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(57) Abstract: A method and apparatus for controlling test devices as needed without interfering with the power of the mast head amplifier or the RF signals. The method and apparatus controls the on/off state of remote devices using a single medium. The present invention includes a first signal generator for generating a signal at a first frequency for controlling the remote device. Next is the signal superimposed at the first frequency on a medium carrying a communications signal at a second frequency. It also includes a detector disposed at a remote location, for detecting the signal at the first frequency on the medium and a processing circuit, coupled to the detector, for controlling the device in response to the detection of the signal at the first frequency on the medium.

METHOD AND APPARATUS FOR CONTROLLING TEST DEVICES AT A MAST HEAD OF A BASE STATION

BACKGROUND OF THE INVENTION

1. Field of the Invention.

5 This invention relates in general to a method and apparatus for controlling remote devices using a single cable, and more particularly to the control of remote devices at a mast head of a communications tower.

2. Description of Related Art.

Cellular communication systems are experiencing tremendous growth in
10 the global communication market place. This growth is fueling many research programs and expanding the technology opportunities for all manufacturers of cellular equipment.

To attract customers and obtain a larger market share, cellular providers are pushing features enabled by the system's purely digital nature, such as
15 Caller ID and short messaging, a paging equivalent. To further obtain a larger market share, cellular providers have turned to reducing the cost of air time. Cutting prices can take many forms. For example, vendors can give more free minutes per month, charge less for additional minutes, charge nothing for the first minute of incoming calls, reduce monthly fees, eliminate long-term
20 contracts -- all tactics available to the established cellular vendors as well. For a provider, this leads to less revenue per customer, but more incentive for

increasing the market share. Thus, any reduction in customer traffic due to network problems has a tremendous impact on revenues and profits.

Accordingly, cellular vendors must take every step to ensure the reliability of the cellular network to maximize customer traffic.

5 A base station is the network element that interfaces the mobile station to the network via the air interface. Each cell in the network has a base station associated with it. The primary function of the base station is to maintain the air interface, or medium, for communication to any mobile station within its cell. Other functions of the base station include call processing, signaling,
10 maintenance, and diagnostics. The functional elements of a base station include the antenna subsystem, transceivers, baseband processing and the cabling and associated hardware such as couplers and combiners.

 In base station applications it is sometimes desirable to remotely control multiple devices that are mounted on the antenna mast, away from the base
15 station. Such remote devices are often used for monitoring and testing the performance of the base station. For example, the performance of feeder cables may be monitored by measuring the reflected RF power from the transmitter at the frequency of the BTS operation using test devices, of which some are mounted at the mast head. Nevertheless, in base station
20 applications, these devices which are mounted on the mast still need to be switched on and off at a point remote from the mast head, i.e., usually near or at the base station. However, the mast head amplifier must stay on full time.

Accordingly, cables separate from the RF cable and separate from the power to the mast head amplifier must be routed up the mast to the remote devices to control the on/off state of the remote devices.

It can be seen there is a need for a method and apparatus for turning
5 test devices on and off as needed without interfering with the power of the mast head amplifier or the RF signals.

It can also be seen there is a need for a method and apparatus for controlling remote devices using a single cable.

SUMMARY OF THE INVENTION

To overcome the limitations in the prior art described above, and to overcome other limitations that will become apparent upon reading and understanding the present specification, the present invention discloses a method and apparatus for turning test devices on and off as needed without interfering with the power of the mast head amplifier or the RF signals.

The present invention solves the above-described problems by providing a method and apparatus for controlling remote devices using a single cable. A first signal generator is provided for generating a signal at a first frequency for controlling the on/off state of at least one remote device and for superimposing the signal at the first frequency on a medium carrying a communications signal at a second frequency. A detector is disposed at a remote location of the medium for detecting the signal at the first frequency on the medium. A processing circuit is coupled to the detector for selecting the on/off state of the at least one device in response to the detection of the signal of the first frequency on the medium.

Other embodiments of a system in accordance with the principles of the invention may include alternative or optional additional aspects. One such aspect of the present invention is that the first signal generator further includes a first switch for receiving a control signal to produce a DC signal. An oscillator is coupled to the first switch for producing the signal at the first frequency in response to the DC signal. The signal is filtered at the first frequency using a

filter, and a combiner combines the signal at the first frequency with the signal at the second frequency onto the medium.

Another aspect of the present invention is that the detector further comprises a filter for filtering the signals on the medium to obtain the signal at
5 the first frequency and a rectifier for rectifying the obtained signal at the first frequency to produce a rectified DC signal.

Another aspect of the present invention is that the processing circuit further comprises a switch for receiving the rectified DC signal the switch controlling the on/off state of the at least one device in response to the rectified
10 DC signal.

Another embodiment of the present invention includes a base station, an antenna, an RF cable coupled between the antenna and the base station and a device control system. A mobile station communicates with a communications network over an air interface and base station. The antenna is disposed at a
15 head of the antenna mast for transmitting and receiving communications signal to and from the mobile station via the air interface. The RF cable carries communications signals between the base station and the antenna and the device control system controls the on/off state of at least one device located at the mast head of the base station.

20 The device control system includes a signal generator for generating a signal at a second frequency for controlling the on/off state of at least one remote device at the mast head and for superimposing the signal at the second

frequency on the RF cable carrying the communications signal at the first frequency. A detector is disposed at the mast head for detecting the signal at the second frequency on the RF cable. A processing circuit is coupled to the detector for selecting the on/off state of the at least one device in response to
5 the detection of the signal of the second frequency on the medium.

These and various other advantages and features of novelty which characterize the invention are pointed out with particularity in the claims annexed hereto and form a part hereof. However, for a better understanding of the invention, its advantages, and the objects obtained by its use, reference should
10 be made to the drawings which form a further part hereof, and to accompanying descriptive matter, in which there are illustrated and described specific examples of an apparatus in accordance with the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

Referring now to the drawings in which like reference numbers represent corresponding parts throughout:

Fig. 1 illustrates a block diagram of a mobile communication system;

5 Fig. 2 illustrates a diagram of a wireless communications system; and

Fig. 3 illustrates a system for allowing the on/off state of remote devices at a mast head to be controlled at a second location according to the present invention.

DETAILED DESCRIPTION OF THE INVENTION

In the following description of the exemplary embodiment, reference is made to the accompanying drawings which form a part hereof, and in which is shown by way of illustration the specific embodiment in which the invention may
5 be practiced. It is to be understood that other embodiments may be utilized because structural changes may be made without departing from the scope of the present invention.

The present invention provides a method and apparatus for turning test devices on and off as needed without interfering with the power of the mast
10 head amplifier or the RF signals. Accordingly, the on/off state of remote devices may be controlled using a single cable.

Fig. 1 illustrates a block diagram of a mobile communication system 100 according to an embodiment of the present invention. The system 100 is comprised of a plurality of base stations 102 connected to system controllers
15 101, and mobile terminals 103. A service area of the mobile communication system 100 is divided into a plurality of cells 110-120. The mobile switching center 130 is connected with another mobile communication system or fixed network 132 and coordinates the setting up of calls to the mobile terminals 103. The mobile terminal 103 can move within a service area which is formed by a
20 plurality of base stations 102 for communication through a channel allocated to the neighboring base station 102.

The base station 102 includes transceivers 140, 142, 144. The transceivers 140, 142, 144, which represent at least one receiver and one transmitter, provide coverage to cells 110, 112, 114 respectively, wherein each transmitter/receiver pair 140, 142, 144 comprises a channel unit. The
5 transceivers 140, 142, 144 also receive calling signals sent from the mobile terminal 103 moving in the corresponding cell, and detect up-link carrier wave power of the received signal.

Fig. 2 illustrates a diagram 200 of a wireless communications system. In Fig. 2, a base station 214 maintains the air interface for communication to any
10 mobile station 210 within its cell 240. Calls and messages are passed between the base station 210 and a switch 216. The switch 216 in turn is connected to the network 250, e.g., public switched telephone network (PSTN), public land mobile network (PLMN), Internet, LAN, WAN, etc. The base station 214 handles call processing, such as a handoff to another cell 242 that may be
15 serviced by another base station 244. The base station 214, antenna/antenna mast 218 are positioned within the cell 240. Some type of medium 260, typically an coax RF cable, is used to route signals between the antenna/antenna mast 218 and the base station 214. Those skilled in the art will recognize that the antenna mast may actually included multiple antennas to
20 provide sectorized cells. Moreover, as stated above, in base station applications it is sometimes desirable to remotely control multiple devices that are mounted on the antenna mast which may be located at a distance from the base station.

Fig. 3 illustrates a system 300 for allowing the on/off state of remote devices at a mast head to be controlled at a second location, such as , for example, at the base station itself. The present invention uses low frequency (non-DC) signals, very selective bandpass filters, rectifying diodes, and

5 transistors to selectively control the remote devices via the frequency domain.

In Fig. 3, a control signal 310 starts out, for example, as a TTL signal out of the base station. For explanation purposes, a low logic level will be assumed to turn the device on and a high logic level will turn it off. However, those skilled in the art will recognize that other signaling conventions could be used

10 without departing from the scope of the present invention. The control signal 310 is sent to the base 312 of a transistor switch 314 which supplies the DC voltage 316 to a fixed frequency oscillator 320. The oscillator 320 operates at a frequency distinct from the RF frequency of the system. For example, the oscillator may operate in the hundred kilohertz region. The frequency of the

15 oscillator will herein be referred to as F1.

F1 330 is filtered by a narrow band filter 334 to produce a filtered F1 signal 338. The filtered F1 signal 338 is combined with the RF signal 339 via a combiner 336 and propagated on the RF cable 332. The filtered F1 signal 338 is then sent up the RF cable 332 to the mast head where another selective filter

20 340 strips it out to produce a recovered signal, $F1_R$ 342. The recovered $F1_R$ 342 is then rectified by rectifier 350 to produce a rectified DC signal R_{dc} 352. The rectified DC signal R_{dc} 352 is applied to the base 354 of a transistor switch

356 which saturates and supplies the DC voltage to the device 360 being turned on. If additional devices are to be controlled other sets of filters and oscillators operating at a different frequencies can utilize the same scheme.

The RF signal 339 continues along the RF cable 332 to the mast head
5 amplifier 370. The RF signal 339 is amplified by the mast head amplifier 370 and radiated by the antenna 380. Accordingly, the present invention allows for a constant DC voltage 382, such as might be needed for mast head amplifier 370, to be uninterrupted, while still providing on/off control capability to other devices 360 that use the DC voltage. The mast head amplifier 370 can thus
10 stay on full time and test signal devices 360 can be turned on and off as needed without interference. Control signals, i.e., the filtered F1 signal 338, are transferred via a coax cable 332 without interfering with the wanted RF signal 339 because the control signals 38 are at a different frequency than the RF signal 339. Further, the control signal 338 may be modulated, e.g., Amplitude
15 Modulated.

The foregoing description of the exemplary embodiment of the invention has been presented for the purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise form disclosed. Many modifications and variations are possible in light of the above teaching. It
20 is intended that the scope of the invention be limited not with this detailed description, but rather by the claims appended hereto.

WHAT IS CLAIMED IS:

1. A method for controlling at least one device located at a mast head of a base station, comprising:
 - superimposing a signal at a first frequency onto a medium for
 - 5 transmitting and receiving a communication signal at a second frequency;
 - detecting the signal at the first frequency on the medium at the mast head of the base station; and
 - processing the detected signal to control the at least one device.
2. The method of claim 1 wherein the superimposing further
 - 10 comprises sending a control signal to a first switch, using the first switch to turn an oscillator on and off in response to the control signal to select the production of the signal at the first frequency, filtering the signal at the first frequency and combining the signal at the first frequency with the communication signal at the second frequency onto the medium.
3. The method of claim 2 wherein the detecting further comprises
 - 15 filtering the signals on the medium to obtain the signal at the first frequency and rectifying the obtained signal at the first frequency to produce a rectified DC signal.
4. The method of claim 3 wherein the processing further comprises
 - 20 controlling a state of a second switch using the rectified DC signal to produce

an on/off control signal and selecting an on/off state of the at least one device in response to the control signal.

5 5. The method of claim 1 wherein the detecting further comprises filtering signals on the medium to separate the signal at the first frequency and rectifying the separated signal at the first frequency to produce a rectified DC signal.

6. The method of claim 1 wherein the processing further comprises controlling a state of a switch using the detected signal and selecting an on/off state of the at least one device in response to the state of the switch.

10 7. The method of claim 1 wherein the medium comprises an RF cable.

8. A system for controlling at least one device located at a mast head of a base station, comprising:

15 a signal generator for generating a signal at a first frequency for controlling the at least one remote device and for superimposing the signal at the first frequency on a medium carrying a communications signal at a second frequency;

 a detector, coupled to the medium at the mast head, for detecting the signal at the first frequency; and

a processing circuit, coupled to the detector, for controlling the at least one device in response to the detection by the detector of the signal at the first frequency on the medium at the mast head.

9. The system of claim 8 wherein the signal generator further
5 comprises

a first switch for receiving a control signal to produce a DC signal;

an oscillator, coupled to the first switch, for producing the signal at the first frequency in response to the DC signal;

a filter, coupled to the oscillator, for filtering the signal at the first
10 frequency; and

a combiner, coupled to the filter, for combining the signal at the first frequency with the communications signal at the second frequency on the medium.

10. The system of claim 9 wherein the detector further comprises a
15 filter for filtering the signals on the medium to obtain the signal at the first frequency and a rectifier for rectifying the obtained signal at the first frequency to produce a rectified signal.

11. The system of claim 10 wherein the processing circuit further comprises a second switch for receiving the rectified signal, the second switch

controlling an on/off state of the at least one device in response to the rectified signal.

12. The system of claim 8 wherein the detector further comprises a filter for filtering the signals on the medium to obtain the signal at the first
5 frequency and a rectifier for rectifying the obtained signal at the first frequency to produce a rectified signal.

13. The system of claim 8 wherein the processing circuit further comprises a switch, the switch having a state being turned on and off in response to the signal at the first frequency superimposed on the medium, the
10 state of the switch controlling an on/off state of the at least one device.

14. The system of claim 8 wherein the medium comprises an RF cable.

15. A base station system comprising:
a base station for interfacing a mobile station to a communications
15 network via an air interface;
an antenna mast having an antenna at a head of the antenna mast, the antenna transmitting and receiving communication signals to and from the mobile station via the air interface;

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a medium coupled to the antenna at the head of the antenna mast and to the base station, the medium carrying the communication signals at a first frequency between the base station and the antenna; and

a device control system, coupled to the medium for controlling an on/off
5 state of at least one device located at the mast head, the device control system further comprising:

a signal generator for generating a signal at a second frequency for controlling at least one remote device at the mast head;

a combiner, coupled to the signal generator, for superimposing
10 the signal at the second frequency on the medium carrying the communication signals at the first frequency;

a detector, disposed at the mast head, for detecting the signal at the second frequency on the medium; and

a processing circuit, coupled to the detector, for controlling at
15 least one device in response to the detection of the signal at the second frequency on the medium.

16. The base station system of claim 15 wherein the signal generator further comprises:

a first switch for receiving a control signal to produce a DC signal;

20 an oscillator, coupled to the first switch, for producing the signal at the second frequency in response to the DC signal; and

a filter, coupled to the oscillator, for filtering the signal at the second frequency;

17. The base station system of claim 16 wherein the detector further comprises a filter for filtering the signals on the medium to obtain the signal at
5 the second frequency and a rectifier for rectifying the obtained signal at the second frequency to produce a rectified signal.

18. The base station system of claim 17 wherein the processing circuit further comprises a second switch for receiving the rectified signal, the second switch controlling an on/off state of the at least one device in response
10 to the rectified signal.

19. The base station system of claim 15 wherein the detector further comprises a filter for filtering the signals on the medium to obtain the signal at the second frequency and a rectifier for rectifying the obtained signal at the second frequency to produce a rectified signal.

15 20. The base station system of claim 15 wherein the processing further comprises a switch, a state of the switch being turned on and off in response to the signal at the second frequency being superimposed on the medium, the state of the switch controlling an on/off state of the at least one device.

21. The base station system of claim 15 wherein the medium comprises an RF cable.

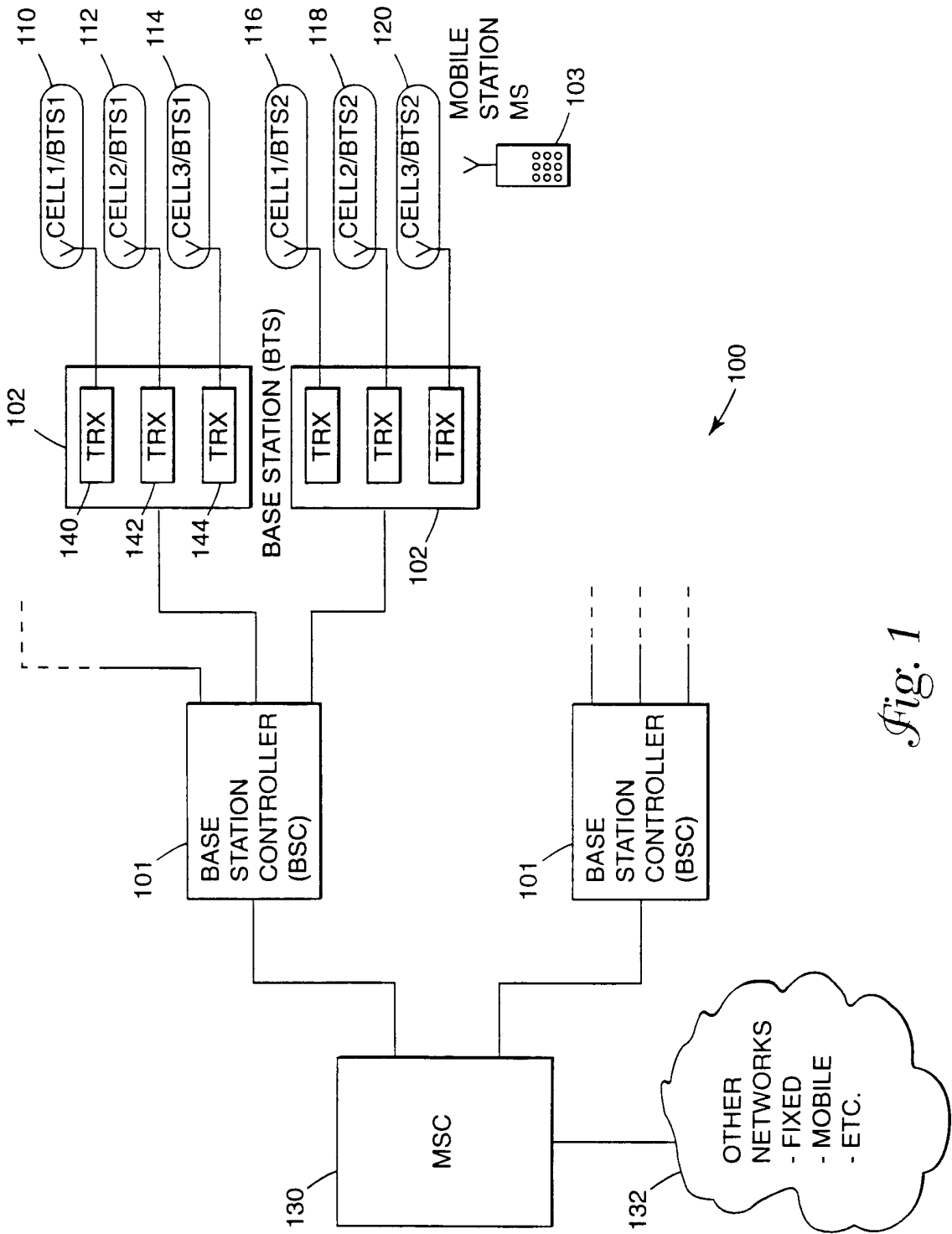
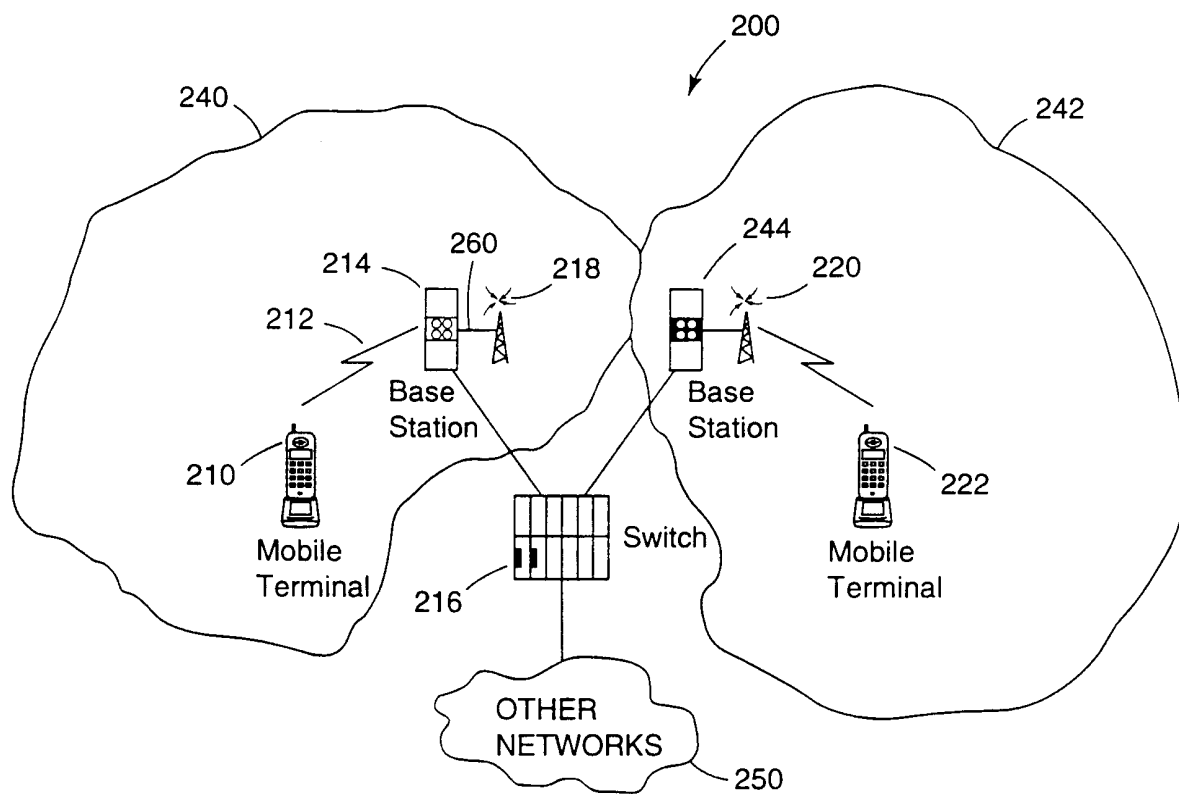


Fig. 1

*Fig. 2*

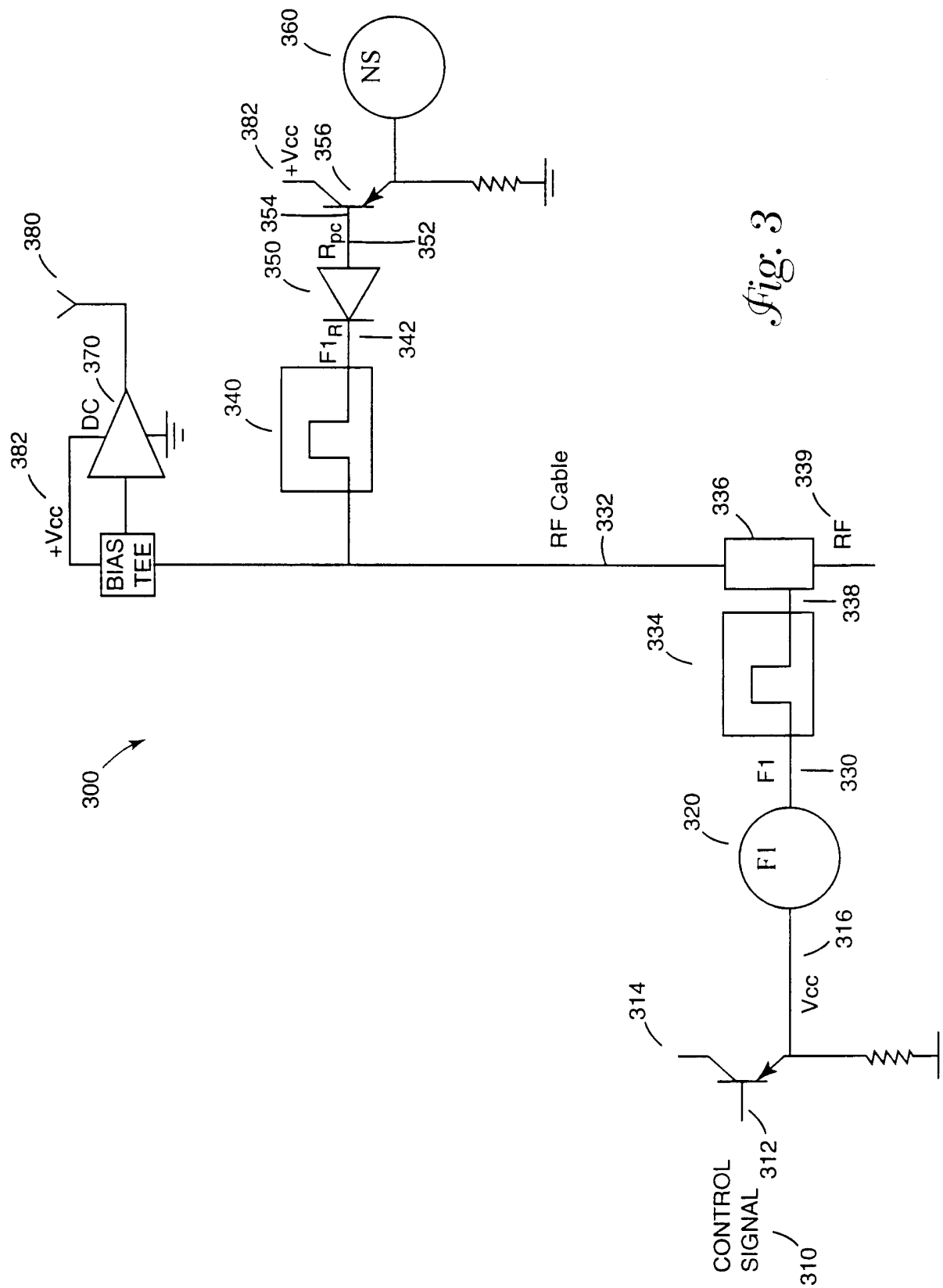


Fig. 3

INTERNATIONAL SEARCH REPORT

Internat Application No

PCT/US 00/18514

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 H04Q7/34

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 7 H04Q G08B H04B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 99 33297 A (ERICSSON TELEFON AB L M) 1 July 1999 (1999-07-01) page 3, line 2 - line 28 ---	1,6-8, 13-15, 20,21
Y	EP 0 718 981 A (MITSUBISHI ELECTRIC CORP) 26 June 1996 (1996-06-26) column 7, line 29 - line 41 ---	1,6-8, 13-15, 20,21
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Further documents are listed in the continuation of box C.



Patent family members are listed in annex.

* 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 document but published on or after the international filing date
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- "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

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INTERNATIONAL SEARCH REPORT

International Application No

PCT/US 00/18514

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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