetically interactive object affixed adjacent the load contacts, and wherein the at least one magnet is disposed within a recess to protect against projection of unwanted magnetic fields and to mate with a complementary structure to provide positive alignment and registration of the terminals and contacts. The force of the magnet is sufficient to hold the load contacts in place for operation but insufficient to provoke damage to the connector plug or attached receptacle and any attached structures, such as cabling, if the connector is pulled apart. the magnets serve as signal carrying terminals.

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## MAGNETICALLY RETAINED ELECTRICAL CONNECTOR

### CROSS-REFERENCES TO RELATED APPLICATIONS

[0001] The present application claims benefit under 35 USC 119(e) of U.S. provisional Application No. 60/745,805, filed on April 27, 2006, entitled "Magnetically Retained Electrical Connector," the content of which is included herein.

### STATEMENT AS TO RIGHTS TO INVENTIONS MADE UNDER FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

[0002] NOT APPLICABLE

### REFERENCE TO A "SEQUENCE LISTING," A TABLE, OR A COMPUTER PROGRAM LISTING APPENDIX SUBMITTED ON A COMPACT DISK.

[0003] NOT APPLICABLE

### BACKGROUND OF THE INVENTION

[0004] This invention relates to electrical connectors, particularly audio headset connectors with retention means and electrical connection means typically used for audio headset connectors.

[0005] A typical mechanism for electrically connecting headphones to audio devices is accomplished through the use of a multi-conductor cable with a small phone plug on the end that inserts into a mating receptacle or phone jack. This arrangement suffers several problems.

[0006] 1. As the contacts inside the receptacle are cycled numerous times, they can become worn and less flexible resulting in poor connections or no connections at all.

[0007] 2. Because the plug is held in the receptacle through friction, repeated cycling of the plug into and out of the receptacle causes wear thereby reducing the retention force exerted by friction.

[0008] 3. If the cable attached to the plug is pulled in a direction that is not collinear with the longitudinal axis of the plug such that excessive strain is placed on the cable, the non-

collinear strain can damage the cable, the plug and the receptacle. The electrical conductors of the cable can be broken or become intermittent. Thus, the headphones will not work consistently. The plug can be damaged as it is bent such that when it is again inserted into a receptacle, its various conductive elements might not adequately contact counterpart elements in the receptacle. The tip of the plug is sometimes broken off and may remain in the receptacle such that it impedes the insertion of another plug. The broken tip may also cause short circuits amongst the conductive elements inside the receptacle.

**[0009]** What is needed is a connector that is not subject to the above-listed problems.

**[0010]** Magnetically held connectors are known for certain applications, such as power. A magnetic plug is used in a power supply connector for some models of personal computers, wherein a magnetic ring surrounds a set of at least four spring-loaded nonmagnetic electrical terminals on the power-receiving unit. Examples are found in certain current models of Apple laptop computers. A patent on power connection owned by Apple is U.S. Pat. No. 5,455,467, which involves inductive power coupling.

**[0011]** Other known magnetic electrical connectors are described in the patent literature including U.S. Pat. No. 2,903,667 for a light bulb, and U.S. Pat. No. 6,039,591 for a locking electrical connector.

#### BRIEF SUMMARY OF THE INVENTION

**[0012]** According to the invention, a signal carrying plug and a signal carrying receptacle form a magnetic signal carrying connector are provided wherein electrical terminals of the source and electrical contacts of the load are held against one another by at least one magnet affixed adjacent the source terminals confronting and attracted to magnetically interactive object affixed adjacent the load contacts, and wherein the at least one magnet is disposed within a recess to protect against projection of unwanted magnetic fields and to mate with a complementary structure to provide positive alignment and registration of the terminals and contacts. The force of the magnet is sufficient to hold the load contacts in place for operation but insufficient to provoke damage to the connector plug or attached receptacle and any attached structures, such as cabling, if the connector is pulled apart. the magnets serve as signal carrying terminals.

**[0013]** In a specific embodiment, the magnetically attractive structure is a ferrous plate. In another specific embodiment, the magnetically interactive structure of the plug is a magnet of

attractive polarity to the at least one magnet of the complementary receptacle. In a further specific embodiment, a plurality of magnets are provided of both the load and on the source, and the magnets are polarized to both attract and provide reliable electrical registration of the connector. Other embodiments include adapters and the like specifically targeted for applications in armrests of aircraft.

[0014] One of the clear advantages of a connector according to the invention is that it supplants or replaces friction forces and locking mechanisms with forces generated by magnetic fields allowing breakaway detachment without damage to structures.

[0015] These and other advantages will be evident to those of skill in the art upon reference to the following detailed description and accompanying drawings.

#### BRIEF DESCRIPTION OF THE DRAWINGS

[0016] Fig. 1 is an illustration of a first plug and receptacle combination for an earphone.

[0017] Fig. 2 is an illustration of a second plug for an earphone receptacle of the invention.

[0018] Fig. 3 is an illustration of a third receptacle combination for receiving a plug for an earphone.

[0019] Fig. 4 is a top view of a receptacle according to the invention.

[0020] Fig. 5 is an illustration of an adapter with a magnetic plug and a phone receptacle.

[0021] Fig. 6 is an illustration of first adapter with a phone plug and a magnetic receptacle.

[0022] Fig. 7 is an illustration of second adapter with a phone plug and a magnetic receptacle.

[0023] Fig. 8 is an illustration of an air rest as might be employed in an airliner with a magnetic receptacle according to the invention.

[0024] Fig. 9 is a further illustration according to the invention.

[0025] Fig. 10 is a further illustration according to the invention.

[0026] Fig. 11 is a further illustration according to the invention.

[0027] Fig. 12 is a further illustration according to the invention.

[0028] Fig. 13 is a further illustration according to the invention.

- [0029] Fig. 14 is a further illustration according to the invention.
- [0030] Fig. 15 is a further illustration according to the invention.
- [0031] Fig. 16 is a further illustration according to the invention.
- [0032] Fig. 17 is a further illustration according to the invention.
- [0033] Fig. 18 is a further illustration according to the invention.
- [0034] Fig. 19 is a further illustration according to the invention.
- [0035] Fig. 20 is a further illustration according to the invention.
- [0036] Fig. 21 is a further illustration according to the invention.
- [0037] Fig. 22 is a further illustration according to the invention.

#### DETAILED DESCRIPTION OF THE INVENTION

[0038] Fig. 1 is an illustration of a first plug 10 and receptacle 12 combination according to the invention for an earphone 14. The earphone could be an ear bud as shown or a headset, connected by a cord 16 to the plug 10. The plug 10 includes a rigid housing 20 with a contact surface 22 having conductive terminals 24, 26, 28 arranged along a circumference. The conductive terminals are for carrying audio level electrical signals to the earphone 14, typically two stereo signals and a common serving as a ground. The terminal 24 is selected to be a permanent magnet having an exposed south polarity face, and the terminals 26 and 28 are arranged on either side of terminal 24 and each have a north polarity face. The plug 10 mates with the receptacle 12, and the receptacle 12 includes a rigid housing 30 preferably with a collar 32 forming a recess for a contact surface 34 having conductive terminals 36, 38, 40 arranged along a circumference.

[0039] The conductive terminals are for audio level electrical signals from a remote audio amplifier (not shown) to the earphone 14 through the terminals, typically two stereo signals and a common serving as a ground. The terminal 36 is selected to be a permanent magnet having an exposed north polarity face, and the terminals 38 and 40 are arranged on either side of terminal 36 and each have a north polarity face. The terminals 24 and 36 mate and attract one another. Similarly the terminals 26 and 38 mate, and the terminals 28 and 40 mate, all attractive to one another with sufficient force to hold them in reliable electrical contact but

with less force than would cause damage to the cord 16 if the plug and receptacle were pulled apart, either intentionally or accidentally. Three terminals 36, 38 and 40 serve as an inherently stable contact platform. Where more than three terminals are needed, it is prudent to provide a mechanism to assure positive contact with all terminals. While this is not necessary for a three-terminal connector, such a positive contact mechanism can also be employed. A suitable positive contact mechanism is a spring-loaded base for each contact in the housing 30. Springs add longitudinal flexibility. An alternative is a magnet made of rubberized magnetic material. These optional features apply to all terminal configurations hereinafter described. The collar 32 serves to keep the plug and the receptacle axially aligned with one another, but the magnetic terminals inherently orient with one another due to magnetic forces to align with the correct mating terminal.

**[0040]** Referring to Fig. 2, a plug 100 is illustrated. In this embodiment, the electrical contacts 124, 126, 128 are preferably of ferrous material, i.e., non-magnetic but magnetically attractable. Hence, the contacts are not of gold, silver, copper or brass per se but include steel or an iron alloy, possibly having an anticorrosion coating. The connector housing 120 is keyed for example with a tab 122 or a bevel selected to mate with a corresponding eccentric recess 123 of a receptacle 112 (Fig. 3). Thus the contacts 124, 126, 128 are aligned mechanically with the terminals 136, 138, 140. The terminals 136, 138, 140 are preferably all magnetic, although one magnet may be sufficient, and such a magnet need not be a normally electrically conductive terminal, so long as it serves to bring terminals in reliable electrical coupling with mating contacts. For example, in Figure 3, the face 134 may be a fixed magnet, and the terminals 136, 138, 140 may be conventional gold contact terminals, optionally spring loaded, as described above. The advantage of non-magnetic contacts of Figure 2 is the assurance that magnets will not interfere with magnetically sensitive devices, such as pacemakers, credit cards and other ferrous-containing objects. The advantage of non-ferrous materials in general is that they can be made to be oxidation and corrosion resistant.

**[0041]** The magnets and terminals of Figure 3 are conveniently within the protective recess 123 so that they are maintained at a safe distance from magnetically sensitive objects. The receptacle 112 is a structure particularly suited for mounting on an armrest 150 of an aircraft (Fig. 8). This structure is a convenient add-on to an existing receptacle in an aircraft armrest (Fig. 8), as it includes a conventional stereo phone plug 139 on its underside that plugs into a conventional chassis mount phone receptacle, as illustrated in Fig. 8. Alternatively, a magnetic receptacle 212 (Fig. 4) can be built into an aircraft armrest to receive

complementary plugs of the type shown in Fig. 2. The recess 123 may be surrounded by a raised flange that mates with an existing opening in the armrest. In addition to the magnetic terminals 136, 138, 140, the center of the mounting face 134 may be provisioned with a conventional phone receptacle 137 also connected to the terminals so that the receptacle 212 is backwards-compatible with conventional and user-supplied headsets (not shown).

**[0042]** Fig. 5 illustrates another design of an adapter 152 constructed in accordance with the invention. At one end is a magnetic plug 100 with non-magnetic contacts and an eccentric key 121, as in Fig. 2. The adapter 152 has an elbow 154 and a neck 156, and at the opposing end a conventional stereo receptacle 158 connected to the terminals 124, 126, 128 for receiving a conventional phone plug (not shown).

**[0043]** Fig. 6 illustrates a still further embodiment of an adapter 252 wherein the body is designed for near-flush mounting on a plurality of surfaces, such as an armrest, and has on one side a magnetic receptacle having the same features as in Fig. 3 with an eccentric recess 123 forming a keyway, and at the other side a conventional phone receptacle as in Fig. 5. An audio plug 239 of any design or other connection known in the art is connected internally to the magnetic receptacle 312 and the conventional receptacle 158.

**[0044]** Fig. 7 illustrates yet another design of an adapter 352 constructed in accordance with the invention wherein the body is designed for near-flush mounting on a surfaces, such as an armrest and with the same features as in Fig. 3 with an eccentric recess 123 forming a keyway. The adapter includes two conventional phone plugs 338, 340 matching the type of phone receptacles found in selected aircraft armrests. It is also of a form factor designed for near flush mounting on an armrest.

**[0045]** The following is the text of the provisional application upon which the foregoing disclosure is based.

**[0046]** This invention improves upon the retention means and electrical connection means typically used for electrical connectors. It supplants or replaces friction forces and locking mechanisms with forces generated by magnetic fields.

**[0047]** A typical method for electrically connecting headphones to audio devices is accomplished through the use of a multi-conductor cable with a plug on the end that inserts into a mating receptacle. This arrangement suffers several problems.

1. As the contacts inside the receptacle are cycled numerous times, they can become worn and less flexible resulting in poor connections or no connections at all.
2. The plug is held in the receptacle through friction. Repeated cycling of the plug into and out of the receptacle causes wear thereby reducing the retention force exerted by friction.
3. If the cable attached to the plug is pulled in a direction that is not collinear with the longitudinal axis of the plug, excessive strain is placed on the cable, the plug and the receptacle with the potential result that the non-collinear strain can damage the cable, the plug and the receptacle. The electrical conductors of the cable can become broken and in many instances intermittent such that the headphones will work at some times and not work at others. The plug can become bent such that when it is again inserted into a receptacle, its various conductive elements might not adequately contact their counterpart elements in the receptacle. The tip of the plug is sometimes broken off and remains in the receptacle such that it impedes the introduction of a new plug and/or the broken tip can cause short circuits amongst the conductive elements inside the receptacle.

**[0048]** This invention eliminates these problems through the use of magnetic forces to augment and/or supplant friction forces and locking mechanisms. Magnetic forces are also employed to establish and maintain electrical circuits through the attractive and repellant forces of groups of magnets. There are several embodiments of the invention but in general the invention makes use of magnetic forces as means for mating and retaining plugs with receptacles as well as completing the individual electrical circuits of the plugs and receptacles. The magnetism may be permanent in nature or created electrically.

**[0049]** Some of the examples provided in this specification make reference to a standard 3.5 mm (millimeter) phone plug-receptacle combination to show how the invention can be used. The invention is not limited to connector styles similar to 3.5 mm phone plugs and receptacles but can be incorporated with or used to replace virtually any type of electrical connector.

**[0050]** Figure 9 shows an audio headphone arrangement with a cable and a 3.5 mm plug for connection to a 3.5 mm receptacle. This is a standard arrangement used by millions of users of portable audio devices.

[0051] In Figure 10, the upper portion depicts the components of a conventional 3.5 mm phone plug and receptacle connector arrangement. The lower portion of the drawing depicts one possible embodiment of the invention while pointing out the respective replacements for the plug and receptacle elements.

[0052] In this embodiment, six magnets are used to retain the plug to the receptacle. Three magnets are incorporated into the plug and three magnets are incorporated into the receptacle. One of the three magnets in the plug is electrically connected to the "Sleeve" circuit, one is connected to the "Ring" circuit and one is connected to the "Tip" circuit of the cable. In the receptacle, respective electrical connections are made between the magnets and the Sleeve, Ring and Tip circuits of the receptacle and in such positions so as to mate with their circuit counterparts in the plug.

[0053] The magnets in the plug and receptacle are arranged in complimentary north-south orientations such that the pairs of magnets attract each other when the three magnets of the plug come into close proximity with the three magnets of the receptacle. It should be noted that two of the magnets in the plug have their N (North) poles facing out of the page and one of the magnets in the plug has its S (South) pole facing out of the page with the inverse being true for the receptacle. This staggering of magnetic polarities provides an indexing means for the connector. The attractive force provides retention for the connector halves and the physical contact between the three magnet pairs completes the electrical circuits for Sleeve, Ring and Tip.

[0054] The magnets may be overlaid with or attached to electrically conductive elements or the magnets may be coated or plated with substances such as gold and copper to ensure electrical conductivity and to reduce corrosion.

[0055] Figure 11 shows the plug and receptacle described in the previous text and drawing in a mated position. The magnet pairs have attracted each other thereby retaining the plug to the receptacle and also simultaneously completing the three circuits of Sleeve, Ring and Tip. It can be seen with this embodiment of the invention that there is no longer a clear distinction of which half of a connector is a plug and which half of a connector is a receptacle in so far as neither half is inserted into the other half. Alternative nomenclature may be required to differentiate between the connector halves such as "hot" half and "cold" half or "source" half and "sink" half.

[0056] Multiple embodiments and variations of the invention can be realized by using different items and different configurations of items. The example above shows the use of six permanent magnets to facilitate retention of the connector halves and to complete the three electrical circuits. The number of circuits could be reduced to one or increased to an larger number.

[0057] Some or all of the permanent magnets could be replaced by electromagnets. There could be a combination of permanent or electromagnets. The electromagnets could be controlled to produce polarity either in a north-south orientation, reversed to a south-north orientation or controlled to be magnetically neutral. Some of the magnets could be replaced by non-magnetized electrically conductive materials. Some magnets might provide retention forces only without acting as components of a circuit.

[0058] The invention can be realized with a variety of different components including but not limited to:

- Permanent magnets
- Electromagnets
- Non-magnetized magnetic elements
- Arrays of permanent magnets
- Specialized magnet arrays such as Halbach arrays
- Arrays of electromagnets
- Electrically conductive non-magnetic elements
- Materials susceptible to induced magnetic fields
- Springs and spring-like elements
- Electrical Conductors
- Connector bodies and housings

[0059] Figure 12 graphically represents some of the combinations of magnetic elements and circuit elements that could be used to realize the invention. The Spring and Electrical Conductor elements are called out in this drawing with their use explained in subsequent text and drawings of this specification.

[0060] The elements in the drawing above indicated as “Circuit Elements” are represented either as a box with the letter “C” contained within or as a single dot. These circuit elements can consist of various means for means for transmitting and receiving signals or conducting energy including but not limited to:

- Electrically conductive materials
- Optical transmitters and receivers
- Radio frequency transmitters and receivers
- Inductive field transmitters and receivers
- Sonic transmitters and receivers
- Capacitive transmitters and receivers
- other signaling systems and methods

[0061] An example of a circuit element comprising electrically conductive material could consist of a switch made of copper elements.

[0062] An example of a circuit element comprising an optical transmitter and receiver could consist of a light emitting device and a light detecting device.

[0063] An example of a circuit element comprising a radio frequency transmitter and receiver could consist of an RFID (Radio Frequency Identification) interrogator and tag.

[0064] The embodiment depicted in Figure 13 is an example of one possible variation of the invention to provide a replacement for a headphone plug and receptacle. In this embodiment, the six magnets are replaced by six circuit elements comprising electrically conductive materials. The retention force for the two connector halves is provided by one permanent magnet mounted behind the circuit elements of the left half of the connector and one permanent magnet mounted behind the circuit elements of the right half of the connector. As the connector halves are brought into proximity, the attractive force of the permanent magnets will cause the respective circuit elements to make physical contact thereby completing their respective electrical circuits.

[0065] Figure 14 shows how physical indexing may be used to ensure that the circuit elements make contact with their appropriate counterparts. The triangular shape of the plug fits into the triangular shape of the receptacle.

[0066] Additional configurations are represented in the following drawings with the understanding that one configuration or a portion of a configuration can be intermixed with other configurations or portions of other configurations to realize additional embodiments of the invention.

[0067] Figure 15 depicts the use of multiple circuit elements and a connector body with such a shape so as to provide mechanical indexing to ensure that a correct pairing is made of the circuit elements in the plug with their counterparts in the receptacle. Additionally the connector body can be of such a shape as to recess or isolate magnetic components in the connector from magnetically sensitive items such as wrist watches or disk drives.

[0068] (Note: For simplicity and clarity, in the following drawings connector bodies housing the magnets are not shown. The magnetic elements and circuit elements are shown with the understanding that connector bodies will house these elements and control their range of motion within the body as appropriate.)

[0069] Figure 16 depicts an arrangement of magnets configured with springs. As one portion of the connector is brought into proximity with the mating portion of the connector, the opposite poles of the magnets attract and the magnets mounted on springs will extend the springs and bring the magnets together. Although the springs in this example are shown relaxed in the un-mated position and under tension when mated, configurations could also be arranged wherein the springs are in different states of relaxation, tension and compression when the connector is un-mated and in alternative states when the connector is mated.

[0070] Apart from allowing forward-reverse motion of the magnets, the springs and the travel guides for the magnets could also allow side-to-side motion. This would permit the magnets to seek their proper connection points with their counterparts even in the event of mechanical misalignments and/or mechanical intolerances. Such an arrangement could also be used to recess the sprung magnets to prevent unintended short-circuiting of the currents they carry when the connector halves are not mated.

[0071] The concept of springs is addressed in the broadest sense of elements that provide motion through compression/decompression and extended/un-extended states. Such elements include but are not limited to coil springs, leaf springs, clockwork springs, torsion springs, foam materials, sponge materials, repelling magnets, attracting magnets and cylinder-piston arrangements containing compressed gases and liquids.

[0072] In Figure 17, an arrangement of magnets mounted on springs is shown. In this instance, one of the magnet pairs is oriented with their like poles facing each other. As one portion of the connector is brought into proximity with the other portion of the connector, those magnets oriented with opposite poles facing each other will attract and extend their springs while the magnets with like poles facing each other will repel and depress the spring. This allows selectivity as to which circuits will be completed and which circuits will remain open when the connector is mated.

[0073] This arrangement could be used to allow configurations of attracting and repelling magnets to be combined to provide switched or keyed capabilities for multiple plug and receptacle combinations.

[0074] In Figure 18, an arrangement of magnets mounted on springs is shown with the replacement of one of the non-sprung magnets with an electromagnet. Two conditions are shown with the connector mated. On the left of the drawing the electromagnet is energized so as to repel its counterpart sprung magnet. On the right of the drawing the electromagnet is energized so as to attract its counterpart sprung magnet. This allows the respective circuit to be put into either an open or closed situation depending upon the energized state of the electromagnet. Electromagnets can be used to replace none, any or all of the permanent magnets.

[0075] In addition to controlling the closure or otherwise of specific circuits, the selective use of repelling force or attractive force of one or more electromagnet-magnet combinations could also be used to physically mate or un-mate the connector halves. The permanent magnet associated with the electromagnet could also be replaced by another electromagnet or by a component of non-magnetized magnetic material.

[0076] In Figure 19, a configuration using magnets mounted on springs is depicted with the addition of circuit elements that act as switches.

[0077] The left elements act as a normally closed switch when the connector is un-mated and going to an open state when the connector halves are mated. The normally closed configuration of the left elements might be used in a situation similar to that found with an audio receptacle in equipment that has external speakers as well as a headphone receptacle. When the headphone plug is not mated with the receptacle the signal will be carried over the closed switch elements to the speakers and when the connector is mated the signal will not be

delivered to the speakers but will be carried through the respective magnet pairs to the headphone.

**[0078]** The center elements provide a switch-type of interface wherein the switch elements are physically connected to the magnet but they may or may not be electrically connected to the magnet. This configuration obviates the need for the magnets to make electrical contact with each other. This switch configuration of the center elements might be used in a situation wherein the signal or current to be carried is more appropriately carried over more conventional switch closure arrangements as opposed to carrying the signal or current through mated magnets.

**[0079]** The right elements act as a normally open switch when the connector is un-mated and going to a closed state when the magnets are mated. This configuration might be used in a situation wherein it is desired to receive a control signal via the normally open switch that indicates when the connector has been mated.

**[0080]** The invention can also be used to create adapters. The invention in Figure 20 is shown as it is applied to produce two halves of an adapter. One half of an adapter connects to a plug and the other half of an adapter connects to a receptacle.

**[0081]** Figure 21 shows the adapter components as they would connect with the standard connector components.

**[0082]** As with conventional connectors the components of this invention can be either mounted into panels or other items or they can be mounted on cables and wires to provide in-line capabilities. Figure 22 shows a possible in-line embodiment of the invention.

**[0083]** Invention Advantages over Conventional Connectors

- Magnetism is used for retention as opposed to friction or locking mechanisms.
- Variable levels of magnetism can be used to control connector retention force from zero upwards.
- Magnetism can be used for connector alignment.
- Magnetism can provide a means for indexing mating connector components.
- Magnetism can provide a means for selectively connecting circuit elements within a mated connector.

- Multiple plug-receptacle configurations can be derived that automatically establish desired circuitry based upon the polarities of the magnets incorporated into the connectors halves.
- Magnetism can be used to automatically select which plugs and receptacles will mate.
- Magnetism can be used to produce repulsive forces to cause disconnection of connectors.
- The use of and combinations of permanent magnets, electromagnets and non-magnetized electrically conductive magnetic materials can permit a wide range of hard-wired and real-time control over the circuitry within a mated plug and receptacle.

[0084] The adapters 112, 252 and 352 are of a type intended to be convenient retrofits for existing conventional armrests, whereas the receptacle 212 of Figure 4 is of a type intended to be a versatile permanent replacement for aircraft headphone receptacles useable with either conventional plugs or with a plug 100 according to the invention. The adapter 152 is of the type allowing a conventional headphone plug to be used with a magnetic receptacle according to the invention. Other adaptations, modifications and improvements will be evident to those of ordinary skill in the art from the illustrations and explanations herein. It is therefore not intended that this invention be limited, except as indicated by the appended claims.

WHAT IS CLAIMED IS:

1. A signal-carrying receptacle for receiving a complementary plug comprising:
  - a housing with a first face;
  - a set of electrical terminals for carrying signals, said terminals being disposed along a circumference on said first face,
  - a magnet of a first polarity on said first face for engaging a second opposing face in the complementary plug; and
  - a structure for receiving and aligning the complementary plug with said first face such that electrical contacts of the complementary plug aligns at least axially with said electrical terminals,wherein said magnet is operative to mate with a specific magnetically attractable element of the complementary plug with sufficient force to maintain reliable electrical connection between said terminals and contacts and not so much force as to result in physical damage upon withdrawal of the plug from said receptacle.
2. The receptacle according to claim 1 wherein said magnet comprises at least one of the electrical terminals, and said magnets are arranged to complement, align and attract said electrical contacts.
3. The receptacle according to claim 1 wherein said aligning and receiving structure comprises at least three magnets mounted on said first face disposed along said circumference, with two of said at least three magnets having a common polarity and being operative to confront magnets arranged in a complementary and opposing polarity pattern on the complementary plug.
4. The receptacle according to claim 3 wherein said magnets are electrical terminals for carrying signals.
5. The receptacle according to claim 1 wherein said aligning and receiving structure is a recess forming a keyway to mate a key shape of the plug for physically orienting the plug to align terminals and contacts.
6. The receptacle according to claim 1 further including a conventional contact phone receptacle, said conventional contact phone receptacle being in said first face.

7. The receptacle according to claim 1 further including a conventional contact phone receptacle, said conventional contact phone receptacle being mounted in the same housing as said terminals and being in electrical contact with said terminals.

8. The receptacle according to claim 7 further including a conventional contact phone plug coupled to the terminals, said conventional contact phone plug being in a position to be inserted into a conventional phone receptacle thereby to define an adapter.

9. The receptacle according to claim 1 further including a conventional contact phone plug coupled to said terminals, said conventional contact phone plug being in a position to be inserted into a conventional phone receptacle thereby to define an adapter.

10. The receptacle according to claim 1 adapted to be mounted in an armrest.

11. A signal-carrying plug for insertion into a complementary signal-carrying receptacle comprising:

a housing with a second face;

electrical contacts for carrying signals, said contacts being disposed along a circumference on said second face,

a magnetically attractable structure on second for mating with a magnet on said first face for engaging a second opposing face in the complementary plug; and

a structure for inserting into and aligning the complementary receptacle with said second face such that electrical contacts of the complementary receptacle align at least axially with said electrical contacts;

wherein said magnetically attractable structure is drawn by the magnet with sufficient force to maintain reliable electrical connection between said contacts and terminals and not so much force as to result in physical damage upon withdrawal of said plug from the magnetic receptacle.

12. The plug according to claim 11 wherein said inserting and aligning structure is a key matched to a recess keyway of a mating shape of the receptacle for physically orienting the plug to align terminals and contacts.

13. The plug according to claim 11 wherein said inserting and aligning structure comprises at least three magnets mounted on said second face disposed along said circumference, with two of said at least three magnets having a common polarity and being operative to confront magnets arranged in a complementary and opposing polarity pattern on the complementary receptacle.

14. The plug according to claim 13 wherein said magnets are electrical contacts for carrying signals.

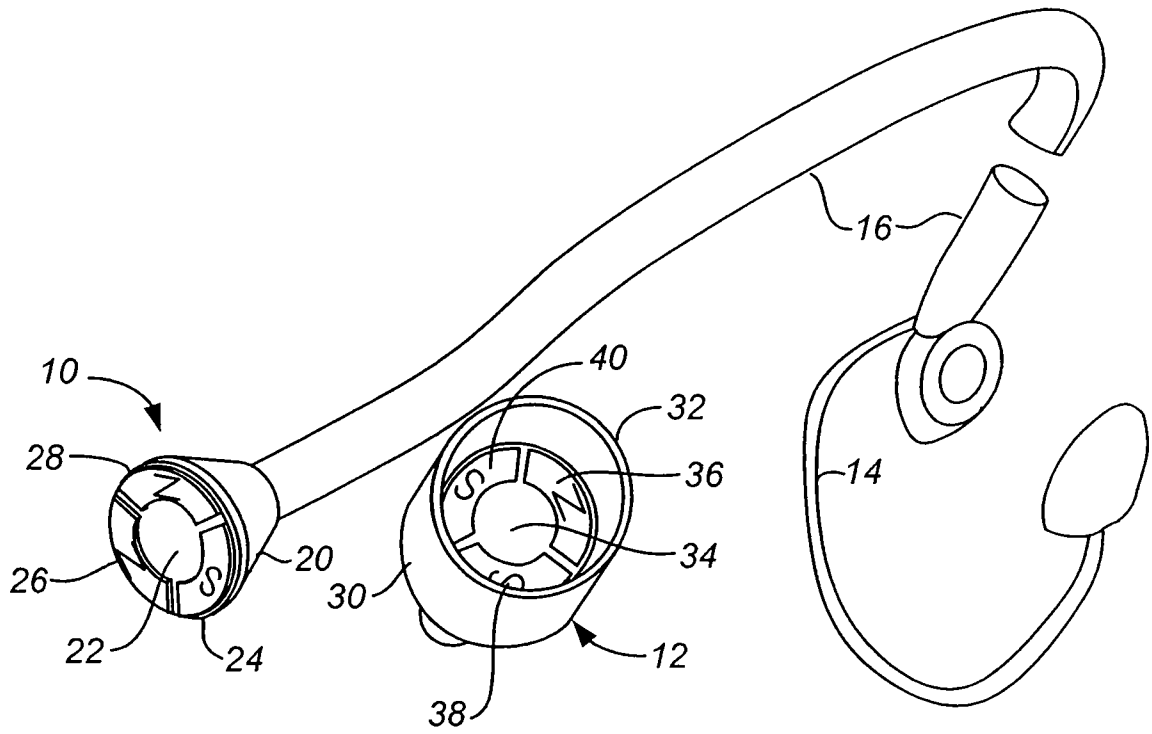
15. The plug according to claim 11 wherein said magnetically attractable structure is an electrical terminal for carrying signals.

16. The plug according to claim 14 further including a conventional contact phone receptacle, thereby to form an adapter.

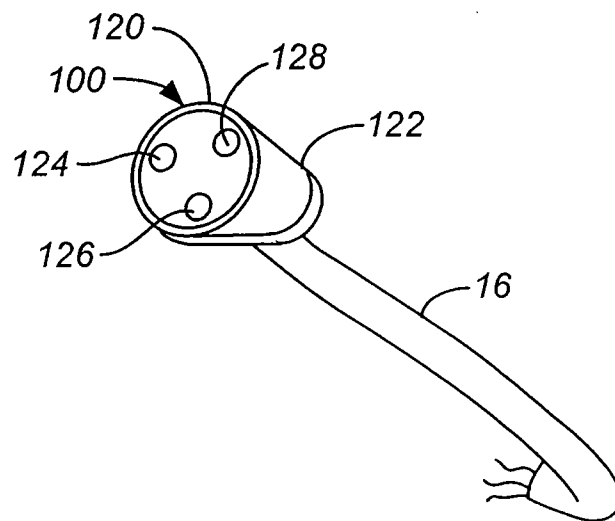
17. The plug according to claim 11 further including a conventional contact phone receptacle, thereby to form an adapter.

18. The receptacle according to claim 1 wherein at least one of the electrical terminals is spring mounted.

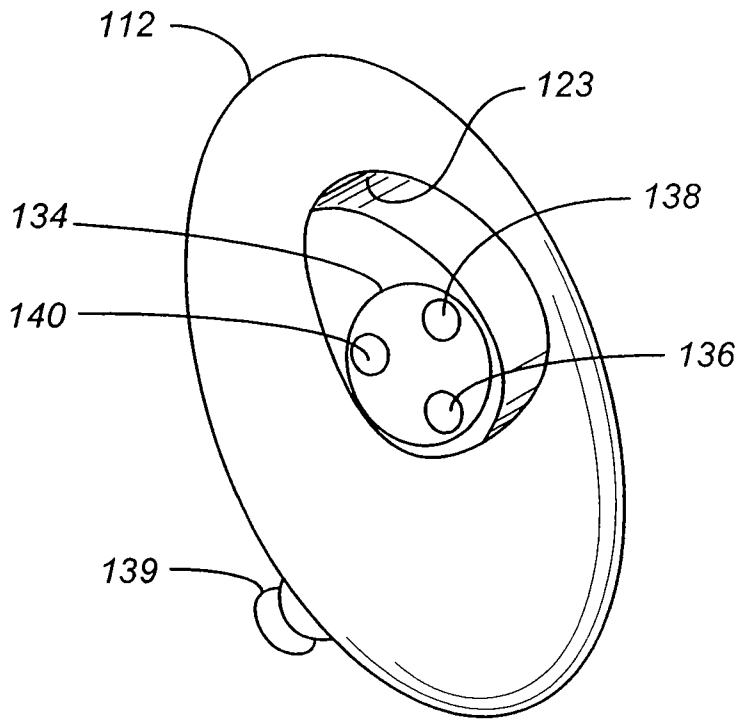
19. The receptacle according to claim 18 wherein the spring mounted electrical terminal incorporates a contact switch.



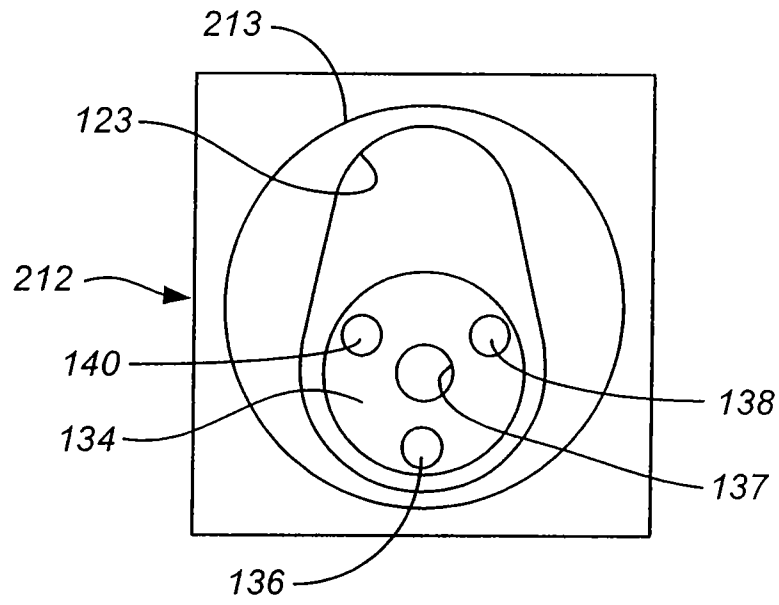
**FIG. 1**



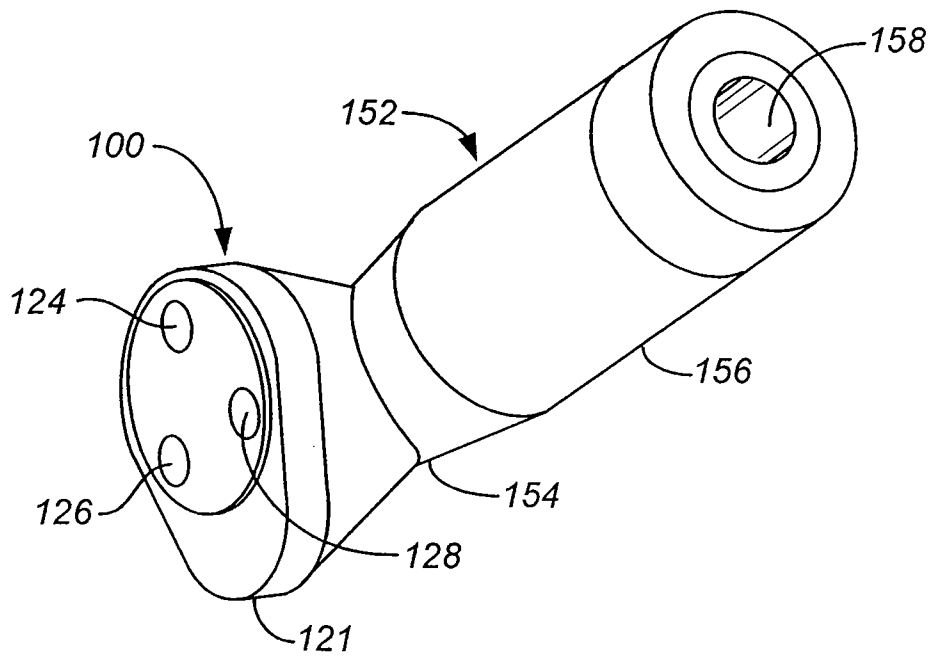
**FIG. 2**



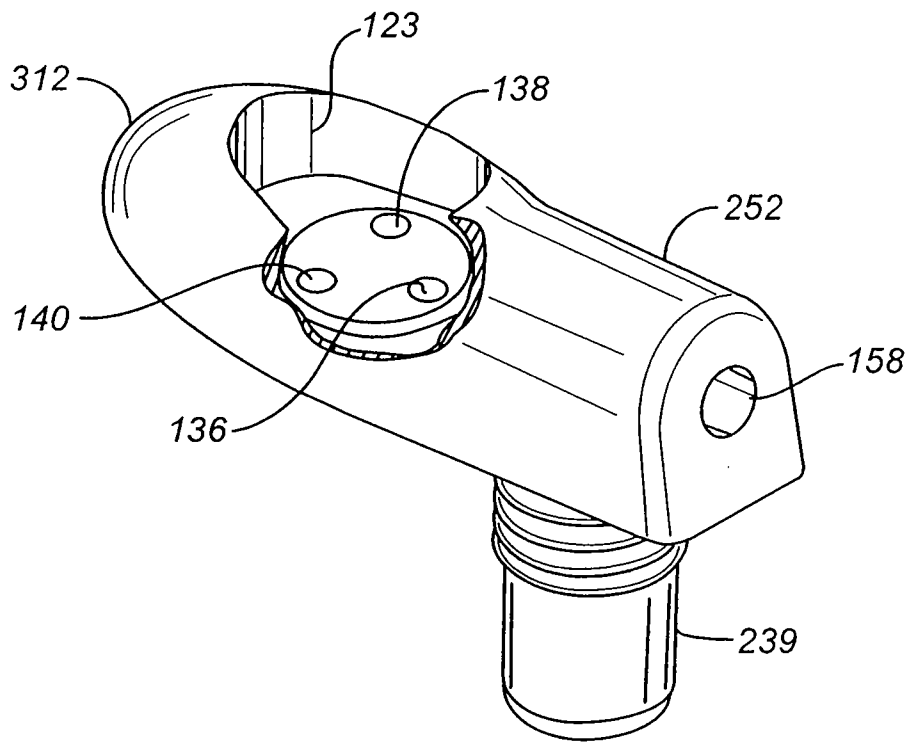
**FIG. 3**



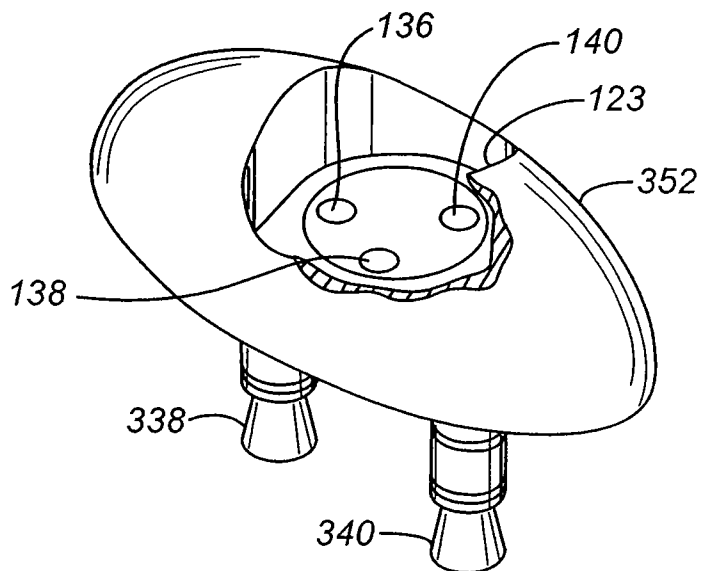
**FIG. 4**



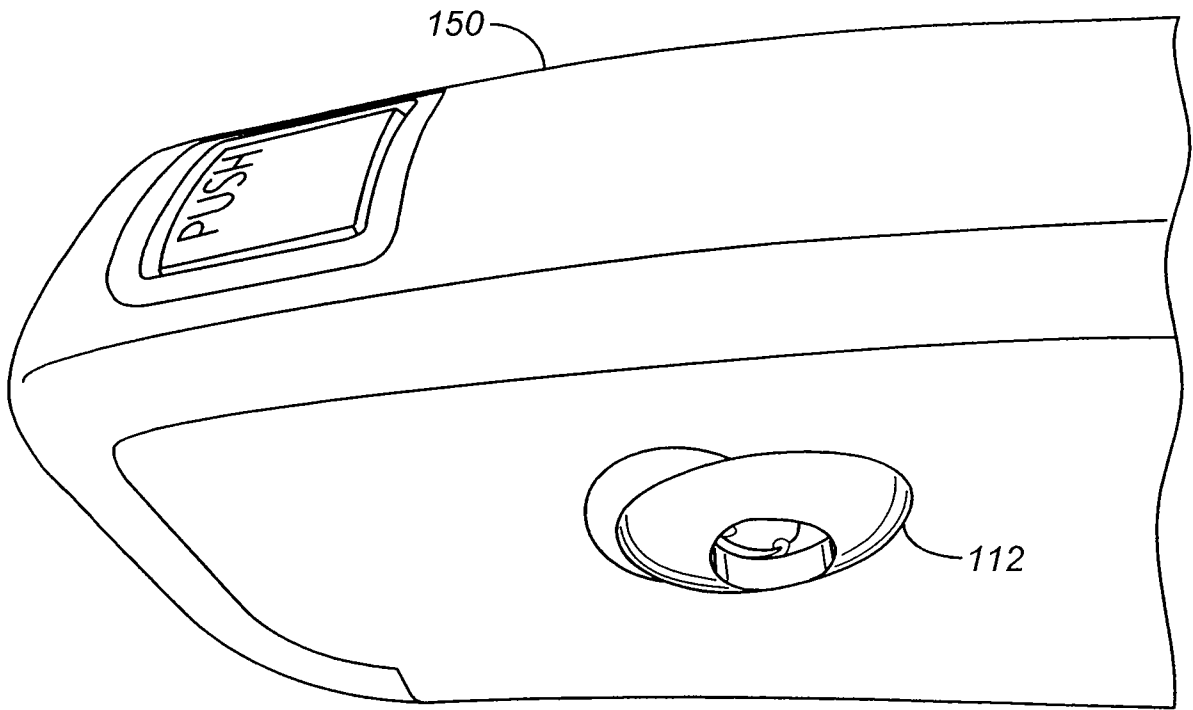
**FIG. 5**



**FIG. 6**



**FIG. 7**



**FIG. 8**

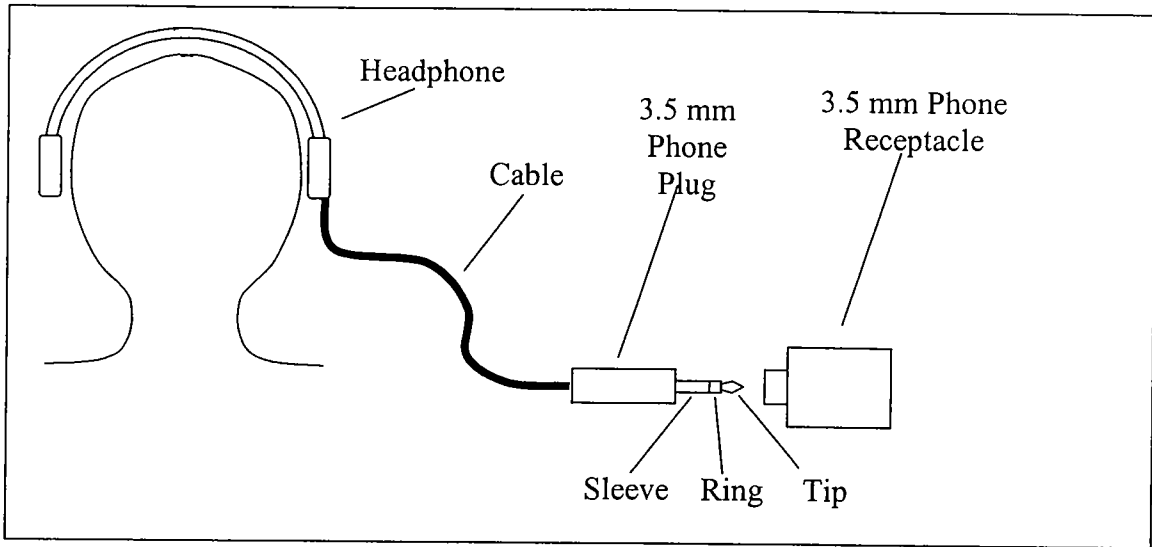


Figure 9

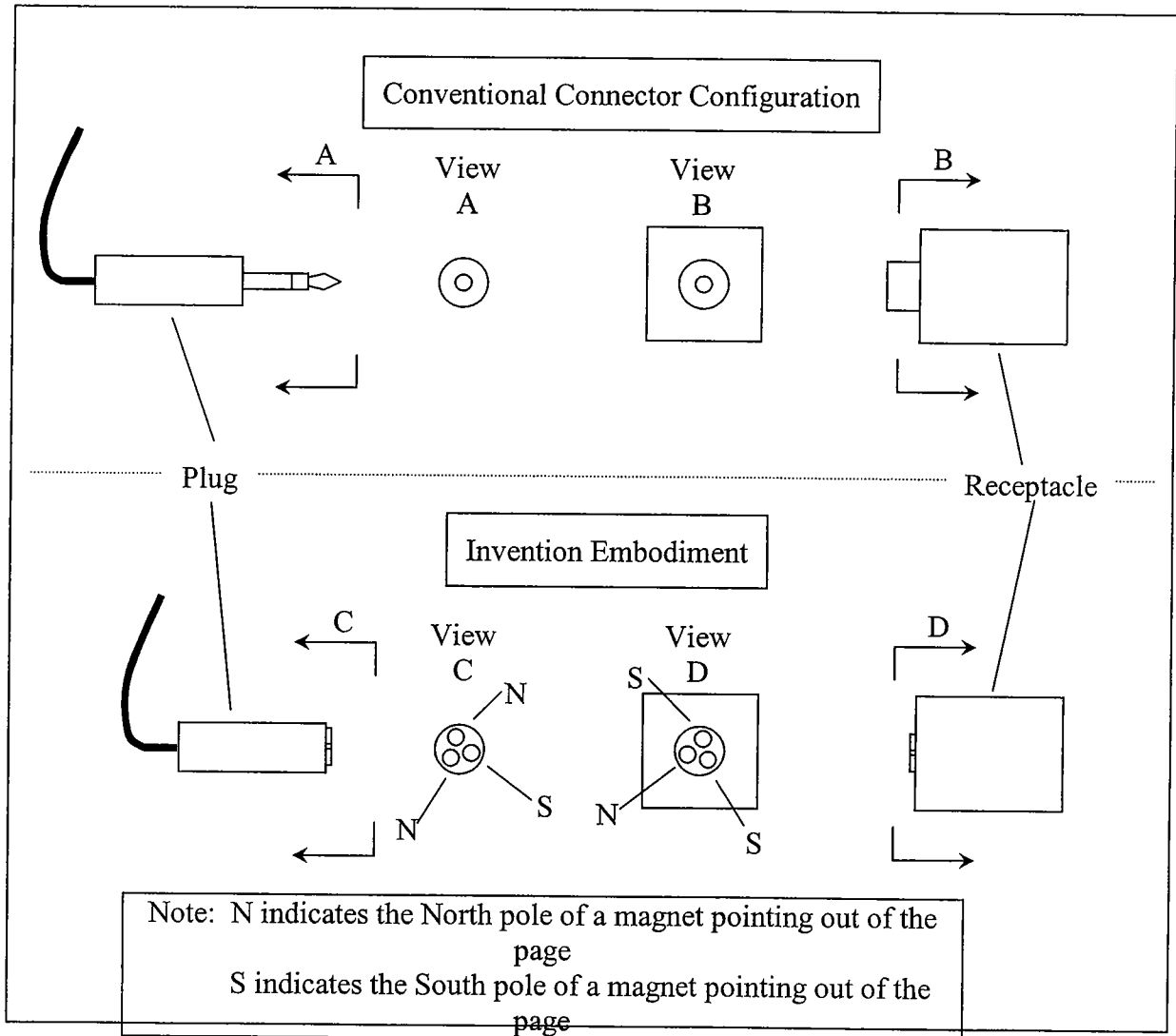


Figure 10

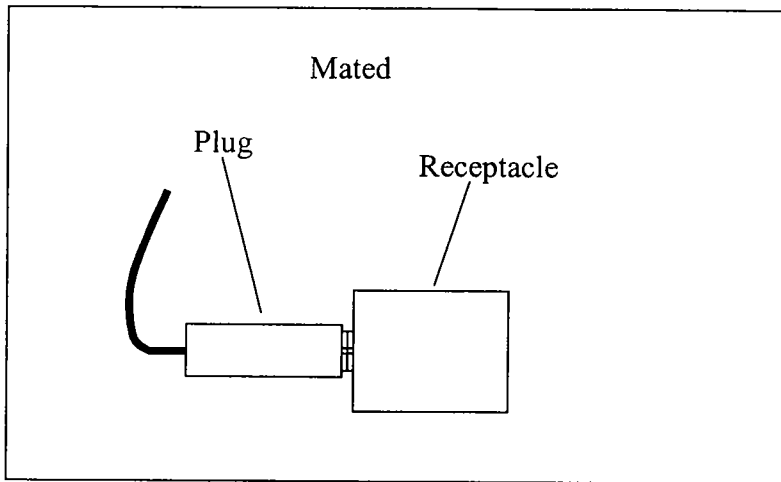


Figure 11

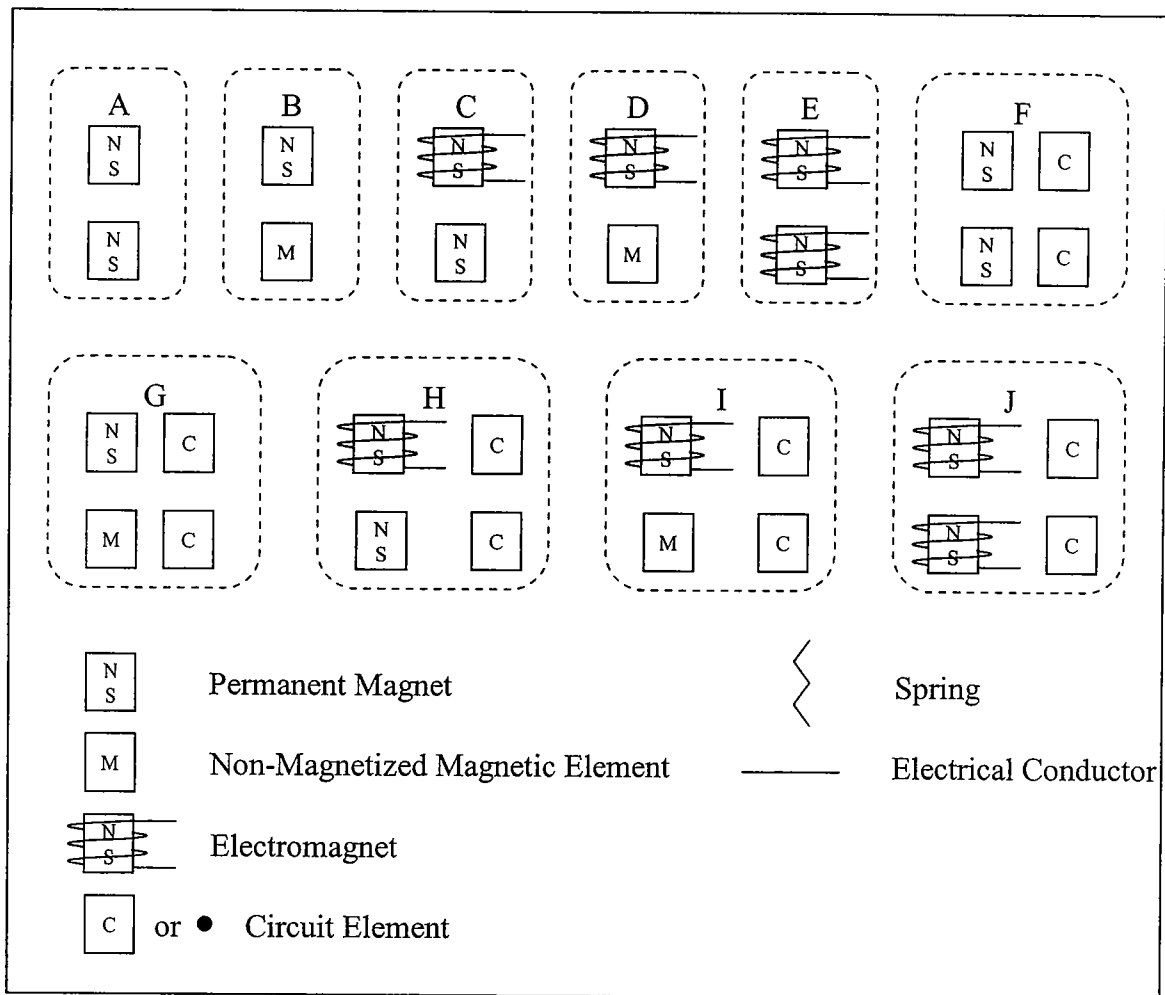


Figure 12

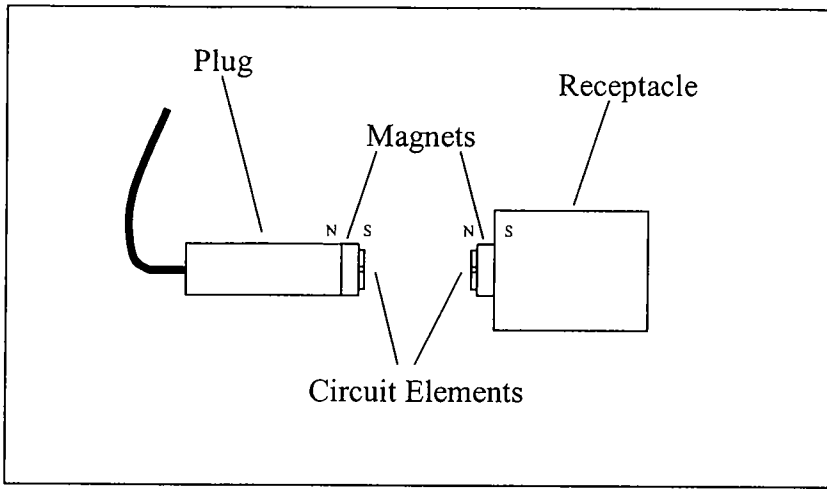


Figure 13

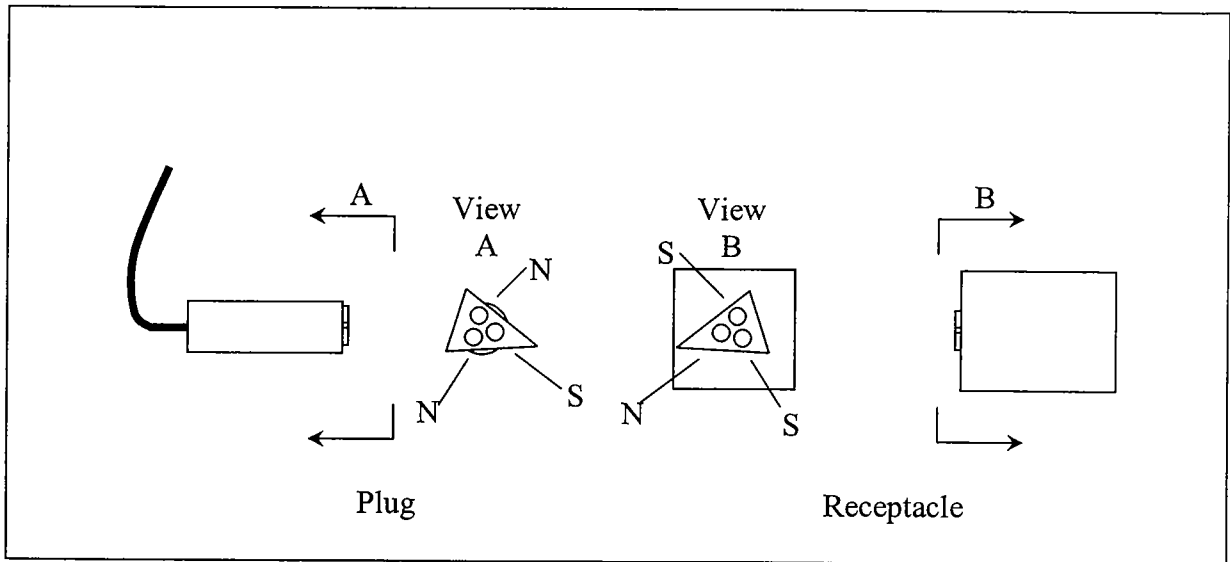
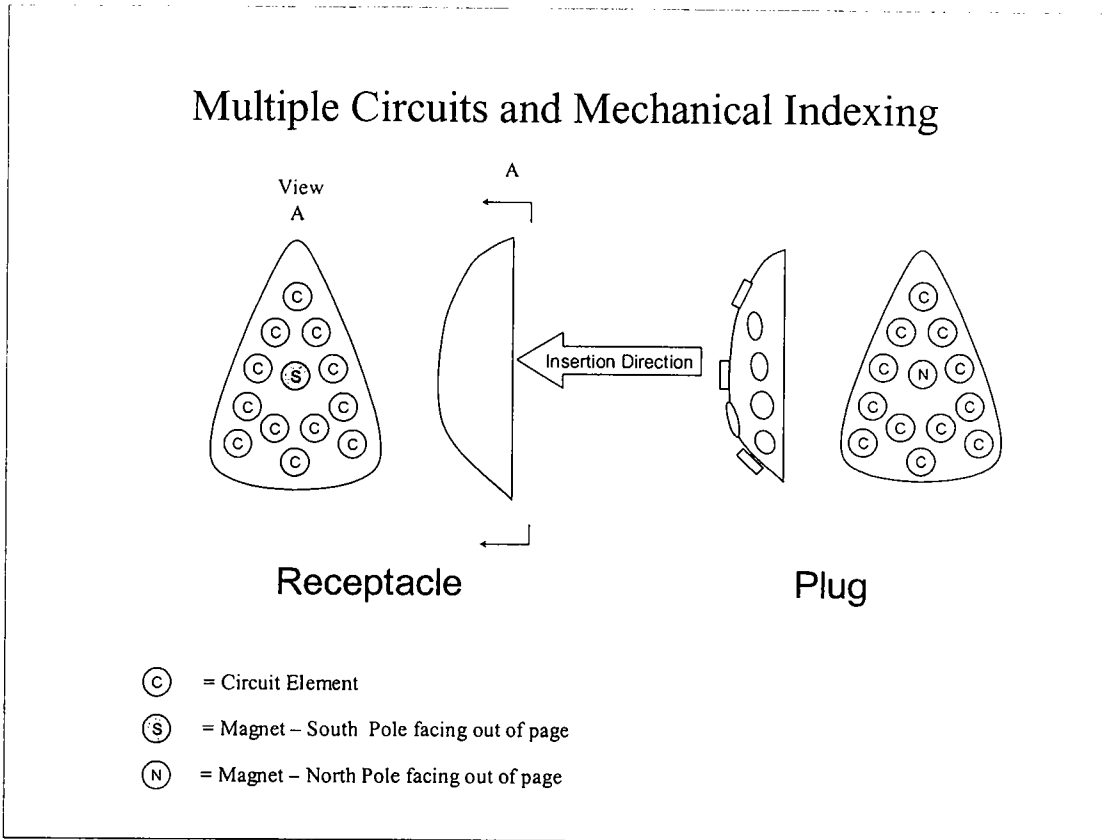


Figure 14



**Figure 15**

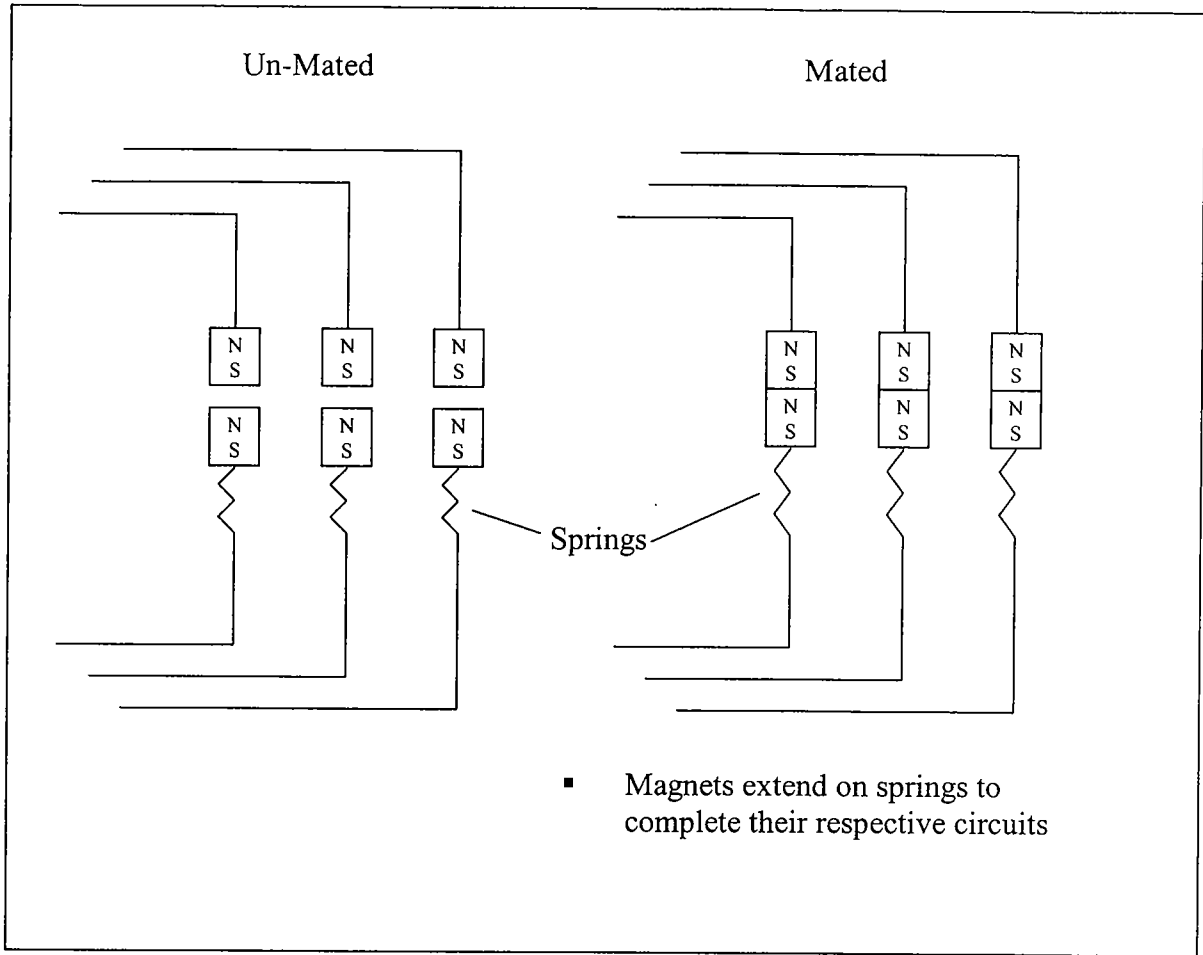


Figure 16

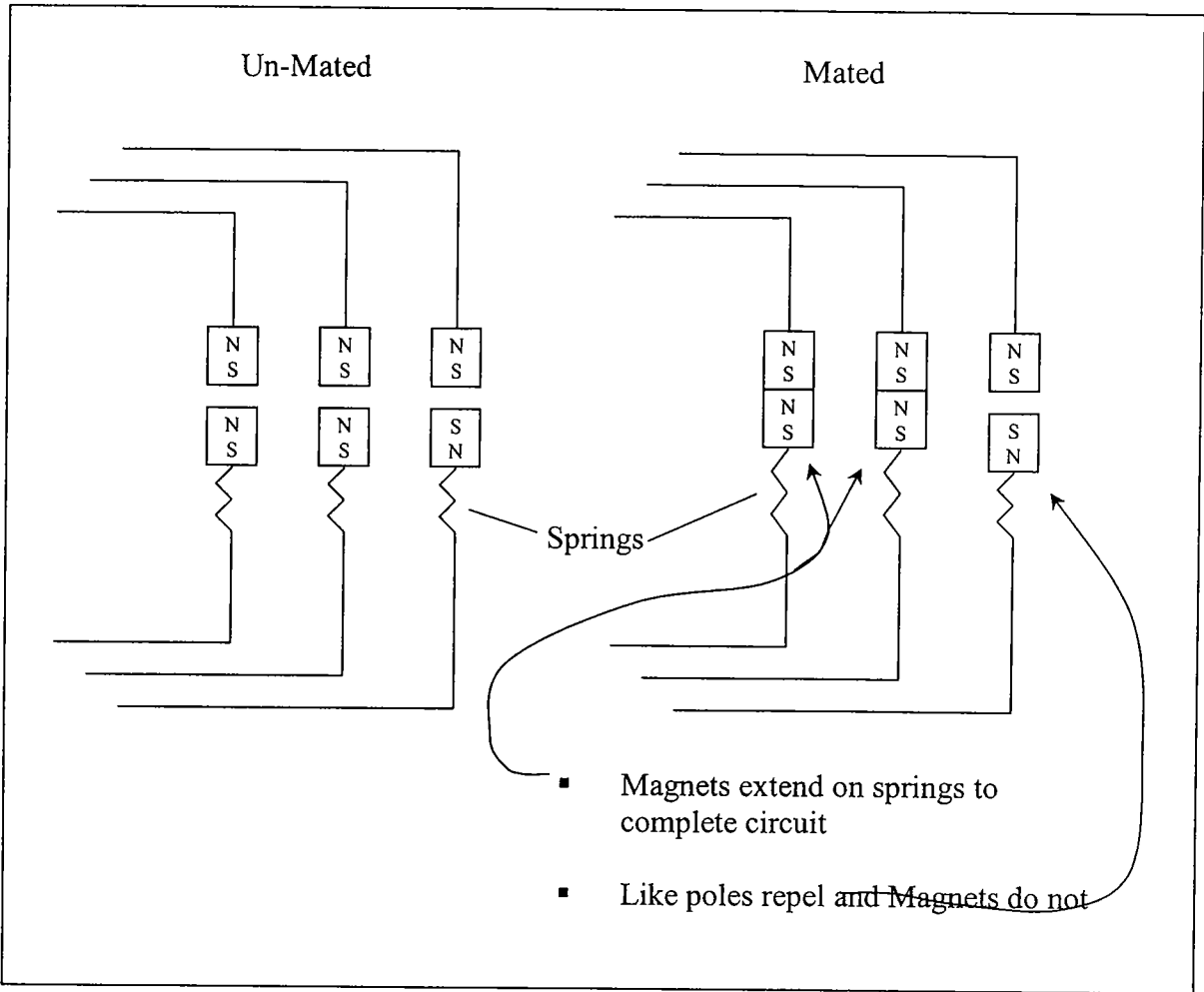


Figure 17

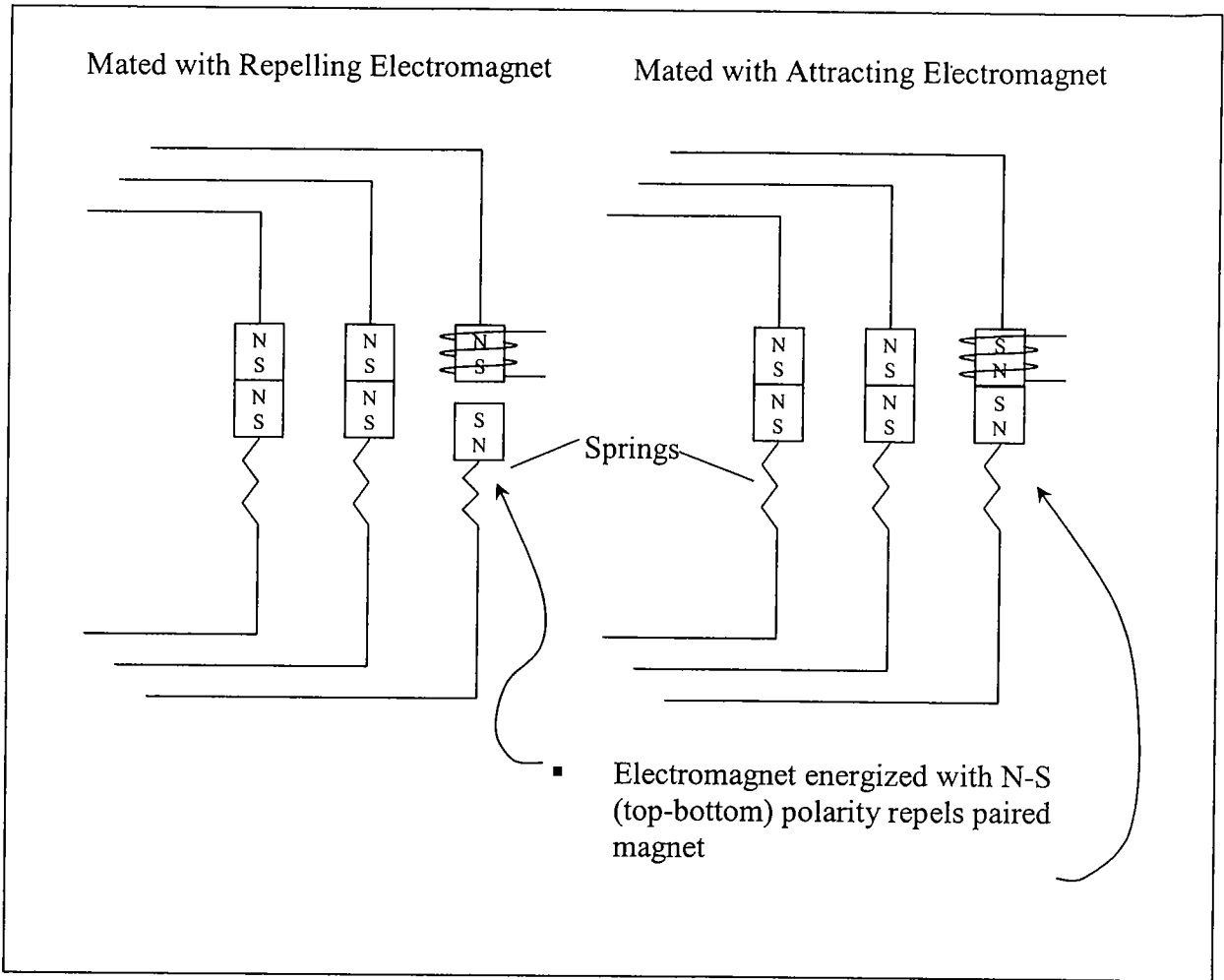


Figure 18

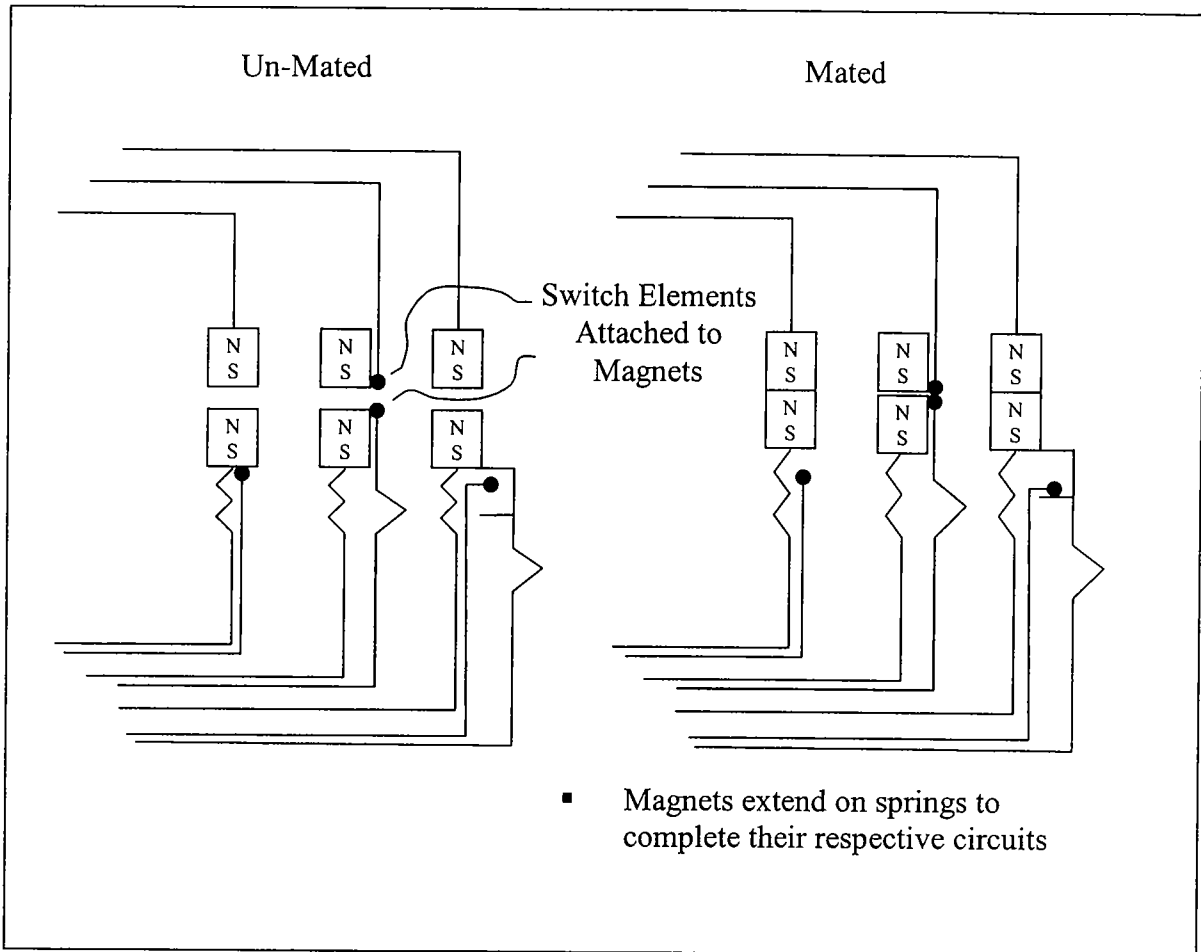


Figure 19

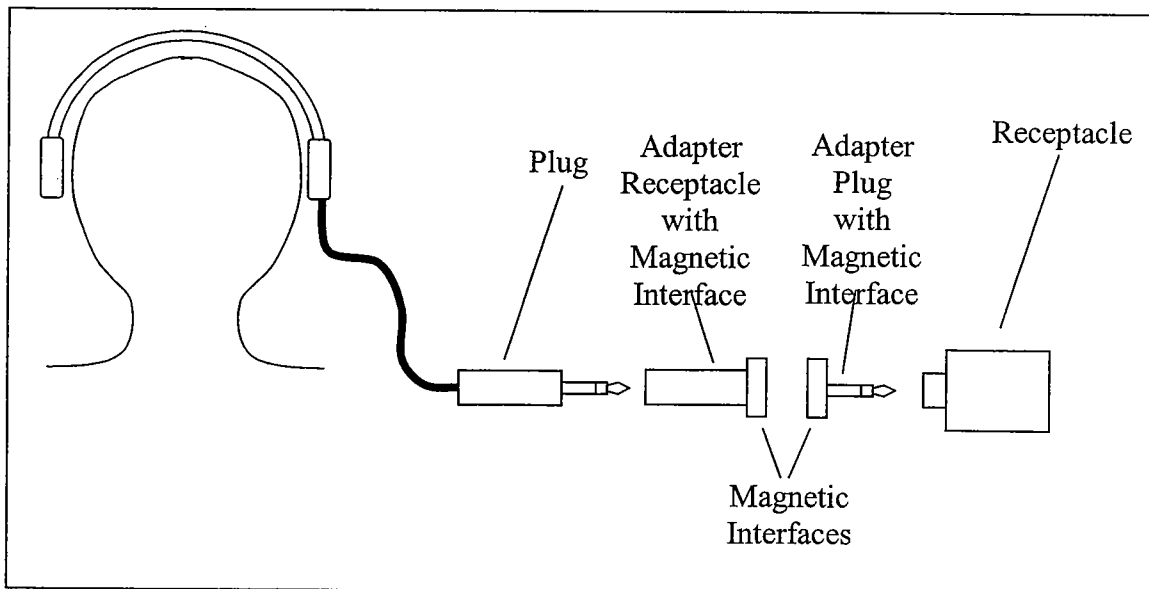


Figure 20

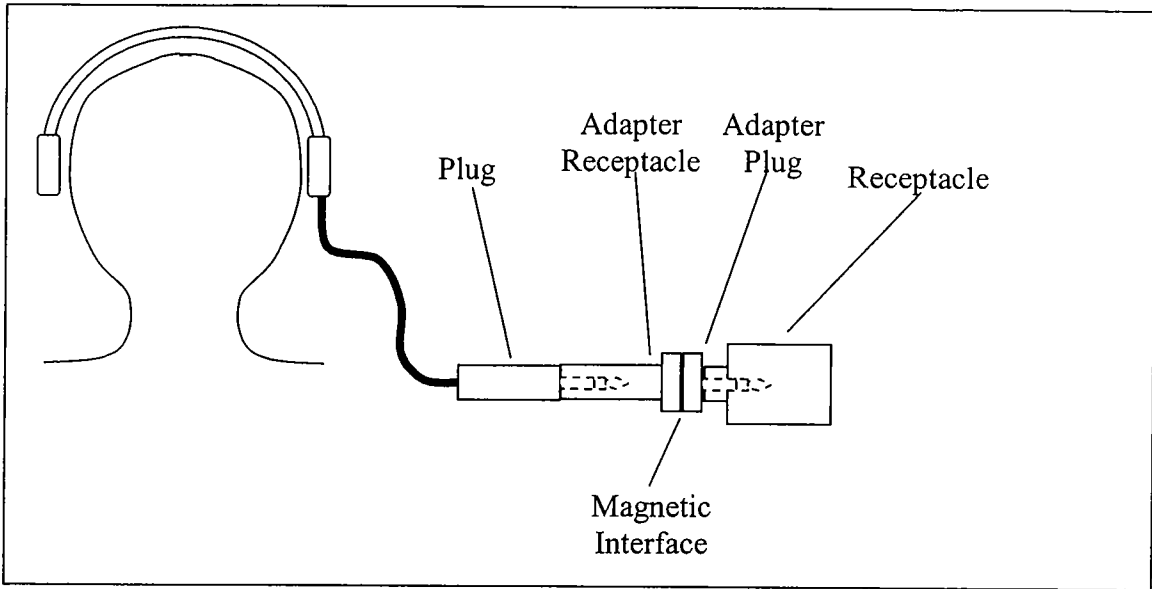


Figure 21

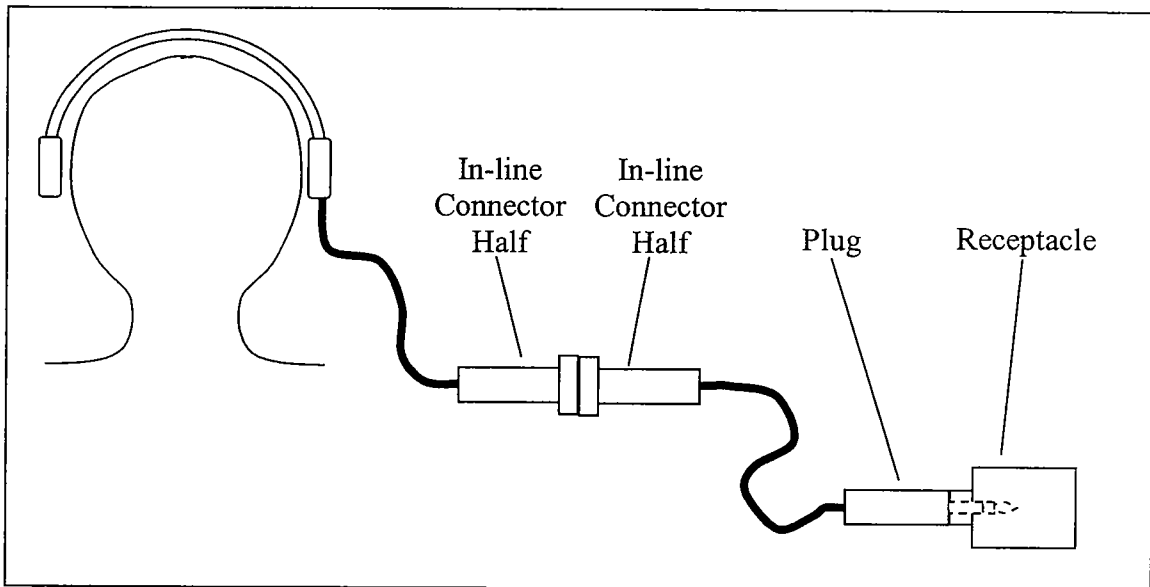


Figure 22