July 2020

Charging Contacts and Data Transfer Through Magnets

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ABSTRACT

This disclosure describes electronic devices with charging contacts and data transfer through magnets. As an example, augmented-reality glasses can include magnets that are flush to the frame. In another example, a virtual-reality headset may include magnets that are flush to the display portion of the headset. Various other electronic devices could also implement the magnets discussed herein. The magnets carry data lines which are effective to decrease the number of electrical contact sites on the electronic devices (e.g., on a frame of augmented-reality glasses). Additionally, a USB cable connector is provided that includes magnets that protrude on the end to achieve sufficient surface-to-surface contact by the magnets. The magnets can have a thick metal coating for high conductivity and to reduce the impact felt by the magnets when in contact with each other.

KEYWORDS

- Artificial reality
- Virtual reality
- Augmented reality
- Mixed reality
- Magnetic contacts
- Charging contacts
- Magnetic data transfer
- Differential Signaling

BACKGROUND

Artificial reality can enhance a user's sense of vision, hearing, touch, and/or other perceptions. In many instances, to achieve visual enhancement, a user can wear glasses or other equipment that overlays computer-generated visual information on top of the user's view of a real-world environment. Since artificial-reality equipment such as augmented-reality glasses are intended to be worn in everyday life, it is useful for the augmented-reality glasses to be similar in size and style to typical glasses.

Data (e.g., operating system settings and log files) is uploaded to the glasses to create the artificial-reality experience. Electrical equipment that utilize USB connections typically require five electrical signal lines to provide power and send and receive data between devices. The data is carried as differential signals in D+ and D- electrical signal lines. Power and ground make up two of the other electrical signal lines that provide power and charge to a device. The fifth electrical signal line is a detect pin. The detect pin allows the user to know if a connector cable has been connected to the power and ground signal lines correctly, or if the connector cable has been connected incorrectly and needs to be adjusted.

Currently, there is a lack of space available on some electronic devices, such as the frame of augmented-reality glasses, to incorporate pogo pins and contact disks for the five typical electrical signal lines of a USB connection. Providing data communication through magnetic connectors can mitigate this issue. However, carrying data through magnets presents several challenges. First, establishing good surface-to-surface contact for magnets can be difficult. Without good surface-to-surface contact, it can be difficult to create good electrical contact. Second, magnets are brittle, and with repeated impact, cracking can become a concern. Traditionally, magnets are designed not to touch each other for this reason. However, such contact is necessary in establishing an electrical connection. Finally, with current passing through the magnets, there is a potential for the magnets to become demagnetized.

DESCRIPTION

This disclosure includes electronic devices, such as artificial-reality devices, with charging contacts and data transfer. FIG. 1 illustrates a view of the electrical connections and magnets that may be incorporated into an electronic device (e.g., into a housing of the electronic device).

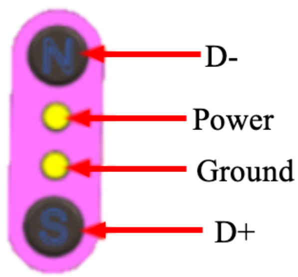

FIG. 1

As one example, the ports for charging and data transfer can be hidden when the temples of augmented-reality glasses are open, as they are when worn by a user. When the temples are folded, for example when not in use and stored in a case, the ports can be revealed. Magnets can be used to aid in retaining a cable for charging and data transfer to the glasses. The addition of magnets can increase the number of needed connection points on the frame of the glasses from the standard five USB connections. To decrease the number of connection points, the magnets can carry the data lines, D+ and D-.

The use of magnets also mitigates the need for a detect pin, since the top magnet can be aligned north-to-south and the bottom magnet can be aligned south-to-north. The top magnet in the cable can be aligned south-to-north and the bottom magnet can be aligned north-to-south. This ensures that the cable is connected correctly to the electronic device.

The magnets in the housing on the electronic device (e.g., augmented-reality glasses) can be flush with the housing. For example, the magnets can be press fit into a holding piece that is fitted into the housing. To keep the magnet in place within the holding piece, a feature on the holding piece can be engaged when the magnet is press-fit. For example, the feature can be a V-shape that protrudes form the holding piece to fit into a V-shaped cut out of the magnet.

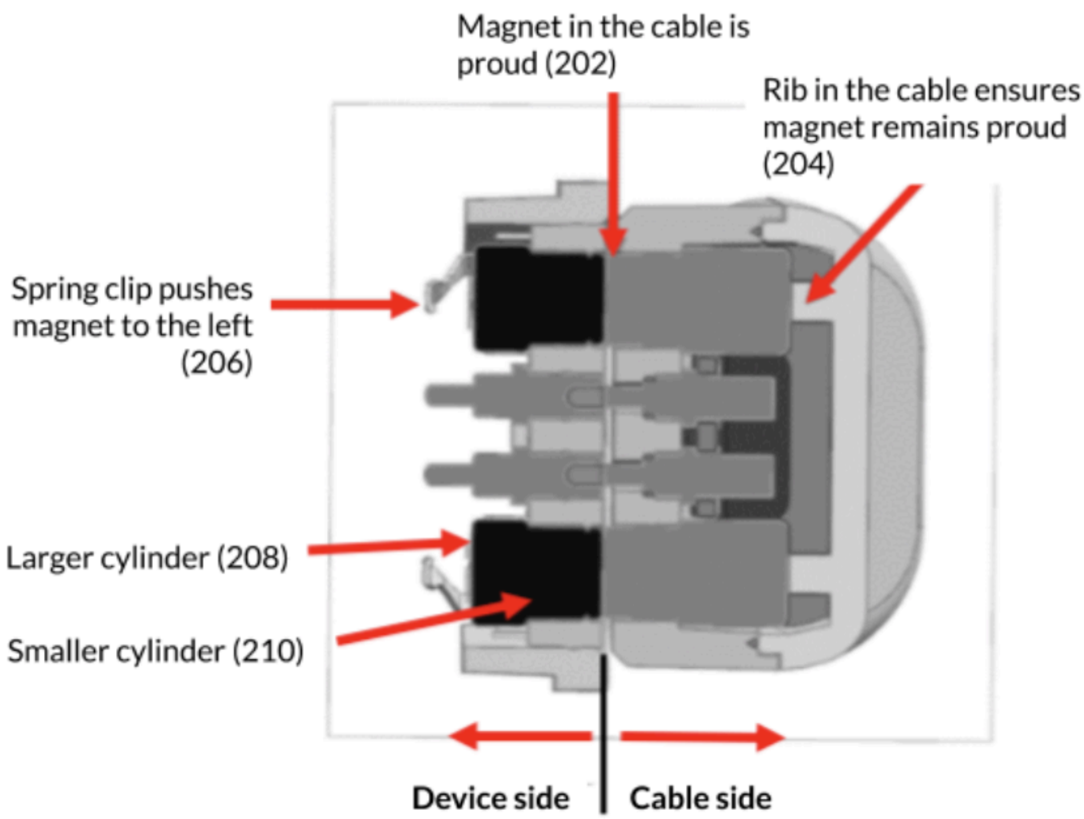

FIG. 2

FIG. 2 illustrates a view of a cable being connected to an electronic device. Press-fitting the magnets into the holding piece can cause the magnets to be misaligned. If this is the case, the magnets in the cable may not completely align properly upon connection to the electronic device. If the magnets do not align properly, there is potential for a decreased electrical connection between the magnets.

To make sure the magnets make sufficient contact, the magnets protrude (e.g., by a small distance such as 0.2 mm) on the cable side (202) so they are the first components to touch when the cable is connected to the electronic device. A rib in the cable (204) ensures that the magnets stay proud. Additionally, the magnets can have rounded surfaces to increase the contact area between the magnets. For example, the magnets can have a curvature radius of 0.15 mm.

On the device side (e.g., augmented-reality glasses), a metal spring clip (206) is mated around each magnet when the magnets are fitted into the device housing. A metal spring finger extends from the spring clip, which is in contact with a flex cable connected to the main circuit board in the device. The spring finger contacting the flex cable establishes an electrical connection between the magnet and the flex cable. For example, the flex cable and spring clip can provide 5-6 N of retention force on the magnet to keep it in place.

Additionally, a magnet can be made up of a larger cylinder (208) and a smaller cylinder (210). The smaller cylinder can be the side of the magnet that makes contact with the cable, and the larger cylinder can be pressed against the back of the holding piece. The larger cylinder can ensure that the magnet stays flush with the device housing and does not protrude.

On the cable side, a pogo pin with a spring-loaded head is in contact with each magnet. The back of the pogo pin can be soldered to a printed circuit board to help hold the magnet in place and establish an electrical connection to the magnet. The wires within the cable can be soldered onto the printed circuit board. The other end of the cable can be a USB-A connector to plug into a computer or other electrical source that provides power or data to the device.

Magnets are brittle and are not usually designed to withstand repeated impact. Providing magnets with rounded edges can aid in decreasing the pressure on the magnets. A lower force concentration is associated with rounded edges than with sharp edges. Typically, magnets are plated with a thin metal layer around 10-20 microns thick. A thicker layer of an alternative metal plating material can be used to coat the magnets so the magnets in the cable and in the device can endure repeated contact with each other. The coating is effective to absorb the impact of the magnets when they come into contact with each other to decrease the chance of the magnets cracking. The metal coating can also increase the conductivity of the magnets. Additionally, alternative plating materials can allow the magnets to have a different surface finish, e.g., a black surface finish.

Carrying the data lines through the magnets requires current to pass through the magnets. Current, which creates a magnetic field, can potentially demagnetize magnets. Per techniques described herein, the USB lines used in the cable are low powered, and as a result, the magnetic field that is created is low powered. Additionally, the USB lines can swap polarity very quickly. The combination of the low power and quick swapping of polarity mitigates the potential of demagnetizing the magnets.

In some cases, the use of the data lines can be restricted such that the data lines are only in a factory (or other similar setting, e.g., a repair center) to upload an operating system and/or other data required for the electronic device to function. In such cases, the user of the electronic device is prevented connecting to the data lines, and the use of the cable connection is limited to charging. The magnets do not have current running through them enough for the magnets to be demagnetized.

The foregoing description of the configurations are illustrative. Modifications to the configurations and variations are possible. For example, electrical tape or a conductor foam can be used instead of plating material. Additionally, when data transmission through magnets is restricted to a factory setting, a gap can be provided between the magnets in the cable and the magnets in the electronic device such that they do not come into contact during regular connection of the cable and electronic device. Further, while the foregoing description is with reference to a USB connection, other types of connection technology can be used for charging and/or data connection using magnets.

CONCLUSION

This disclosure describes electronic devices (e.g., artificial-reality equipment) with charging contacts and data transfer through magnets. As an example, augmented-reality glasses can include magnets that are flush to the frame. The magnets carry data lines which is effective to decrease the number of electrical contact sites on the electronic device. Additionally, a USB cable connector is provided that includes magnets that protrude on the end to achieve sufficient surface-to-surface contact by the magnets. The magnets can have a thick metal coating for high conductivity and to reduce the impact felt by the magnets when in contact with each other.