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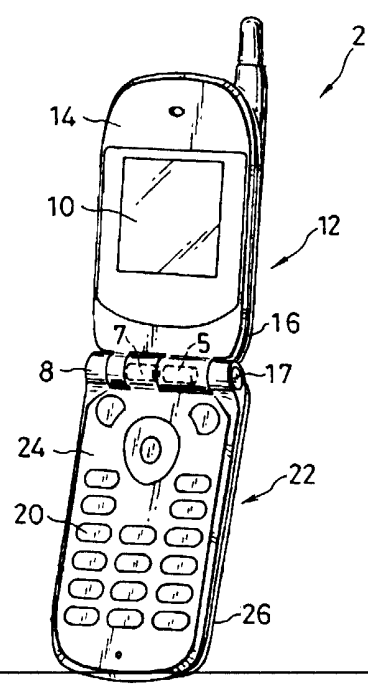
(56) Documents Cited
GB 2351201 A **GB 2324674 A**
EP 1217501 A2 **US 6028764 A**
US 5661641 A

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UK CL (Edition V) H4J
INT CL⁷ G06F, H04M
Other: WPI, EPODOC, JAPIO

(54) Abstract Title
Wireless communication between two hinged housings of an electronic device

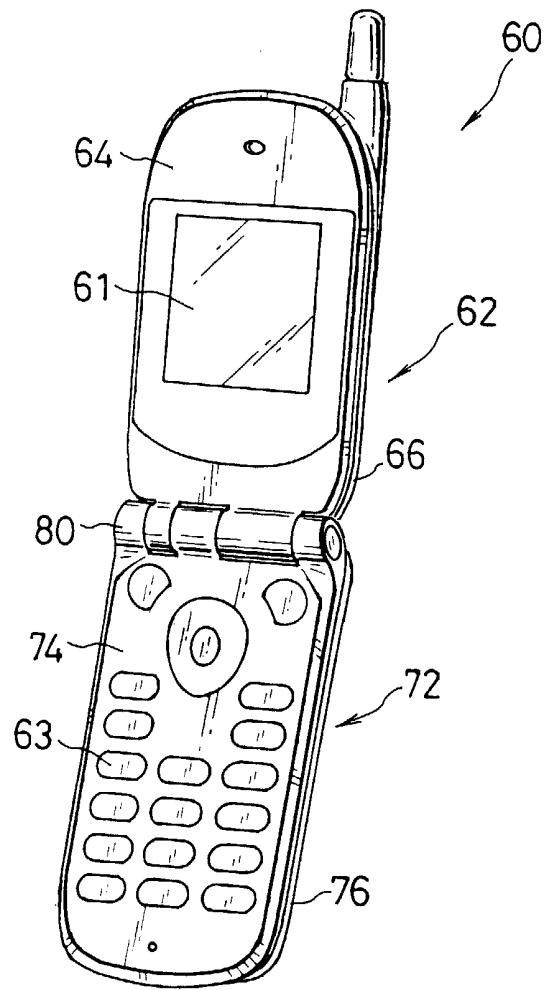
(57) A folding electronic device (eg mobile phone) has first and second housings 12,22 which connect together with a hinge unit 8. Circuit boards in the first and second housings are in optical (IR, UV, visible) or low power radio frequency communication with each other. The optical modules 5,7 (transmitter/receiver) or antennas required for communication between the housings may be coaxially located in the hinge unit 8 itself. The device solves the problem of easily damaged flexible conductors which are conventionally used to connect the two circuit boards.

FIG. 4



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FIG. 1
PRIOR ART



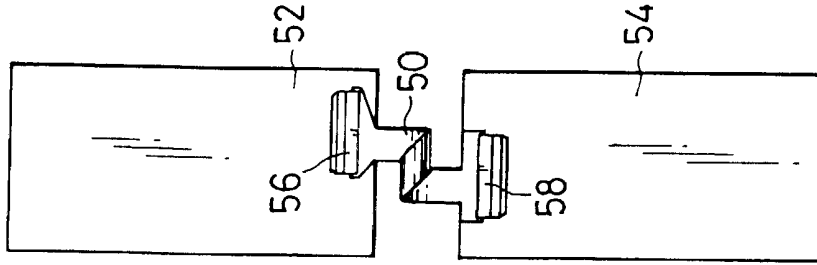


FIG. 3
PRIOR ART

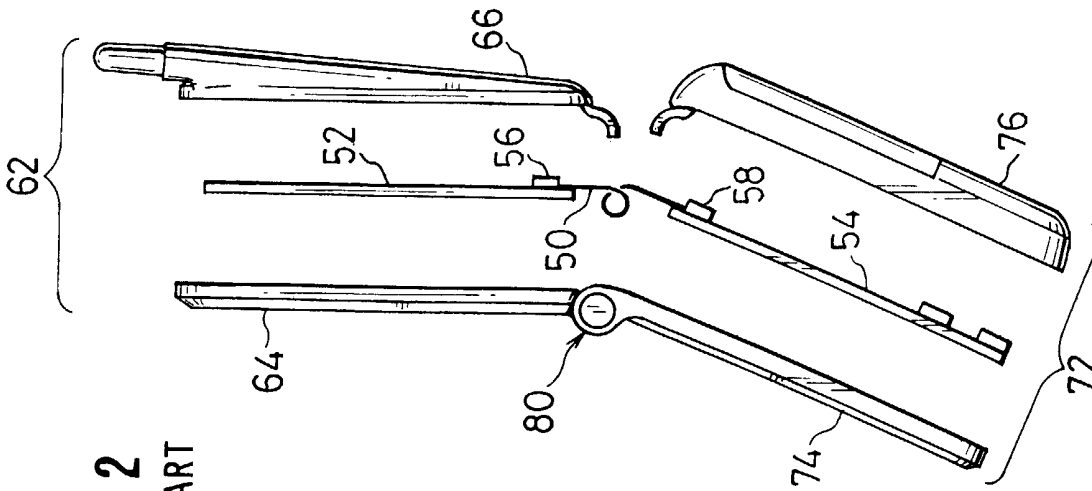
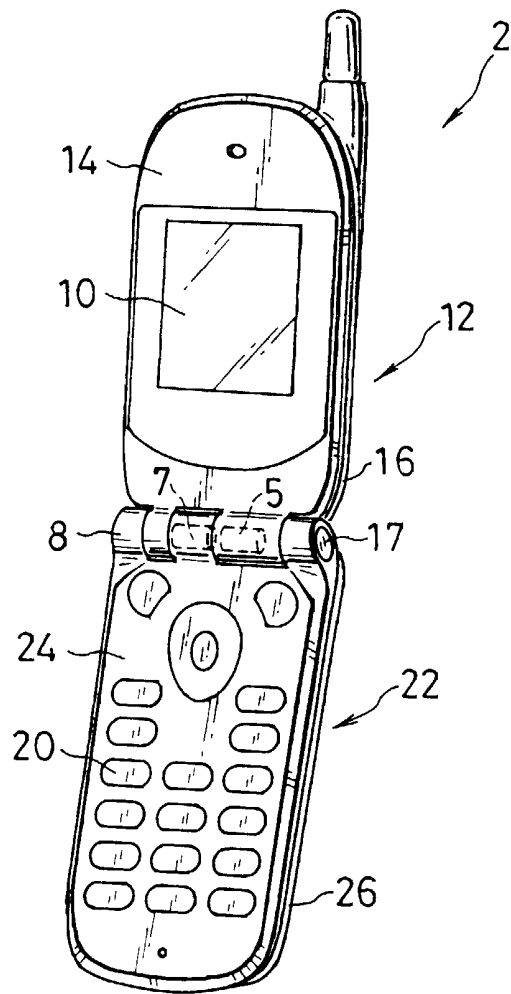


FIG. 2
PRIOR ART

FIG. 4



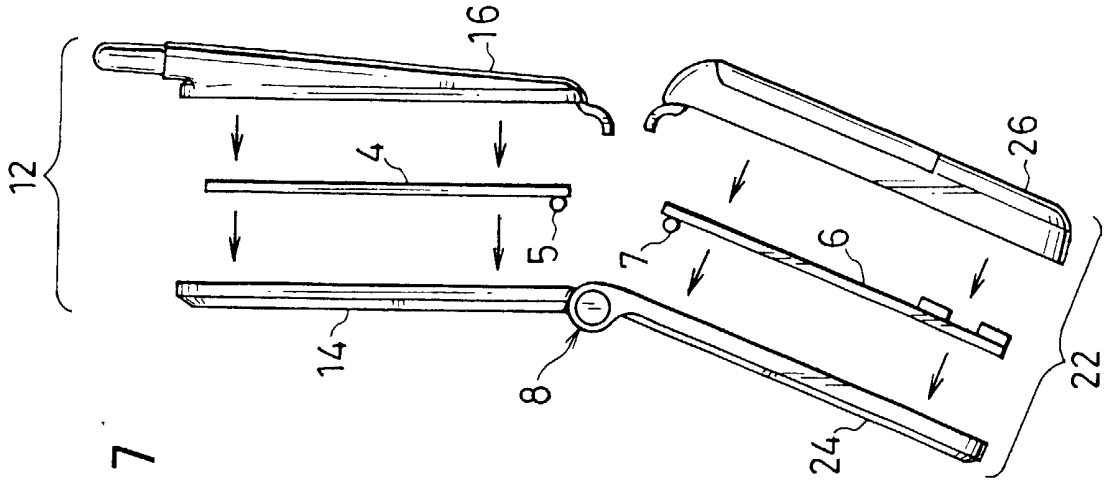


FIG. 7

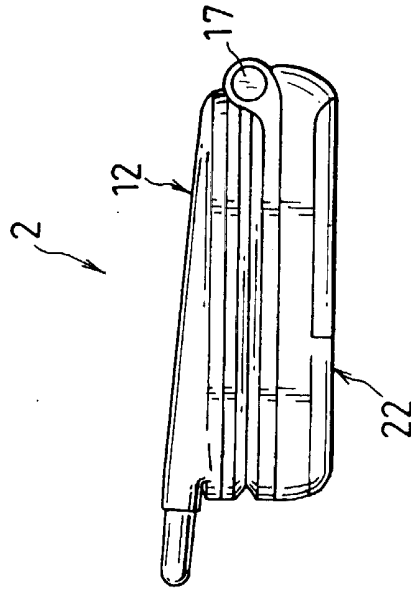


FIG. 6

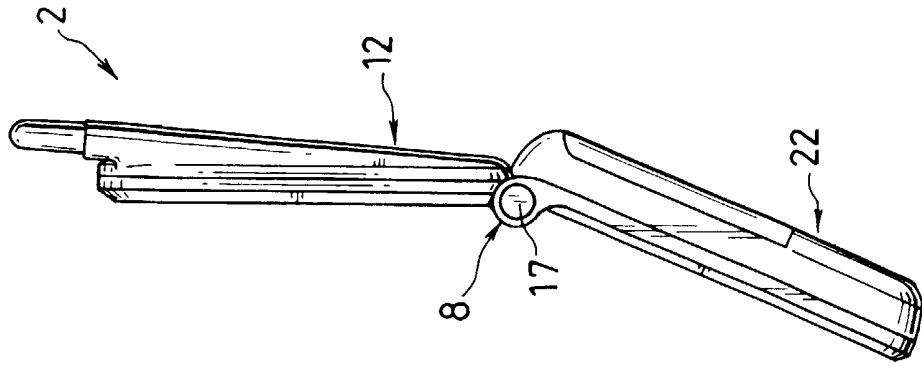


FIG. 5

FIG. 9

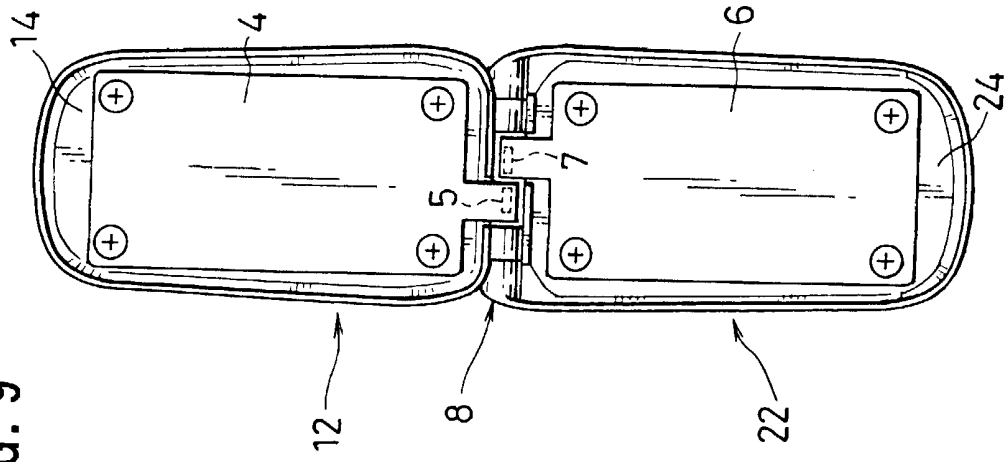


FIG. 8

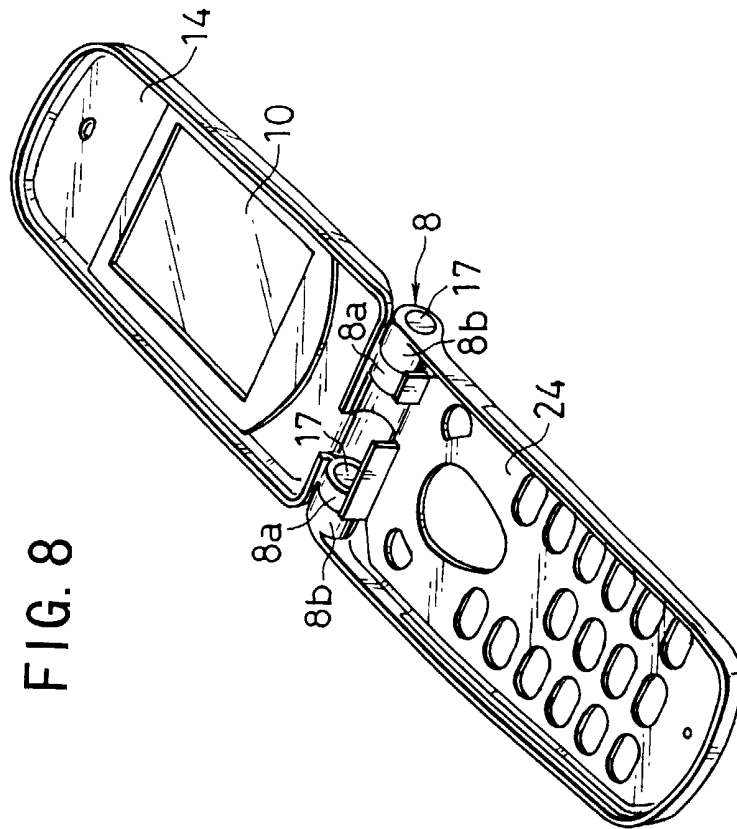


FIG. 10

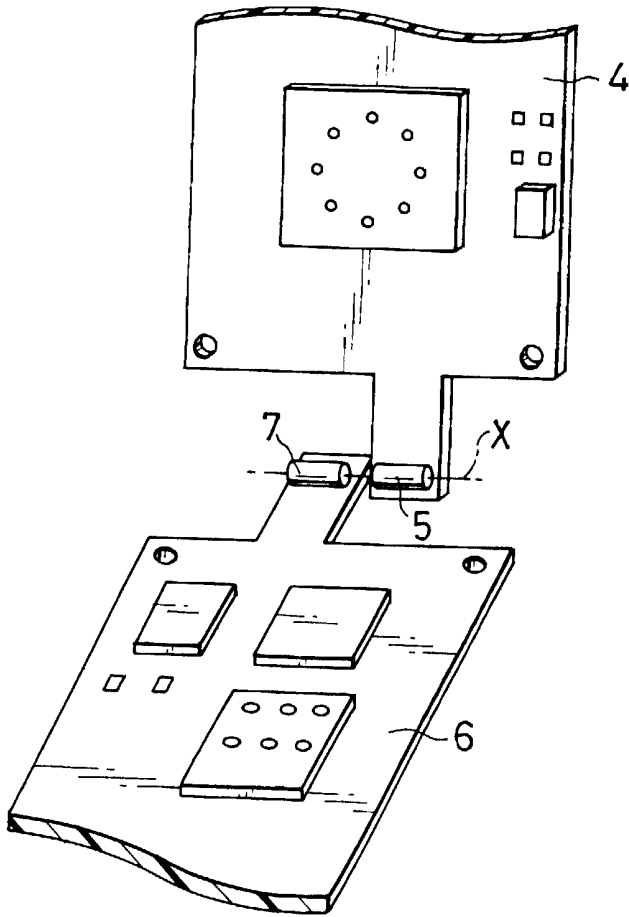


FIG. 11

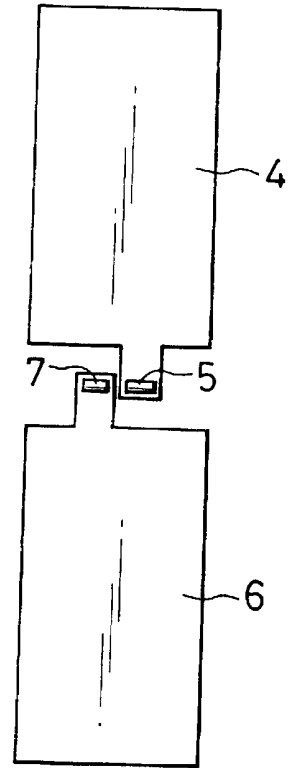


FIG. 13

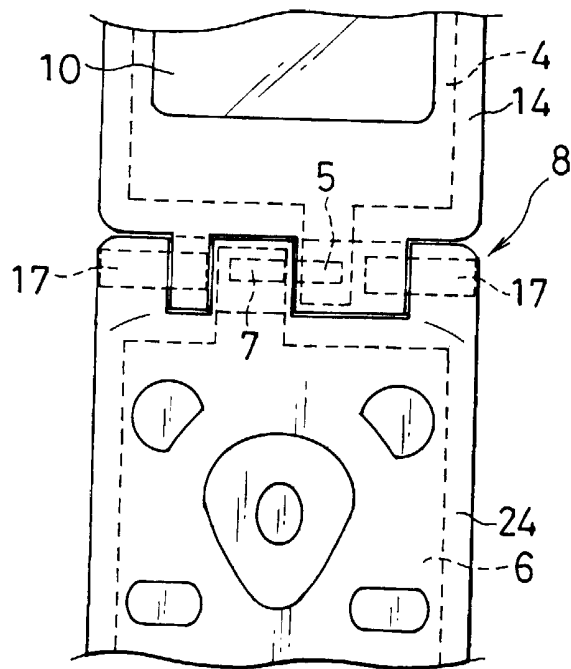


FIG. 12

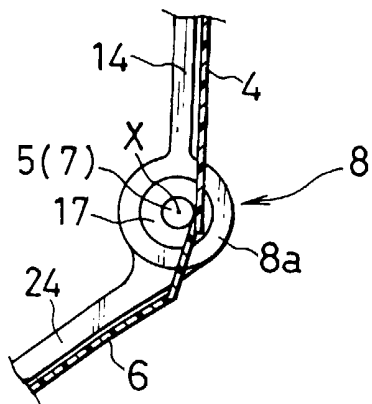


FIG. 14

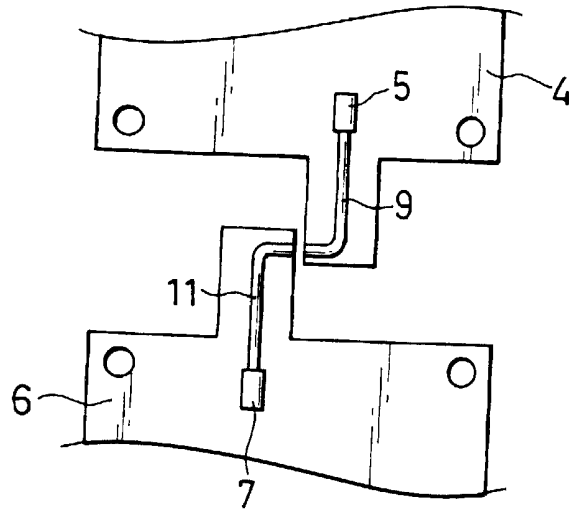
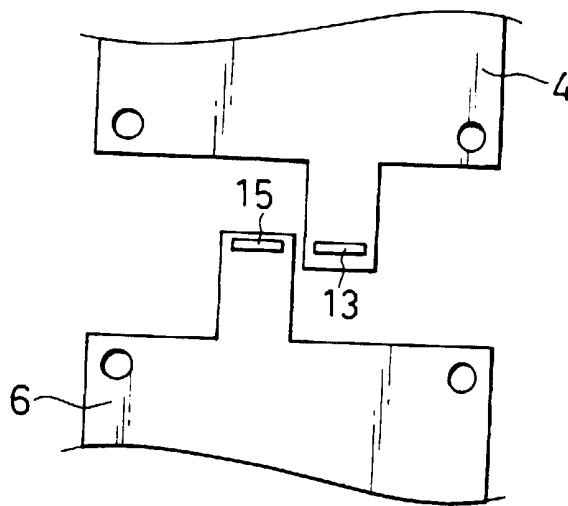


FIG. 15



FOLDABLE ELECTRONIC DEVICE

5

The present invention relates to an electronic device, and in particular to a foldable device such as a cellular phone, having a folding portion.

10

As shown in Fig. 1, a foldable cellular phone set 60 is comprised of one side portion 62 having a display screen 61 and the like, and the other side portion 72 having input buttons 63 and the like. The two side portions 62 and 72 are foldably connected at substantially their central position by a connecting portion 80, so they can be opened/closed. As shown in Fig. 2, one side portion 62 of the foldable cellular phone set 60 is comprised of a first front casing 64 and first back lid 66 that can be divided in the front and back directions. The other side portion 72 is similarly formed of a second front casing 74 and second back lid 76. The connecting portion 80 has a connecting member 80a on the first front casing 64 side and a connecting member 80b on the second front casing 74 side. The connecting members 80a and 80b

are built in the connecting portion 80 together with other connecting members, so the connecting portion 80 is pivotal.

As shown in Fig. 3, one side portion 62 of the foldable cellular phone set has a first board 52, to which a liquid crystal panel for the display screen 61 and a receiver for producing the voice of the other party are to be connected, such that the board 52 is stored between the first front casing 64 and first back lid 66. The other side portion 72 has a second board 54, to which contact components of the input buttons 63 for inputting telephone numbers and the like and a microphone are to be connected, such that the board 54 is stored between the second front casing 74 and second back lid 76.

As shown in Fig. 3, the first and second boards 52 and 54 are electrically connected through a flexible FPC (Flexible Printed Circuit board) 50. The FPC 50 is connected at its one end to the first board 52 through a connector 56, and at its other end to the second board 54 through a connector 58. The FPC 50 is twisted by one turn to form one helical loop at its substantial center in the longitudinal direction, and is connected to the first and second boards 52 and 54. The first and second boards 52 and 54 are fixed to the first and second front casings 64 and 74, respectively, and the first and second back lids

66 and 76 are attached to the first and second front casings 64 and 74, respectively so the first and second boards 52 and 54 are stored. In this manner, since the FPC 50 is stored in the connecting portion 80 as it is
5 twisted by one turn, one and the other side portions 62 and 74 respectively storing the first and second boards 52 and 54 can be folded while maintaining electrical connection to each other.

10 In Japanese Unexamined Patent Publication No. 11-308173, photocouplers are formed on those portions of two casings through which the casings are foldably connected to each other. The casings are electrically connected to each other through the photocouplers.

15 In the conventional foldable cellular phone set, the FPC connectors 56 and 58 are mounted on the respective boards. The two ends of the FPC 50 are fitted in the connectors 56 and 58, so the first and second boards 52 and 54 are electrically connected to each other. Hence,
20 the manufacturing line requires the operation of building the FPC 50 to the connectors 56 and 58 and the like, which is cumbersome. Since the ends of the FPC 50 are thin, when they are to be fitted in the connectors, the connector 56 may be damaged, or the FPC 50 may undesirably
25 bend. Furthermore, if the FPC 50 and connector 56 and the

like are not sufficiently fitted with each other, they cause defective electrical connection, resulting in a defective product.

The FPC 50 is twisted into a loop in the connecting portion 80, and is usually in substantially tight contact with the inner surface of the connecting portion 80. When water enters through the connecting portion 80, capillarity occurs between the FPC 50 and the inner surface of the connecting portion 80, and the water may flow deeply into the connecting portion 80 to wet the first board 52 and the like. This causes corrosion of the first board 52 and the like to lead to a trouble or the like. As the FPC 50 runs from the inside to the outside of the connecting portion 80, the connecting portion 80 cannot be sealed completely.

As the functions of the cellular phone set increase, the amount of information transmitted between the first and second boards 52 and 54 increases. To transmit the information, it is required to increase the number of signal lines in the FPC 50. The space in the connecting portion 80 through which the FPC 50 can run is limited. If the width of the FPC 50 is increased in an attempt to increase the number of signal lines, the FPC 50 cannot run through the connecting portion 80. In addition, in recent years, demands for downsizing of the cellular phone set

increase. To increase the width of the connecting portion 80 for the FPC 50 leads to an increase in size of the phone set main body, failing to downsizing. Information transmission using the FPC 50 is reaching its limit.

5 According to the invention disclosed in Japanese Unexamined Publication No. 11-308173, the casings are electrically connected to each other through the photocouplers respectively provided to the two casings. The two photocouplers abut against each other when the respective 10 casings are opened completely. During opening/closing operation, communication between the two photocouplers is disconnected.

 The present invention seeks to provide for an electronic device having advantages over known such 15 devices.

 According to the present invention, there is provided an electronic device or foldable cellular phone set, in which boards arranged in two casings, foldably connected to each other through a connecting portion are electrically 20 connected to each other by a wireless communication means using infrared rays or the like. More specifically, transmission/reception modules for infrared communication (IrDA) are arranged in the connecting portion coaxially with the rotation axis of the connecting portion, such that

they oppose each other. Even when the connecting portion
of the foldable cellular phone set is bent, the
transmission/reception surfaces of the transmission/
5 reception modules can always oppose each other, and
communication between them is not disconnected by folding
operation.

The present invention is advantageous in that it can
provide an electronic device or foldable cellular phone
10 formed by foldably connecting two casings, which can be
assembled easily, perform communication reliably, cope with
a large communication amount, and always make electrical
connection regardless of the folded state of the casings,
so downsizing and cost reduction can be realized.

15 As the wireless communication means, ultraviolet rays,
visible light, and a radio wave with a weak output can be
used in addition to the infrared rays. When the
transmitting/receiving portions use light, their
transmitting/receiving surfaces must oppose each other.
20 When the transmitting/receiving portions use a radio wave,
their transmitting/receiving surfaces need not oppose each
other, and transmission/reception antennas may be
appropriately arranged on the two casings respectively.
When the pivot angle of the connecting portion is not
25 large, the board may be connected by using optical fibers.

The transmission/reception modules can be arranged at

that portion of the connecting portion having the conventional structure where the FPC used to run. When the FPC is used, it is twisted and arranged, so a substantially cylindrical space is formed in advance.

5 When the transmission/reception modules are arranged at the portion where the FPC used to run, a connecting method which uses infrared modules and the like can be easily applied to the structure of the conventional foldable cellular phone set in which the transmission/reception
10 modules are connected by using the FPC, without largely changing the shape of the basic constituent components such as casings.

As is apparent from the above aspects, with the electronic device or foldable cellular phone set that can
15 be obtained by the present invention, the cumbersome operation of connecting the FPC can be omitted, so the assembly cost can be reduced. In particular, as the IrDA modules can be mounted on the boards by an automatic mounter or the like, they do not need manual assembly
20 unlike in the case using the FPC, so the assembly cost can be reduced largely.

Damage to the FPC connector which occurs when connecting the FPC to the FPC connector can be prevented. Also, disconnection in the FPC, which is due to the
25 bending of the FPC, can be prevented.

Water can be prevented from entering the foldable cellular phone set through the connecting portion. Even if water should enter the phone set, it does not come in contact with any board.

5 Even if the amount of information exchanged between the connected boards increases, this increase in the amount of information can be easily coped with without adding or enlarging the interconnections structurally, unlike in the case of connection using wires.

10 The above and many other objects, features and advantages of the present invention will become manifest to those skilled in the art upon making reference to the following detailed description and accompanying drawings in which preferred embodiments incorporating the principle
15 of the present invention are shown by way of illustrative examples.

Fig. 1 is a perspective view showing the outer appearance of a conventional foldable cellular phone set;

20 Fig. 2 is an exploded side view showing components of the conventional foldable cellular phone set;

Fig. 3 is a plan view showing the boards of the conventional foldable cellular phone set;

25 Fig. 4 is a perspective view showing the outer appearance of a foldable cellular phone set of the present invention;

Fig. 5 is a side view showing a foldable cellular phone set of the present invention in the open state;

Fig. 6 is a side view showing a foldable cellular
5 phone set of the present invention in the folded state;

Fig. 7 is an exploded side view showing components of a foldable cellular phone set of the present invention;

Fig. 8 is a rear perspective view showing the two front casings of a foldable cellular phone set of the
10 present invention;

Fig. 9 is a plan view showing how the boards are attached in a foldable cellular phone set of the present invention;

Fig. 10 is a perspective view showing the two boards
15 of a foldable cellular phone set of the present invention;

Fig. 11 is a plan view showing the two boards of a foldable cellular phone set of the present invention;

Fig. 12 is a partial sectional view showing the connecting portion of a foldable cellular phone set of the
20 present invention;

Fig. 13 is a partial plan view showing the connecting portion of a foldable cellular phone set of the present invention;

Fig. 14 is a partial plan view showing another example
25

of a foldable cellular phone set of the present invention;
and

Fig. 15 is a partial plan view showing still another
example of a foldable cellular phone set of the present
5 invention.

Several preferred embodiments of the present
invention will be described with reference to the
accompanying drawings by way of a foldable cellular phone
10 set.

Fig. 4 shows a foldable cellular phone set 2 of the
present invention entirely. Similarly to the conventional
foldable cellular phone set 60, the foldable cellular
phone set 2 is comprised of one side portion 12 having a
15 display screen 10 and the like, and the other side portion
22 having input buttons 20 and the like. As shown in
Figs. 5 and 6, one and the other side portions 12 and 22
are foldably connected to each other at substantially
their center by a connecting portion 8. Fig. 5 shows an
20 open state, and Fig. 6 shows a folded state.

As shown in Fig. 7, one side portion 12 is formed of
a first front casing 14 and first back lid 16 to be
respectively fitted in its front and back sides, and a
first board 4 to be inserted between the first front
25 casing 14 and the first back lid 16. A connecting member

8a to serve as part of the connecting portion 8 is formed on the first front casing 14 on the connecting portion 8 side.

As shown in Fig. 7, the other side portion 22 is formed of a second front casing 24 and second back lid 26 to be respectively fitted in its front and back sides, and a board 6 to be inserted between the second front casing 24 and the second back lid 26. A connecting member 8b to serve as part of the connecting portion 8 is formed on the second front casing 24 on the connecting portion 8 side.

As shown in Fig. 8, the connecting portion 8 is substantially cylindrical as a whole, and has stoppers 17 at its two ends for pivotally stopping the respective connecting members of one and the other side portions 12 and 22. A cylindrical space is formed in the center of the connecting portion 8.

A liquid crystal panel for the display and a receiver for producing the voice of the other party are mounted on the first board 4. The contact components of the buttons for inputting telephone numbers and the like, a microphone, and the like are mounted on the board 6. Fig. 9 shows a state wherein the first and second boards 4 and 6 are respectively fixed to the first and second front casings 14 and 24.

As shown in Figs. 9 to 11, infrared modules 5 and 7

are attached to the first and second boards 4 and 6 on the connecting portion 8 sides. In Fig. 10, a line denoted by a reference character X shows a rotation axis of the connecting portion 8. The infrared module 5 having an infrared-ray-receiving/emitting element (not shown) in it converts a signal from the first board 4 into infrared rays and emits an infrared signal. Upon reception of an infrared signal, the infrared module 5 converts it into an electrical signal and sends it to the first board 4. The infrared module 7 has the same arrangement as that of the infrared module 5. The infrared modules 5 and 7 oppose each other with their light-receiving/emitting surfaces, as shown in Fig. 13, and are attached to the first and second boards 4 and 6, respectively, such that their two center axes coincide with the rotation axis X of the connecting portion 8, as shown in Fig. 12, when the first and second boards 4 and 6 are respectively fixed to the first and second front casings 14 and 24.

In this manner, in the foldable cellular phone set 2 of the present invention, since the center axes of the infrared modules 5 and 7 are arranged coaxially with the rotation axis X of the connecting portion 8, the positional relationship between the infrared modules 5 and 7 relative to each other does not change at all whether in the open state or the folded state, as shown in Figs. 5

and 6, and the infrared modules 5 and 7 are constantly held to oppose each other.

Therefore, no matter how the connecting portion 8 of the foldable cellular phone set 2 is bent (rotated) during communication using the infrared modules 5 and 7, communication can be maintained. The foldable cellular phone set 2 can operate not only in the open state but also in any state.

Other than the above embodiment, the infrared modules 5 and 7 may come into tight contact with the inner surface of the connecting portion 8, or the gap between the first or second board 4 or 6 extending from one or the other side portion 12 or 22, respectively, and one or the other side portion 12 or 22 may be waterproofed. This can prevent water or the like from entering one and the other side portions 12 and 22 through the connecting portion 8. At this time, the transmitting/receiving surfaces of the infrared modules 5 and 7 may expose from the foldable cellular phone set 2 or may be inside the connecting portion 8.

The infrared modules 5 and 7 need not be formed in the connecting portion 8, but may be formed at appropriate portions of the main bodies of the first boards 4 and 6 arranged in one and the other side portions 12 and 22, respectively, and may be connected to each other through

optical fibers 9 and 11, as shown in Fig. 14. In this case, one end of the optical fiber 9 is attached to the light-receiving/emitting surface of the infrared module 5. The other end of the optical fiber 9 runs into the connecting portion 8 and is arranged coaxially with the rotation axis of the connecting portion 8. One end of the optical fiber 11 is attached to the light-receiving/emitting surface of the infrared module 7. The other end of the optical fiber 11 runs into the connecting portion 8 and is arranged coaxially with the rotation center of the connecting portion 8, so it opposes the end face of the optical fiber 9.

With this arrangement, infrared communication is performed through the optical fibers 9 and 11. The other end face of the optical fiber 9 and that of the optical fiber 11 constantly oppose each other regardless of whether the foldable cellular phone set 2 is folded or not. Hence, communication is not disconnected.

Furthermore, according to the present invention, one and the other side portions 12 and 22 may be connected to each other by a radio wave method, in place of the infrared modules 5 and 7. In this case, the first and second boards 4 and 6 have a wireless transmitting/receiving function (not shown) with a predetermined frequency and output. As shown in Fig. 15,

antennas 13 and 15 are formed in the connecting portion 8
or at those positions of one and the other side portions
12 and 22 where a radio wave can be transmitted or
received. Hence, one and the other side portions 12 and
5 22 can transmit and receive signals to and from each other
through the antennas 13 and 15 regardless of whether the
foldable cellular phone set 2 is folded. Also, since the
antennas can be formed even when the connecting portion 8
is sealed, entering of water or the like can be prevented
10 reliably.

CLAIMS

1. A foldable electronic device having two casings foldably connected to each other by means of a connecting
5 portion which includes wireless communication means for communication between the two casings.

2. A device according to Claim 1, wherein the wireless communication means comprises infrared communication means.

10 3. A device according to Claim 1, wherein the wireless communication means is arranged to transmit and receive radio waves.

4. A foldable radio communications device having two casings foldably connected to each other through a
15 connecting portion and including wireless communication means for communication between the two casings.

5. A device according to Claim 4, wherein the wireless communication means comprises infrared communication means.

20 6. A device according to Claim 4, wherein the wireless communication means is arranged to transmit and receive radio waves.

7. A device according to Claim 2 or 5, wherein the infrared communication means is housed within the
25 connecting portion.

8. A device according to Claim 2 or 5, wherein the

infrared communication means rays is removably mounted in the connecting portion.

9. A device according to Claim 2 or 5, wherein the
5 infrared communication means comprises a first infrared module connected to one of the two casings and a second infrared module connected to the other one of the two casings.

10. A device according to Claim 9, wherein the first
10 and second infrared modules connected respectively to the casings and are arranged coaxially with a rotation axis of the connecting portion, and with light-receiving/emitting surfaces thereof opposing each other.

11. A device according to Claim 9, wherein the
15 infrared modules are connected by optical fiber means.

12. A device according to Claim 11, wherein the
optical fiber means comprises a first optical fiber having one end which is attached to a light-receiving surface of the first infrared module fixed to a first board arranged
20 in one of the two casings and the other end which extends into the connecting portion and is arranged coaxially with a rotation axis of the connecting portion, and a second optical fiber having one end which is attached to a light-receiving surface of the second infrared module fixed to a
25 second board arranged in the other one of the two casings and the other end which extends into the connecting portion

and is arranged coaxially with the rotation axis of the connecting portion so as to oppose the other end face of the first optical fiber.

5 13. A device according to any one or more of the preceding claims, wherein one of the two casings includes a liquid crystal display screen and the other one thereof includes a button operation section.

10 14. A device according to any one or more of Claims 9 to 12, wherein the infrared modules comprise IrDA modules.

15 15. A foldable electronic device substantially as hereinbefore described with reference to and as illustrated in Figs. 4-12, Fig. 14 and Fig. 15 of the accompanying drawings.

20 16. A foldable radio communication device substantially as hereinbefore described with reference to, and as illustrated in, Figs. 4-12, Fig. 14 and Fig. 15 of the accompanying drawings.

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INVESTOR IN PEOPLE

Application No: GB 0225257.5
Claims searched: 1-16

19

Examiner: Stephen Jennings
Date of search: 6 March 2003

Patents Act 1977 : Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance	
X	1-2,4-5,7,9,13-14	GB 2324674 A	(NEC Corporation) See figure 8
X	1-6,9,13-14	GB 2351201 A	(Motorola Inc) See page 7 line 33 to page 9 line 8
X	1-2,4-5,9,13-14	US 5661641	(Shindo) See figure 5
X	1-3,9,13-14	US 6028764	(Richardson et al) See abstract and figure 2
X	1,3,4,6,13	EP 1217501 A2	(Nokia Corporation) See paragraph [0042]

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^v:

H4J

Worldwide search of patent documents classified in the following areas of the IPC⁷:

H04M; G06F

The following online and other databases have been used in the preparation of this search report:

WPI, EPODOC, JAPIO