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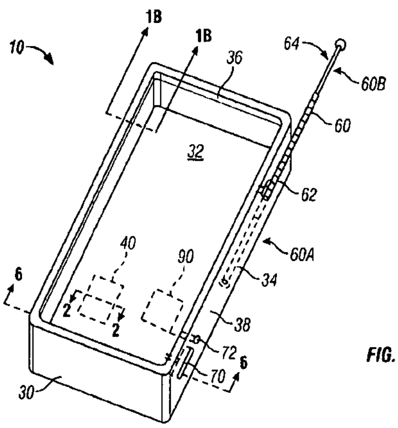

FIG. 1A

(57) **Abstract**: A passively re-radiating cell phone sleeve assembly capable of receiving a nested cell phone provides signal 'boosting capabilities and provides a radar enablement. Signal, boosting is enabled by use of an additional antenna, a pass-through repeater, dual antenna isolation capability and other features.

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SLEEVE WITH ELECTRONIC EXTENSIONS FOR A CELL PHONE

BACKGROUND

[001] This disclosure relates to the field of wireless telecommunications and more particularly to a sleeve enclosure for extending the functional capability of a cell phone. Publication WO 2020/098540 discloses a double molding process wherein in a first molding step, an antenna is embedded within a resin jacket and in a second molding step the resin jacket is embedded within a device case by an insertion molding processes. Publication JP2006/148751 discloses the coupling of antennas built into a cover which when placed over the case of a portable terminal are positioned in close proximity to internal antennas of the terminal and are thereby able to be inductively coupled for strengthening transmitted signals.

SUMMARY

[002] The present disclosure describes a sleeve capable of physically receiving and electronically communicating with a cell phone or other portable wireless communication device and also providing certain ancillary features and supports to the operation of the cell phone including: boosting the cell phone's signal reception and transmission including by use of an additional antenna, providing a radar feature whereby the cell phone is able to display a photo or video of a distant moving object while also calculating and displaying its velocity, providing a repeater capable of auto-tuning to a frequency of the cell phone and boosting signal strength, and employing dual planar antennas capable of operating in close proximity at two different frequencies with excellent isolation between the antennas, such antennas supporting the capabilities of the repeater. The sleeve increases the range of the cell phone and has integrated construction so that it is relatively inexpensive to manufacture and durable in use. The sleeve is able to combine the reception and transmission capacities of a nested cell phone's built-in antenna with an external antenna mounted on the sleeve, or a remote antenna, for greatly improved RF reception and transmission

[003] The details of one or more embodiments of these concepts are set forth in the accompanying drawings and the description below. Other features, objects, and advantages of these concepts will be apparent from the description and drawings, and from the claims.

DESCRIPTION OF DRAWINGS

[004] Figure 1A is an example perspective view of the presently described sleeve;

[005] Figure 1B is an example partial sectional side view of the sleeve taken from cutting plane 1B-1B and additionally showing a portion of a nested cell phone within the sleeve;

[006] Figure 1C is an example partial cutaway portion of the sleeve shown in Fig. 1A showing an additional enablement for storing an external antenna;

[007] Figure 2 is an example sectional view taken from cutting plane 2-2 in Fig. 1A showing a portion of a nested cell phone above a portion of the sleeve;

[008] Figure 3 is an example perspective view of the interior of a back panel of the sleeve showing details of a radar system's components therewithin;

[009] Figure 4 is an example front face view of a cell phone showing a radar related display;

[0010] Figure 5 is an example electrical schematic diagram of the sleeve and the cell phone showing an electrical interconnection;

[0011] Figures 6A and 6B are example sectional views taken from cutting plane 6-6 in Fig. 1;

[0012] Figure 7 is an example block diagram showing the sleeve and radar communicating with a target;

[0013] Figure 8 is an example schematic diagram of the radar;

[0014] Figure 9 is a logical flow diagram of an exemplary radar process;

[0015] Figures 10, 11, and 12 are exemplary electrical schematic diagrams of a signal repeater circuit;

[0016] Figure 13 is a logical flow diagram of an exemplary process of the repeater circuits of Figs. 10, 11, and 12;

[0017] Figure 14 is an example plan view of a dual antenna system with slot isolation; and

[0018] Figure 15 is an example graphical plot showing isolation between antenna elements.

[0019] Like reference symbols in the various drawing figures indicate like elements.

DETAILED DESCRIPTION

[0020] **Fig. 1A** illustrates a re-radiating cell phone sleeve assembly, referred to herein as "sleeve **10**," capable of conforming to, and nesting with, a cell phone or similar portable wireless device which is not a part of sleeve **10**. The term cell phone, referred to herein as "phone **20**," is used throughout this description and it should be recognized that this term may refer to a cellular telephone or any other portable RF communication apparatus and sleeve **10** may be fabricated to dimensions that will accept each different size and shape phone **20**. Sleeve **10** includes a full or partial enclosure **30** made of a conformable material such as rubber, rubberized plastic, a plastic and rubber combination, or a combination of plastic polymers. Enclosure **30** is capable of tightly fitting over and around at least a portion of phone **20**. In the preferred embodiment shown in **Figs. 1A** and **1B**, enclosure **30** has a rear panel **32** integral with a surrounding side wall **34** which has an internal lip flange **36** all around. When phone **20** is nested within sleeve **10**, a lip flange **36** (**Fig. 1B**) extends peripherally over a portion of a face **22** (**Fig. 4**) of phone **20** so as to secure phone **20** within sleeve **10**. Also, the material of which enclosure **30** is fabricated may be at least partially elastic so that it may be stretched slightly upon receiving phone **20** and thereby providing an improved securement.

[0021] Referring again to **Fig. 1A**, a planar multi-layer radio frequency (RF) coupling probe **40** may be embedded within rear panel **32** by insertion injection molding or other means, and may be in a location that is in close proximity to, and may lay directly adjacent to an internal antenna **50** (**Fig. 2**) of phone **20** when phone **20** is within sleeve **10**. In this manner, probe **40** is in a position for electromagnetic coupling with internal antenna **50** for boosting the phone's signal strength. Inductive, capacitive or other electromagnetic coupling may be employed.

[0022] Referring still to **Fig. 2**, probe **40** may have a multilayer planar construction including a first material layer **44**, such as, but not limited to fiberglass epoxy or thermoset laminate of low relative dielectric constant (DK) typically in the range of DK=2 to DK=5; a second patterned metallization layer **45** of copper, silver-filled paste or other electrical conductor which may be deposited or printed on one side of the first layer **44** and may have a material thickness of about 0.7 to 1.4 mils for optimal operation, thereby forming a distributed resonant circuit; and a third material layer **46** such as a ceramic-filled laminate having a relatively high DK typically in the range of DK=20 to DK=50, whereby layer **46** may be in intimate face-to-face contact with second layer **45**. Probe **40** may have the same size and shape as internal antenna **50** for optimal operation. An important characteristic of probe **40** is that it functions as an anti-resonant network because of its high capacitance-to-inductance ratio which enables near field coupling and may be reception band selective by virtue of its unloaded high-Q quality factor. Band selectivity may provide multi-band resonance, for example, resonance for one or more frequency bands such as: 700, 850, 900, 1800, 1900, and 2100 MHz and others are possible, a highly desirable and novel characteristic.

[0023] An external antenna **60**, as shown physically in **Figs. 1A**, **1C**, and **6B** may be mounted on, and in parallel alignment, with side wall **34**. Transmission line **42**, as shown in **Fig. 1A** and **6B** may be embedded within the rear panel **32** in order to connect probe **40** with external antenna **60** for RF signal transfer therebetween. Transmission line **42** may be a metallized or printed conductive strip. This arrangement enables RF transmission/reception at both the antennas **50** and **60** simultaneously while minimizing mutual interference. Antenna **60** may be mounted on enclosure **30** using a mechanical swivel joint **62** so that antenna **60** may be able to rotate between a retracted position **60A**, shown in dashed line in **Fig. 1A**, and an extended position **60B** shown with solid lines. Antenna **60** may be a simple rigid rod, telescoping or other. Side wall **34** may have a recess as shown in **Fig. 1C** for securing antenna **60** when retracted. Antenna **60** may be operational in both its retracted position **60A** as well as its extended position **60B**.

[0024] As shown in **Figs. 1A** and **5**, sleeve **10** may have a remote antenna port **70**, molded into side wall **34** along with a toggle switch **72**. Switch **72** may function to select either external antenna **60** or a remote antenna **80** (**Fig. 5**). A signal boosting amplifier **90** may be in signal communication with probe **40**, and switch **72** using metallized conductor paths **42** and **74**. Amplifier **90** may be single or bi-directional and may be enabled with diplexers, duplexers and automatic gain control (AGC) and other features for improved performance. Amplifier **90**, may be a planar device powered by battery **92** which may be mounted within side wall **34**. Elements **40**, **60**, **70**, **72**, and **90** may be electrically interconnected using metallized or printed paths **42** and the paths **42** and elements **40**, and **90** may be embedded within rear panel **32**. This is shown in **Figs. 6A** and **6B** where enclosure **30** may be fabricated by injection molding techniques in a preferred approach where the rear panel **32** is constructed of layers **32A** and **32B** encapsulating probe **40**, amplifier **90** and said conductive interconnecting paths **42** as shown in the schematic diagram of Fig. 5. As described above, sleeve **10** taken by itself defines one embodiment of the present apparatus.

The sleeve **10**, as nested and electronically interconnected with cell phone **20**, defines a second embodiment.

[0025] As shown in **Fig. 3** sleeve **10** may additionally be configured, with a radar system ("radar transceiver **230**") physically integrated into rear panel **32**. Radar transceiver **230** provides a means for measuring the speed of a distant object "target **205**" as shown in **Fig. 7**, with the convenience of a cell phone **20**. The radar transceiver **230** may be a Doppler radar system or another type of radar system. In this embodiment, the phone **10** has an optical targeting device such as a cellphone camera **21** which may be used to sight on target **205**, while radar transceiver **230** measures its speed. A display such as a cellphone screen **25** may present the target **205** and its speed information as shown in **Fig. 4**. A storage medium such as a cellphone memory **23** is able to store this information while a wireless transmitter such as cellphone transceiver **26** transmits the information to one or more selected distant receivers such as other cell phones, land-line phones, automated computers, and other devices. The cellphone elements: **21**, **23**, **25**, and **26** are operated by a cellphone processor **22** in accordance with cellphone electrical circuit and software protocols that are well known in the field of cell phone technology. Prior to using cell phone **20** for the present application, operational software **24** is loaded into cellphone memory **23**, and then digital processor **22** carries out the instructions of software **24** in accordance with the present method as shown in **Fig. 9** and described herein.

[0026] Use of the cell phone camera display **25** as a targeting device allows this hand-held system to be manually positioned for viewing target **205** so as to achieve an advantageous level of accuracy in determining the target's speed rather than that of extraneous nearby objects, and also in avoiding mixed or confused determinations due to moving backgrounds as the phone 20 tracks the path of target 25. As described, display **25** may be a solid-state display screen or it may be any other display device. Likewise, the wireless transmitter may be a phone transceiver **26** as stated, or it may be any other personal or mobile telephone or similar device. One or more of the: display **25**, memory **23**, software **24**, processor **22**, and wireless transceiver **26** may be integrated into sleeve **10**, or may be a separate component but may be interconnected as shown in **Fig. 7**.

[0027] As shown in **Figs. 7** and **8**, radar transceiver **230** includes transmit-receive antenna **232**, transmit amplifier **234f**, receive amplifier **234d**, variable amplifiers **234c**, voltage controlled oscillator **234a (VCO)**, transceiver processor/controller **233 (CPU)**, quadrature demodulator **234b (DQD)**, analog-to-digital converter **246 (ADC)**, and digital-to-analog converter **244 (DAC)**.

[0028] When phone **20** is placed within sleeve **10** the link between phone **20** and radar transceiver **230** is made by, for instance connector **36 (Fig. 3)**, or by a wireless method such as Bluetooth, or by induced signals between adjacent non-conducting elements as fully explained above. Radar transceiver **230** may use a highly directional transmit antenna to better focus radiated RF energy in the direction of target **205**. Various antenna designs may be used including a planar array of patch antenna elements, as shown in **Fig. 3**, which provide the necessary gain and directivity. The transmit-receive antenna **232** may alternately be separate antennas for receive and transmit.

[0029] Radar transceiver **230** utilizes the Doppler effect, as previously described, comparing a transmitted wave frequency with a bounced wave frequency to determine the shift in frequency due to the relative motion between the target **205** and the transmit/receive antenna **232**.

[0030] Once phone **20** is installed in sleeve **10** and software **24** is installed in memory **23** the apparatus is ready to measure the speed of a distant moving object. With the back panel **32** directed toward a moving target **205** an "app" icon is selected on display **25** which sends a start signal to radar transceiver processor **233** to initiate instructions for carrying-out a speed measurement cycle. The electrical circuit diagram of **Fig. 18** supports an understanding of this process. A radar burst (RF energy) is emitted by transmit amplifier **234f** through antenna **232** in the direction of target **205**. This RF energy impinges on target **205** and a small amount of the RF energy signal is reflected and acquired by antenna **232**. Low noise receive amplifier **234d** boosts the acquired reflected signal and quadrature demodulator **234b** down-converts the signal. Demodulator **234b** comprises high-frequency splitter **234b-3** which delivers the reflected signal to mixers **234b-2**. Low frequency splitter **234b-1** delivers the transmitted signal to mixers **234b-2.** The output from mixers **234b-2** is the difference between the transmitted and reflected frequencies. This difference signal is the Doppler frequency shift due to the relative velocities of sleeve **10** and target **205**. The difference signal is digitally sampled and the speed of the target is calculated by **CPU 233** using the well-known formula **v = Fd/2(Ft/c)** and the speed information is routed to phone processor **22**. The calculated speed of the target is displayed as shown in **Fig. 4**. Alternately, the digital samples may be routed directly to phone processor **22** for speed calculation and display. **Fig. 9** is an overview of the process.

[0031] Radar transceiver processor **233**, driven by battery **235**, communicates with the cellphone processor **22** and also sets amplifier gain, VCO frequency, and other settings as directed by software **24**. The process is identical whether or not the phone **20** and the radar transceiver **230** are integral or separate units. When software **24** is initialized it produces a user interface on cellphone display **25** and also initiates a background process communicating with radar transceiver **230.** To acquire a speed measurement, as said, phone **20** is directed toward target **205** so that it is visible on display **25**. The software **24** enables the capture of video images using the cellphone's camera which is able to view target **205** through opening **43** in the back panel **32** of sleeve **10**. As said, speed measurements may be displayed and also recorded into memory **23** in along with video capture.

[0032] Sleeve **10** may further include a frequency selective repeater circuit **310** which uses frequency information received from enclosed phone **20** to adjust signal filtering in order to boost signal strength at a selected frequency. As shown in **Figs. 10, 11,** and **12**, phone **20** may communicate with a base station **BS** as is well known. Also well known in cellular telephony, is that cell phones **20** adapt their operating frequency as dictated by the base stations **BS** through which they operate. This operating frequency is stored in cell phone memory. The operating frequency is transmitted by the cell phone **20** continuously in accordance with a software application **325** stored in cell phone memory and executed by the cell phone's processor **22**. Repeater **310** receives the cell phone's signal and adjusts to the operating frequency.

[0033] **Figs. 10, 11**, and **12** disclose embodiments of a repeater **310**. **Fig. 10** shows a circuit downlink path including antenna **AE1**, filter **FL1**, amplifier stage **A1**, variable filter **FL2**, amplifier stage **A2**, filter **FL3** and antenna **AE2**. An uplink path includes antenna **AE2**, filter **FL4**, amplifier stage **A3**, variable filter **FL5**, amplifier stage **A4**, filter **FL6** and antenna **AE1**. A controller **C**, such as model SAM9 manufactured by Atmel, Inc., receives an operating frequency designation and adjusts **FL2** and **FL5** each of which may be a model Micro-400-700 manufactured by Pole Zero, Inc. to pass only a band centered on the operating frequency. This circuit enables information relayed from base station **BS** to cell phone **20** to be used to adjust the band pass within the circuit so as to exclude other frequencies and noise and only repeat and boost a selected RF frequency or pass band of frequencies. In this embodiment all analog components function at RF frequencies. This has the advantage of being relatively less expensive, however, it does not achieve the out-of-band frequency and noise rejection that a circuit operating at an intermediate frequency (IF) can achieve.

[0034] **Fig. 11** discloses a further embodiment of repeater **310** having a downlink path including antenna **AE1**, RF filter **FL1**, amplifier stage **A1**, mixer **M1**, local oscillator **LO1**, amplifier stage **A2**, IF filter **FL2**, IF variable gain amplifier stage **A3**, mixer **M2**, RF amplifier stage **A4**, RF filter **FL3** and antenna **AE2**. An uplink path includes antenna **AE2**, RF filter **FL4**, RF amplifier stage **A5**, mixer **M3**, local oscillator **LO2**, IF amplifier stage **A6**, IF filter **FL5**, variable IF amplifier stage **A7**, mixer **M4**, RF amplifier stage **A8**, RF filter **FL6**, and antenna **AE1**. As with the circuit of **Fig. 10**, controller **C** receives operating frequency information from cell phone **20** and adjusts their band pass by adjusting the local oscillators **LO1** and **LO2**. As above, this circuit enables information relayed from base station **BS** to cell phone **20** to adjust the band pass within the circuit so as to exclude other frequencies and noise and only repeat and boost a selected RF frequency or pass band of frequencies. In this embodiment the drawback of circuit **Fig. 10** is avoided since filtering and amplification functions are able to be conducted in the IF frequency range. **Fig. 12** operates in the same manner as the circuit of **Fig. 11** with the improvement of digital processing at controller **C** which results in an improved control over oscillators **LO1** and **LO2**.

[0035] In the circuits shown in **Figs. 11** and **12** filtering and amplification is conducted in the IF range. As is known, it is difficult to build amplifiers, filters, and detectors that can be tuned to different frequencies, but it is easy to build tunable oscillators. Also, in RF communications, converting to a lower intermediate frequency offers an advantage because RF amplifiers have upper frequency gain limits so that a lower IF offers the possibility of higher gain. Also, at IF, filtering to extract a single frequency from signals that are close together is easier and noise is also easier to exclude. This is because a filter's bandwidth increases proportionately with the signal's frequency. So a narrower bandwidth and more selectivity can be achieved by converting the signal to an IF. The IF used may be 10.7 MHz or a frequency in that range. **Fig. 13** defines a method of operation of these circuits. In this method, repeater hardware and software are initialized for communications. Repeater fault detection may find positive and if so, repeater **310** is shut down awaiting instructions. If no fault is detected, phone software collects channel information from a base station **BS** and this information is transmitted to repeater **310**. Next, repeater **310** adjusts VCO frequency or signal filters in accordance with the channel information and adjusts RF power and gain. Repeater **310** is now able to monitor for fault detection and if detected, repeater **310** sends fault information to phone **20** and shuts down awaiting further instructions. If no fault is detected channel information is collected and this cycle is repeated continuously.

[0036] The antenna system **410** shown in **Fig. 14** may represent antennas **AE1** and **AE2** of repeater **310** and has broad applicability beyond such repeaters. For optimal operation elements **420** and **430** may have a length of lambda/4, 2, or 1. Elements **420** and **430** are part of the antenna structure shown and has a tuned slot element **440** positioned between the antenna elements **420**, **430**, the tuned slot element **440** enabling preferential signal reception by the antenna elements **420**, **430** in two selected frequency bands with the advantage of providing isolation of the radiation of each of the antenna elements **420**, **430** from each other. The antenna elements **420**, **430** and the tuned slot element **440** may be planar and may be electrically conductive, and mounted on a dielectric sheet **450**. Elements **420**, **430**, **440** may be covered by a dielectric layer (not shown). The antenna and tuned slot elements **420**, **430**, **440** may be of copper sheet material and the dielectric sheet **450** may be of a glass epoxy substrate material or similar substance. As shown in **Fig. 14**, the tuned slot element **440** may have two spaced apart segments, a C-shaped segment **460** and a roughly linear segment **470**. The C-shaped segment **460** may have a first linear leg **462** extending in a first direction (arrow **A**), and a second linear leg **464** extending in a second direction (arrow **B**), and the second direction may be orthogonal with respect to the first direction. The C-shaped segment **460** may also have a triangular portion **466**. The linear segment **470** may form an acute angle (a) with the triangular portion **466** and also form a second acute angle (b) with the first linear leg **462**. Spacing between the linear segment **470** and the triangular portion **466** may enable 1900 MHz signal reception by the antenna elements **420**, **430** while spacing between the linear segment **470** and the first linear leg **462** may enable 850 MHz signal reception by the antenna elements. **Fig. 15** is a plot of antenna signal isolation (**i**) with respect to radio frequency (**f**). Curve **A** (solid line) is as measured with the tuned slot element 440 missing or removed, while curve **B** (broken line) is as measured with tuned slot element 440 as shown in **Fig. 14**. It is clear that tuned slot element **440** provides almost infinite isolation at the operating frequency **F1**.

[0037] The common functions of signal reception and transmission, filtering, amplification, mixing using a local oscillator, and converting between analog and digital signal forms are well known in the field so that further details of these functions and the nature of these operations is not further described herein. The "Electrical Engineering Reference Manual," ISBN: 9781591261117 is incorporated herein by reference in its entirety to provide details and technical support related to the elements and functions presented herein. Embodiments of the subject apparatus and method have been described herein. Nevertheless, it will be understood that various modifications may be made without departing from the spirit and understanding of this disclosure. Accordingly, other embodiments and approaches are within the scope of the following claims.

[0038] Applications US13/238,894 filed on 21/09/2011, US13/590,053 filed on 20/08/2012, US13/591,152 filed on 21/08/2012, and US13/591171 filed on 21/08/2012 are hereby incorporated into this document by reference in their entirety.

CLAIMS

WHAT IS CLAIMED IS:

Claim 1. A re-radiating cell phone sleeve assembly for engaging a cell phone in a nested relationship, the assembly comprising:

an enclosure having a back panel integral with a surrounding side wall and a frontal peripheral lip, the lip positioned for partially covering the engaged cell phone;

an embedded electrical circuit within a back panel of the enclosure, the circuit providing a signal boosting external antenna circuit, a signal boosting repeater, and a dual antenna isolation circuit, the circuit further including a radar enablement.

Claim 2. The sleeve assembly of claim 1 wherein the signal boosting external antenna circuit has a planar multi-layer radio frequency coupling probe positioned for electromagnetic coupling with an antenna of the cell phone.

Claim 3. The sleeve assembly of claim 1 wherein the signal boosting repeater uses a method including receiving and storing channel information in a cell phone memory of a cell phone, tuning the cell phone to a channel designated in the channel information, transmitting said channel information from the cell phone to a channel selective repeater, adapting the repeater to pass only signals in the channel, collecting off-the-air signals at the repeater, filtering the signals to pass only signals in the channel; and transmitting signals in the channel to the cell phone.

Claim 4. The sleeve assembly of claim 1 wherein the dual antenna isolation circuit has a pair of spaced apart planar antenna elements, and a planar tuned slot element positioned between the antenna elements, the tuned slot element preferentially enabling signal reception by the antenna elements in two selected frequency bands using two segments, a C-shaped segment and a linear segment wherein the C-shaped segment has a first linear leg extending in a first direction, and a second linear leg extending in a second direction and a triangular portion and wherein the linear segment is convergent on the triangular portion and on the first linear leg.

Claim 5. The sleeve assembly of claim 1 wherein the radar enablement uses a Doppler transmit-receive antenna, a radar transceiver, a software program stored in a memory of the cell phone, and a circuit for communicating between the radar transceiver and a processor of the cell phone.

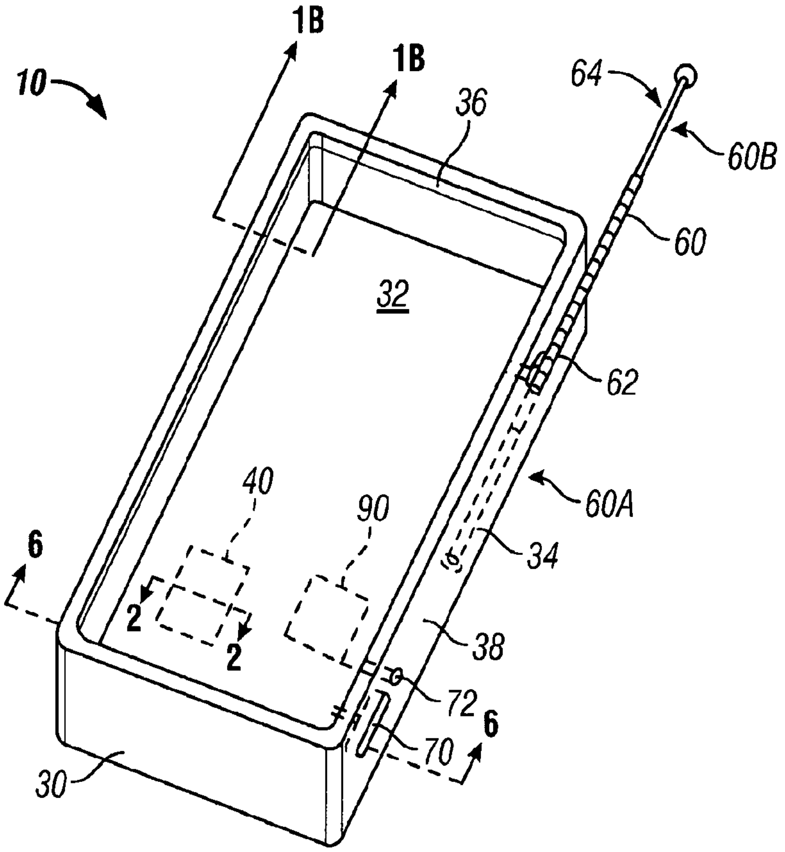

FIG. 1A

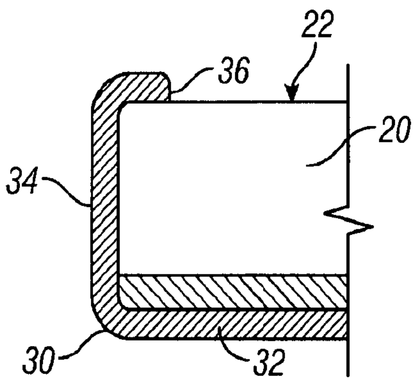

FIG. 1B

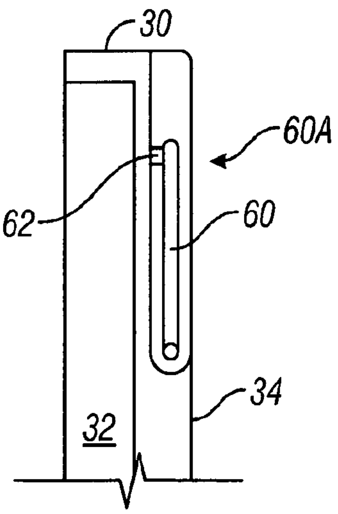

FIG. 1C

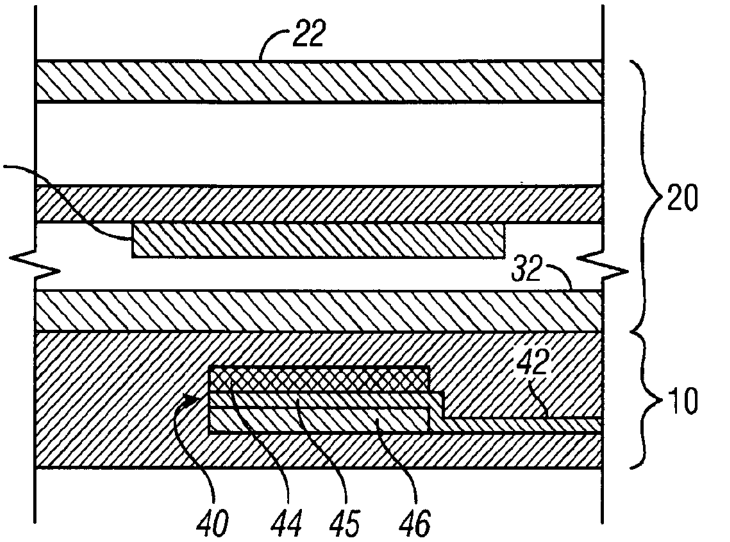

FIG. 2

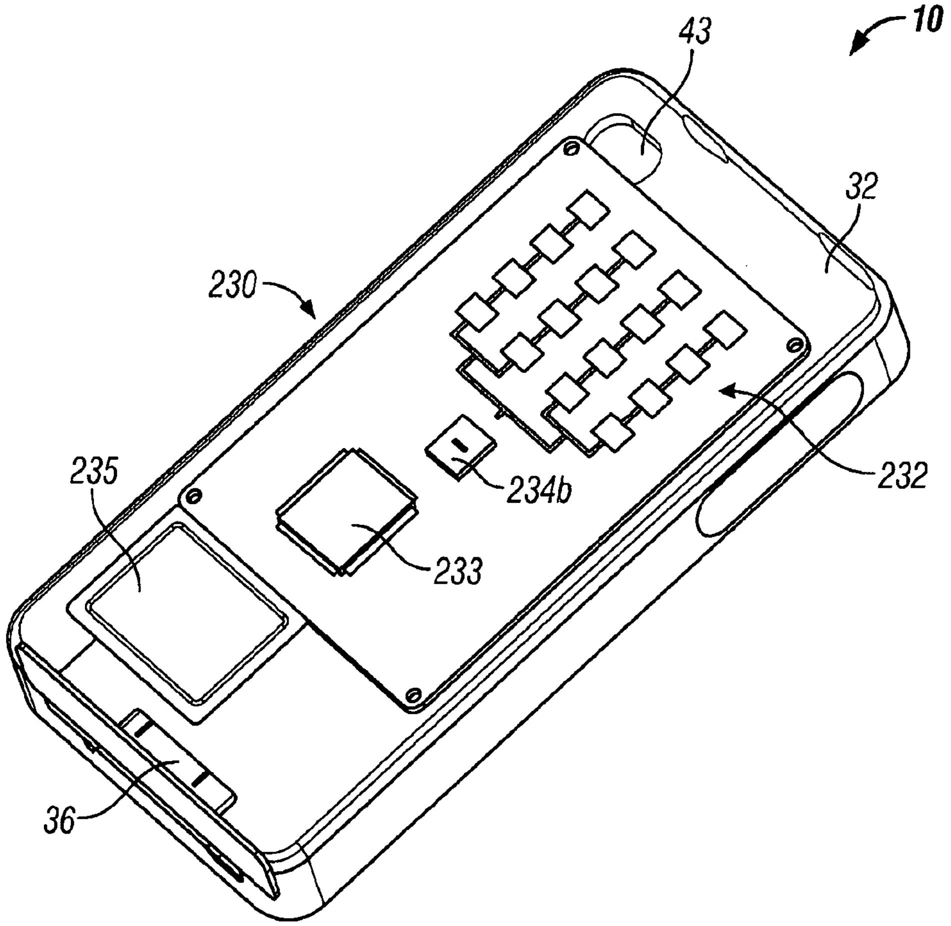

FIG. 3

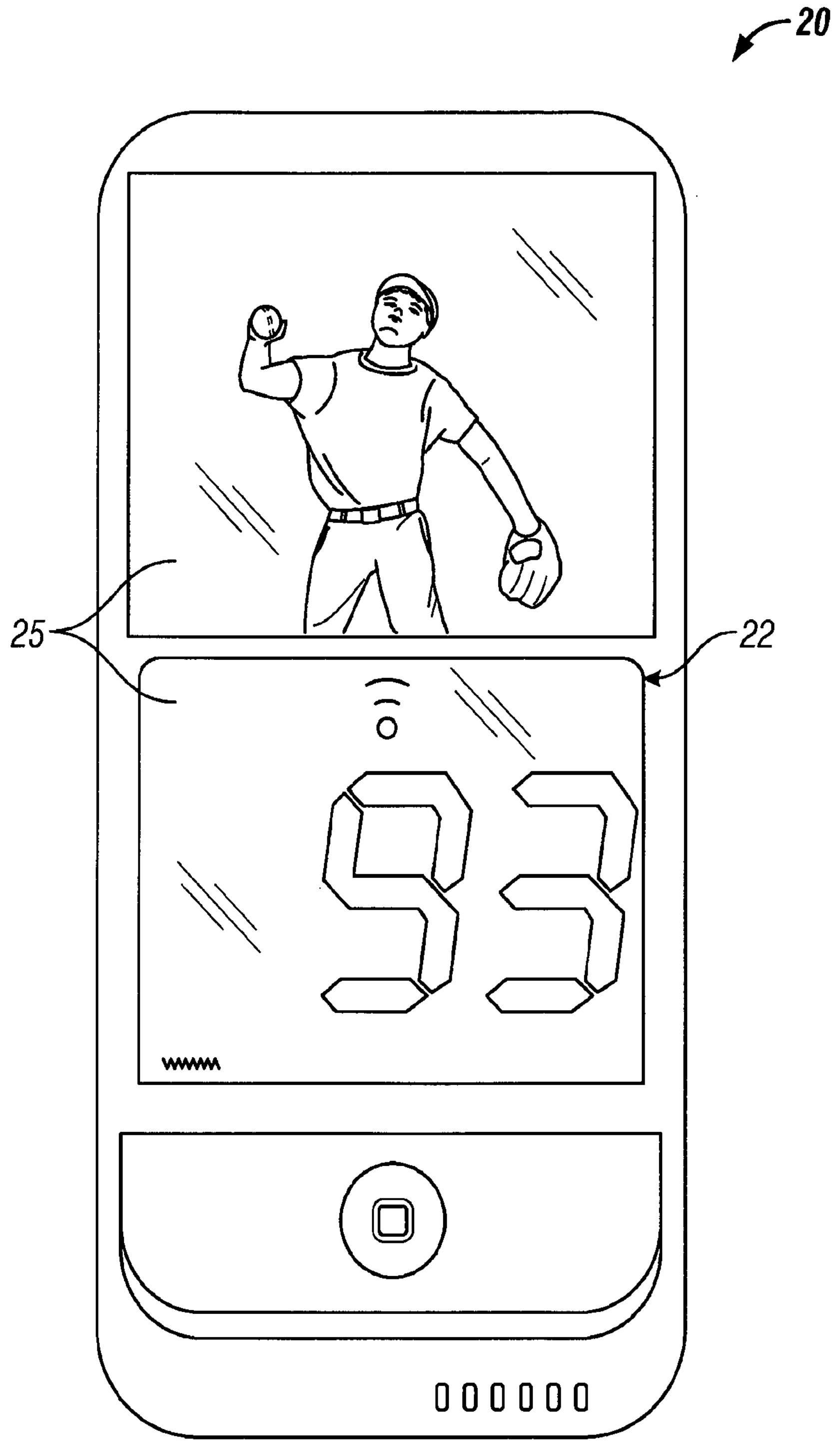

FIG. 4

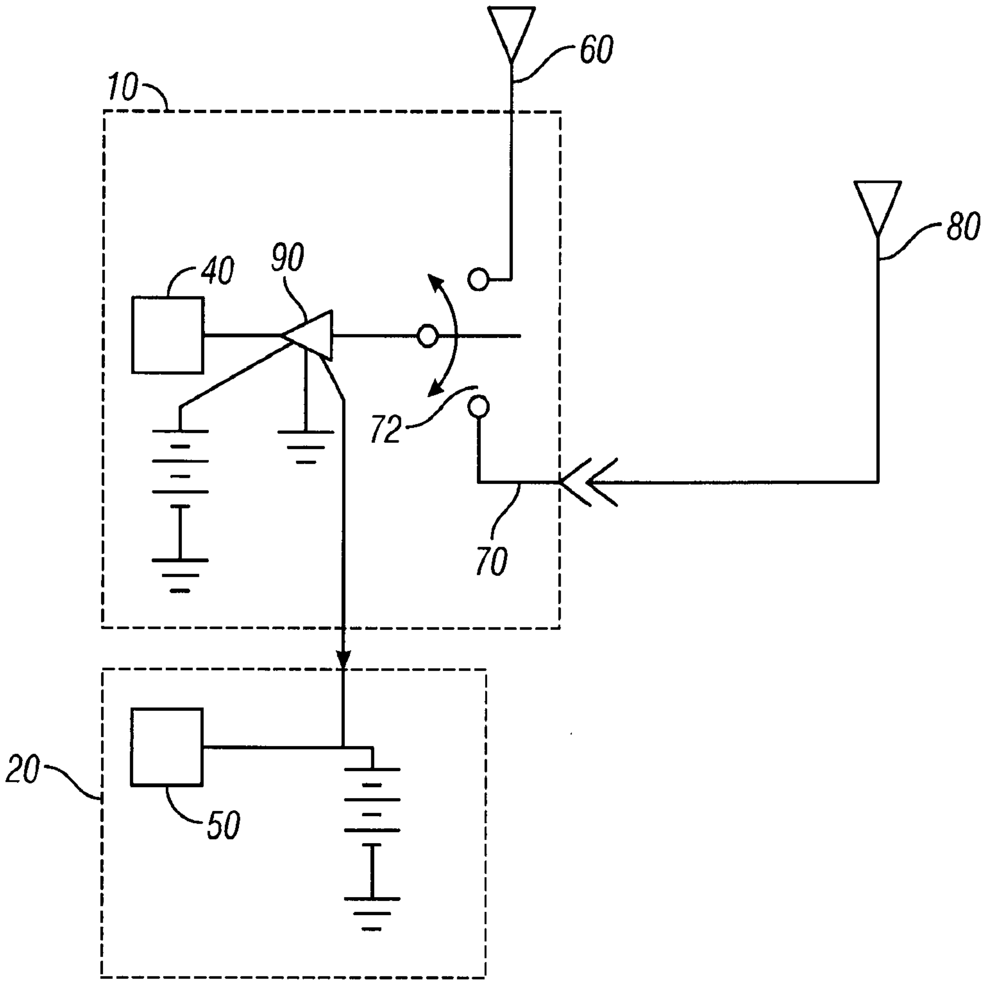

FIG. 5

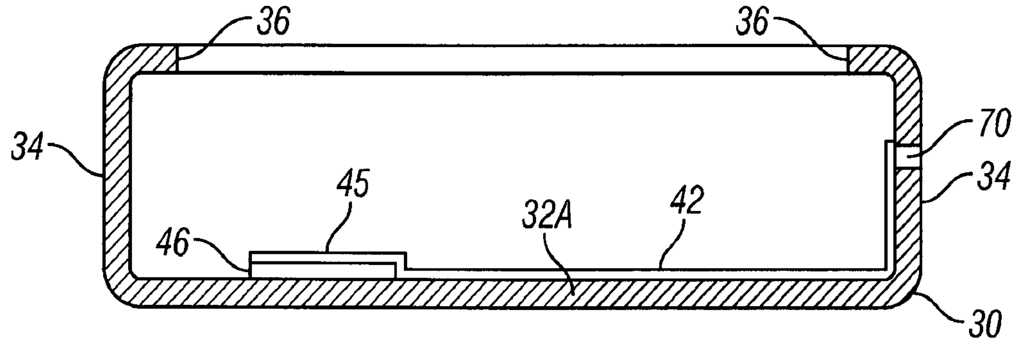

FIG. 6A

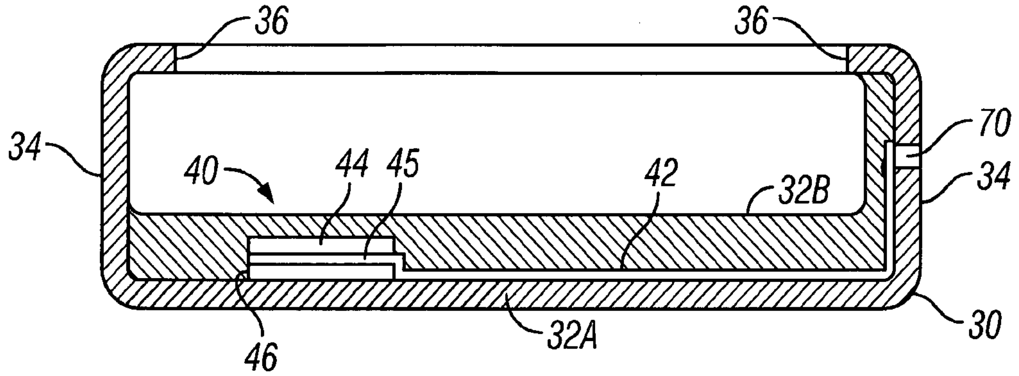

FIG. 6B

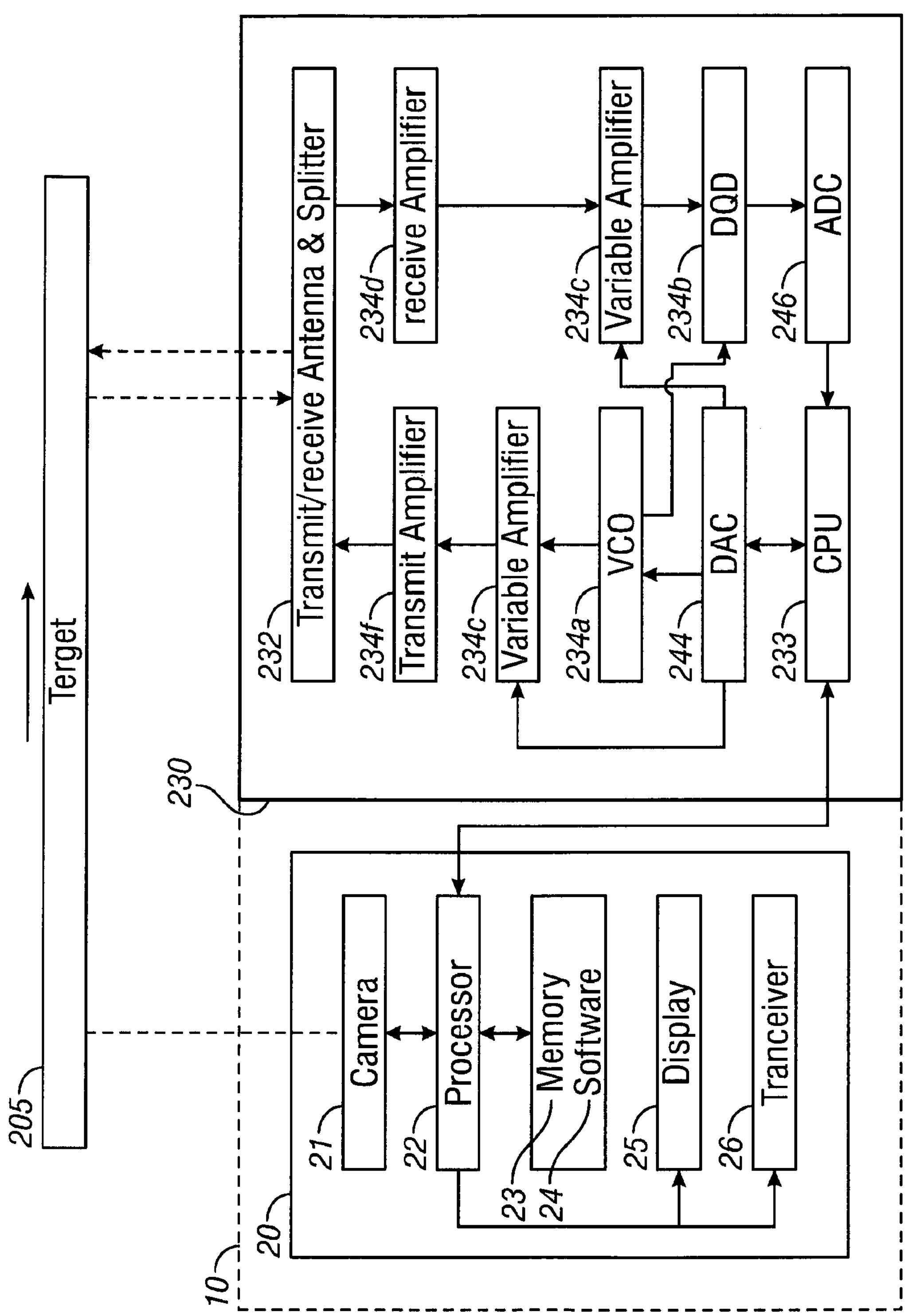
Terget
205
Transmit/receive Antenna & Splitter
232
receive Amplifier
234d
Transmit Amplifier
234f
Variable Amplifier
234c
Variable Amplifier
234c
VCO
234a
DQD
234b
DAC
244
ADC
246
CPU
233
230
Camera
21
Processor
22
Memory
23
Software
24
Display
25
Tranceiver
26
20
10

FIG. 7

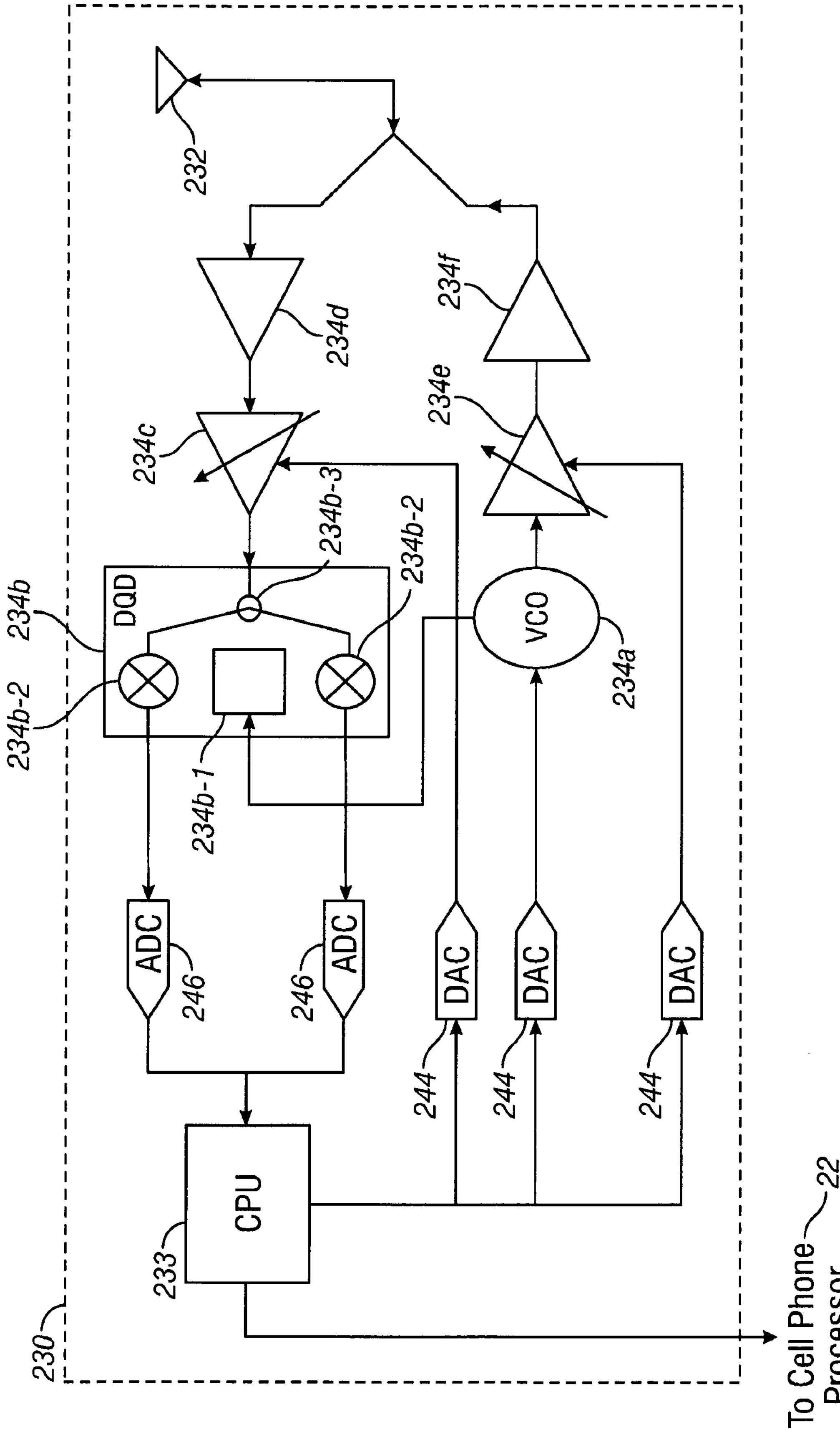
232
234d
234f
234c
234e
234b-3
234b-2
234b
DQD
234b-2
234b-1
VCO
234a
ADC
246
ADC
246
DAC
DAC
DAC
244
244
244
CPU
233
230
To Cell Phone Processor
22

FIG. 8

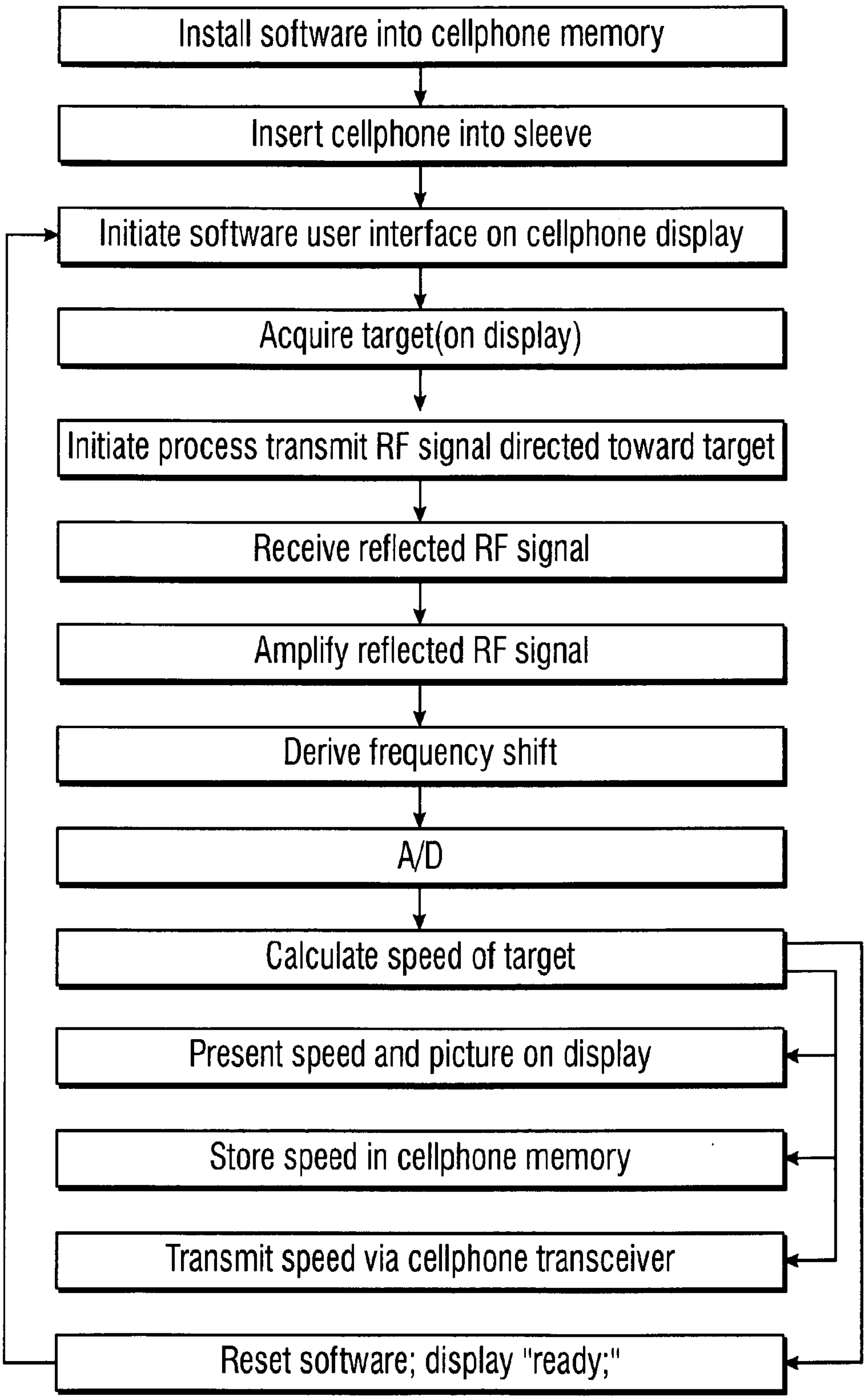
Install software into cellphone memory
Insert cellphone into sleeve
Initiate software user interface on cellphone display
Acquire target(on display)
Initiate process transmit RF signal directed toward target
Receive reflected RF signal
Amplify reflected RF signal
Derive frequency shift
A/D
Calculate speed of target
Present speed and picture on display
Store speed in cellphone memory
Transmit speed via cellphone transceiver
Reset software; display "ready;"

FIG. 9

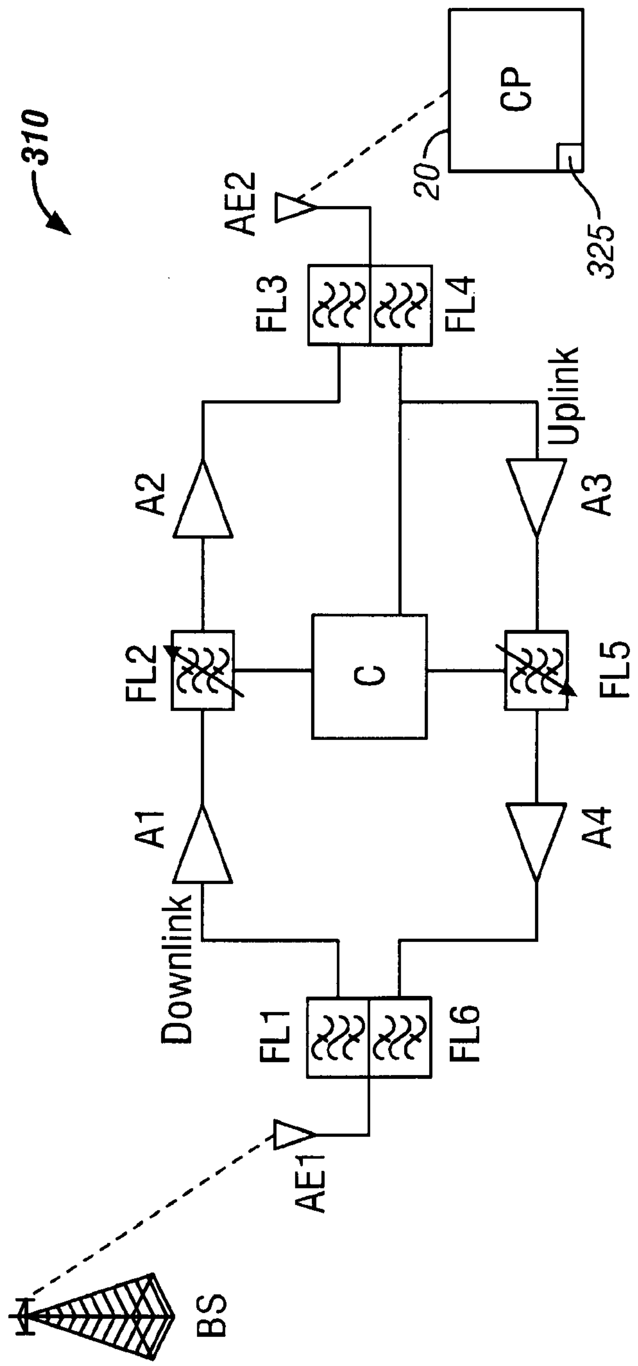
310
CP
20
325
AE2
FL3
FL4
Uplink
A2
A3
FL2
C
FL5
A1
A4
Downlink
FL1
FL6
AE1
BS

FIG. 10

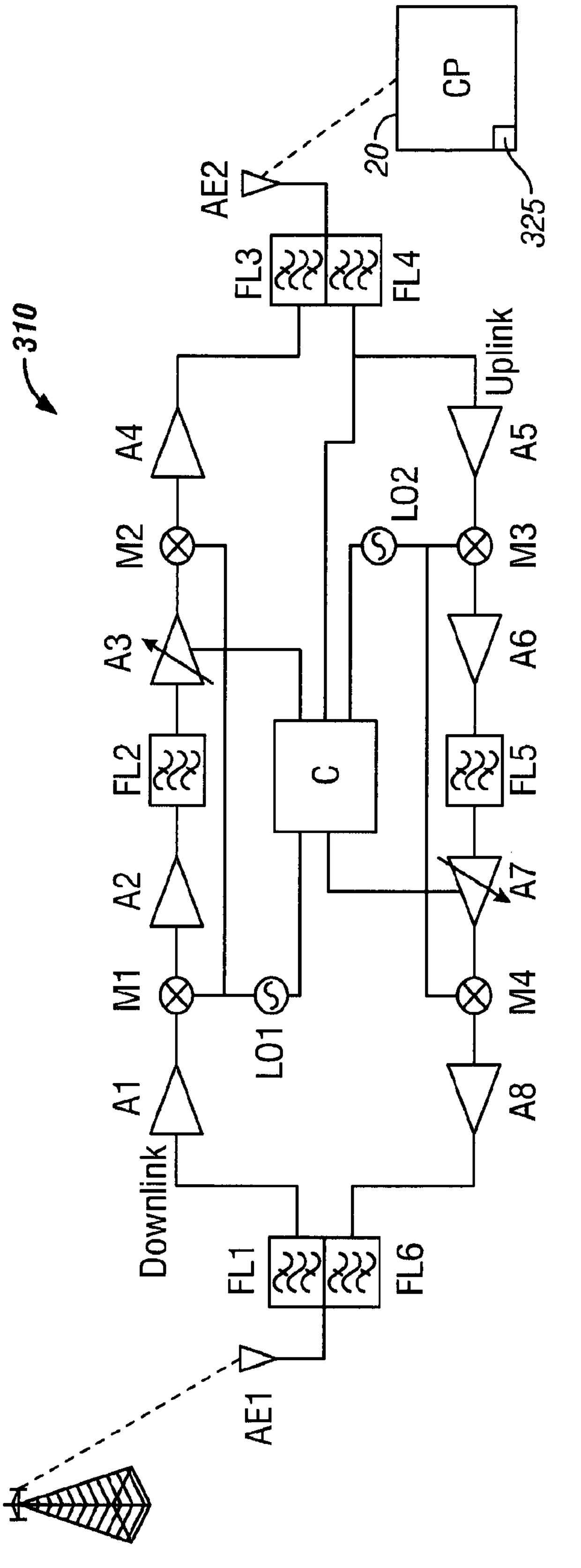
310
CP
20
325
AE2
FL3
FL4
Uplink
A4
A5
LO2
M2
M3
A3
A6
FL2
C
FL5
A2
A7
M1
M4
LO1
A1
A8
Downlink
FL1
FL6
AE1

FIG. 11

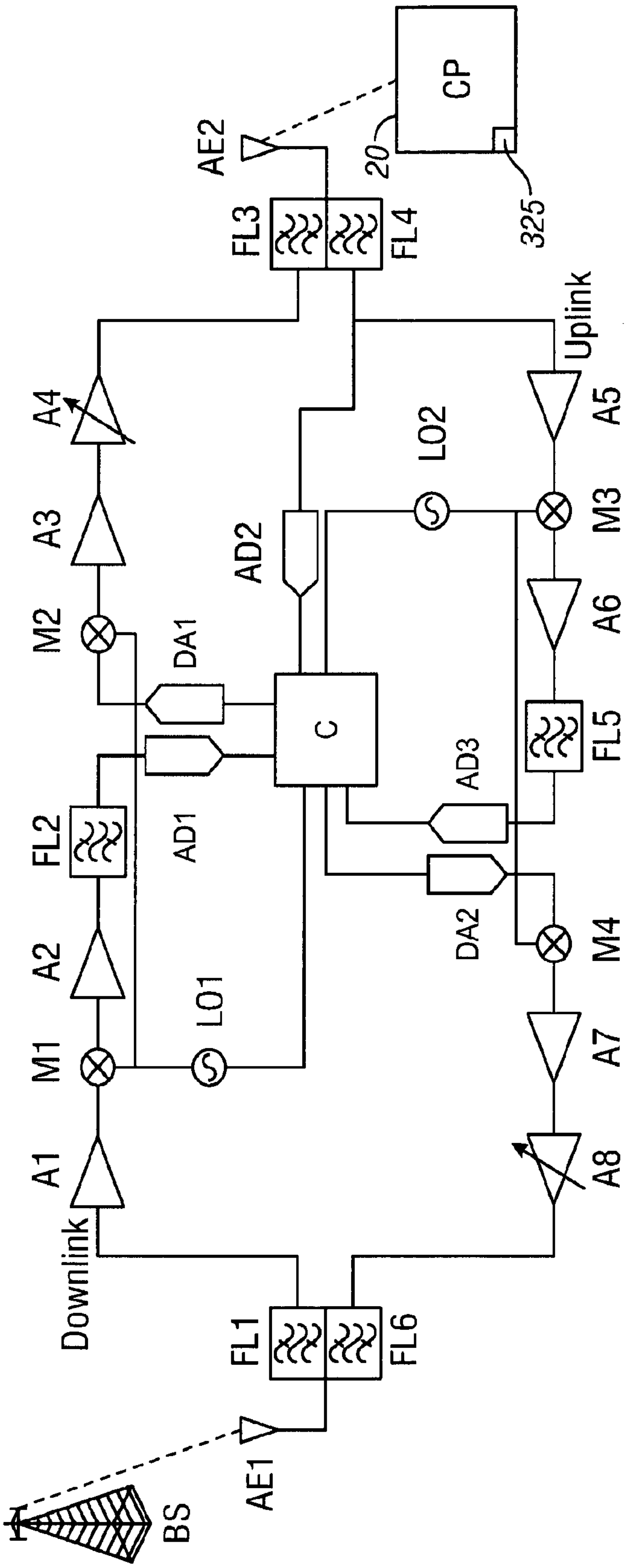
310
CP
20
325
AE2
FL3
FL4
Uplink
A4
A3
M2
AD2
LO2
A5
M3
A6
DA1
C
FL5
AD3
FL2
AD1
DA2
M4
A2
LO1
M1
A7
A1
A8
Downlink
FL1
FL6
AE1
BS

FIG. 12

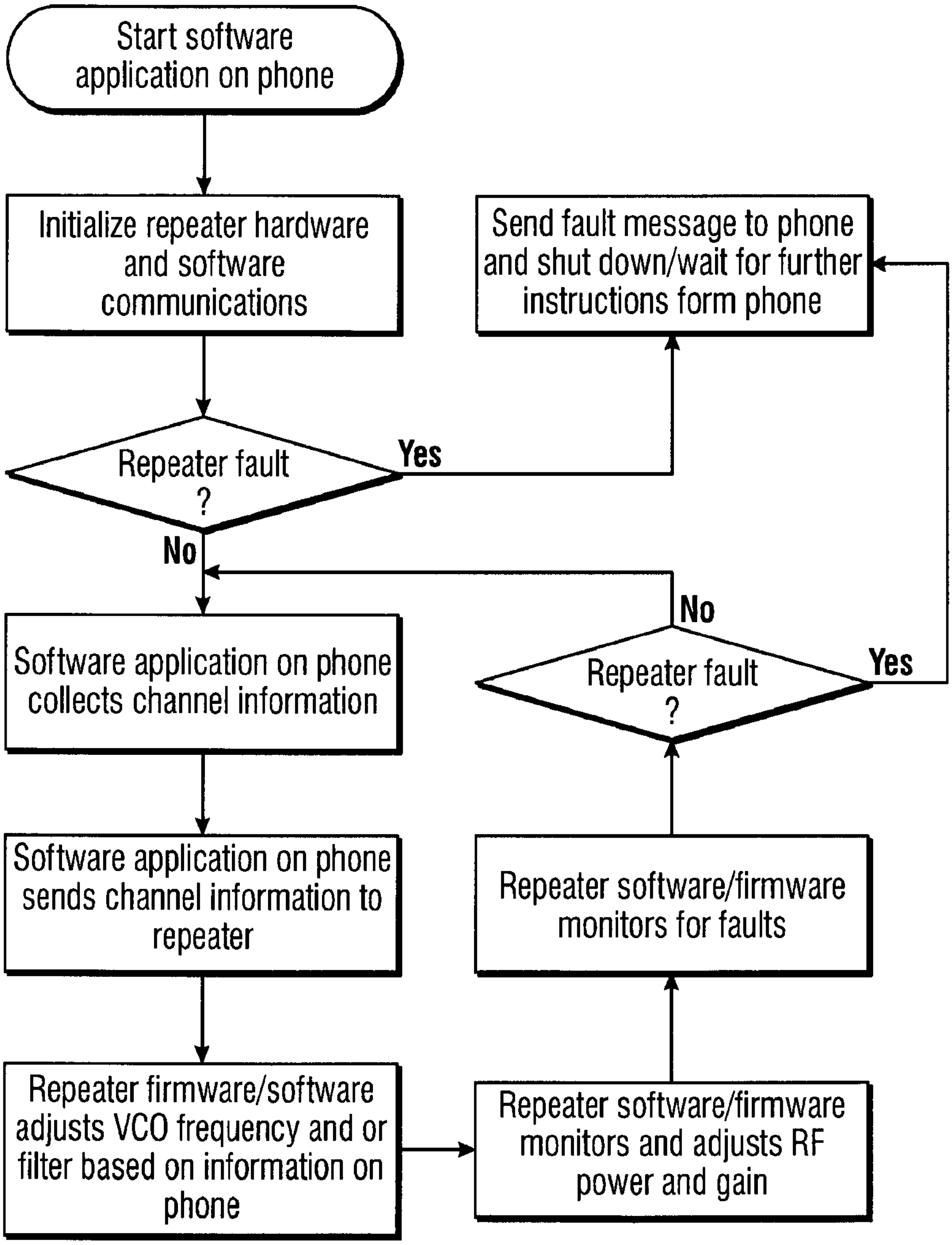
Start software application on phone
Initialize repeater hardware and software communications
Repeater fault ?
Yes
No
Send fault message to phone and shut down/wait for further instructions form phone
Software application on phone collects channel information
No
Repeater fault ?
Yes
Software application on phone sends channel information to repeater
Repeater software/firmware monitors for faults
Repeater firmware/software adjusts VCO frequency and or filter based on information on phone
Repeater software/firmware monitors and adjusts RF power and gain

FIG. 13

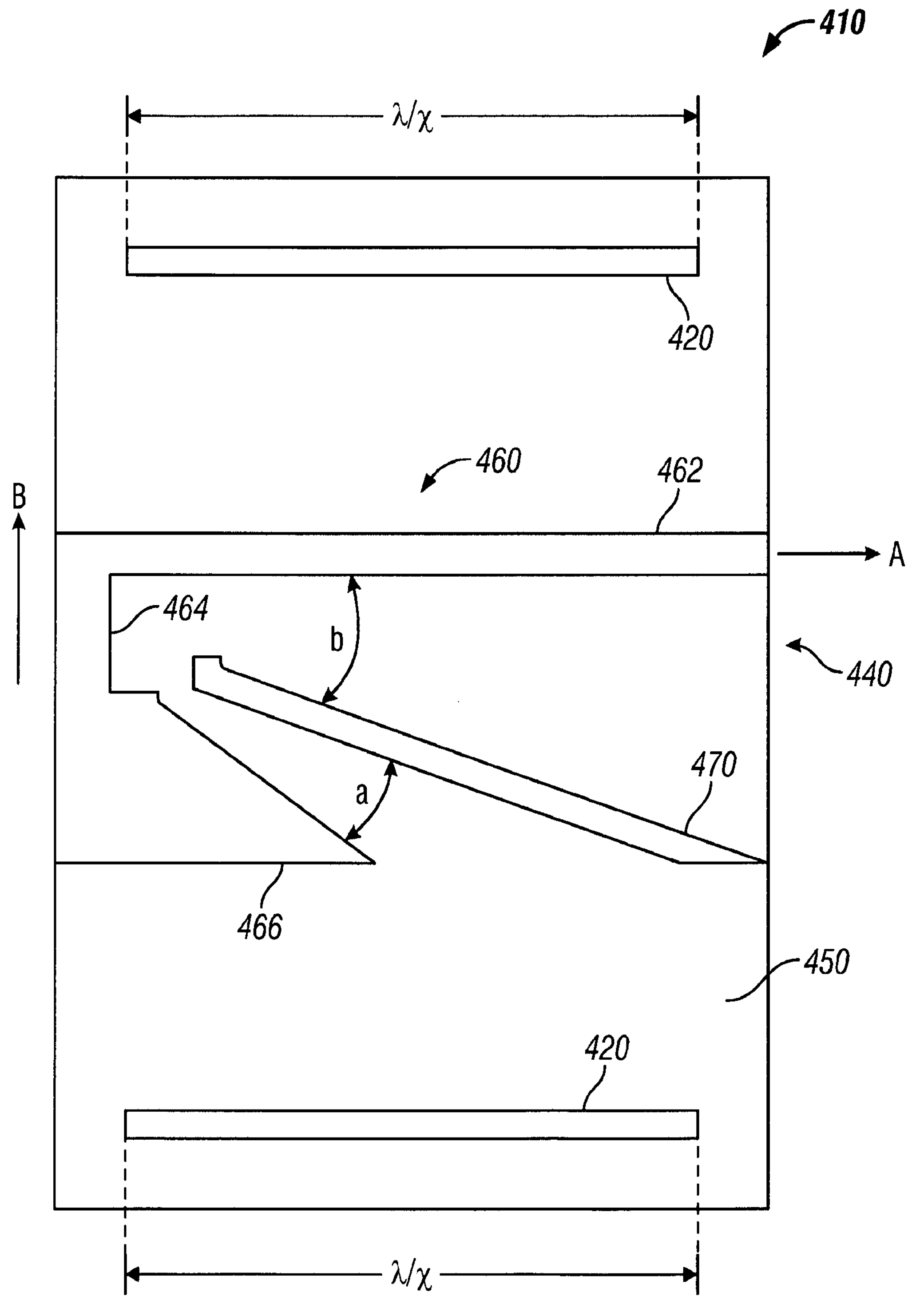

FIG. 14

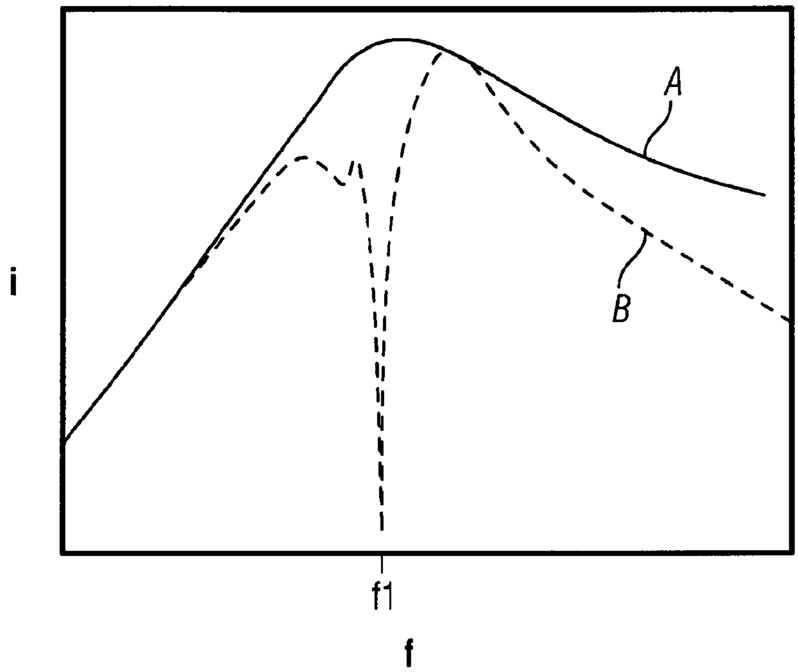

FIG. 15

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 12/56708

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - H01Q 1/36 (2012.01)
USPC - 343/908
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC(8): H01Q 1/36 (2012.01)
USPC: 343/908

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
IPC(8): H01Q 1/36 (2012.01)
USPC: 343/700R; 343/720; 343/729

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
PubWEST(PGPB, USPT, EPAB, JPAB); PatBase(all); Google Scholar; Google Patent; Search Terms: RF boost repeater cell mobile telephone antenna tune band frequency signal inductive coupler transmit receiver transceiver amplifier filter modulator processor phase directional quarter half wavelength amplifier gain case sleeve housing holster cradle saddle

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2002/0154066 A1 (Barna et al.) 24 October 2002 (24.10.2002) para. [0035], Fig. 1	1-5
Y	US 2007/0218951 A1 (Risheq et al.) 20 September 2007 (20.09.2007) para. [0036]-[0091], Fig. 1-14	1-5
Y	US 2005/0088345 A1 (DeLa Torre Barreiro et al.) 28 April 2005 (28.04.2005) para. [0014], [0021]-[0044], Fig. 2-4	4
Y	US 2006/0052112 A1 (Baussi et al.) 09 March 2006 (09.03.2006) para. [0037], [0062], [0063], Fig. 2	5
A	US 2010/0075595 A1 (DeMarco et al.) 25 March 2010 (25.03.2010) entire document	1-5
A	US 2001/0051537 A1 (Nakamura et al.) 13 December 2001 (13.12.2001) entire document	1-5

☐ Further documents are listed in the continuation of Box C. ☐

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
30 November 2012 (30.11.2012)	24 DEC 2012

Name and mailing address of the ISA/US	Authorized officer:
Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

(19)中华人民共和国国家知识产权局

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WO2013/044131 EN 2013.03.28
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代理人 鲍进
(51)Int.Cl.
H01Q 1/36(2006.01)

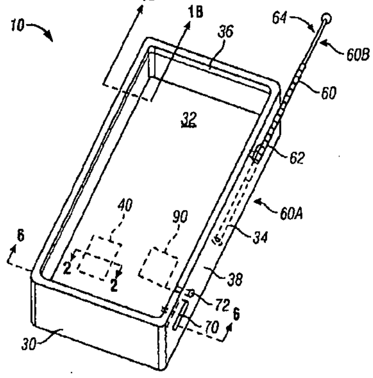
权利要求书1页 说明书6页 附图14页

(54)发明名称

用于手机的具有电扩展的封套

(57)摘要

本公开涉及用于手机的具有电扩展的封套。无源再辐射手机封套组件能够容纳嵌套的手机，所述组件提供信号提升能力并提供雷达实现。通过使用额外的天线、直通中继器、双天线隔离能力和其他特征，可以使能信号放大。



CN 103988366 A

1. 一种以嵌套关系接合手机的再辐射手机封套组件，所述组件包括：

外壳，具有前部外缘和与周围的侧壁一体化的后面板，所述前部外缘被定位成部分地覆盖所接合的手机；

所述外壳的后面板内的嵌入式电路，所述电路提供信号放大外部天线电路、信号放大中继器和双天线隔离电路，所述嵌入式电路还包括雷达实现。

2. 根据权利要求 1 所述的封套组件，其中所述信号放大外部天线电路具有平面多层射频耦合探针，所述探针被定位成与所述手机的天线电磁耦合。

3. 根据权利要求 1 所述的封套组件，其中所述信号放大中继器使用一种方法，所述方法包括：接收信道信息并将其存储到手机的手机存储器中，将所述手机调谐到在所述信道信息中指定的信道，将所述信道信息从所述手机发送到信道选择中继器，适配所述中继器以只传递所述信道中的信号，在所述中继器收集停止广播信号，对所述信号滤波以只传递所述信道中的信号；和将所述信道中的信号发送到所述手机。

4. 根据权利要求 1 所述的封套组件，其中所述双天线隔离电路具有一对隔开的平面天线元件以及位于所述天线元件之间的平面调谐槽元件，所述平面调谐槽元件优先地使能通过所述天线元件使用两个段在两个选定的频带中进行的信号接收，所述两个段包括 C 形段和线性段，其中所述 C 形段具有沿第一方向延伸的第一线性支脚和沿第二方向延伸的第二线性支脚以及三角形部分，并且其中所述线性段收敛于所述三角形部分和所述第一线性支脚上。

5. 根据权利要求 1 所述的封套组件，其中所述雷达实现使用多普勒收发天线、雷达收发器、存储在所述手机的存储器中的软件程序和用于在所述雷达收发器和所述手机的处理器之间进行通信的电路。

用于手机的具有电扩展的封套

背景技术

[0001]　本公开涉及无线电信领域，更具体地，涉及一种扩展手机的功能能力的封套外壳。公布 WO 2010/098540 公开了一种二次成型 (double molding) 处理，其中在第一次成型步骤中，将天线嵌入树脂护套内，而在第二次成型步骤中，树脂护套通过插入成型处理而被嵌入设备壳体内。公布 JP 2006/148751 公开了内置于封套中的天线耦合，当被放置在便携终端的壳体之上时，封套被放置成靠近该终端的内部天线，并且由此能够被感应耦合以加强发送信号。

发明内容

[0002]　本公开描述了一种封套 (sleeve)，该封套能够物理地接收并与手机或其他便携式无线通信装置进行电通信，并且还提供某些辅助功能以及对手机的操作的支持，包括：提高手机的信号接收和发送，包括通过使用额外的天线，提供雷达特征，籍此该手机能够显示远处移动物体的照片或视频，同时还计算并显示它的速度，提供能够自动调谐到手机频率及提升信号强度的中继器，并采用双平面天线，该双平面天线能够在两个不同频率紧密靠近地工作，并且在该双平面天线之间具有良好的隔离，这种天线支持中继器的能力。封套增加了手机的范围并且具有集成结构，因此其制造相对便宜且经久耐用。封套能够结合嵌套手机内置天线的接收和发送能力与安装于封套上的外部天线、或远程天线，以便极大地提高了射频的接收和发送。

[0003]　这些概念的一个或多个实施方案的细节阐述于附图和以下说明中。其它特征、目的和这些概念的优点将在说明书和附图以及权利要求书中显现。

附图说明

[0004]　图 1A 是当前描述的封套的示例透视图；

[0005]　图 1B 是从切割平面 1B-1B 获取的并另外示出封套内的嵌套手机的一部分的示例部分截面侧视图；

[0006]　图 1C 是在图 1A 中示出的封套的示例部分截取部分，该图显示用于存储外部天线的额外实现 (enablement)；

[0007]　图 2 是从图 1A 中的切割平面 2-2 获取的示例剖视图，该图显示在部分封套上的内嵌手机部分；

[0008]　图 3 是封套的后面板 (back panel) 内部的示例透视图，该图显示其中的雷达系统的组件的细节；

[0009]　图 4 是手机的示例正面图，该图示出与雷达相关的显示器；

[0010]　图 5 是封套和手机的示例电原理图，该图示出电互连；

[0011]　图 6A 和 6B 是从图 1 中的切割平面 6-6 获取的示例剖视图；

[0012]　图 7 是示出了封套和与目标进行通信的雷达的示例框图；

[0013]　图 8 是雷达的示例示意图；

[0014] 图 9 是示例性雷达过程的逻辑流程图；

[0015] 图 10、11 和 12 是信号中继器电路的示例性电示意图；

[0016] 图 13 是图 10、11 和 12 的中继器电路的示例性过程的逻辑流程图；

[0017] 图 14 是具有槽隔离的双天线系统的示例平面图；和

[0018] 图 15 是示例曲线图，该图示出了天线元件之间的隔离。

[0019] 在各附图中相同的附图标号指示相同的元件。

具体实施方式

[0020] 图 1A 示出了再辐射手机封套组件，在本文中称为“封套 10”，能够适应手机或类似的便携式无线装置，其不是封套 10 的一部分，并与该手机或类似的便携式无线装置嵌套。术语手机，在此称为“手机 20”用于本说明书，应该认识到，该术语可以指蜂窝式电话或任何其他便携式射频通信装置，并且封套 10 可被制造成其尺寸能够接受每个不同尺寸和形状的手机 20。封套 10 包括由适合材料——诸如橡胶、橡胶化塑料、塑料和橡胶的组合，或塑料聚合物的组合——制成的外壳 30 的全部或部分。外壳 30 能够紧密地装配在手机 20 的至少一部分之上或围绕其进行装配。在图 1A 和 1B 所示的优选实施例中，外壳 30 具有与周围的侧壁 34 一体化的后面板 32，侧壁 34 的四周有内部唇缘 (lip flange)36。当手机 20 嵌套在封套 10 内时，唇缘 36(图 1B) 在手机 20(图 4) 的面 22 的一部分之上沿周边延伸，以便将手机 20 紧固在封套 10 内。同时，制成外壳 30 的材料至少部分是弹性的，以便它接纳手机 20 时可以稍稍拉伸，从而提供改进的紧固。

[0021] 再次参考图 1A，当手机 20 在封套 10 内时，平面多层射频 (RF) 耦合探针 40 可以通过插入注射成型或其它方式嵌入在后面板 32 中，并可能在靠近、直接邻接手机 20 的内部天线 50(图 2) 的位置。以这种方式，探针 40 是在与内部天线 50 电磁耦合以便增强手机的信号强度的位置上。电感性、电容性或其它电磁耦合也可使用。

[0022] 仍参考图 2，探针 40 可以具有多层平面结构，其包括第一材料层 44，诸如，但不限于，玻璃纤维环氧树脂或低的相对介电常数 (DK)，通常在 DK ＝ 2 至 DK ＝ 5 的范围内，的热固性叠层 (therrnoset laminate)；铜、银填充膏或其它电导体的第二图案化金属层 45，其可沉积或印刷在第一层 44 的一侧并可具有约 0.7 至 1.4mil(密耳) 的材料厚度以供进行最佳操作，从而形成分布式谐振电路；和第三材料层 46，诸如具有相对高的 DK，通常在 DK ＝ 20 至 DK ＝ 50 范围内，的陶瓷填充叠层，由此，层 46 可以与第二面 45 面对面地紧密接触。探针 40 可具有与内部天线 50 相同的尺寸和形状以供进行最佳操作。探针 40 的一个重要特征是它起抗谐振网络的作用，因为它的高电容对电感比，这使能近场耦合，并且可以凭借其卸载高 Q 品质因数而是接收频带可选择的。频带选择性可提供多频带谐振，例如，一个或多个频带，诸如 700、850、900、1800、1900 和 2100MHz 和其它频带，的谐振是可能的，是高度期望的和新颖特性。

[0023] 外部天线 60，如图 1A、1C 和图 6B 物理地示出的，可以安装在侧壁 34 上并与侧壁 34 平行对准。传输线 42，如图 1A 和 6B 所示，可以嵌入后面板 32 内，以便连接探针 40 与外部天线 60 以在它们之间传输 RF 信号。传输线 42 可以是金属化的或印刷的导电条。这种布置使两个天线 50 和 60 能同时进行 RF 发送 / 接收，同时最小化相互干扰。天线 60 可使用机械旋转接头 62 而被安装在外壳 30 上，使得天线 60 能够在以虚线示于图 1A 中的缩回

位置 60A 与用实线所示的延伸位置 60B 之间旋转。天线 60 可以是简单的刚性杆、套管式的或其他。侧壁 34 可具有凹部，如图 1C 所示，当天线 60 缩回时可固定天线 60。天线 60 可在其缩回位置 60A 以及其延伸位置 60B 之间操作。

[0024] 如图 1A 和图 5 所示，封套 10 可以具有远程天线端口 70，其和拨动开关 72 一起成型到侧壁 34 内。开关 72 可以起选择外部天线 60 或远程天线 80（图 5）的作用。信号提升放大器 90 可以与探针 40 信号通信，以及开关 72 使用金属化导体路径 42 和 74。为提高性能，放大器 90 可以是单向的或双向的，可以使能双工器 (diplexer)、双工机 (duplexer) 和自动增益控制 (AGC) 和其它特征。放大器 90 可以是由电池 92 供电的平面设备，电池可以安装在侧壁 34 中。元件 40、60、70、72 和 90 可以用金属化或印刷的路径 42 电互连，并且路径 42 和元件 40 及 90 可被嵌入后面板 32 内，这被显示在图 6A 和 6B 中，其中以其中如图 5 的原理图所示，后面板 32 由封装探针 40、放大器 90 与所述导电互连路径 42 的层 32A 和 32B 构造的优选方法，通过注射成型技术制造外壳 30。如上所述，自身采用的封套 10 定义了本装置的一个实施例。嵌套的且与手机 20 电互连的封套 10 限定了第二实施例。

[0025] 如图 3 所示，封套 10 可以用物理地集成到后面板 32 的雷达系统（“雷达收发机 230”）来额外地配置。如图 7 所示，雷达收发机 230 提供用于测量远处物体“目标 205”的速度的装置，方便了手机 20。雷达收发机 230 可以是多普勒雷达系统或其它类型的雷达系统。在本实施例中，电话 10 具有光学瞄准装置，诸如手机照相机 21，其可被用于瞄准目标 205，而雷达收发机 230 测量其速度。如图 4 所示，显示器，诸如手机屏幕 25，可以呈现目标 205 和其速度信息。存储介质，诸如手机存储器 23，能够存储这些信息，而无线发射机，诸如手机收发机 26，发送该信息到一个或多个选定的遥远接收机，诸如其他手机、陆线电话、自动计算机和其他设备。手机元件 21、23、25 和 26 都通过手机处理器 22 根据在手机技术领域内公知的手机电路和软件协议来操作。在将手机 20 用于本发明之前，操作软件 24 被加载到手机存储器 23 中，然后数字处理器 22 按照如图 9 所示的以及这里描述的方法执行软件 24 的指令。

[0026] 使用手机照相机屏幕 25 作为目标设备，允许这种手持式系统可手动定位观察目标 205，从而实现在确定目标而不是外部邻近物体的速度中以及还在避免由于在手机 20 跟踪目标 205 的路径时所导致的移动背景的混合或混淆确定中的有利的精确水平。如上所述，显示器 25 可以是固态的显示屏幕，或者它可以是任何其他显示装置。同样地，无线发射机可以是所述的电话收发机 26，或者它可以是任何其它个人或移动电话或类似装置。显示器 25、存储器 23、软件 24、处理器 22 和无线收发机 26 中的一个或多个可以被集成到封套 10 中，或可以是单独的组件，但可以相互连接，如图 7 所示。

[0027] 如图 7 和 8 所示，雷达收发机 230 包括发射 - 接收天线 232、发射放大器 234f、接收放大器 234d、可变放大器 234c、压控振荡器 234a(VCO)、收发机处理器 / 控制器 233(CPU)、正交解调器 234b(DQD)、模数转换器 246(ADC) 和数模转换器 244(DAC)。

[0028] 当手机 20 被放置在封套 10 中时，手机 20 和雷达收发机 230 之间的链路是由例如连接器 36（图 3）构成，或通过无线方法，诸如蓝牙，或者通过如上面充分说明的在相邻的非传导元件之间感应信号。雷达收发机 230 可使用高度定向发射天线，以更好地在目标 205 的方向上聚焦辐射的射频能量。可以使用各种天线设计，包括如图 3 所示的贴片天线元件的平面阵列，其提供了必要的增益和方向性。发射 - 接收天线 232 可备选地为分别用于接

收和发送的分离天线。

[0029] 如前所述，雷达收发机 230 利用多普勒效应，比较发射波的频率和回波频率来确定由于目标 205 和发射 / 接收天线 232 之间的相对运动而产生的频移。

[0030] 一旦手机 20 安装在封套 10 中并且软件 24 被安装在存储器 23 中，装置就准备好测量远处移动物体的速度。在后面板 32 朝向移动目标 205 时，显示器 25 上的“应用程序”图标被选择，它发送开始信号给雷达收发机处理器 233 以启动执行速度测量周期的指令。图 8 的电子电路支持该过程的理解。雷达脉冲串 (RF 能量) 由发射放大器 234 通过天线 232 在目标 205 的方向上发射出，该射频能量撞击目标 205，并且少量的 RF 能量信号被反射并通过天线 232 被获得。低噪声接收放大器 234d 提升所获得的反射信号，并且正交解调器 234b 下变频该信号。解调器 234b 包括高频分离器 234b-3，它将反射信号传递给混频器 234b-2。低频分离器 234b-1 将发送的信号传递到混频器 234b-2。混频器 234b-2 的输出是发射频率和反射频率之间的差。这个差信号是由于封套 10 和目标 205 的相对速度而导致的多普勒频移。对差信号进行数字采样，并且目标的速度是由 CPU233 使用公知的公式 $v = Fd/2(Ft/c)$ 计算的，并且速度信息被发送到电话处理器 22。如图 4 所示，计算出的目标速度被显示。备选地，该数字采样可以被直接传送到电话处理器 22 以供进行速度计算和显示。图 9 是该过程的概述。

[0031] 由电池 235 驱动的雷达收发机处理器 233 与手机处理器 22 进行通信，并且还设置放大器增益、VCO 频率和由软件 24 指示的其他设置。无论手机 20 和雷达接收机 230 是一体的还是分离的单元，这个过程是相同。当软件 24 被初始化，它在手机显示器 25 上产生用户界面，并启动与雷达收发机 230 进行通信的后台进程。为了获得速度测量，如所述的，手机 20 指向目标 205，使得它在显示器 25 上可见。软件 24 能够使用手机的照相机捕获视频图像，照相机能够通过封套 10 的后面板 32 中的开口 43 看到目标 205。如所述的，速度测量可以在视频拍摄时显示并记录到存储器 23 中。

[0032] 封套 10 还可以包括频率选择中继器电路 310，为了提高选定频率上的信号强度，中继器电路 310 使用从所包围手机 20 接收的频率信息来调整信号滤波。如图 10、11 和 12 所示，手机 20 可以与基站 BS 进行公知的通信。此外，手机中众所周知的是，手机 20 按照手机 20 通过其进行操作的基站 BS 的指示适配其工作频率。此工作频率被存储在手机存储器中。按照存储在手机存储器中并通过手机的处理器 22 执行的软件应用 325，工作频率由手机 20 连续地发送。中继器 310 接收手机信号，并调节到工作频率。

[0033] 图 10、11 和 12 中公开了中继器 310 的实施例。图 10 示出了电路下行链路路径，包括天线 AE1、滤波器 FL1、放大器级 A1、可变滤波器 FL2、放大器级 A2、滤波器 FL3 和天线 AE2。上行链路路径包括天线 AE2、滤波器 FL4、放大器级 A3、可变滤波器 FL5、放大器级 A4、滤波器 FL6 和天线 AE1。控制器 C，诸如由 Atmel 公司生产的型号 SAM9，接收工作频率的指定和调整 FL2 和 FL5，每一个都可能是 Pole Zero 公司生产的型号 Micro-400-700，以仅使以工作频率为中心的频带通过。该电路使从基站 BS 转发到手机 20 的信息可以用于调节电路内的带通，从而排除其它频率和噪声，并仅中继和提升选定的 RF 频率或使频带通过。在本实施例中，所有的模拟组件工作在 RF 频率。这具有相对较便宜的优点，但是，它并没有实现工作在中频 (IF) 的电路可以实现的带外频率和噪声抑制。

[0034] 图 11 进一步公开了中继器 310，其具有下行链路路径，包括天线 AE1、RF 滤波器

FL1、放大器级 A1、混频器 M1、本地振荡器 LO1、放大器级 A2、中频滤波器 FL2、中频可变增益放大器级 A3、混频器 M2、RF 放大器级 A4、RF 滤波器 FL3 和天线 AE2。上行链路路径包括天线 AE2、RF 滤波器 FL4、射频放大器级 A5、混频器 M3、本地振荡器 LO2、中频放大器级 A6、中频滤波器 FL5、可变中频放大器级 A7、混频器 M4、射频放大器级 A8、RF 滤波器 FL6 和天线 AE1。参考图 10 的电路，控制器 C 从手机 20 接收工作频率信息，并通过调整本地振荡器 LO1 和 LO2 来调整其带通。如上所述，该电路使从基站 BS 转发到手机 20 的信息可以用于调节电路内的带通，从而排除其它频率和噪声，并仅中继并提升选定的 RF 频率或频率的带通。在本实施例中，由于滤波和放大的功能都能够在中频频率范围内进行，避免了电路图 10 的缺点。图 12 的工作方式与图 11 的电路相同并且改进了在控制器 C 的数字处理，这导致改进了振荡器 LO1 和 LO2 的控制。

[0035] 在图 11 和 12 所示的电路中，滤波和放大是在中频范围内进行。如已知的，难以建立可以调谐到不同频率的放大器、滤波器以及检测器，但很容易建立可调谐振荡器。此外，在射频通信中，变换为较低的中频提供了优点，这是因为射频放大器具有频率增益上限，使得较低的中频可提供更高增益的可能性。另外，在中频，滤波以从彼此接近的信号中提取单个频率比较容易，并且噪声也更容易排除。这是因为滤波器的带宽与信号的频率成比例地增大。所以更窄的带宽和更多的选择性可以通过将信号转换为中频来实现。所用的中频可以是 10.7MHz 或在该范围内的频率。图 13 定义了这些电路的工作方法。在这种方法中，中继器的硬件和软件被初始化以进行通信。中继器的故障检测可发现故障，如果发现故障，中继器 310 被关闭，等待指令。如果没有检测到故障，电话软件从基站 BS 收集信道信息并且该信息被发送到中继器 310。接着，中继器 310 根据该信道信息调整 VCO 频率或信号滤波器，并调整射频功率和增益。中继器 310 现在能够监测以进行故障检测，如果检测到故障，中继器 310 发送故障信息到手机 20 并关机等待进一步的指示。如果没有检测到故障，就收集信道信息，该循环不断重复。

[0036] 图 14 中所示的天线系统 410 可代表中继器 310 的天线 AE1 和 AE2，并具有超越这种中继器的广泛适用性。为了获得最佳操作，元件 420 和 430 可以具有 λ/4、2 或 1 的长度。元件 420 和 430 是所示天线结构的一部分，并且具有位于所述天线元件 420、430 之间的调谐槽元件 440，该调谐槽元件 440 在具有提供天线元件 420、430 每一个相对于彼此的辐射隔离的优点的情况下，使能优选的通过天线元件 420、430 在两个选定的频带中进行的信号接收。天线元件 420、430 和调谐槽元件 440 可以是平面的，并且可以是导电的，并被安装在电介质片 450 上。元件 420、430、440 可被电介质层（未示出）覆盖。天线和调谐槽元件 420、430、440 可以是铜薄片材料，电介质片 450 可以是玻璃环氧树脂基板材料或类似物质。如图 14 所示，调谐槽元件 440 可以具有两个隔开的段，一个 C 形段 460 和一个大致线性的段 470。C 形段 460 可具有在第一方向（箭头 A）上延伸的第一线性支脚 462 和在第二方向（箭头 B）上延伸的第二线性支脚 464，并且所述第二方向可以与所述第一方向正交。C 形段 460 还可以具有三角形部分 466。线性段 470 可以与三角形部分 466 形成锐角 (a)，并且还与第一线性支脚 462 形成第二锐角 (b)。线性段 470 和三角形部分 466 之间的间距可以使天线元件 420、430 进行 1900 兆赫信号接收，而线性段 470 和第一线性支脚 462 之间的间距可以使天线元件进行 850 兆赫信号接收。图 15 是天线信号隔离 (i) 相对于无线电频率 (f) 的曲线图。曲线 A（实线）是没有或移除调谐槽元件 440 的测量结果，而曲线 B（虚

线）是具有如图 14 所示的调谐槽元件 440 的测量结果。很显然，调谐槽元件 440 在工作频率 F1 提供了几乎无限的隔离。

[0037] 信号接收和发送、滤波、放大、使用本地振荡器的混频以及模拟和数字信号形式之间的转换的常用功能是本领域公知的，因此这些功能和这些操作的性质的进一步细节此处不再赘述。“Electrical Engineering Reference Manual（电气工程参考手册）”，ISBN：9781591261117，全部并入本文中以作参考，以提供有关本文中提出的元件和功能的细节和技术支持。本文描述了主题装置和方法的实施例。然而，应该理解的是，在不脱离本发明的精神和理解的前提下，可以进行各种修改。因此，其它的实施方式和方法都在以下权利要求的范围之内。

[0038] 2011 年 09 月 21 日提交的申请 US13/238,894、2012 年 08 月 20 日提交的申请 US13/590,053、2012 年 08 月 21 日提交的申请 US13/591,152 和 2012 年 08 月 21 日提交的申请 US13/591,171 现通过引用全部并入本文。

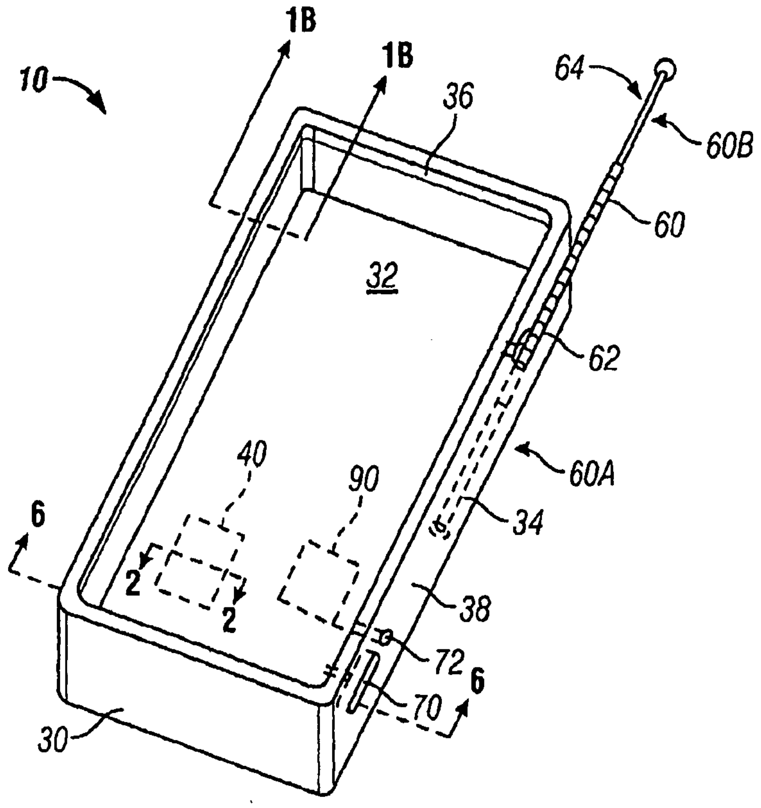

10
1B
1B
36
64
60B
60
32
62
60A
40
90
34
6
2
2
38
72
6
70
30

图 1A

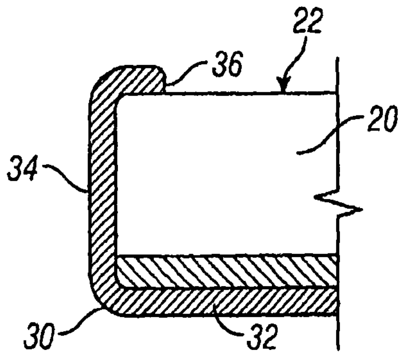

22
36
20
34
30
32

图 1B

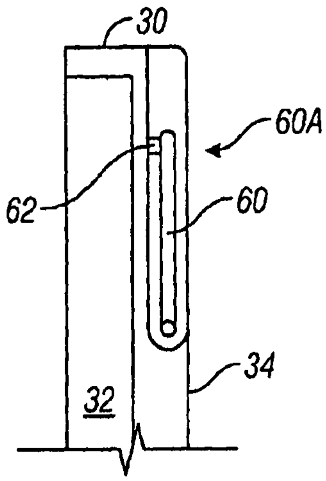

30
60A
62
60
34
32

图 1C

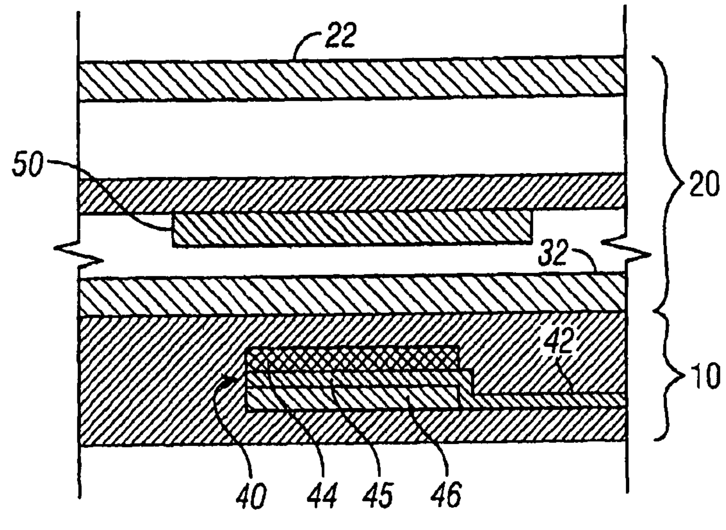


图 2

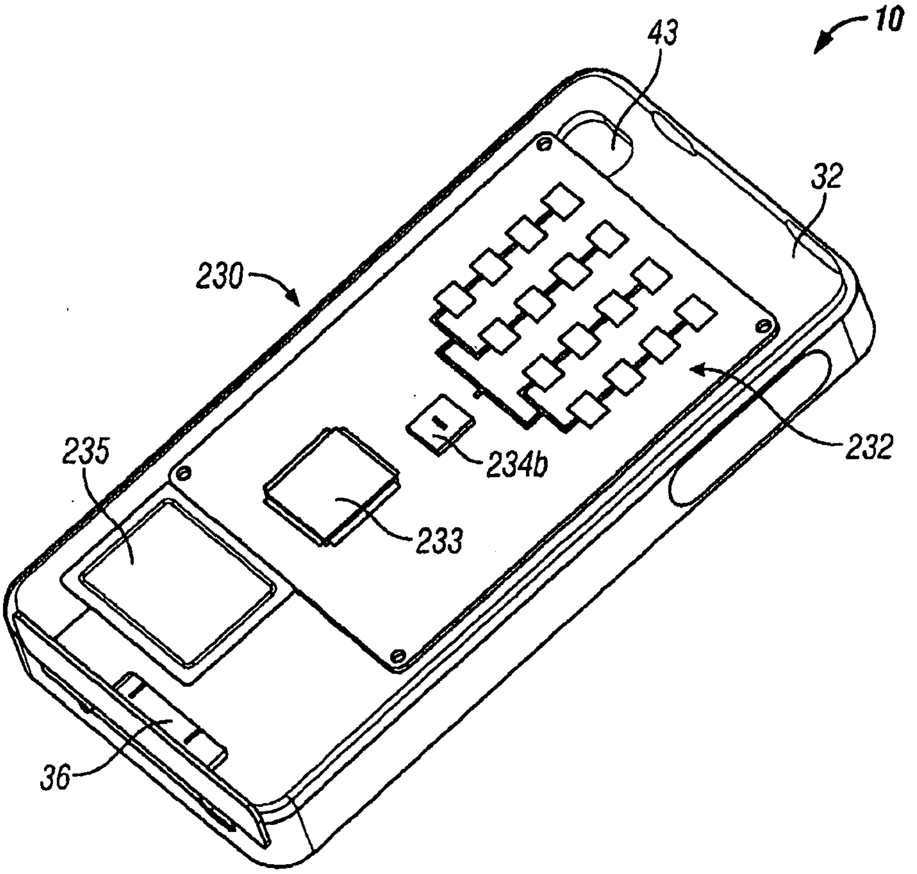


图 3

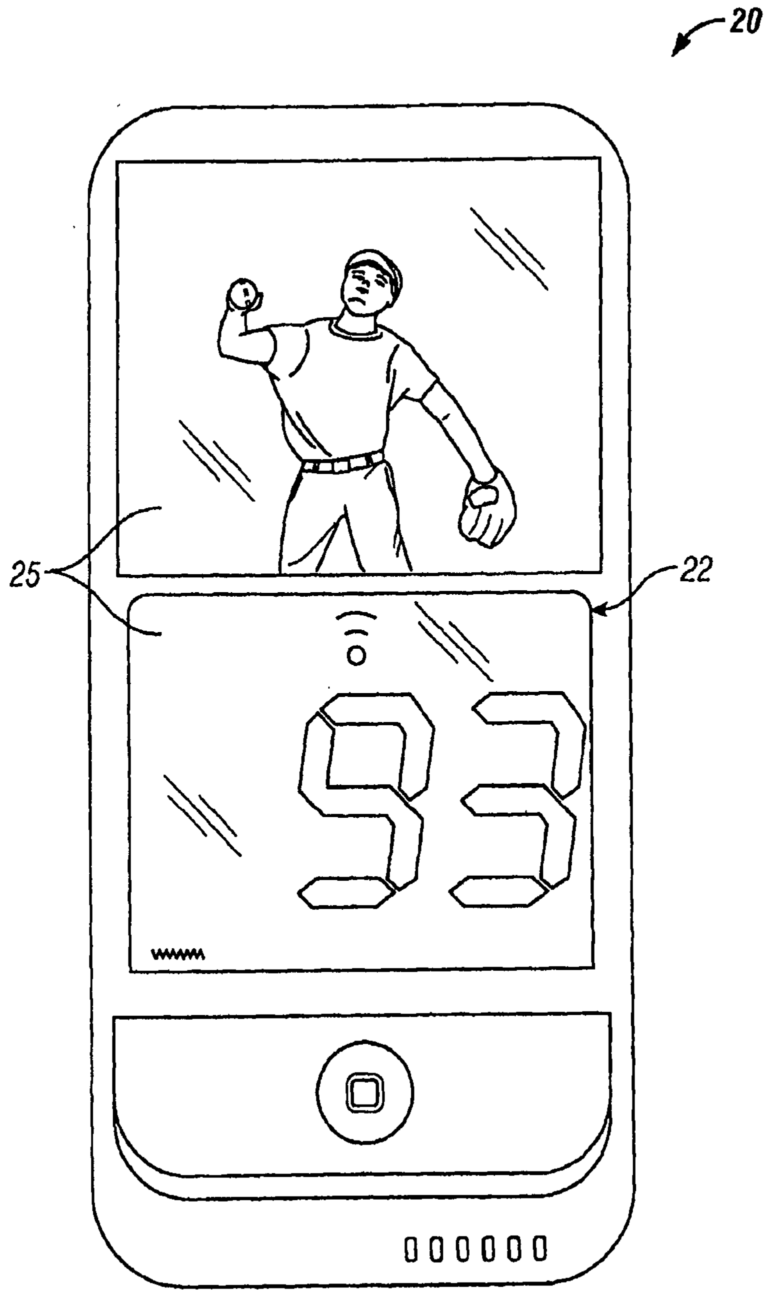


图 4

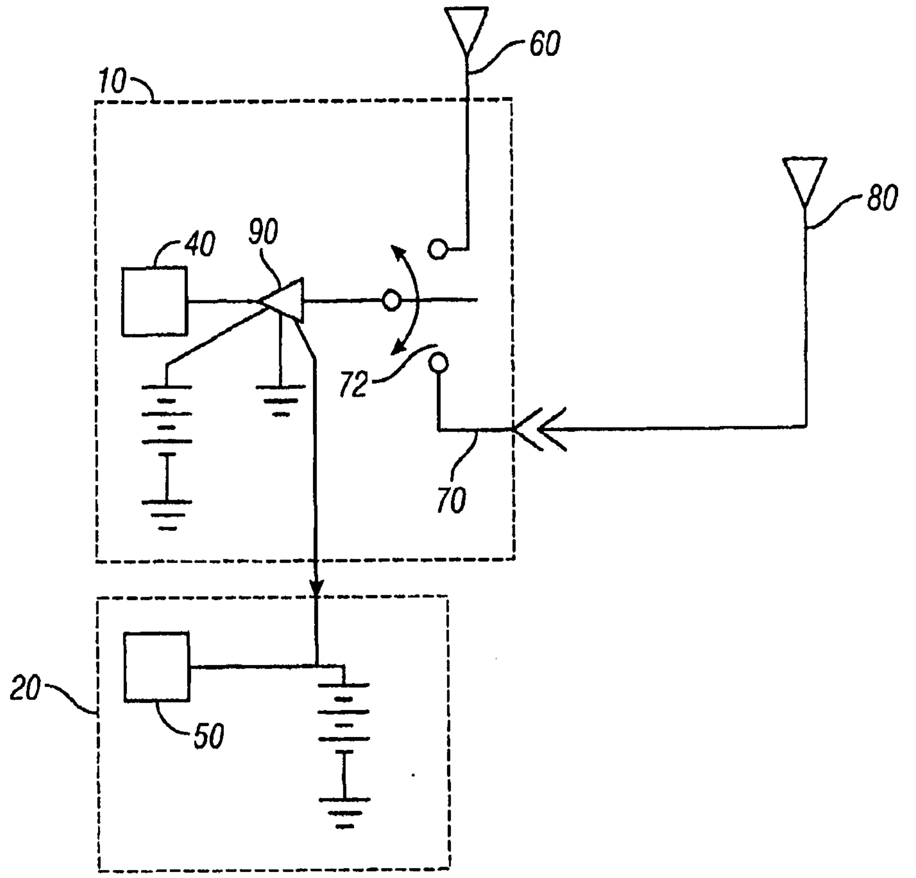


图 5

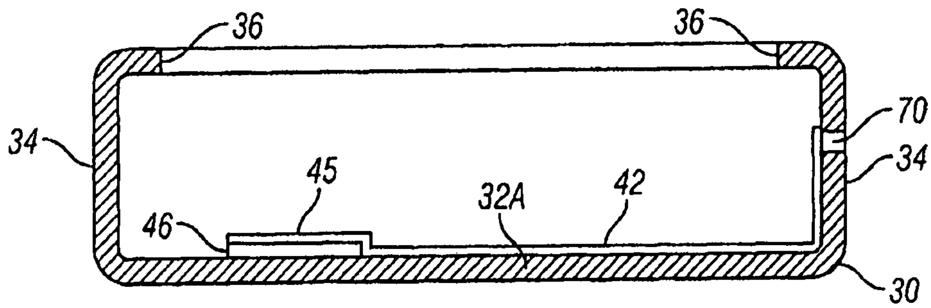


图 6A

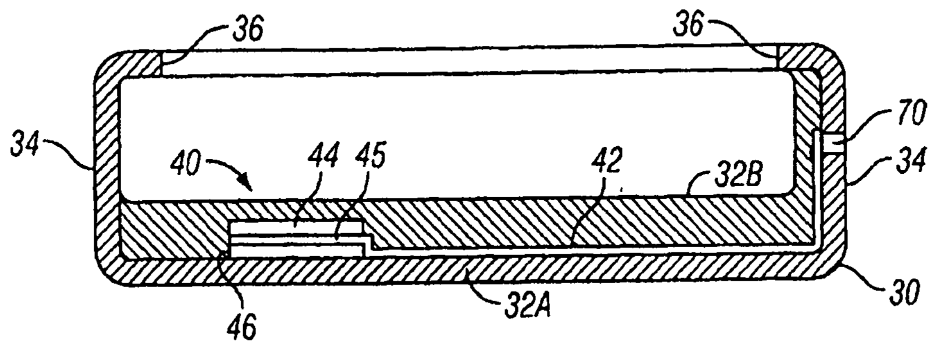


图 6B

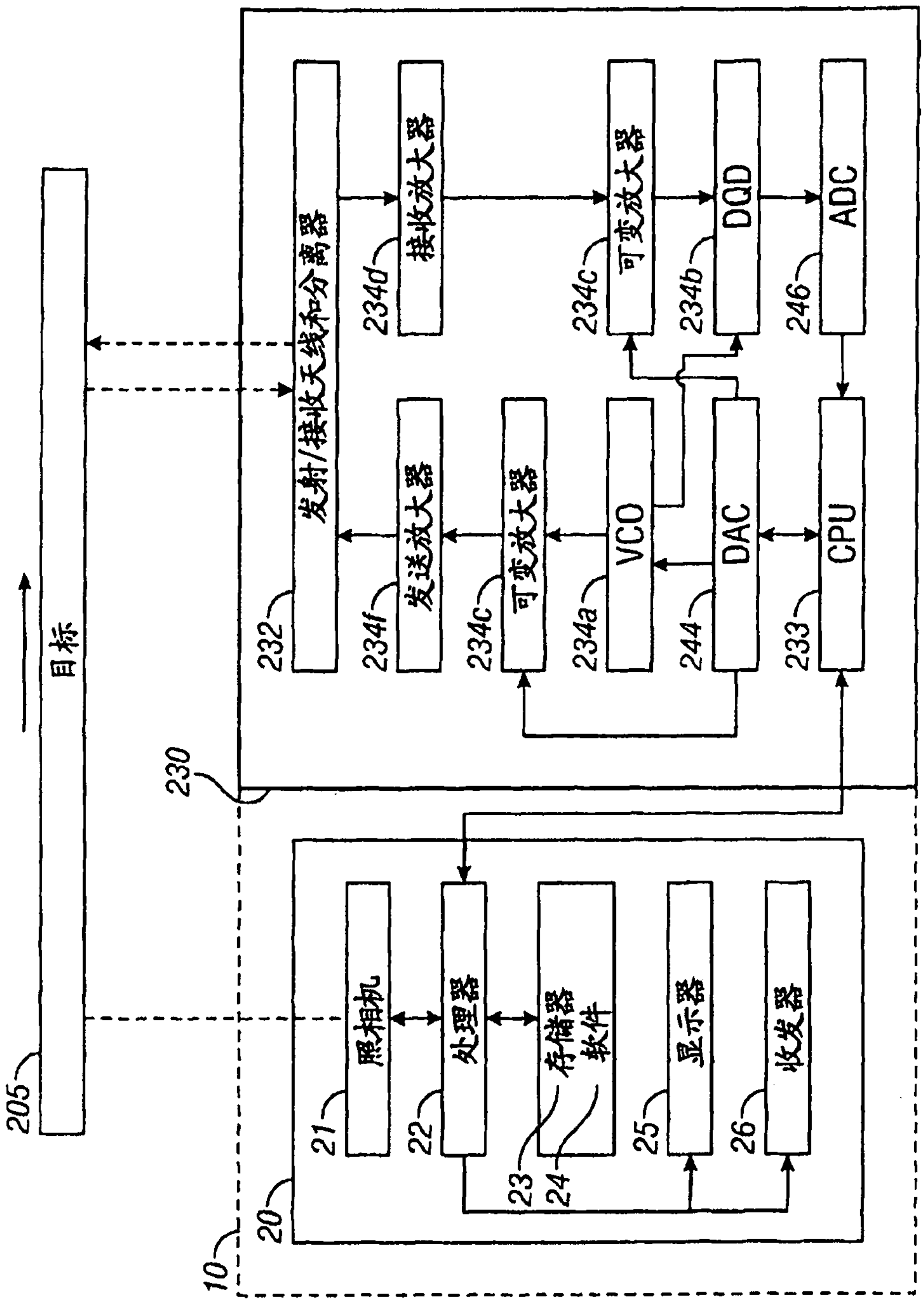

目标
205
发射/接收天线和分离器
232
接收放大器
234d
可变放大器
234c
DQD
234b
ADC
246
发送放大器
234f
可变放大器
234c
VCO
234a
DAC
244
CPU
233
230
照相机
21
处理器
22
存储器
23
软件
24
显示器
25
收发器
26
20
10

图 7

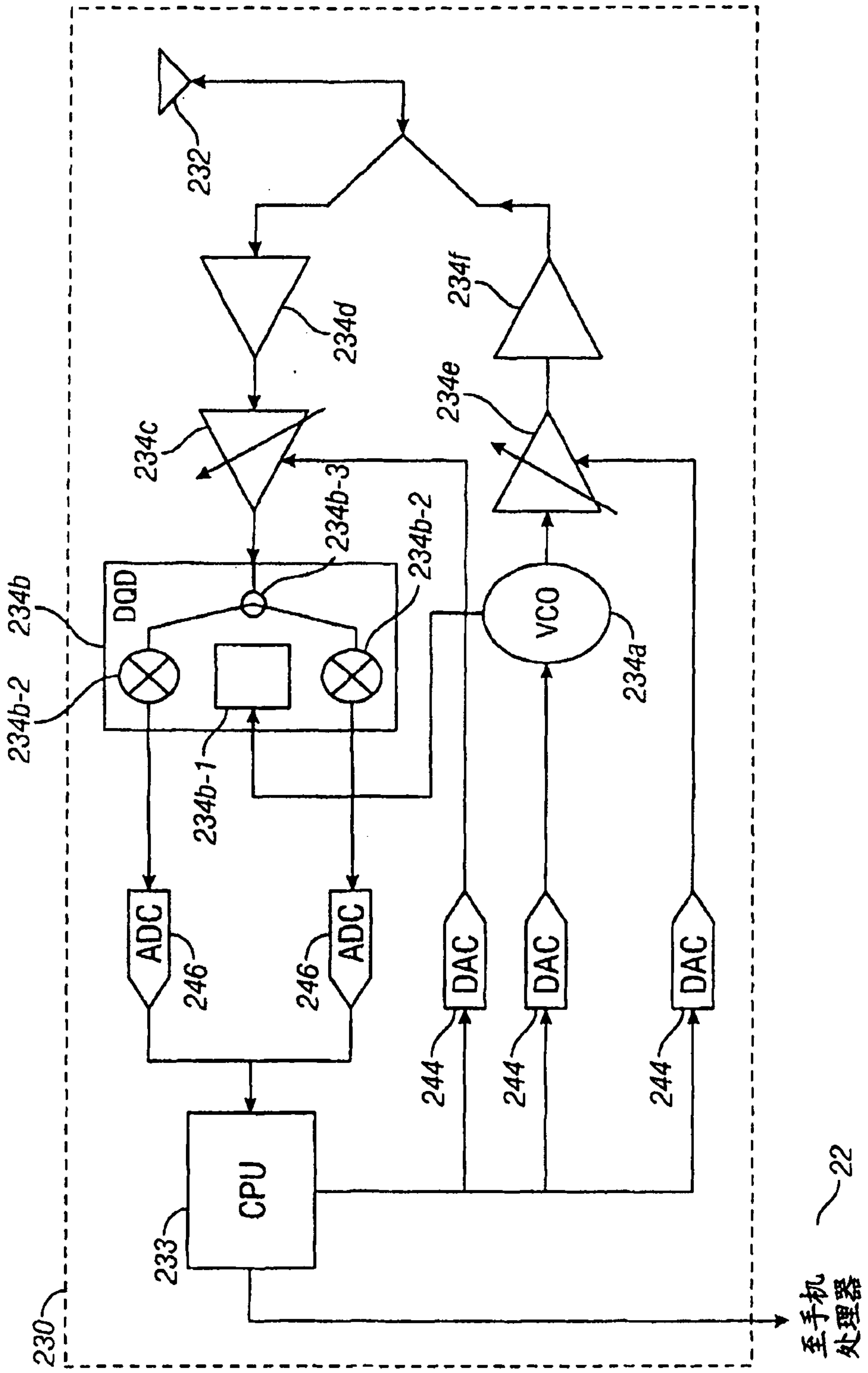

232
234d
234f
234c
234e
234b-3
234b-2
234b
DQD
VCO
234a
234b-2
234b-1
ADC
246
ADC
246
DAC
DAC
DAC
244
244
244
CPU
233
230
22
至手机
处理器

图 8

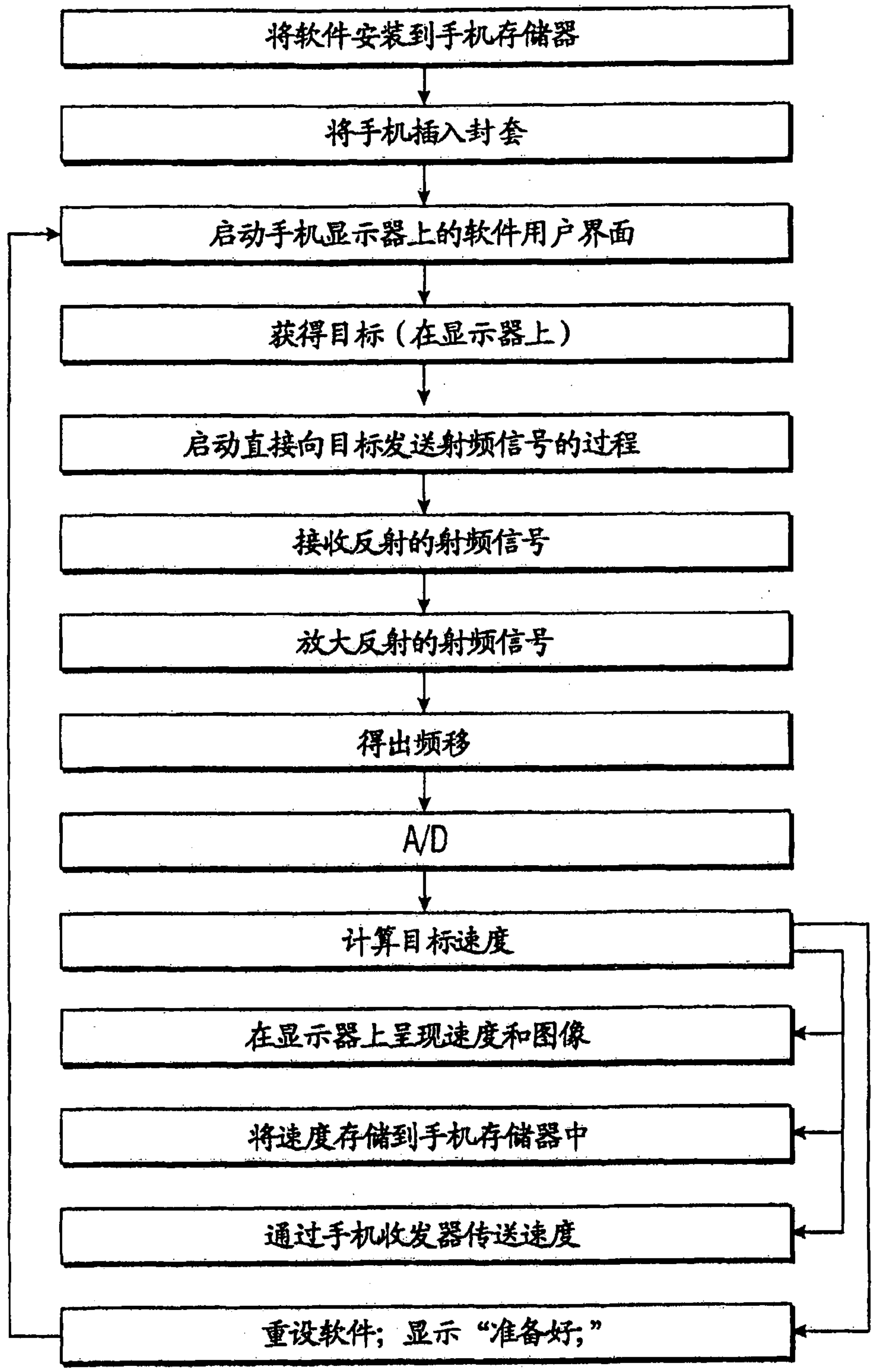

将软件安装到手机存储器
将手机插入封套
启动手机显示器上的软件用户界面
获得目标（在显示器上）
启动直接向目标发送射频信号的过程
接收反射的射频信号
放大反射的射频信号
得出频移
A/D
计算目标速度
在显示器上呈现速度和图像
将速度存储到手机存储器中
通过手机收发器传送速度
重设软件；显示“准备好；”

图 9

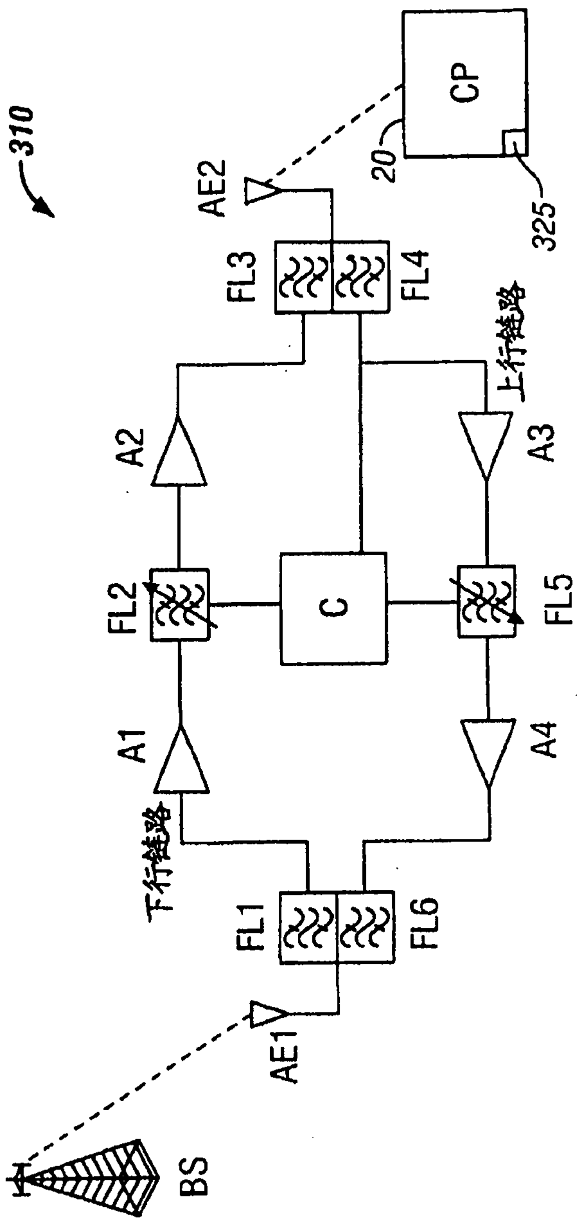

310
CP
20
325
AE2
FL3
FL4
上行链路
A2
A3
FL2
C
FL5
A1
A4
下行链路
FL1
FL6
AE1
BS

图 10

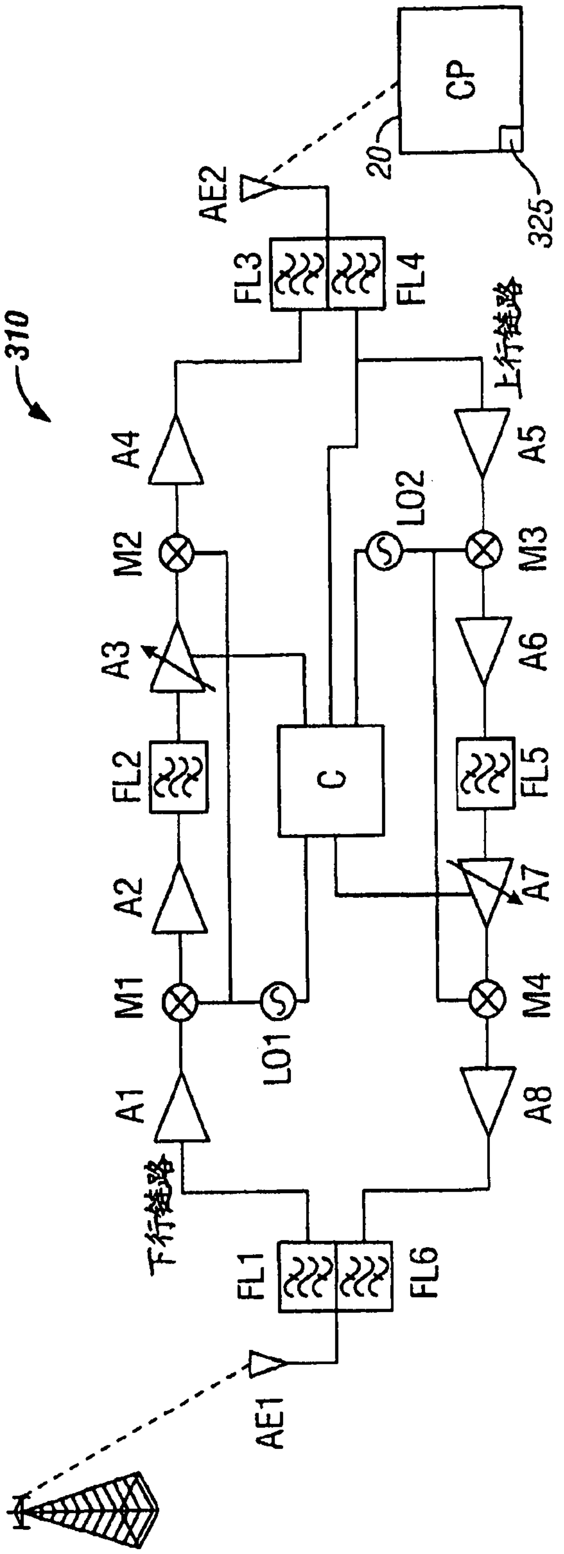

310
CP
20
325
AE2
FL3
FL4
上行链路
A4
A5
M2
M3
LO2
A3
A6
C
FL2
FL5
A2
A7
M1
M4
LO1
A1
A8
下行链路
FL1
FL6
AE1

图 11

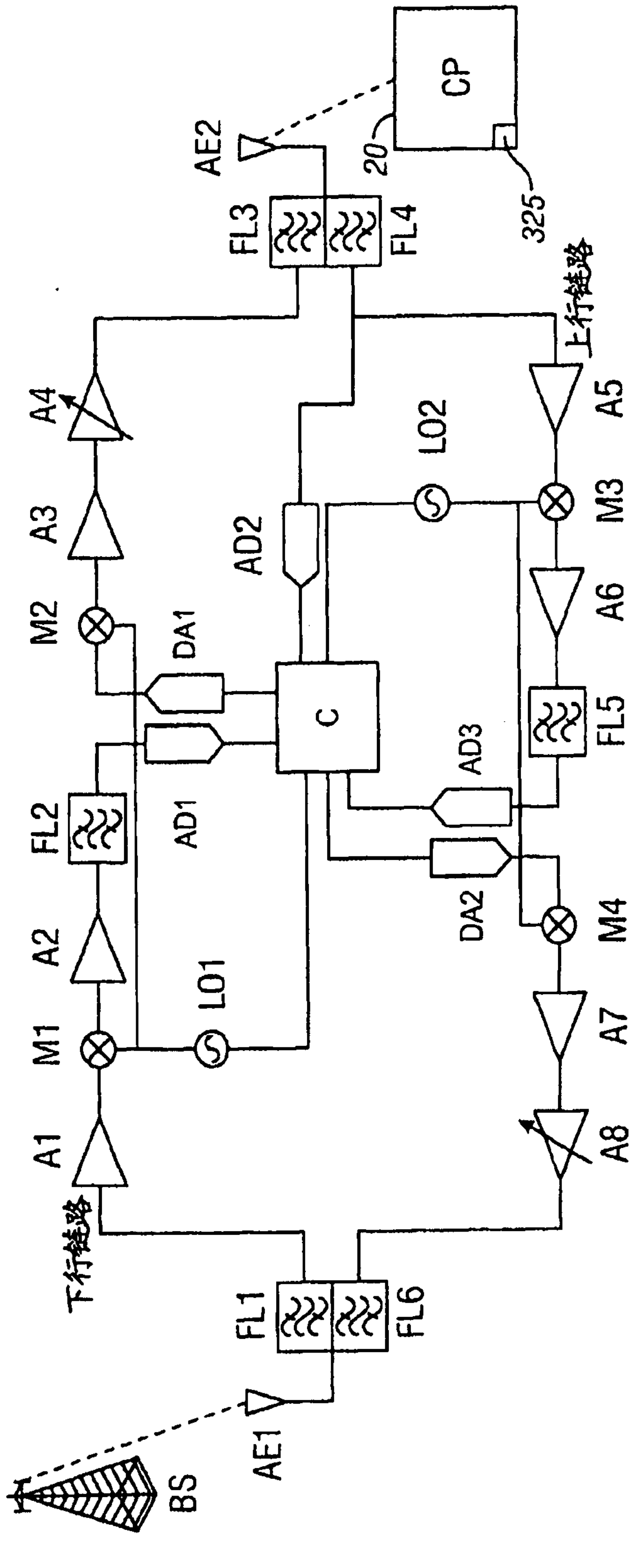

CP
20
325
AE2
FL3
FL4
310
上行链路
A4
A5
LO2
A3
AD2
M3
M2
DA1
A6
C
FL5
AD3
FL2
AD1
DA2
A2
M4
LO1
M1
A7
A1
A8
下行链路
FL1
FL6
AE1
BS

图 12

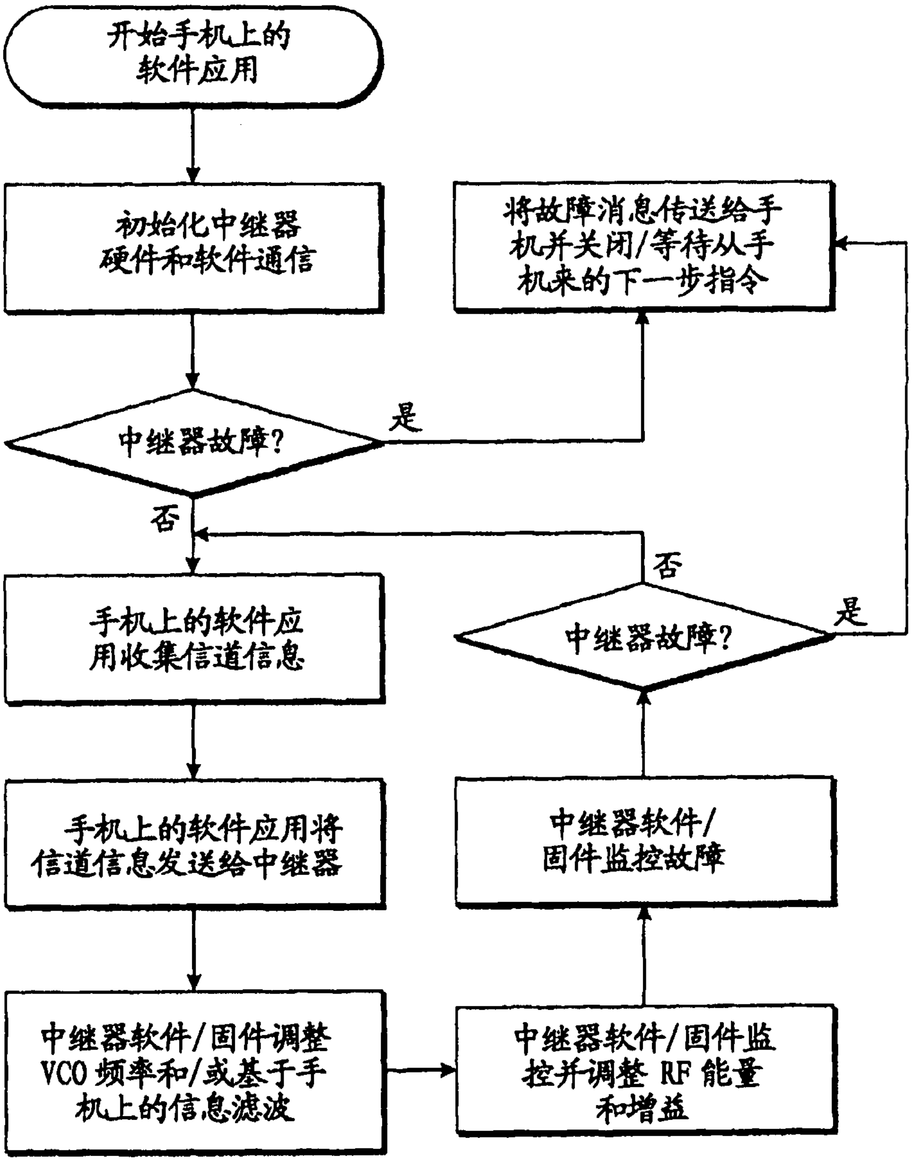

开始手机上的软件应用
初始化中继器硬件和软件通信
中继器故障?
是
否
将故障消息传送给手机并关闭/等待从手机来的下一步指令
手机上的软件应用收集信道信息
手机上的软件应用将信道信息发送给中继器
中继器软件/固件调整VCO频率和/或基于手机上的信息滤波
中继器软件/固件监控并调整RF能量和增益
中继器软件/固件监控故障
中继器故障?
否
是

图 13

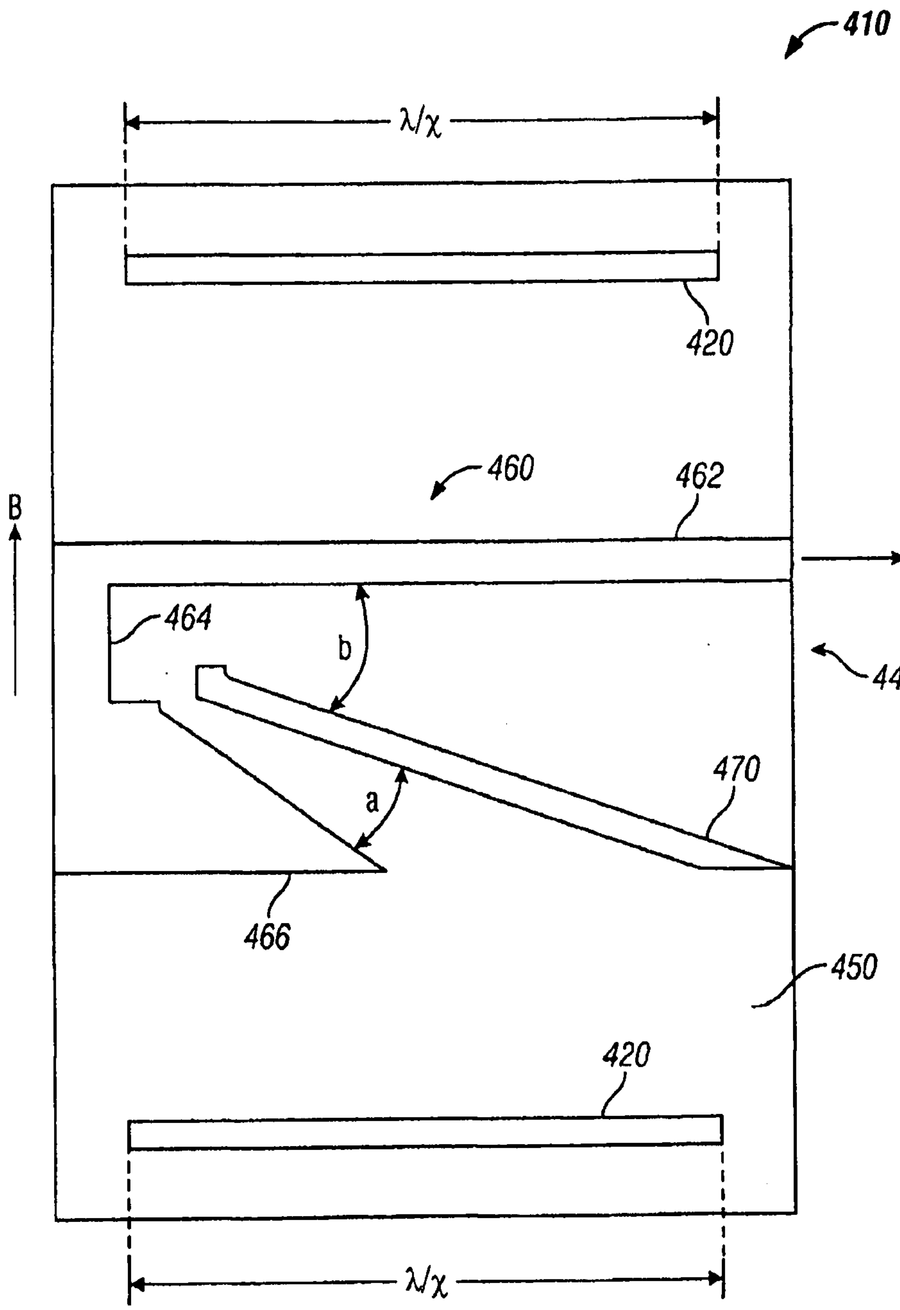


图 14

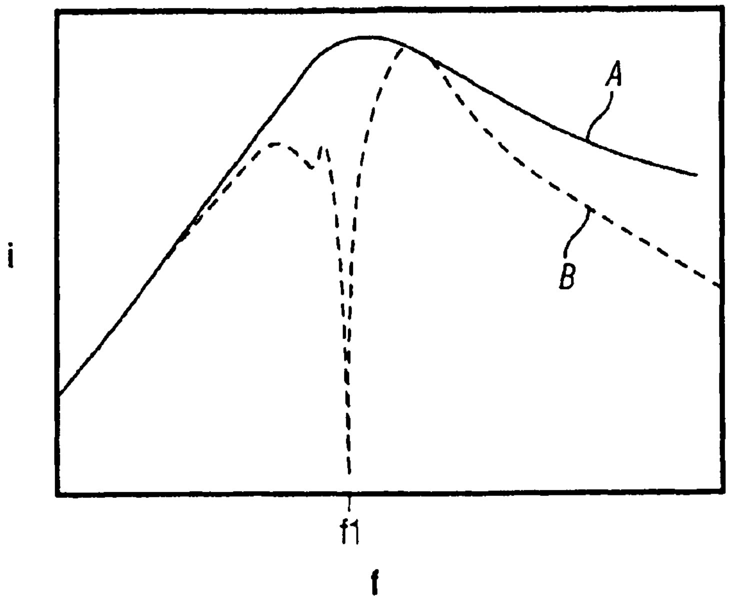


图 15