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# United States Patent [19]

**Bodin et al.**

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[54] **METHOD OF CONTROLLING OUTPUT POWER IN A MOBILE RADIO COMMUNICATION SYSTEM**

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[22] Filed: **Apr. 11, 1994**

**Related U.S. Application Data**

[63] Continuation of Ser. No. 763,231, Sep. 20, 1991, abandoned.

[30] **Foreign Application Priority Data**

Oct. 5, 1990 [SE] Sweden ..... 90031964

[51] **Int. Cl.**[6] ..... **H04B 1/00**; H04Q 7/00

[52] **U.S. Cl.** ..... **455/33.1**; 455/54.1; 455/67.6; 455/69; 379/63

[58] **Field of Search** ..... 455/33.1, 54.1, 63, 455/67.6, 69, 126, 127; 379/59–60, 63

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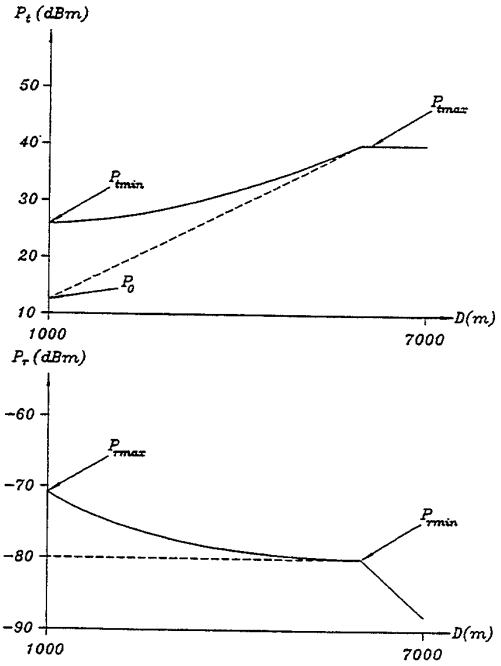
[57] **ABSTRACT**

The invention relates to a method of controlling, in a cellular mobile radio communication system, the output power of radio signals transmitted from a transmitter to a receiver located in the same cell as the transmitter. The method comprises controlling the output power of the transmitter in dependence of a parameter, that is characteristic of the distance between transmitter and receiver, to approximately follow, from a predetermined maximum output power that is transmitted when the distance between the transmitter and receiver is the maximum within the cell, a first function that monotonically decreases with decreasing distance and approaches a predetermined minimum output power as the distance approaches zero, so that the power of the transmitted radio signals as received by the receiver from a minimum received power, that is received when the distance between transmitter and receiver is the maximum within the cell, approximately follows a second function that monotonically increases with decreasing distance and approaches a maximum received power as the distance approaches zero.

**14 Claims, 3 Drawing Sheets**



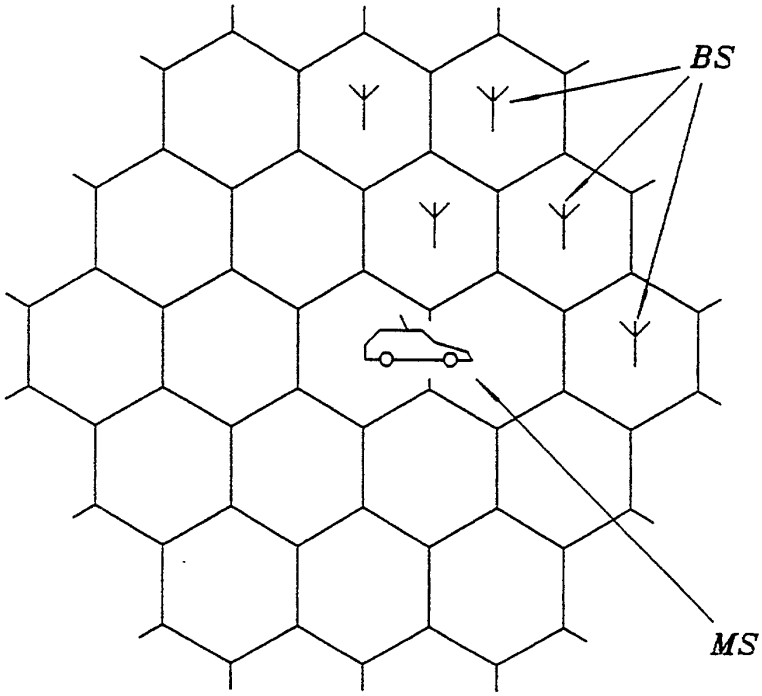



Fig. 1

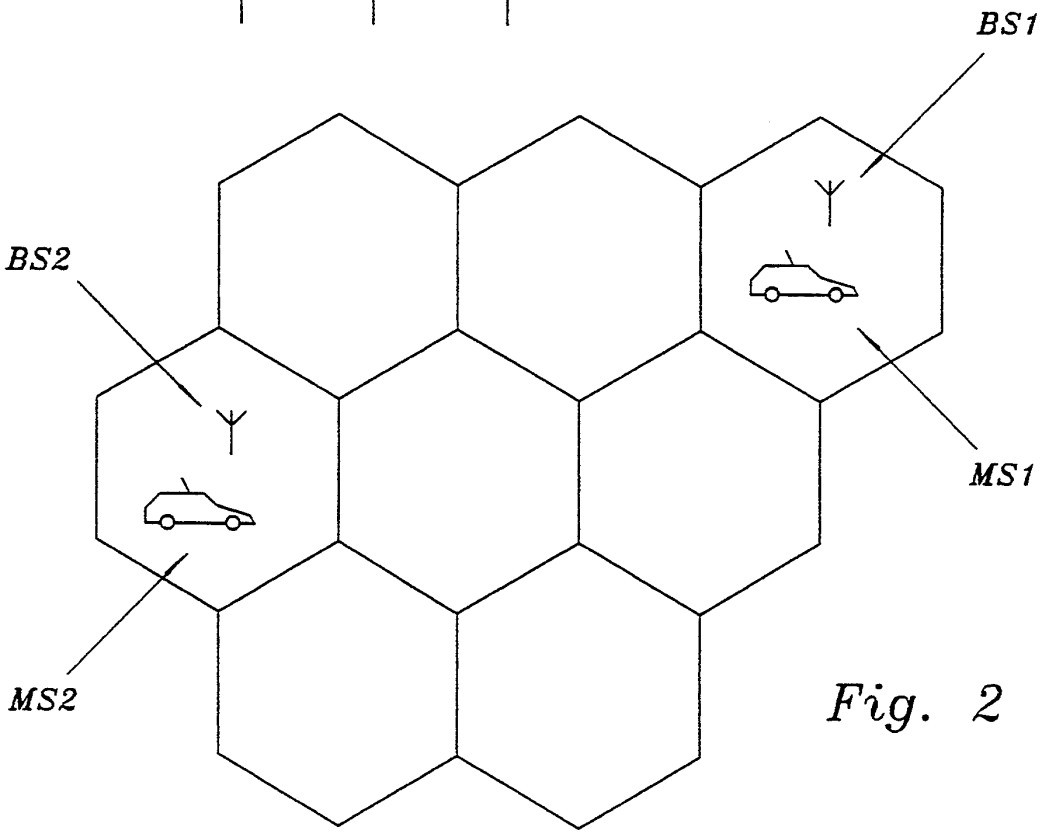



Fig. 2

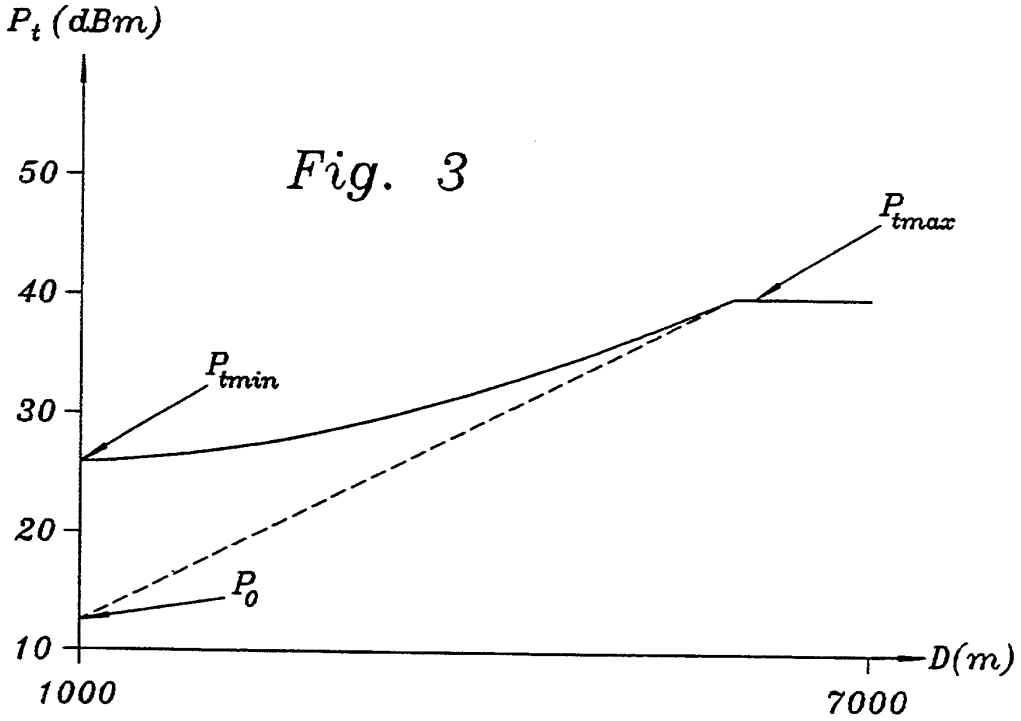



Fig. 3

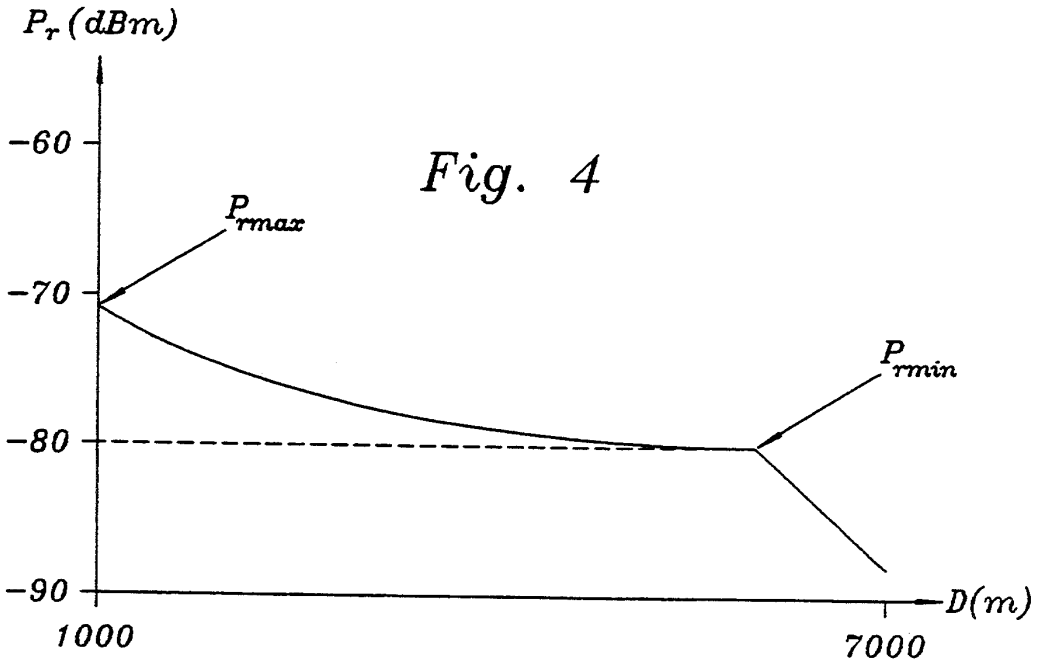



Fig. 4

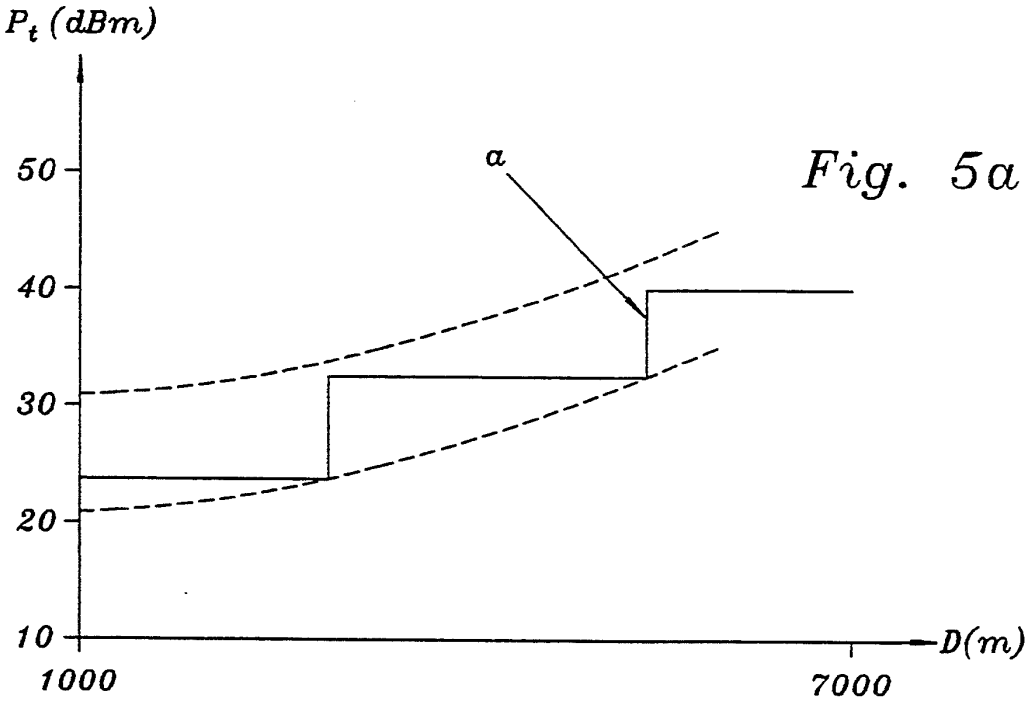



Fig. 5a

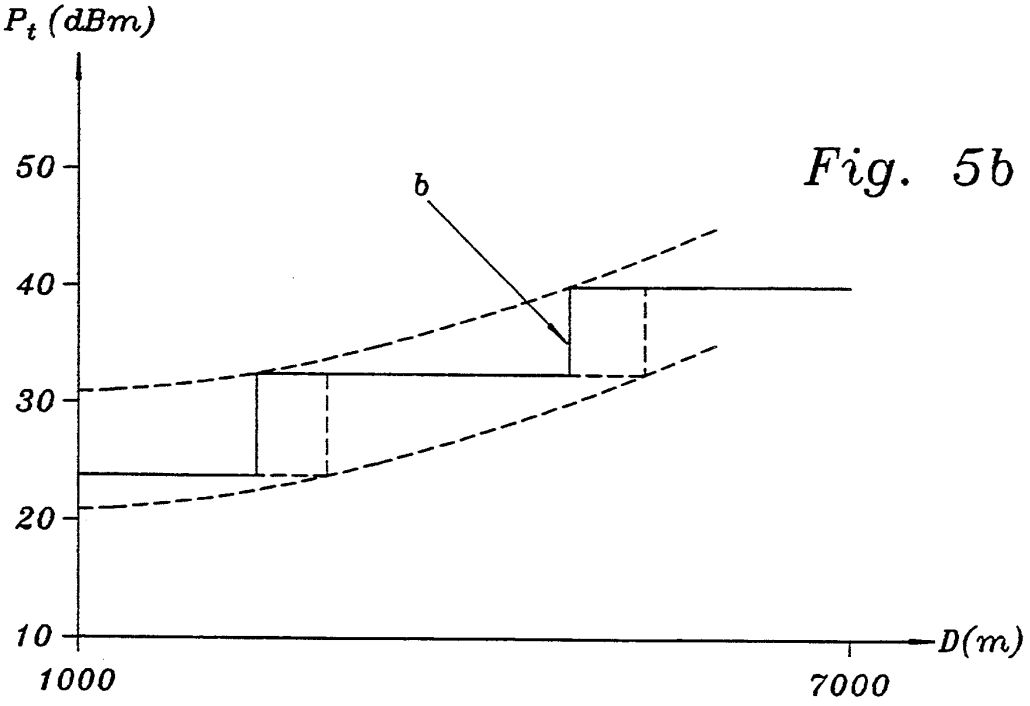



Fig. 5b

# METHOD OF CONTROLLING OUTPUT POWER IN A MOBILE RADIO COMMUNICATION SYSTEM

This application is a continuation of application Ser. No. 07/763,231, filed Sep. 20, 1991, abandoned.

## TECHNICAL FIELD

The present invention relates to a method for controlling, in a cellular mobile radio communication system, the output power of radio signals transmitted from a transmitter to a receiver that is located in the same cell as the transmitter.

## PRIOR ART

A cellular mobile radio communication system comprises a number of cells, each containing a base station. These base stations communicate with mobile stations that can move freely within and between the cells. Since the number of available frequencies for the total system is limited, frequencies are reused for cells that are sufficiently separated from each other.

However, in such reuse of radio frequencies there is a risk that a radio connection is disturbed by signals intended for another radio connection using the same frequency. Thus, it is desirable to control the output power from, for instance, a mobile station in such a way that sufficient output power is transmitted to guarantee that the quality of the radio connection is maintained at the same time as the output power is limited so as to not unnecessarily disturb other radio connections that may use the same frequency.

In U.S. Pat. No. 4,485,486 it has been suggested to control the output power of the mobile station in such a way that the signal received by the base station has constant power irrespective of the distance between mobile station and base station. A drawback of this previously known method is that C/I, that is the ratio between the power received at the base station of the carrier transmitted by the mobile station and the power of interfering signals, on the average is lower than is actually permissible. This is due to the fact that the output power of the mobile station at small distances, where a further reduction of the output power from an already low level has a very small influence on the disturbance on other radio connections, is reduced to an extent uncalled for. On the other hand this further reduction can increase the risk of jeopardizing the mobile stations own radio connection.

## SUMMARY OF THE INVENTION

An object of the present invention is to provide a method for controlling the output power from a mobile station and/or a base station in a cellular analog or digital mobile radio communication system in dependence of the distance between the base station and mobile station in such a way that the variation in transmitted power and received power is distributed in a more optimal way.

Accordingly the invention relates to a method of controlling, in a cellular mobile radio communication system, the output power of radio signals transmitted from a transmitter to a receiver, which is located in the same cell as the transmitter. This method comprises controlling the output power of the transmitter in dependence on a parameter, that is characteristic of the distance between transmitter and receiver, to approximately follow, from a predetermined maximum output power that is transmitted when the distance between the transmitter and receiver is the maximum within the cell, a first function that monotonically decreases with decreasing distance and approaches a predetermined minimum output power as the distance approaches zero, so that the power of the transmitted radio signals as received by the receiver from a minimum received power, that is received when the distance between transmitter and receiver is the maximum within the cell, approximately follows a second function that monotonically increases with decreasing distance and approaches a maximum received power as the distance approaches zero.



The transmitter can comprise either a mobile station in the current cell or the base station of the same cell.

## SHORT DESCRIPTION OF DRAWINGS

The invention, further objects and advantages obtained by the invention are best understood by reference to the following description and the accompanying drawings, in which:

FIG. **1** shows a cellular mobile telephone system;

FIG. **2** shows a number of cells in this cellular mobile telephone system of which two use for instance the same radio frequency or radio channel;

FIG. **3** shows the output power $P_t$ of the radio signal transmitted from a mobile station as a function of the distance D between mobile station and base station in the method in accordance with the present invention;

FIG. **4** shows the power $P_r$ of the radio signal received by the base station as a function of the distance D between mobile station and base station when the output power of the radio signal transmitted by the mobile station is controlled in accordance with the curve in FIG. **3**; and

FIGS. **5**(*a*) and **5**(*b*) illustrates a preferred embodiment of the method in accordance with the present invention.

## PREFERRED EMBODIMENT

FIG. **1** shows, as an example of a mobile radio communication system, the structure of an embodiment of a cellular mobile telephone system. Such a system comprises a number of cells, each cell in this embodiment including one base station BS. For reasons of simplicity only a number of such base stations BS are shown in the figure. Base stations BS are in radio contact with a number of mobile stations MS, of which only one is shown in the figure. Mobile station MS generally communicates with the base station BS of that cell in which it currently is located.

FIG. **2** shows a number of cells in a cellular mobile telephone system. A mobile **MS1** is in radio contact with base station **BS1** in a first cell. In the second cell, separated from the first cell, there is another mobile **MS2** in radio contact with base station **BS2**. If the load on the radio communication system is heavy and the distance between the first and the second cell is sufficiently large, both radio connections may use the same communication channel, for instance the same radio frequency or time slots for the same radio frequency. However, this implies that the output power transmitted from the base stations to the respective mobile stations should be sufficiently low to avoid interference between the cells. On the other hand, the power can not be too low, since this would jeopardize the radio connection between the respective mobile and base station.

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