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An agency of Industry Canada

CA 2275698 C 2008/02/05

(11)(21) 2 275 698

(12) BREVET CANADIEN
CANADIAN PATENT

(13) C

(86) Date de dépôt PCT/PCT Filing Date: 1997/12/23
(87) Date publication PCT/PCT Publication Date: 1998/07/02
(45) Date de délivrance/Issue Date: 2008/02/05
(85) Entrée phase nationale/National Entry: 1999/06/22
(86) N° demande PCT/PCT Application No.: SE 1997/002212
(87) N° publication PCT/PCT Publication No.: 1998/028903
(30) Priorités/Priorities: 1996/12/23 (US08/772,471); 1997/03/25 (US08/826,794); 1997/03/25 (US08/826,793)

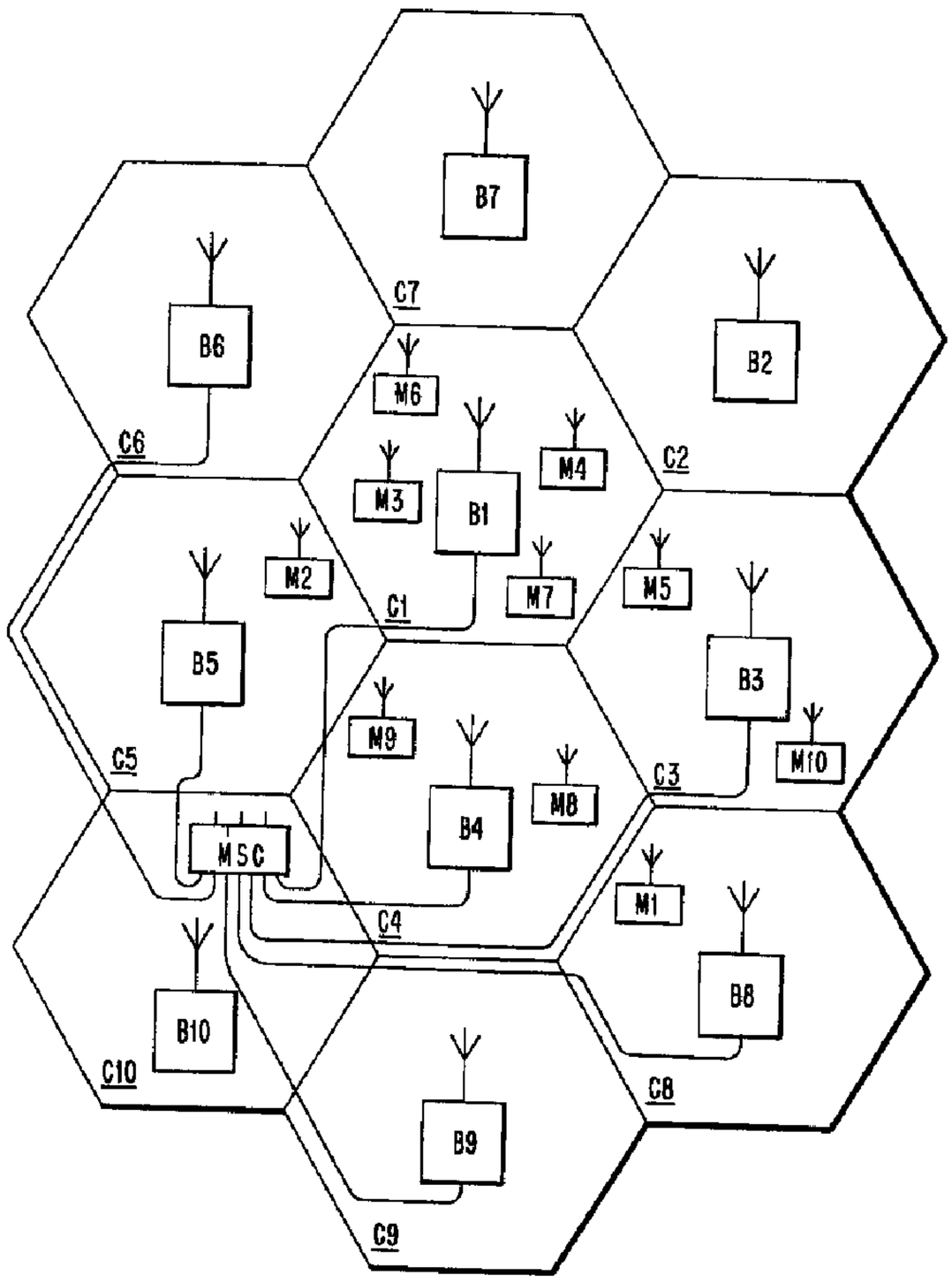
(51) Cl.Int./Int.Cl. *H04M 15/00* (2006.01), *H04M 15/28* (2006.01), *H04M 17/00* (2006.01), *H04M 17/02* (2006.01), *H04Q 7/22* (2006.01), *H04Q 7/38* (2006.01)

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(54) Titre : PROCEDES RELATIFS AU SUPPORT DE FACTURATION POUR PUBLIPHONES
(54) Title: METHODS FOR CELLULAR PAY PHONE/DEBIT PHONE SUPPORT



(57) Abrégé/Abstract:
A communications system for providing charge rate support, and a method for providing Authentication and Privacy, to pay/debit phones are disclosed. A cellular controller within the system enables the pay/debit phones to communicate with other phones. The

CA 2275698 C 2008/02/05

(11)(21) 2 275 698

(13) C

(57) Abrégé(suite)/Abstract(continued):
system calculates a charge rate for a call being made by a pay/debit phone and sends it to that phone in a message containing a standard air interface message that is being used in a non-standard manner. This message allows the pay/debit phone to determine the charge rate. The charge rate information is also sent using mobile station control messages in a non-standard manner. Each control message contains an Order Code, a Qualifier Code, and a Local/Message Type. A first combination of these items is assigned to Authentication and Privacy and a second combination, mutually exclusive with the first, is assigned to sending charge rates.

PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 :
H04M 15/00, 17/02, 17/00, H04Q 7/22, H04M 15/28

A1

(11) International Publication Number: **WO 98/28903**

(43) International Publication Date: 2 July 1998 (02.07.98)

(21) International Application Number: PCT/SE97/02212

(22) International Filing Date: 23 December 1997 (23.12.97)

(30) Priority Data:

08/772,471	23 December 1996 (23.12.96)	US
08/826,793	25 March 1997 (25.03.97)	US
08/826,794	25 March 1997 (25.03.97)	US

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(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, GM, GW, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).

Published

With international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: METHODS FOR CELLULAR PAY PHONE/DEBIT PHONE SUPPORT

(57) Abstract

A communications system for providing charge rate support, and a method for providing Authentication and Privacy, to pay/debit phones are disclosed. A cellular controller within the system enables the pay/debit phones to communicate with other phones. The system calculates a charge rate for a call being made by a pay/debit phone and sends it to that phone in a message containing a standard air interface message that is being used in a non–standard manner. This message allows the pay/debit phone to determine the charge rate. The charge rate information is also sent using mobile station control messages in a non–standard manner. Each control message contains an Order Code, a Qualifier Code, and a Local/Message Type. A first combination of these items is assigned to Authentication and Privacy and a second combination, mutually exclusive with the first, is assigned to sending charge rates.

METHODS FOR CELLULAR PAY PHONE/DEBIT PHONE SUPPORT

FIELD OF THE INVENTION

The present invention relates to a method and apparatus for providing both charge rate support and Authentication and Privacy for cellular pay phones and debit phones in an analog/digital communications system.

BACKGROUND OF THE INVENTION

Recently, there has been a rapid growth of industry and residences into rural and isolated areas. Thus, more people are having to spend more time in what used to be rural and isolated areas. Since there are more people in these areas now, there is now a need for additional telephone support in these areas. For example, there is a need for pay phones throughout these areas to allow people to make telephone calls. Pay phones are phones in which a user pays for the call using money or credit cards and they are usually placed in public areas. The cellular pay phones are fixedly installed but are connected via radio signals to a cellular system, thus the term cellular pay phone. Debit phones are regular cellular phones with a prepaid number of call credits. Debit phones are typically used in markets where fraud or the occurrence of people not paying their bills is prevalent. Typically, pay phones are connected to land line systems by telephone cables. However, it can be very expensive to run new land line cables to isolated or rural areas which did not previously have land line telephone service. In addition, the cellular provider may want to provide pay phones in areas in which the cellular provider does not have a land line system. Furthermore, the cellular provider may want to provide cellular pay phones on public transportation vehicles such as trains or buses.

Figure 1 illustrates a cellular communication system which can provide support for cellular pay phones and debit phones. Figure 1 illustrates 10 cells, C1-C10, of a cellular radio system. For each cell, there is a corresponding base station B1-B10. Remote stations which can either be cellular pay phones, debit phones, or regular cellular phones are shown as M1-M10 Some of the remote stations may be moved

within a cell and from one cell to another. A mobile switching center MSC is connected to all of the base stations by cables or other fixed means, like radio signals. The MSC is also connected by cables or links to a fixed public telephone network or a similar fixed communication network. The MSC communicates with the remote stations by sending signals or commands to the base stations wherein the base stations transmit and receive the appropriate signals to and from the remote stations.

One requirement for pay phone/debit phone service is that the pay phones/debit phones need to be given charge rate information, a currency unit per time unit, for each call so that the user will know how much money to deposit into the machine or how much money is going to be charged to a credit or debit card for the call or how many monetary units will be removed from the prepaid amount in the debit phone. This charge rate information can be provided in several ways. For example, in some systems, the pay phones/debit phones can have a chart of different charge rates which are selected by analysis of the called numbers. The problem with this arrangement is that every time the system operators change the rates, the chart stored in each pay phone/debit phone needs to be upgraded. There is also a need for authenticating the users of a pay phone. If a user is not authenticated or a simple authentication algorithm is used, the pay phones may be cloned or calls hi-jacked enabling people to make calls without being charged. Some analog AMPS (Advanced Mobile Phone Service system) operators have introduced pay phones into their cellular networks using Charge Rate Order messages (CRO) to send the charge rate information to the pay phone/debit phone. However, Authentication and Privacy functions, e.g. Authentication, disabling DTMF, and enabling/disabling encryption, are no longer available. The Charge Rate Order is a standard function in the British TACS system which happens to also work in AMPS systems but only as a non-standardized proprietary function. In some systems, the Charge Rate Order is based upon giving the cellular phones a special subscriber category (MCH) which differentiates them from ordinary cellular subscriptions. When a call is made and the mobile switching center detects that the called party has answered the call, the MSC checks the MCH category of the originating phone. If the category indicates that the cellular phone is indeed a pay phone/debit phone, the CRO function

within the MSC sends a message to the pay phone/debit phone through the appropriate base station indicating that the called party has answered the call and which charge rate is to be used during the call.

However, there are several problems with using charge rate order functions. First of all, the charge rate order is a standard TACS function only and is not standardized in AMPS/D-AMPS systems. Furthermore, when authentication and Privacy was introduced into AMPS/D-AMPS systems, a spare air interface order code was used for authentication which happens to be the same air interface order code as charge rate order that a TACS uses. Thus, the charge rate order message can no longer be used to send the charge rates in AMPS/D-AMPS systems. In AMPS systems, the Charge Rate Order message can no longer be used to send the charge rates without disabling Authentication and Privacy. Finally, charge rate order only worked with analog channels on AMPS systems, which is now a problem since some cellular systems now support both analog and digital channels.

As noted above, the TACS system provides a Charge Rate Order function. In addition, the TACS system provides an Authentication function. However, the Authentication function uses a simpler security algorithm and does not provide the same level of protection against cloning. Furthermore, the TACS system does not provide message encryption (enabling/disabling).

In the Pan-European digital TDMA cellular system known as the Global System for Mobile Communications (GSM), a remote station is supplied with charge advice information (CAI) at the charging point on a per call basis, in a signalling message over the radio interface. The CAI service is provided in the GSM specification as an original/specific service. The remote station receives at the beginning of each call, and as necessary during the call, a message containing the charge advice information. The charge advice information contains a plurality of elements which define various parameters associated with calculating the cost of making the call. The remote station uses the CAI elements to compute an advice of charge (AOC) value for the relevant call.

Also, as noted above, the AMPS/D-AMPS systems do not support charge rate orders. It is not practicable to introduce a specific dedicated message for this function in the AMPS/D-AMPS system for several reasons. First of all, it would require upgraded software not only in the mobile service centers and remote stations, but also in radio base stations. That is, to use a solution according to GSM, all old base stations where a pay phone is to be connected would have to be upgraded. Furthermore, a debit phone roaming into an area served by old, non-upgraded base stations, would not work. Furthermore, it takes time to standardize and implement new messages in the AMPS/D-AMPS system. Thus, there is a need for a solution where only the MSC software and the pay/debit phones need to be upgraded in order to provide appropriate cellular coverage. There is also a need for performing this upgrade without disabling the Authenticating and Privacy capability.

SUMMARY OF THE INVENTION

It is an object of the present invention to overcome the problems cited above by providing a method and apparatus for providing pay/debit phone support in analog and digital cellular communication systems by using existing methods (TACS Charge Rate Order and AMPS Authentication and Privacy) and existing air interface messages in a non-standard manner. The Charge Rate Order function is used as specified in TACS but without several Charge Rate Order codes which have been reserved for Authentication and Privacy. The Charge Rate Order or Authentication and Privacy functions include sending mobile station control messages to the mobile station.

According to one embodiment of the present invention, a communications system which provides support for at least one cellular pay phone/debit phone is disclosed. The system has cellular control means for providing cellular communication services to the pay phones/debit phones so as to allow the pay phones/debit phones to communicate with other phones. The system calculates a charge rate for a call being made by a pay phone/debit phone and sends the charge rate to the pay phone/debit phone in a standard air interface message which is being used in a non-standard

manner. The message contains information which allows the pay phone/debit phone to determine the charge rate.

According to another embodiment of the present invention, a method for providing cellular pay phone/debit phone support within a cellular system is disclosed. The cellular system comprises at least one mobile switching center which can be connected to other communication systems and at least one base station controlled by said mobile switching center. A special category code is assigned to each pay phone/debit phone and is stored in the mobile switching center. When a pay phone/debit phone makes a call, the system directs the call from the pay phone/debit phone to a called phone. The mobile switching center then detects when the call is successfully connected to the called phone. The system then checks the category code for the pay phone/debit phone making the call and sends a message to the pay phone/debit phone indicating that the called phone has been successfully connected and a charge rate which will be used during the call. The message is sent to the pay phone/debit phone in a standard cellular air interface message which is being used in a non-standard manner. The message contains information which allows the pay phone/debit phone to determine the charge rate.

According to yet another embodiment of the present invention, a method for providing support for Charge Rate Order and Authentication and Privacy functions for pay phones/debit phones in a communications system is disclosed which sends control messages between base stations and said pay phones/debit phones on an analog channel, wherein each control message contains an Order Code, a Qualifier Code, and a Local/Message Type. A first group of combinations of Order Code, Qualifier Code, and Local/Message Type is used to identify Authentication and Privacy, while the remaining combinations of Order Code, Qualifier Code and Local/Message Type are used according to TACS Charge Rate Order.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other features and advantages of the invention will be readily apparent to one of ordinary skill in the art from the following written description, used in conjunction with the drawings, in which:

Figure 1 illustrates a mobile telephony communication system;

Figure 2 illustrates a cellular communication system with cellular pay phones/debit phones according to one embodiment of the present invention;

Figure 3 is a flow chart illustrating cellular pay phone/debit phone support with air interface messages;

Figure 4 illustrates the signalling between a MSC, base station and a pay phone/debit phone according to one embodiment of the present invention;

Figure 5 illustrates the signalling between a MSC, base station and pay phone/debit phone according to another embodiment of the present invention;

Figure 6 illustrates the format of a Mobile Station Control Message Word on the Analog Voice channel;

Figure 7 illustrates the format of Flash With Info words on the Analog Voice channel;

Figure 8 illustrates the format of a digital Flash With Info message;

Figure 9 is a flow chart describing the actions of the communications system according to one embodiment of the present invention; and

Figure 10 is a flow chart describing the updating of the charge rate during a call.

Figures 11 (a)-(c) illustrate Authentication and Encryption enabling/disabling processes;

Figure 12 illustrates the first word of a Mobile Station Control message which is used to decide which action is to be performed by the MS;

Figure 13 illustrates the codes for the mobile station Authentication and Privacy procedures according to IS-136 which coincide with Charge Rate Order;

Figure 14 illustrates, among other things, the codes for the mobile station Charge Rate Order procedure according to TACS; and

Figure 15 illustrates a 10 bit charge rate qualifier word.

DETAILED DESCRIPTION

Although the description hereinafter focuses on systems which comply with IS-136 and its predecessors (IS 54B, EIA 553, etc.), the principles of the present invention are equally applicable to a variety of wireless communication systems, e.g. cellular and satellite radio systems, irrespective of the particular mode of operation (analog, digital, dual-mode, etc.), the access technique (FDMA, TDMA, CDMA, hybrid FDMA/TDMA/CDMA, etc.), or the architecture (macrocells, microcells, picocells, etc.). As will be appreciated by one skilled in the art, the logical channel which carries speech and/or data may be implemented in different ways at the physical layer level. The physical channel may be, for example, a relatively narrow RF band (FDMA), a time slot and a radio frequency (TDMA), a unique code sequence (CDMA), or a combination of the foregoing. For purposes of the present invention, the term "channel" means any physical channel which can carry speech and/or data, and is not limited to any particular mode of operation, access technique or system architecture.

Figure 2 illustrates a cellular communication system with cellular pay phone/debit phone support according to one embodiment of the present invention. In Figure 2, a pay phone/debit phone 22 communicates with a mobile switching center 26 via a base station 24 in the same manner as a conventional cellular station. The mobile switching center 26 can be connected to a variety of other communication systems like the fixed public telephone network so as to allow the user of the pay phone/debit phone 22 to contact any phone regardless of whether the phone is in the cellular system.

As noted above, pay phones/debit phones like the ones illustrated in Figure 2 require the cellular system to send the pay phone/debit phone information regarding how much to charge the customer for each time unit that has passed since the connection of the call. This is referred to as charge rate information.

The invention will be further described with reference to Figure 3 which illustrates a flow chart for pay phone/debit phone support. In order to allow the MSC to distinguish regular phones from pay phone/debit phones, the pay phone/debit phones

are assigned special codes when they are defined/activated in the MSC. In some systems, different types of phones are assigned to specific mobile charging (MCH) subscriber classes, e.g. MCH-0, MCH-1, etc.. Thus, for example, a regular subscriber which does not need charge rate information can be assigned to subscriber class MCH-0 while pay phones/debit phones can be assigned to subscriber class MCH-2. The codes are stored in the MSC and can be referenced whenever a call is made.

When a call is made from the pay phone/debit phone in step S1 of Figure 3, the base station receives the call request and forwards the call request to the MSC. The MSC then forwards the call to the called phone in a known manner in step S2. The MSC then detects whether or not the call is answered in step S3. If the call is not answered, the call is disconnected in step S4. However, if the call is answered, the MSC checks the pay phone/debit phone's mobile charging subscriber class and determines the charge rate that needs to be employed by the pay phone/debit phone. The MSC then sends a signal to the base station indicating that the call has been answered and what charge rate to use for the call. The base station then sends the charge rate information to the pay phone/debit phone using standard cellular air interface messages in a non-standard manner in step S5. The pay phone/debit phone is then connected to the called phone once the charge rate has been accepted in step S6.

Air interface messages have been designed to carry out specific functions or applications as set forth in various standards. In the present invention, some air interface messages are used for functions other than those assigned by the standards. Thus, the air interface messages are used in a non-standard manner.

Suitable messages for use in a non-standard manner are those messages which can be used in a non-standard manner without disturbing the standard usage of the message. For example, the Calling Party Number mechanism or Voice Message Waiting mechanism can be used to send the charge rate information between the MSC and the base station. The base station will use the Flash With Info message on digital traffic channel or the mobile station control message on analog voice channel, both of which are standard cellular air interface messages, can be used to send the charge rate information between the base station and the pay phone/debit phone.

The Calling Party Number mechanism is normally used for sending the phone number of the calling party for display. The Calling Party Number information can be replaced by charge rate information if a code is added so the pay phone/debit phone can understand that this information is charge rate information. As illustrated in Figure 4, the MSC sends a signal to the base station wherein the Calling Party Number is replaced by a special string of characters and the charge rate. For the digital traffic channel the base station 42 then sends a Flash With Info message which contains the charge rate and the special string of characters in the calling party number field to the pay phone/debit phone 44.

For the analog voice channel, the base station 42 then sends a mobile station control message with the Order code Flash With Info and the charge rate and the special string of characters is contained in the character fields of the Flash With Info words. The special string of characters is a unique code that is not part of a regular phone number. An example of a special string of characters is "**#**#" and is needed to allow pay phone/debit phones to differentiate between Calling party Number and charge rate. In other words, the pay phone/debit phones are programmed to interpret Calling Party Number as a charge rate information.

Likewise, the Voice Message Waiting mechanism is normally used by the MSC in some cellular systems to notify a subscriber that a number of voicemail messages are waiting for retrieval. However, in the present invention, the Voice Message Waiting mechanism can be used to send the charge rate information to pay phones/debit phones as many times as needed. As illustrated in Figure 5, the MSC 50 sends a signal to the base station 52 wherein the Voice Message Waiting information is replaced by the charge rate. When on the analog voice channel, the base station 52 then sends a mobile station control message with order qualifier Voice Message Waiting to the pay phone 54 wherein the charge rate is contained in the Message Type field. When on the digital traffic channel the base station 52 then sends a FWI message to the pay phone 54 wherein the charge rate is contained in the Voice Message Waiting field. In other words, pay phones/debit phones are programmed to interpret Voice Message Waiting information as charge rate information.

There are several advantages with using existing Air Interface messages in a non-standard manner instead of implementing new messages to send the charge rate information to the pay phones/debit phones. First of all, development cost is lower since changes are only needed on the application level, while lower protocol levels do not need to be changed. In addition, as mentioned above, only the MSC, not the base stations, needs to be upgraded. The implementation may be made now without waiting for new revisions of the standard. Furthermore, the cost of the pay phone/debit phone is lower due to less processor load, less design complexity, and memory requirements. There is also a lower battery consumption in the phones due to a decrease in the processing that is required. Finally, using existing air interface messages in a non-standard manner will not seriously impact standard mobile stations if they receive this message by error.

For analog voice channels, the Voice Message Waiting and the Flash With Info are both sent to the pay phone/debit phone using a mobile station control message whose structure is illustrated in Figure 6. The interpretation of the data fields of Figure 6 is as follows:

T_1T_2	Type Field. Set to 10 in Word 1. Set to 01 in Word 2 and all subsequent words. Word 2 is sent after Word 1 only when the order is 01110, a digital traffic channel assignment, or one of the following orders or order confirmation: • Base Station Challenge Order Confirmation • Unique Challenge Order • SSD Update Order • Alert With Info • Flash With Info • Release With Digital Control Channel Information • Release Complete
SCC	SAT color code for new channel (see Table 3.7.1-2).
PSCC	Present SAT color code. Indicates the SAT color code associated witht the present channel.
DVCC	Digital Verification Color Code

EF	Extended Protocol Forward Channel Indicator. Mobile stations operating in compliance with the requirements of this Standard shall set this bit to zero.
Hyperband	Designates Hyperband. 00 = 800 MHz, 01 = 1900 MHz. All other values are reserved
MSG, TYPE	Message Type Field. Qualifies the order to a specific action (See Table 3.7.1-1).
ORDER	Order Field. Identifies the order type (See Table 3.7.1-1).
ORDQ	Order Qualifier Field. Qualifies the order to a specific action (See Table 3.7.1-1).
LOCAL	Local Control Field. This field is specific to each system. The ORDER field must be set to local control (See Table 3.7.1-1) for this field to be interpreted.
CPN_RL	A 6-bit field used to indicate the number of CHARACTERs in the Calling Party Number.
PI	Presentation Indicator. A 2-bit field used to indicate whether or not the calling number should be displayed. See Section 3.7.3.1.3.3.1 for coding rules.
SI	Screening Indicator. A 2-bit field indicating how the calling number was screened. See section 2.7.3.1.3.3.1 for coding rules.
CHARACTER	An 8-bit representation of an ASCII character, coded as described in Section 2.7.3.1.3.4 and the references cited therein. Note that in the absence of a sufficient number of character to completely fill the last Alert With Info or Flash With Info Word, null characters (00000000) are to be used as filler.
DTX	Discontinuous Transmission. DTX=0 indicates that DTX is disabled. DTX=1 indicates that the mobile station's current DTX mode is to be maintained.
PVI	Protocol Version Indicator. A 1-bit value used to indicate whether TIA/EIA 627 or IS-136 is supported on the assigned channel: 0 = TIA/EIA 627; I = IS-136.
P	Parity Field

The interpretation of a mobile station control message is determined by an order field in the mobile station control message. In one embodiment. an order field set to 10010 is interpreted to be a Flash With Info, while an order field set to 00101 is interpreted to be a Voice Message Waiting, but the present invention is not limited thereto. For the situation where the Voice Message Waiting is being used to send the charge rate information to the pay phone/debit phone, the charge rate information is contained in the Local/Message Type field. Thus, when a pay phone/debit phone receives a mobile station control message which is interpreted as a Voice Message Waiting, the pay phone/debit phone interprets the information contained in the Local/Message Type field as the charge rate information. Alternatively, for the situation where the Calling Party Number mechanism is used to transmit the charge rate information to the pay phone/debit phone, the charge rate information is placed in character fields in subsequent Flash With Info words. The structure of the Flash With Info words is disclosed in Figure 7. Thus, when a pay phone/debit phone interprets a mobile station control message as being a Flash With Info, the pay phone/debit phone will look to the character fields of the subsequent Flash With Info words so as to obtain the charge rate information.

According to another embodiment of the present invention, the charge rate information can be contained within the Flash With Info words of a mobile station control message with Order Code Flash with Info and be indicated to the pay phone/debit phone using a different order qualifier code. The current Flash With Info order qualifier code is 000. However, according to the present invention, the pay phone/debit phone can be programmed in such a way that when it receives an order qualifier code which is not the appropriate code, for example, 001, the mobile station determines that the message contains charge rate information. In this embodiment, the base stations will have to be updated to set the new order qualifier codes as being indicative of the charge rate information. In this case the special string of characters used to indicate the charge rate is not needed. It will be understood by one skilled in the art that other order qualifier codes can be used to indicate charge rate information

so long as the order qualifier code is not the code which has already been assigned to a specific action.

According to another embodiment of the present invention, charge rate information can also be sent on digital voice channels using available information element fields within the Flash With Info message. The format of the Flash With Info message is illustrated in Figure 8. As illustrated in Figure 8, the Flash With Info message contains a plurality of information elements. If the Voice Message Waiting mechanism is being used, the charge rate information is transmitted in the Voice Message Waiting information element of the Flash With Info Message. Alternatively, if the Calling Party Number mechanism is being used, the charge rate information is transmitted in the Calling Party Number information element field of the Flash With Info message.

Alternatively, a new information element field can be added to the Flash With Info message which is specifically designed to carry the charge rate information. In this embodiment, the base stations will have to be updated to set the new information element field.

The operation of the communication system will now be described with reference to Figure 9. In this embodiment, the mobile switching center detects that the pay phone/debit phone initiates a call to a terminal in step 100. The mobile switching center then forwards the call to the called terminal in a known manner. The mobile switching center then detects whether or not the call has been answered in step S102. If the call is not answered, the call is disconnected in step S104. If the call is answered, the mobile switching center calculates the charge rate information for the call in a known manner. The mobile switching center then determines whether to send the charge rate information to the pay phone/debit phone using either an analog voice channel or a digital traffic channel depending on the capabilities of the pay phone/debit phone and the capacity of the system in step S108. If the mobile switching center decides to send the charge rate information using an analog voice channel, the charge rate information is sent in a mobile station control message as described above, in step S110. However, if the mobile switching center decides to send the charge rate

information using a digital traffic channel, the charge rate information is sent to the pay phone/debit phone in a field of the Flash With Info message as described above, in step S112. In either case, the system determines whether the rate has been accepted by the user of the pay phone/debit phone, in step S114. If the rate is not accepted, the call is disconnected in step S116. However, if the rate is accepted, the mobile switching center connects the pay phone/debit phone to the called terminal in step S118.

Furthermore, the charge rate may need to be changed during a call because of various parameters such as handoff, time of day, changed charging areas, etc. When a new rate is needed during a call, the base station sends a charge rate order to the pay phone/debit phone using one of the methods described above and as illustrated in Figure 10.

The Flash With Info and mobile station control message air interface messages can also be used to implement an "Advice of Charge" functionality within the cellular system. The "Advice of Charge" function allows the served pay phone/debit phone to be informed of the charge for a utilized service. The pay phone/debit phone can receive the Advice of Charge message at the beginning of each call and during the call if it is needed. The Advice of Charge message is sent to the pay phones/debit phones in the same manner that the charge rate information is sent to the pay phones/debit phones in the embodiments described above. When the pay phone/debit phone determines that it has received the Advice of Charge message, the pay phone/debit phone displays the charge information on a display screen. In most of the solutions described above, this can be done without updating the base stations. If the Calling Party Number mechanism is used and the Charge Rate (and the special string of characters) are sent as readable characters then no modifications are needed in existing mobile stations to display the Advice of Charge message. However, in the GSM system, the base station will have to be updated to provide this service.

Also, in the present invention, in AMPS, the Mobile Station Authentication and Privacy messages are used in their standard manner for authentication and encryption purposes and in a non-standard manner to transmit the charge rate to the pay phones/debit phones. In TACS, the Mobile Station Control message is used in a

standard manner for charge rate purposes except for five specific code values (Fig. 13) which are reserved for Authentication and Privacy as specified in AMPS.

As illustrated in Figures 11(a)-(c), the authentication and encryption functions can be performed in several manners on the analog voice channel in several states: waiting for order; waiting for answer; and conversation. In Figure 11(a), the Shared Secret Data (SSD) Update is used. SSD is a value that can only be calculated by the MSC and the specific MS and is used as a part of the Authentication procedure. First, the base station sends a SSD Update order to the mobile station. The mobile station calculates new Shared Secret Data and sends a base station challenge order to the base station. The base station confirms the base station challenge order and the mobile station sends a SSD Update order confirmation to the base station. In Figure 11(b), a Unique Challenge Response which is another part of the Authentication procedure. When the base station issues a Unique Challenge order, the mobile station executes the Unique Challenge Response procedure and transmits a confirmation signal to the base station. In Figure 11(c), the base station issues a Message Encryption Order to activate/deactivate encryption and the mobile station acknowledges the Message Encryption Order.

The mobile station control message is used to order the mobile station to perform specific functions. The first word of the mobile station control message has a format which is illustrated in Figure 12. The mobile station control message has a plurality of information elements such as an Order Code field, an Order Qualifier field and a Local/Message Type field. The Order Code field, the Order Qualifier field, and the Local/Message Type field identifies the message indicating a specific action. The Authentication process can use two of these code combinations, the message encryption process can use two of these code combinations and one code combination can be used in AMPS for disabling DTMF signalling. The Authentication and Privacy process refers to the action during which information is exchanged between a mobile station and a base station for the purpose of enabling the base station to confirm the identity of the mobile station (Figs. 11 a-b) or to enabling/disabling encryption (Fig. 11(c)) or disabling DTMF. The mobile station Authentication and Privacy order has specific

Order Codes of 10100, 10101, 10110, and 10111 with the Qualifier Code of 000, and the Order Code of 10111 with the Qualifier Code of 001 as illustrated in Figure 13. The different Authentication and Privacy Order Codes (e.g. 10100, 10101, 10110, and 10111) and the different Qualifier Codes (000, 001) and the Message Type (00000) are used to distinguish between the five different Authentication and Privacy procedures which the mobile station has been programmed to perform. Figure 14 illustrates a table of Order Codes and Qualifier Codes and their associated functions.

According to the present invention, charge rate information can be sent to the pay phones/debit phones using the codes specific for TACS CRO so long as the two least significant digits of the Order Code, the entire Qualifier Code and Local/Message type do not correspond to the two least significant digits of the Order Code, the entire Qualifier code and Local/Message Type assigned to the AMPS Authentication and Privacy process. As set forth in Figure 13, the Local/Message Type is 00000 and the Qualifier Codes for all of the Authentication and Privacy messages are 000 and in one case 001. Thus, the charge rate information can be sent to the pay phones/debit phones using an order code (101XY) as long as the Order Code, Qualifier Code, and the Local/Message Type do not have one of the 5 values illustrated in Figure 13. The bits XY of the Order Code and the bits in the Qualifier Code and the Local/Message Type are interpreted by the pay phone/debit phone as a charge rate information. For example, as illustrated in Figure 15, the 10 bit charge rate qualifier word formed by the XY bits of the Order Code, the 5 bits of the Local/Message Type and the 3 bits of the Qualifier code can represent a number from 0 to 1023 and indicate the number of tenths of seconds purchased for one credit unit, wherein the value zero represents a free call.

There are several advantages with using existing air interface messages in a non-standard manner instead of implementing new messages to send the charge rate information to the pay phone/debit phone. First of all, developmental cost is lower since changes are only needed on an application level, while lower protocol levels do not need to be changed. In addition, as mentioned above, the base stations do not need to be upgraded only the MSC needs to be upgraded. Furthermore, the cost of the pay phone/debit phone is lower due to less processor load, less design complexity, and

memory requirements. Finally, there is a lower battery consumption in the phones due to less processing being required.

It will be appreciated by those of ordinary skill in the art that the present invention can be embodied in other specific forms without departing from the spirit or central character thereof. The present disclosed embodiments are therefore considered to be illustrative and not restrictive. The scope of the invention is indicated by the appended claims rather than the foregoing description and all changes which come within the meaning and range of equivalents thereof are intended to be embraced therein.

WHAT IS CLAIMED IS:

1. A communications system which provides support for at least one cellular pay phone/debit phone, comprising:

cellular control means for providing cellular communication services to said pay phones/debit phones so as to allow the pay phones/debit phones to communicate with other phones;

means for calculating a charge rate for a call being made by a pay phone/debit phone; and

means for sending said charge rate to said pay phone/debit phone in a standard air interface message, said standard air interface message being designed to carry out a specific function different than sending said charge rate, whereby allowing the pay phone/debit phone to determine the charge rate.

2. A communications system according to claim 1, wherein said charge rate is sent to said pay phone/debit phone on an analog voice channel using a mobile station control message having an order code.

3. A communications system according to claim 2, wherein said Order Code is a Voice Message Waiting.

4. A communications system according to claim 2, wherein said charge rate is contained within Local/Message Type field within said mobile station control message.

5. A communications system according to claim 2, wherein said Order Code is a Flash with Info.

6. A communications system according to claim 2, wherein said charge rate is contained in character fields of the Flash with Info.

7. A communications system according to claim 6, wherein a special string of characters is inserted at the beginning of the character field and the charge rate is contained in the remaining characters of the character field, wherein said special string of characters alerts said pay phone/debit phone that the mobile station control message contains said charge rate.

8. A communications system according to claim 6, wherein an order qualifier code indicates that the character field contains a charge rate.

9. A communications system according to claim 1, wherein said charge rate is sent to said pay phone/debit phone on a digital voice channel.

10. A communications system according to claim 9, wherein said charge rate is transmitted in an information element of a Flash With Info message.

11. A communications system according to claim 9, wherein said charge rate is transmitted in a Voice Message Waiting Information element of a Flash With Info message.

12. A communications system according to claim 9, wherein said charge rate is transmitted in a Calling Party Number information element of a Flash With Info message.

13. A communications system according to claim 12, wherein a special string of characters is inserted at the beginning of the Calling Party Number field and the charge rate is contained in the remaining digits of the Calling Party Number field, wherein said special string of characters alerts said pay phone/debit phone that the Flash With Info message contains said charge rate.

14. A communications system according to claim 1, wherein said charge rate information is displayed on a display screen on said pay phone/debit phone.

15. A method for providing cellular pay phone/debit phone support within a cellular system, said cellular system comprising at least one mobile switching center which can be connected to other communication systems and at least one base station controlled by said mobile switching center, comprising the steps of:

assigning a special category code to each pay phone/debit phone and storing said codes in said mobile switching center;

directing a call from one pay phone/debit phone to a called phone;

detecting at said mobile switching center when the call is successfully connected to the called phone;

checking said category code for the pay phone/debit phone making the call; and

sending a charge rate to said pay phone/debit phone in a standard air interface message, which is being used in a non-standard manner and which contains information which said standard air interface message being designed to carry out a specific function different than sending said

charge rate, whereby allowing the pay phone/debit phone to determine the charge rate.

16. A method according to claim 15, wherein said charge rate is sent to said pay phone/debit phone on an analog voice channel using a mobile station control message having an order code.

17. A method according to claim 16, wherein said Order Code is Voice Message Waiting.

18. A method according to claim 16, wherein said charge rate is contained within Local/Message Type within said mobile station control message.

19. A method according to claim 16, wherein said Order Code is a Flash with Info.

20. A method according to claim 16, wherein said charge rate is contained in character fields of the Flash With Info message.

21. A method according to claim 20, wherein a special string of characters is inserted at the beginning of the character field and the charge rate is contained in the remaining characters of the character field, wherein said special string of characters alerts said pay phone/debit phone that the mobile station control message contains said charge rate.

22. A method according to claim 19, wherein an order qualifier field within the Flash With Info message indicates a charge rate.

23. A method according to claim 15, wherein said charge rate is sent to said pay phone/debit phone on a digital voice channel.

24. A method according to claim 23, wherein said charge rate is transmitted in an information element of a Flash With Info message.

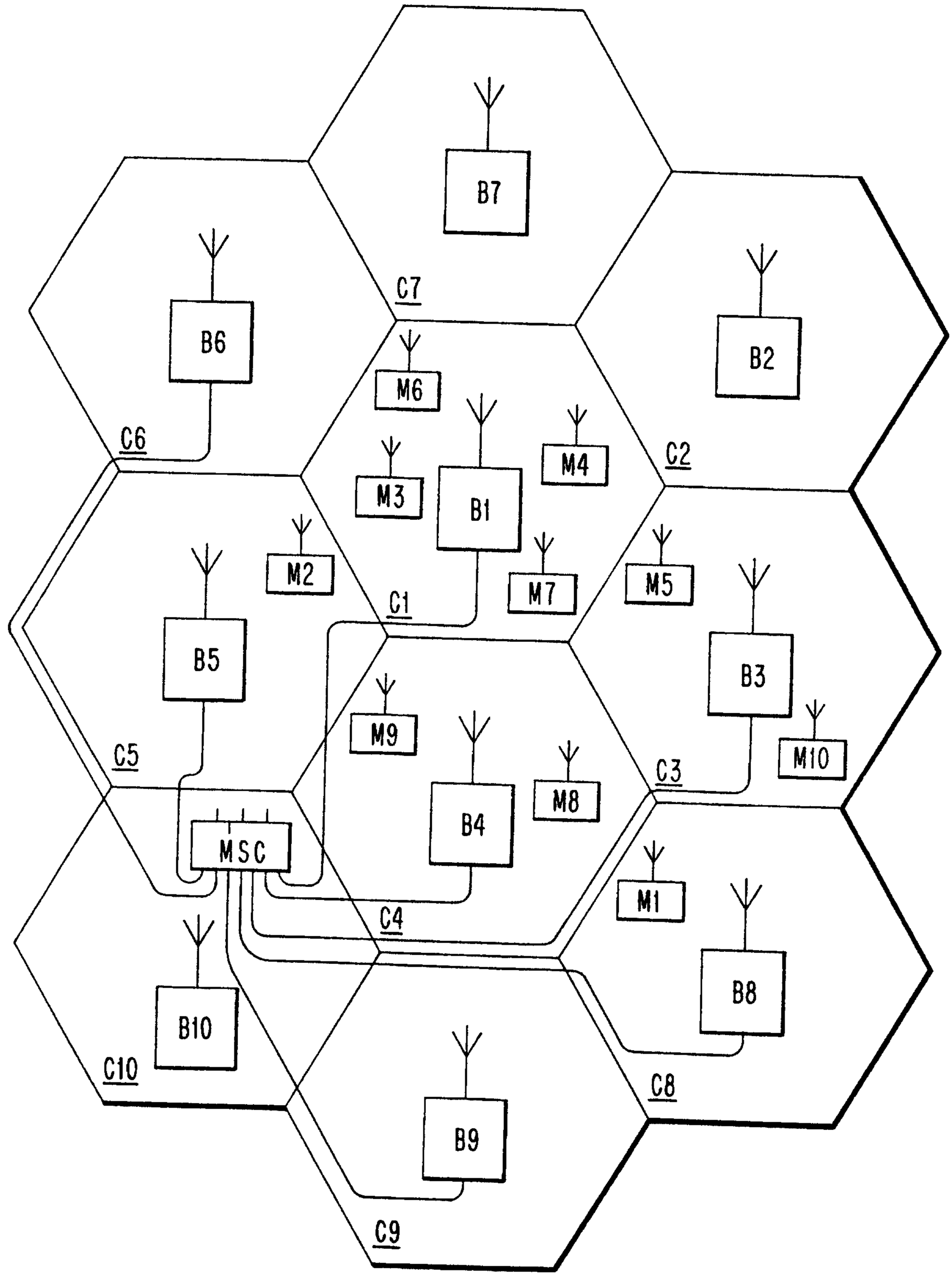
25. A method according to claim 23, wherein said charge rate is transmitted in a Voice Message Waiting Information element of a Flash With Info message.

26. A method according to claim 23, wherein said charge rate is transmitted in a Calling Party Number information element of a Flash With Info message.

27. A method according to claim 26, wherein a special string of characters is inserted at the beginning of the Calling Party Number field and the charge rate is contained in the remaining digits of the Calling Party Number field, wherein said special string of characters alerts said pay phone/debit phone that the Flash With Info message contains said charge rate.

28. A method according to claim 15, wherein said charge rate is displayed on a display screen on said pay phone/debit phone.

FIG. 1


B7
B6
C7
M6
B2
C6
M3
B1
M4
C2
M2
M7
M5
C1
B5
B3
M9
M10
C5
C3
B4
M8
MSC
M1
C4
B8
B10
C10
C8
B9
C9

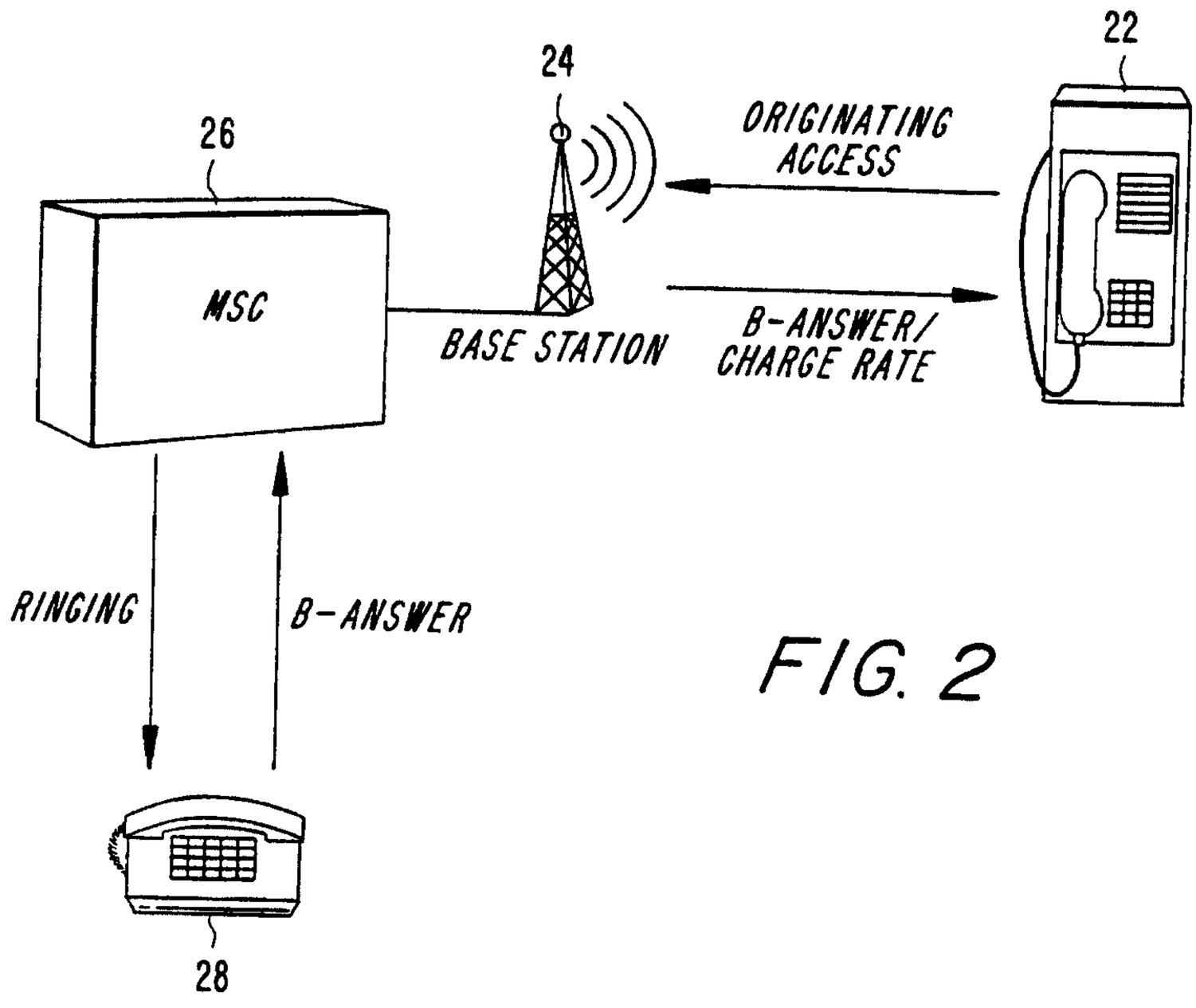


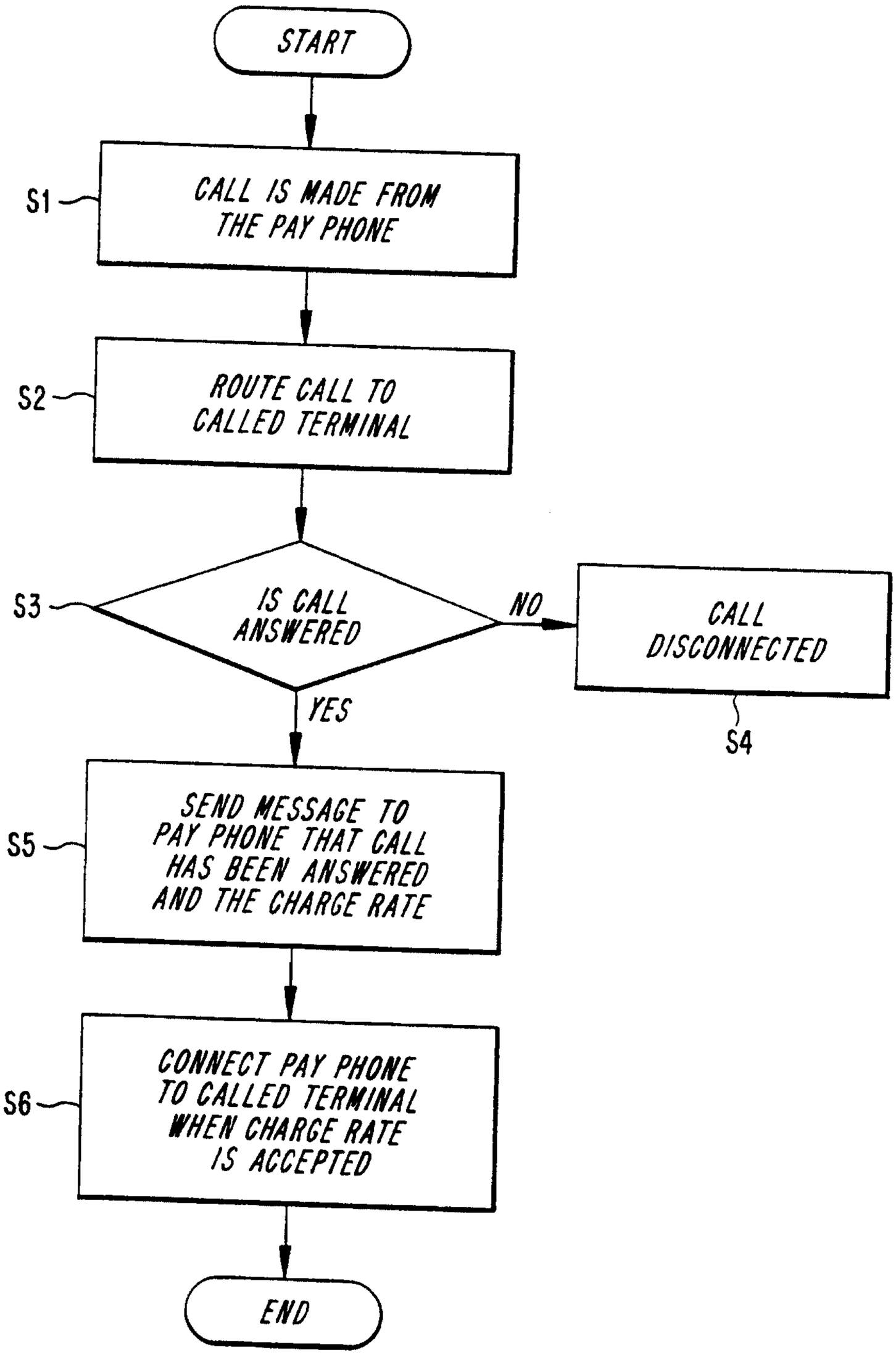
FIG. 2

MESSAGE FORMAT

INFORMATION ELEMENT	REV	TYPE	LENGTH (BITS)
PROTOCOL DISCRIMINATOR	0	M	2
MESSAGE TYPE	0	M	8
REQUEST NUMBER	0	M	4
REMAINING LENGTH	0	M	6
VOICE MESSAGE WAITING	0	0	10-16
SIGNAL	0	0	10-18
CALLING PARTY NUMBER (NOTE 1)	0	0	26-146
OTHER MESSAGES WAITING INFO	0	0	20-170
CALLING PARTY NAME	A	0	26-514
NOTE 1: 0 TO 2 INSTANCES MAY BE SENT			

FIG. 8

FIG. 3


START
S1
CALL IS MADE FROM THE PAY PHONE
S2
ROUTE CALL TO CALLED TERMINAL
S3
IS CALL ANSWERED
NO
CALL DISCONNECTED
S4
YES
S5
SEND MESSAGE TO PAY PHONE THAT CALL HAS BEEN ANSWERED AND THE CHARGE RATE
S6
CONNECT PAY PHONE TO CALLED TERMINAL WHEN CHARGE RATE IS ACCEPTED
END

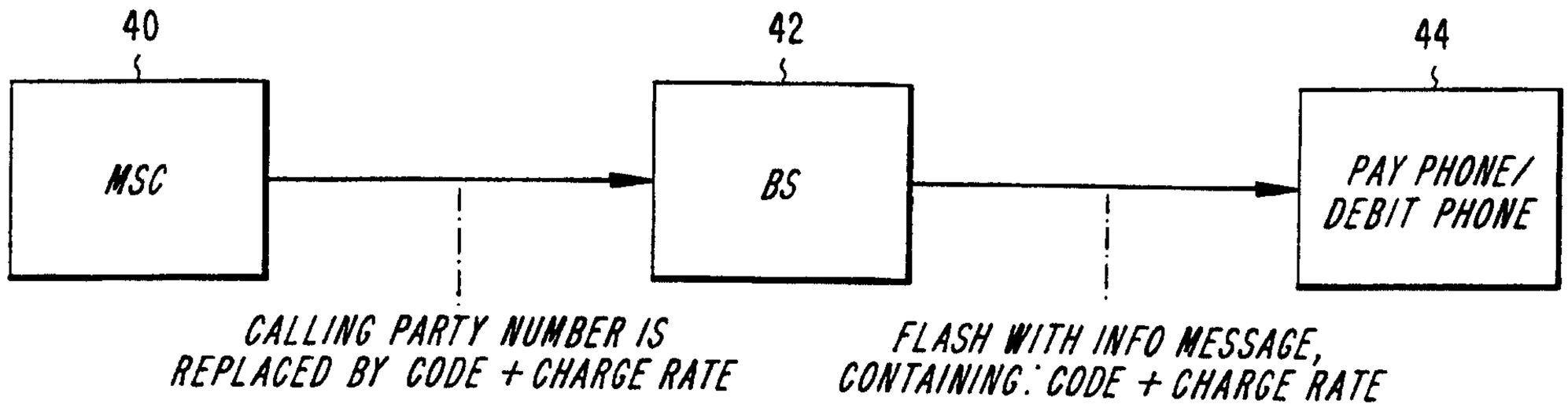


FIG. 4

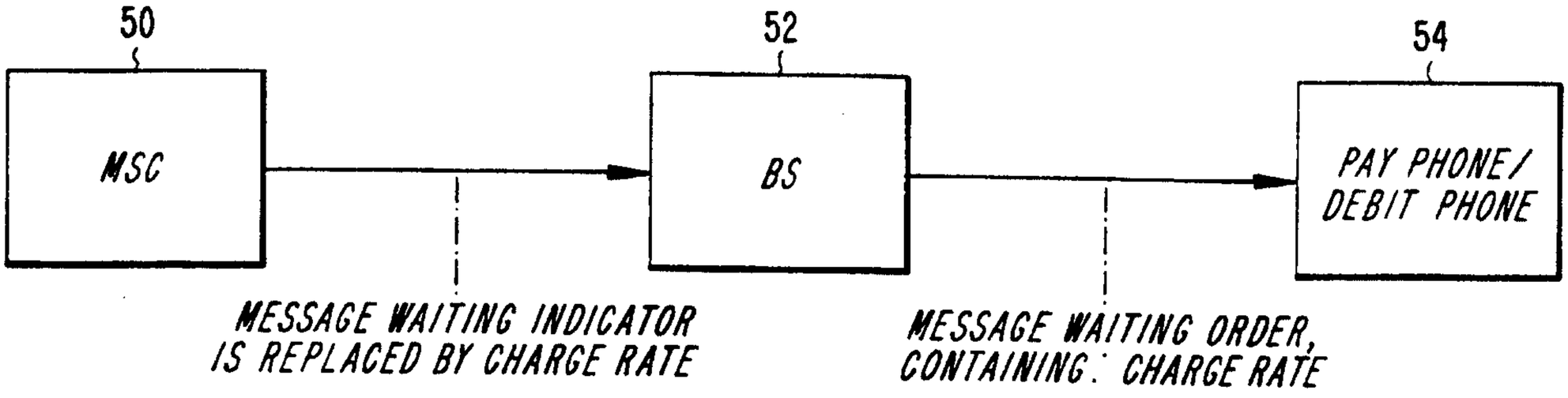


FIG. 5

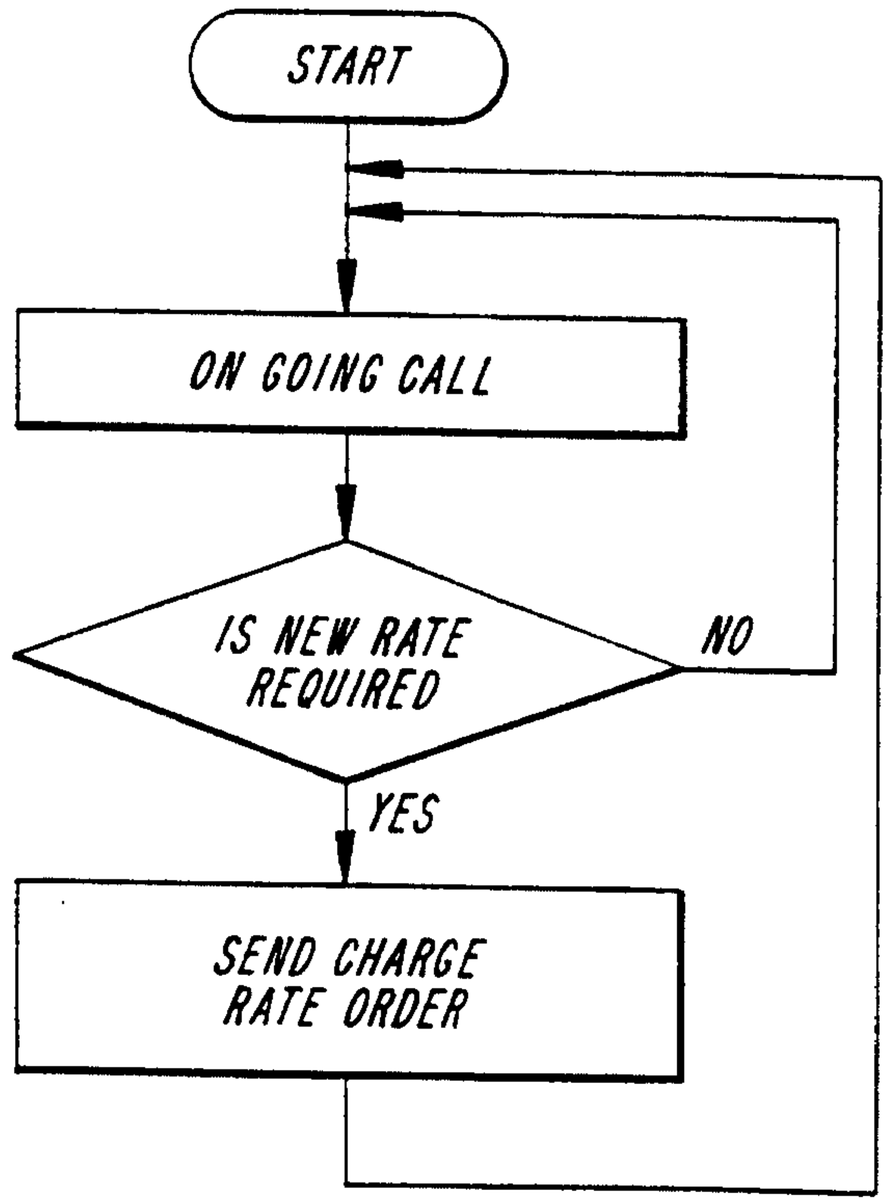


FIG. 10

FIG. 6

INFORMATION ELEMENT		LENGTH (BITS)	
$T_1 T_2 = 10$		2	
SCC		2	
SCC = 11		SCC ≠ 11	
INFORMATION ELEMENT	LENGTH (BITS)	INFORMATION ELEMENT	LENGTH (BITS)
PSCC	2	PSCC	2
EF (=0)	1	EF (=0)	1
RSVD=00000000/ DVCC	8	RSVD = 0...0	4
LOCAL/MSG TYPE	5	DTX	1
ORDQ	3	PVI	1
ORDER	5	PI	
P	12	SI	
CPN_RL		CHAN	11
CHARACTER		P	12

WORD 2 - FIRST FLASH WITH INFO WORD

INFORMATION ELEMENT	LENGTH (BITS)
$T_1 T_2 = 01$	2
RL_W	5
CPN_RL	6
PI	2
SI	2
RSVD = 0...0	11
P	12

WORD 3 - SECOND FLASH WITH INFO WORD

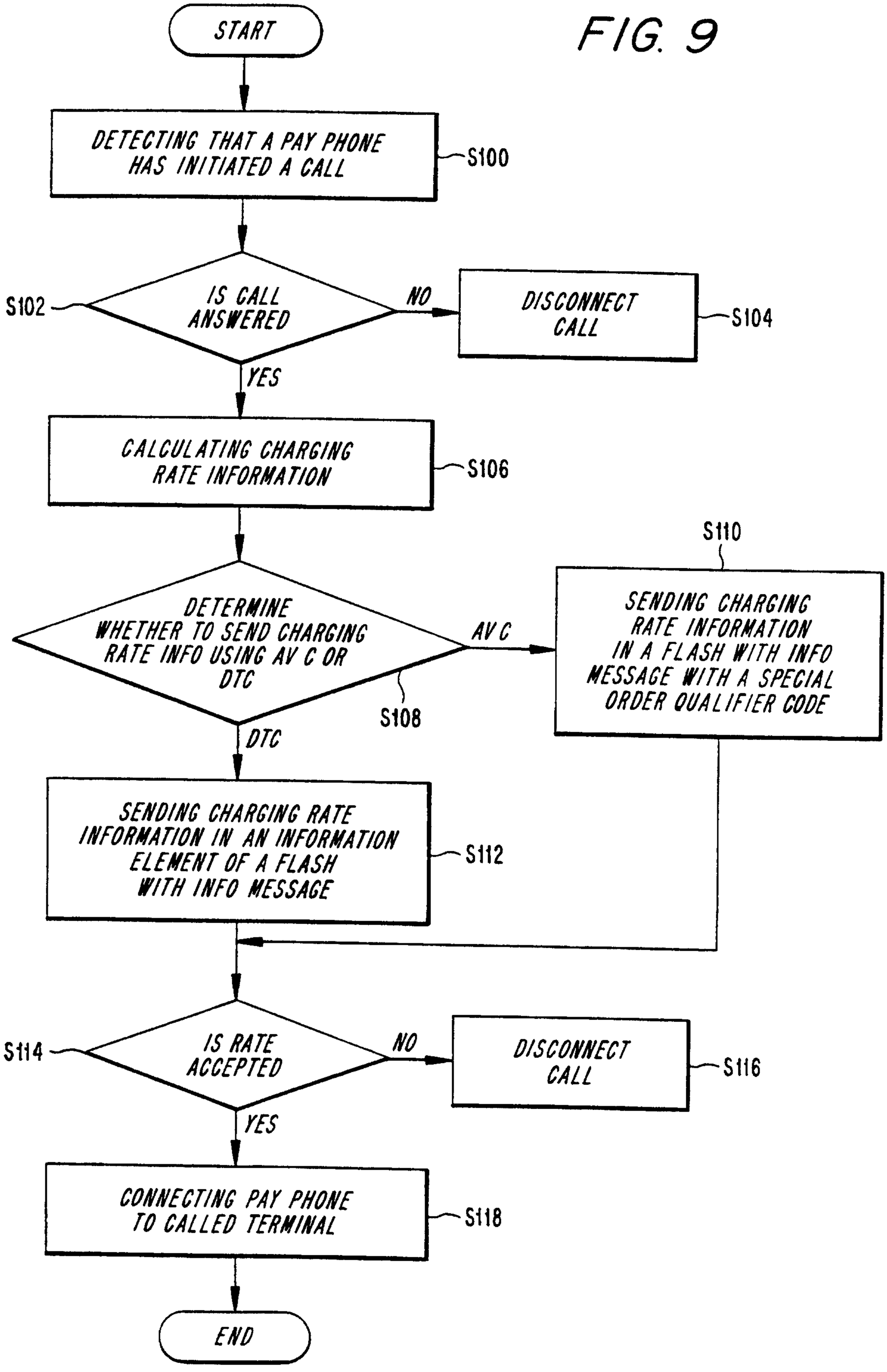
INFORMATION ELEMENT	LENGTH (BITS)
$T_1 T_2 = 01$	2
RSVD = 00	2
CHARACTER	8
CHARACTER	8
CHARACTER	8
P	12

WORD N - (N-1)TH FLASH WITH INFO WORD

INFORMATION ELEMENT	LENGTH (BITS)
$T_1 T_2 = 01$	2
RSVD = 00	2
CHARACTER	8
CHARACTER	8
CHARACTER	8
P	12

FIG. 7

FIG. 9


START
DETECTING THAT A PAY PHONE HAS INITIATED A CALL
S100
IS CALL ANSWERED
S102
NO
DISCONNECT CALL
S104
YES
CALCULATING CHARGING RATE INFORMATION
S106
DETERMINE WHETHER TO SEND CHARGING RATE INFO USING AV C OR DTC
S108
AV C
DTC
S110
SENDING CHARGING RATE INFORMATION IN A FLASH WITH INFO MESSAGE WITH A SPECIAL ORDER QUALIFIER CODE
SENDING CHARGING RATE INFORMATION IN AN INFORMATION ELEMENT OF A FLASH WITH INFO MESSAGE
S112
IS RATE ACCEPTED
S114
NO
DISCONNECT CALL
S116
YES
CONNECTING PAY PHONE TO CALLED TERMINAL
S118
END

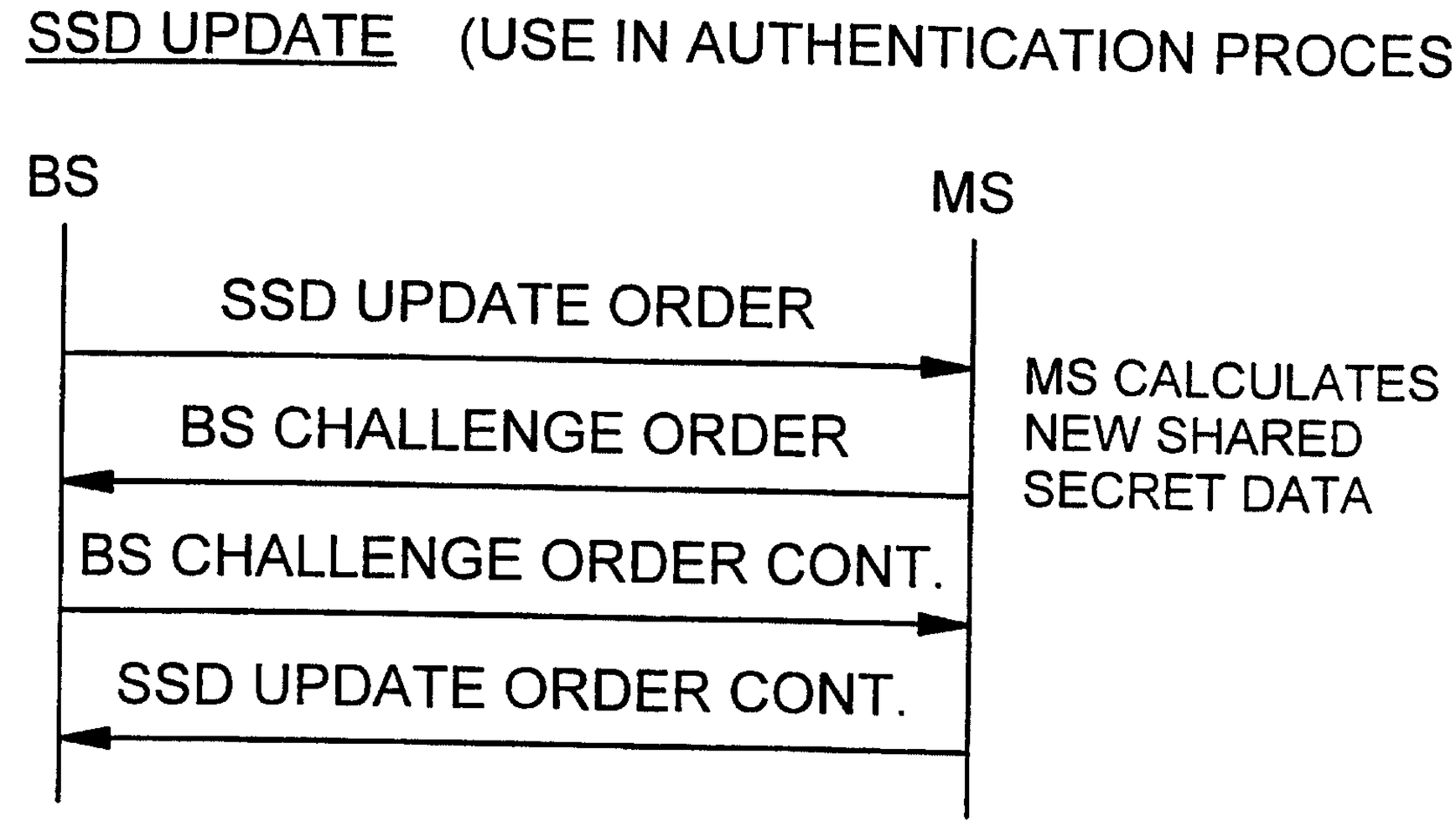


FIG. 11(a)

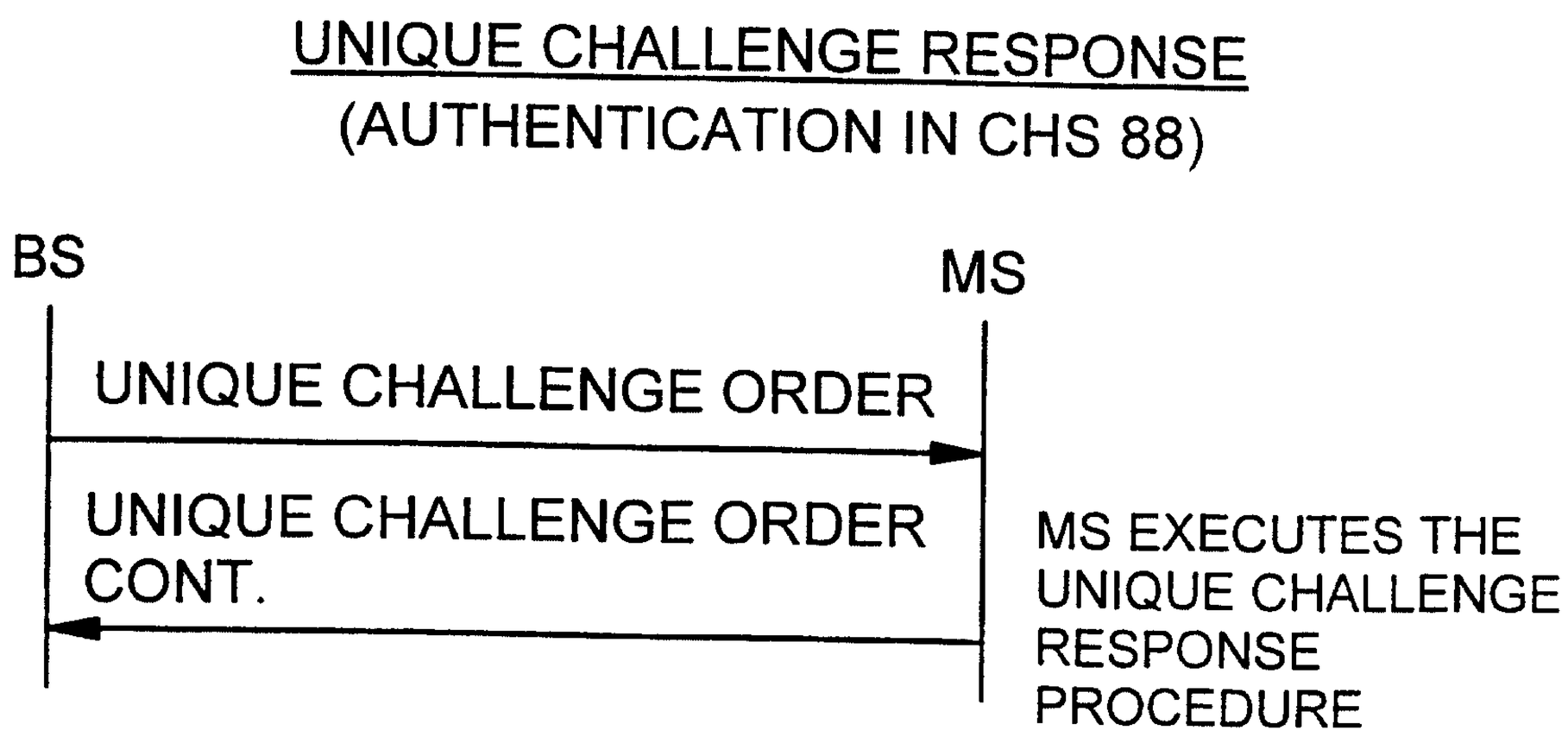


FIG. 11(b)

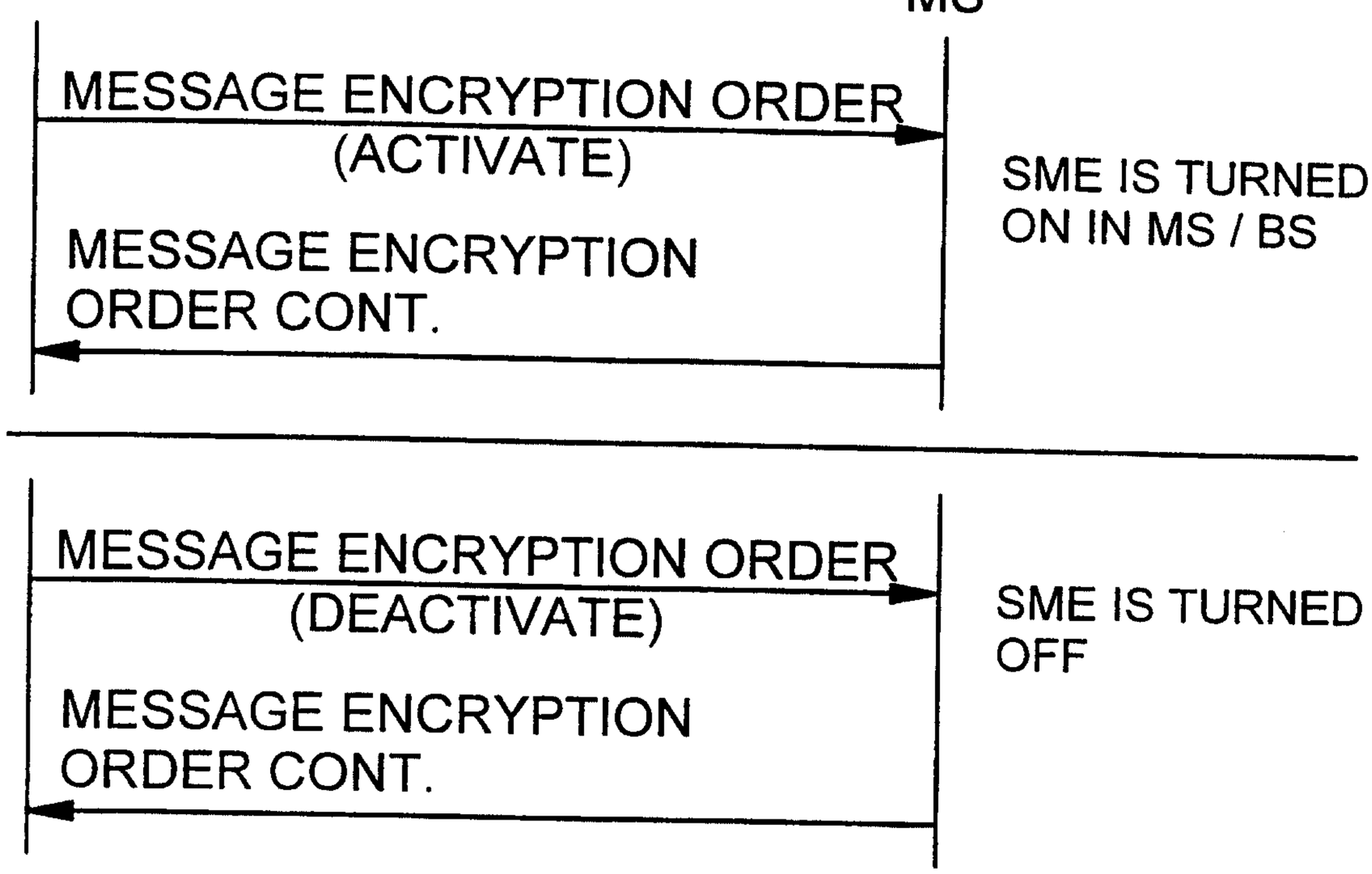

(SIGNALLING) MESSAGE ENCRYPTION
ACTIVATE / DEACTIVATE
BS
MS
MESSAGE ENCRYPTION ORDER
(ACTIVATE)
MESSAGE ENCRYPTION
ORDER CONT.
SME IS TURNED
ON IN MS / BS
MESSAGE ENCRYPTION ORDER
(DEACTIVATE)
MESSAGE ENCRYPTION
ORDER CONT.
SME IS TURNED
OFF

FIG. 11(c)

INFORMATION ELEMENT	LENGTH (BITS)
$T_1 T_2 = 10$	2
SCC	2
SCC = 11	1

INFORMATION ELEMENT	LENGTH (BITS)
PSCC	2
EF (=0)	1
RSVD = 0..0	5
PVI	1
MEM	1
VMAC	3
CHAN	11
P	12

INFORMATION ELEMENT	LENGTH (BITS)
PSCC	2
EF (=0)	1
RSVD = 00000000/ DVCC	8
LOCAL / MSG TYPE	5
ORDQ	3
ORDER	5
P	12

FIG. 12

ORDER CODE	QUAL CODE	MESSAGE TYPE	FUNCTION
(BASE STATION INITIATED MESSAGES ONLY - MOBILE STATION AUTHENTICATION AND PRIVACY)			
10100	000	00000	UNIQUE CHALLENGE ORDER
10101	000	00000	SSD UPDATE ORDER
10110	000	00000	DISABLE DTMF ORDER
10111	000	00000	MESSAGE ENCRYPTION MODE ORDER WITH DISABLE INDICATION
10111	001	00000	MESSAGE ENCRYPTION MODE ORDER WITH ENABLE INDICATION

FIG. 13

FIELD: ORDER LOCAL ORDQ

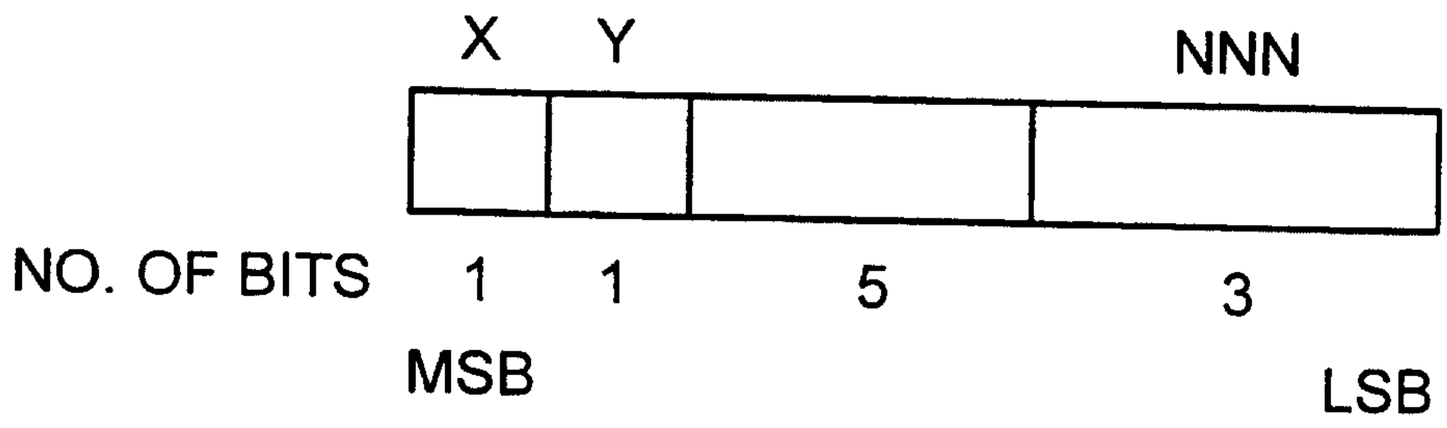
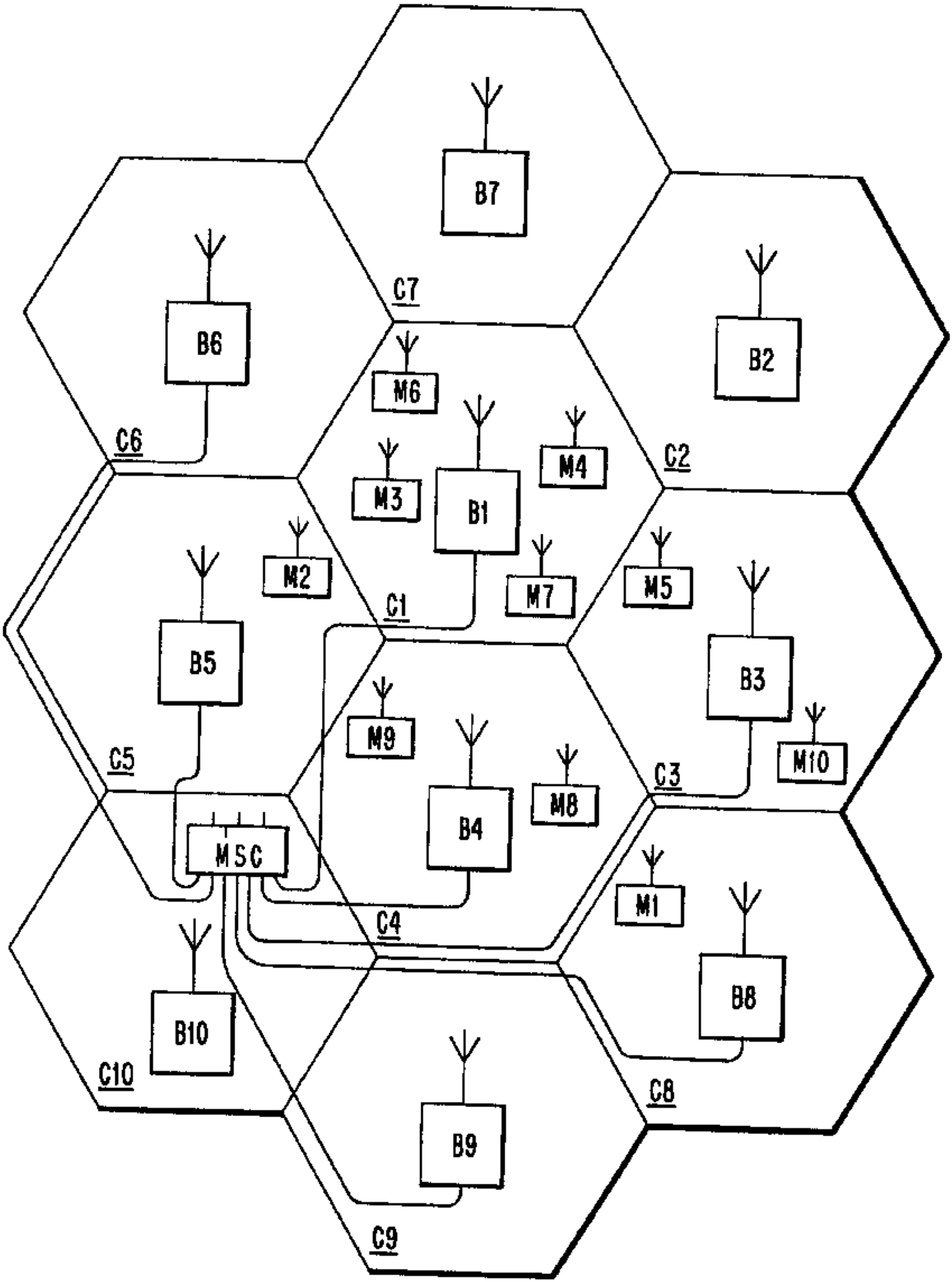


FIG. 15

ORDER CODE	ORDER QUALIFIER	FUNCTION	
00000	ABC	PAGE (OR ORIGINATION)	
00001	000	ALERT	
00010	000	ANSWER	
00011	000	LAND RELEASE	
00100	000	REORDER	
00111	ABC	AUDIT	
01000	000	SEND CALLED - ADDRESS	
01001	000	INTERCEPT	
01010	000	MAINTENANCE	
01011	000	CHANGE POWER TO POWER LEVEL 0 (SEE SECTION 2.1.2.2)	
01011	001	CHANGE POWER TO POWER LEVEL 1	
01011	010	CHANGE POWER TO POWER LEVEL 2	
01011	011	CHANGE POWER TO POWER LEVEL 3	
01011	100	CHANGE POWER TO POWER LEVEL 4	
01011	101	CHANGE POWER TO POWER LEVEL 5	
01011	110	CHANGE POWER TO POWER LEVEL 6	
01011	111	CHANGE POWER TO POWER LEVEL 7	
01100	000	DIRECTED REENTRY - NOT LAST TRY	
01100	001	DIRECTED REENTRY - LAST TRY	
01101	000	REGISTRATION	
01110	ABC	REGISTRATION - SWITCH ON	FOR MS_SUP_LEV_s = 01 OR HIGHER
01111	ABC	REGISTRATION - FORCED	
11010	ABC	REGISTRATION - PERIODIC	
101XY	NNN	CHARGE RATE (X, Y, N MAY BE 0 OR 1)	
11011	000	MOBILE RELEASE	
00110	000	STOP ALERT	
11101	000	CALL QUEUED	
11110	ABC	LOCAL CONTROL	

(ALL OTHER CODES ARE RESERVED)

FIG. 14


B7
B6
C7
M6
B2
C6
M3
B1
M4
C2
M2
M5
C1
M7
B5
B3
M9
M10
C5
B4
M8
C3
MSC
M1
C4
B8
B10
C10
C8
B9
C9