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(54) Title: A GROUND-TO-AIR TELEPHONE CALLING SYSTEM AND RELATED METHOD

A ground-to-air telephone calling system is provided including a computer (22) for receiving an airborne telephone number and a call-back number from a calling party (20) and forming the telephone numbers into a data signal conforming with existing protocol filed in the FCC, an uplink unit (24) for uplinking the data signal to a satellite (26) and a plurality of downlink stations (28) for receiving the data signal from the satellite, a plurality of ground stations (30) corresponding to each of the downlink units for receiving the data signals and passing a call signal identifying the airborne telephone and particular ground station to a corresponding transmit/receive unit (32) for subsequent transmission to the aircraft; a call being initiated from the ground station to the calling party over the public switched telephone network if the aircraft responds to the call signal.

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(57) Abstract

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A GROUND-TO-AIR TELEPHONE CALLING
SYSTEM AND RELATED METHOD

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a ground-to-air telephone system which permits a ground based caller to establish telephon-ic communication with an airborne telephone of unknown location.

Background Information

Airborne telephone systems are well known and widely used. Such systems are typically utilized by a passenger on an aircraft to initiate a telephone call to a ground based party connected to the public switched telephone network (PSTN). Through such systems, an airborne party can initiate telephone calls to any telephone in the world. Such calls are transmitted from the airborne telephone to ground stations which route the telephone calls by way of the PSTN to the called party.

However, if a ground based party wishes to call an airborne telephone using such a system, the ground based party must know which specific ground station is within transmission range of the aircraft. This requirement necessitates that the ground based party know the particular location of the aircraft at any given time, thereby presenting prohibitive mapping requirements. As a result, ground-to-air telephone calls are seldom attempted because of the unfeasibility of knowing the particular location of an aircraft at any given time.

Mobile ground telephone systems, such as cellular systems, are known, wherein a central location coordinates the selection of calls, i.e., the central location selects which ground station
is in communication with the mobile telephone and routes and completes the call accordingly. Such mobile ground systems are inadequate for airborne use, however, because the use of such a central location in airborne applications causes inadequate contention between ground stations for the selection of channel frequencies.

**SUMMARY OF THE INVENTION**

In view of the foregoing, an object of the present invention is to provide a ground-to-air telephone system by which a ground based caller can initiate a telephone call to an airborne telephone of unknown location.

An additional object of the present invention is to provide a ground-to-air telephone system in which no modifications or variations are required to known airborne telephones.

Another object of the present invention is to permit selected activation of ground stations to provide the system with regional or national extent.

A further object of the present invention is to eliminate contention between ground stations for channel frequencies.

Additional objects and advantages of the invention will be set forth in the description which follows and, in part, will be obvious from that description or may be learned by practice of the invention.

To achieve the foregoing objects and in accordance with the purpose of the invention as embodied and broadly described herein, a system for establishing telephonic communication between a

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ground based caller and an airborne telephone of unknown location is provided which comprises: means for forming and communicating a first data signal in response to a telephone call from the ground based caller, the data signal comprising at least data identifying the airborne telephone and data identifying the caller; a plurality of ground stations for receiving the first data signal and forming call signals in response thereto, the call signals comprising at least data identifying the airborne telephone and data identifying the ground station, the call signals being transmitted to a plurality of possible aircraft locations, the airborne telephone forming and communicating an aircraft response signal to said ground station which transmitted the call signal in response to receipt by said airborne telephone of said call signal; a plurality of receiving means, located at each of the ground stations, for receiving an aircraft response signal from the airborne telephone if the aircraft received the call signal from a corresponding ground station; and calling means, coupled to each of the plurality of receiving means, for calling the caller in response to the aircraft response signal.

**BRIEF DESCRIPTION OF THE DRAWINGS**

Figure 1 is a general block diagram of a presently preferred embodiment of a ground-to-air telephone calling system incorporating the teachings of the present invention;

Figure 2 is a detailed block diagram of a ground station utilized in the system of Figure 1;
Figures 3a-3c are diagrams illustrating the formats of particular signals used in the system of Figure 1; and

Figures 4a-4d are flow charts of the operation of a ground-to-air telephone system incorporating the teachings of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to Figure 1, there is shown a generalized block diagram illustrating a ground-to-air telephone calling system incorporating the teachings of the present invention. The system of Figure 1 includes a telephone 20, a national paging control computer (NPCC) 22, an uplink unit 24, a satellite 26, a plurality of downlink units 28, a plurality of ground stations 30, a plurality of transmit/receive units 32, and an aircraft 34 having a conventional airborne telephone thereon (not shown).

Telephone 20 is coupled to the input of NPCC computer 22 via the public switched telephone network (PSTN). The output of NPCC computer 22 is coupled to the input of uplink unit 24 and passes a data signal 21 thereto. Data signal 21 is subsequently uplinked by uplink unit 24 to satellite 26 which transmits data signal 21 to downlink units 28. The output of each downlink unit 28 is coupled to an input of a corresponding ground station 30. Ground stations 30 receive data signals 21 from downlink units 28. An output of each ground station 30, i.e., a call signal 31, is coupled to an input of a corresponding transmit/receive unit 32. Each transmit/receive unit 32 subsequently transmits call signal 31 to possible aircraft locations. If the airborne
telephone on aircraft 34 receives a call signal from any transmit/receive unit 32, then an aircraft response signal 35 is formed and transmitted from the airborne telephone to the transmit/receive unit 32 from which the call signal was received. Aircraft response signal 35 is then passed from an output of transmit/receive unit 32 to an input of the corresponding ground station 30. Ground station 30 is coupled to the calling party over the PSTN.

In accordance with the teachings of the present invention, the calling party, via telephone 20, initiates a telephone call to NPCC computer 22. After receiving the telephone call, NPCC computer 22 then prompts the calling party to input an air-ground radiotelephone automated service (AGRAS) number, representing an identification number of the airborne telephone to be called. NPCC computer 22 further prompts the calling party to input a call-back number to which a subsequent telephone call can be placed to reach the calling party. After input of this information via telephone 20 over the PSTN, the calling party then hangs up his telephone.

NPCC computer 22 automatically generates data signal 21 and passes data signal 21 to uplink unit 24 via standard techniques, i.e., land lines, microwave transmissions, etc. The format of data signal 21 fully complies with established protocol filed with the FCC and will be discussed below in more detail in connection with Figures 3a-3c. Uplink unit 24 then transmits data signal 21 to satellite 26 in a conventional manner. Likewise,
data signal 21 is reflected by satellite 26 to downlink units 28, as is known in the art. Each down link unit 28 has associated with it a corresponding ground station 30 and transmit/receive unit 32. Preferably, down link units 28 are distributed nationwide, thus providing nationwide ground-to-air calling ability. The structure and function of ground stations 30 will be discussed below in more detail in connection with Figure 2.

Data signal 21 received from satellite 26 by downlink unit 28 is automatically passed to ground station 30. Ground station 30 receives and unpacks data signal 21 and outputs call signal 31, which comprises the AGRAS number and a ground station identification number. Each ground station is assigned a unique ground station identification number and, therefore, each call signal 31 output from a ground station 30 is unique. Each call signal 31 is transmitted by its corresponding transmit/receive unit 32.

If aircraft 34 is within transmission range of a particular transmit/receive unit 32, then the call signal transmitted by that transmit/receive unit will be received by the airborne telephone on aircraft 34. In response thereto, the airborne telephone forms and transmits aircraft response signal 35 on the same frequency channel on which call signal 31 was received, i.e., to the same transmit/receive unit 32 which transmitted the call signal received. Aircraft response signal 35 is passed from transmit/receive unit 32 to its corresponding ground station 30. In response to aircraft response signal 35, ground station 30 automatically initiates a telephone call over the PSTN to telephone
20. When the calling party answers the call, the calling party is connected via ground station 30 and transmit/receive unit 32 to the airborne telephone located in aircraft 34.

Figure 2 is a more detailed block diagram of ground station 30 illustrated in Figure 1. Specifically, ground station 30 includes a first receiver 36, an unpacking unit 38, a first comparator 40, a queue 42, a second comparator 44, a second receiver 46, and a PSTN coupler 48.

An input of first receiver 36 receives data signal 21 from satellite 26, as illustrated in Figure 1. Data signal 21 is passed from an output of first receiver 36 to an input of unpacking unit 38. Unpacking unit 38 unpacks the data signal 21 and outputs the call-back number to queue 42. Unpacking unit 38 further outputs call signal 31 to first comparator 40. Call signal 31 includes the AGRAS number of the airborne telephone to be called, as well as ground station identifying information. First comparator 40 compares the AGRAS number contained in call signal 31 against a list of invalid AGRAS numbers. If the AGRAS number contained in call signal 31 is found by first comparator 40 to be not invalid (i.e. valid), then call signal 31 is output from first comparator 40 to a corresponding transmit/receive unit 32.

As described above, call signal 31 is transmitted by transmit/receive unit 32 to potential locations of aircraft 34. If aircraft 34 is within the transmission range of transmit/receive unit 32, then aircraft the airborne telephone on 34 returns aircraft response signal 35 to the same transmit/receive unit 32.
Aircraft response signal 35 is output from transmit/receive unit 32 to an input of second receiver 46. Second receiver 46 outputs aircraft response signal 35 to an input of second comparator 44 which verifies that ground station identifying information included in aircraft response signal 35 corresponds to the address of the ground station receiving the aircraft response signal. If aircraft response signal 35 has been received by the correct ground station 30, aircraft response signal 35 is output from second comparator 44 to an input of queue 42. Queue 42 then outputs the call-back number to an input of PSTN coupler 48 which initiates a telephone call to the calling party over the PSTN.

The formats of various signals used in the ground-to-air telephone calling system of the present invention will now be described in detail in connection with Figures 3a-3c. As shown in Figure 3a, data signal 21 includes a start-of-header (SOH) flag 50, a header 52, a start-of-text (STX) flag 54, data blocks 56, and end flag (ETX) 58, and cyclic redundancy check code (CRC) 60.

SOH flag 50 preferably comprises one byte of data and identifies the beginning of header 52. Header 52 indicates the source and destination of each data block 56 and is described in more detail below in connection with Figure 3b. STX flag 54 preferably comprises one byte of data and identifies the beginning of data blocks 56. Data blocks 56 are discussed in more detail below in connection with Figure 3c. EXT flag 58 preferably comprises one byte of data and identifies the end of data blocks 56.
CRC 60 preferably comprises two bytes of data which check for errors in the format of data signal 21.

As shown in Figure 3b, header 52 includes a destination address 62, an inertia field 64, a source address 66, and a serial number 68. Destination address 62 preferably comprises four bytes of data allowing for the identification of 65,535 possible destination addresses identifying ground stations selected to receive data signal 21. By varying destination address 62, regional programmability of ground stations may be achieved. Inertia field 64 preferably comprises two bytes of data and represents a value used to determine whether a particular data signal 21 is still valid. Source address 66 preferably comprises four bytes of data representing a source address within NPCC computer 22. Serial number 68 preferably comprises two bytes of data and is used to uniquely identify a particular data signal 21 in order to prevent redundant transmission.

As illustrated in Figure 3c, data block 56 is of a variable length and includes a data block type field 70, a page type field 72, a page class field 74, an RF channel designator field 76, an RF zone designator field 78, a function code field 80, a cap code field 82, a message text field 84, and an end-of-block (ETB) field 86.

Data block type field 70 preferably comprises one byte of data and describes the format of data block 56. Page type field 72 preferably comprises one byte of data and describes a signalling code used with the particular AGRAS number being called.
Page class field 74 preferably comprises one byte of data and describes the message and coding class of the airborne telephone identified by the particular AGRAS number. RF channel designator field 76 preferably comprises one byte of data identifying the particular channel frequency used by transmit/receive unit 32. RF zone designator field 78 preferably comprises one byte of data and identifies the particular frequency zone within the channel identified by RF channel designator field 76 in which transmission by transmit/receive unit 32 will occur. Function code field 80 preferably comprises one byte of data and identifies the priority of call signal 31. Cap code field 82 preferably comprises eight bytes of data and identifies the specific type of airborne telephone identified by the AGRAS number. Message text field 84 is of variable length and consists of characters identified the AGRAS number and call-back number input by the calling party to NPCC computer 22. ETB field 86 identifies the end of message text field 84.

The operation of the system of Figure 1 will now be described with reference to the flow charts of Figures 4a-4d. In order to initiate a ground-to-air telephone call using the system of Figure 1, the calling party dials NPCC computer 22 over the PSTN in step 102. In response to the call, NPCC computer 22 requests the AGRAS number of the airborne telephone to be called. The calling party then inputs, via telephone 20, the AGRAS number of the airborne telephone in step 104. NPCC computer 22 then checks the validity of the AGRAS number input in step 5106 and,
if the AGRAS number is found to be invalid, re-requests a valid AGRAS number from the calling party in step S108. If the calling party fails to input a valid AGRAS number in three attempts, operation of the system is terminated, as shown in steps 110, 112, and 114. If a valid AGRAS number has been input by the calling party, NPCC computer 22 then requests a call-back number in step S116. After inputting the call-back number, the calling party then hangs up.

Next, in step 118, NPCC computer 22 determines from the valid AGRAS number whether the AGRAS number identifies a paging-only user. This step is desired because a common AGRAS number may preferably be used to identify an airborne telephone and/or a paging unit (not shown). The user has the option of selecting whether his AGRAS number is valid for an airborne telephone, paging unit, or both. If the user is a paging-only user, then the user is paged using a known paging sequence (step 120), and the operation is terminated (step 122). If the determination in step 118 is that the user is not a paging only user, thus indicating that the AGRAS number corresponds to an airborne telephone, it is next determined, in step 124, whether the user’s AGRAS number permits paging, or is limited to an airborne telephone. If it is determined that the AGRAS number also corresponds to a pager, a known paging sequence is initiated in step 126.

Next, from the AGRAS number and call-back number input by the calling party to NPCC computer 22, data signal 21 is formed
(step 128). Data signal 21 comports with existing protocol filed with the FCC and is uplinked from uplink unit 24 to satellite 26 (step 130) and is subsequently received by each downlink unit 28 (step 132). After data signal 21 is received by downlink units 28, it is determined whether the destination address 62 of data signal 21 corresponds to the ground station 30 associated with downlink unit 28. If destination address 62 does not correspond to ground station 30, i.e., ground station 30 is not located in a selected region, then operation is terminated (step 136). Otherwise, operation continues and data signal 21 is unpacked by unpacking unit 38 (step 138). In step 140, it is determined whether the AGRAS number unpacked by unpacking unit 38 is invalid. This step is performed to ensure that no transmission errors or skewing of data has occurred. If the AGRAS number is not invalid, then the call-back number is passed from unpacking unit 38 to queue 42 (step 144). In step 146 it is determined whether ground station 30 is busy, i.e., it is determined whether that particular ground station is already in communication with an airborne telephone. If ground station 30 is busy, then operation passes to a first timing circuit represented by steps 148, 150, and 152 in which a first timer is decremented, it is determined whether the first timer has elapsed, and it is again determined whether ground station 30 is busy. This process preferably repeats for a period of approximately 90 seconds in order to maximize the possibility that ground station 30 becomes available to subsequently pass call signal 31 to transmit/receive unit 32. If
ground station 30 remains busy, then operation of the system terminates. If ground station 30 is not initially busy in step 146, or ground station 30 has become available during the decrement of the first timing circuit, system operation proceeds to step 154 in which call signal 31 is passed from ground station 30 to transmit/receive unit 32, which subsequently transmits call signal 31 to the airborne telephone on aircraft 34. If aircraft 34 is within transmission range of a particular transmit/receive unit 32, the airborne telephone will respond to call signal 31 with aircraft response signal 35. If the airborne telephone does not respond initially to call signal 31, then a second timing circuit is entered in which the airborne telephone is allowed a predetermined period of time to respond to call signal 31. If the airborne telephone on aircraft 34 does not respond to call signal 31 within the allotted time, then operation is terminated in step 162. If the airborne telephone responds to call signal 31 by transmitting aircraft response signal 35 to transmit/receive unit 32, then the airborne telephone will begin to ring. It is then determined in step 164 whether the airborne telephone has been answered, i.e., it is determined whether the receiver of the airborne telephone has gone off-hook.

The user of the airborne telephone is given a predetermined amount of time, as shown in steps 166, 168, and 170, in which to answer the airborne telephone. If the user answers the airborne telephone within this time, then PSTN coupler 48 in ground station 30 initiates a telephone call to the call-back number stored.
in queue 42 over the PSTN (step 172). If the calling party answers (step 174), then a clock is initiated in order to record the length of the call for billing purposes. As long as the airborne telephone is off-hook (step 180) the clock is incremented (step 182). When the user of the airborne telephone hangs up, then the elapsed time of the telephone call is recorded for billing purposes (step 184) and operation of the system is terminated (step 186).

The ground-to-air telephone calling system and related method of the subject invention thus provide a combination of features which permit a ground based calling party to establish telephonic communication with an airborne telephone of unknown location. Thus, the system of the present invention provides a distinct improvement over prior art airborne telephone systems. Furthermore, no modification on the part of existing airborne telephones is required by the present invention. Moreover, all signals used by the system of the present invention fully comply with existing protocol filed with the FCC.

Additional advantages and modifications will readily occur to those skilled in the art. The invention in its broader aspects is, therefore, not limited to the specific details, representative apparatus and illustrative method shown and described. For example, instead of communicating the data and call signals over a combination of land lines and satellite links as illustrated, these signals may be communicated by other means or techniques or by any combination thereof which achieves the
communication speed required in ground-to-air communication. Accordingly, departures may be made from such details without departing from the spirit or scope of applicants' generic inventive concept as set forth in the appended claims.
WHAT IS CLAIMED IS:

1. A system for establishing telephonic communication between a ground based caller and an airborne telephone of unknown location, said system comprising:

   means for forming and communicating a data signal in response to a telephone call from said caller, said data signal comprising at least data identifying said airborne telephone and data identifying said caller;

   a plurality of ground stations for receiving said data signal and forming call signals in response thereto, said call signals comprising at least data identifying said airborne telephone and data identifying said ground station, said call signals being transmitted to a plurality of possible aircraft locations, said airborne telephone forming and communicating an aircraft response signal to said ground station which transmitted said call signal in response to receipt by said airborne telephone of said call signal;

   a plurality of receiving means, corresponding to each of said ground stations, for receiving said aircraft response signal from said airborne telephone; and

   calling means, coupled to each of said plurality of receiving means, for calling said caller in response to said aircraft response signal.

2. A system according to claim 1, further comprising a plurality of delay means, coupled to each of said ground stations for delaying said call signals by a predetermined time period for subsequent transmission if said ground station is busy.
3. A system according to claim 1, further comprising means for selectively activating certain of said ground stations.

4. A method of establishing telephonic communication between a ground base caller and an airborne telephone of unknown location, said method comprising the steps of:

- forming and communicating a data signal in response to a telephone call from said caller, said data signal comprising at least data identifying said airborne telephone and data identifying said caller;

- receiving said data signal at a plurality of ground stations and forming call signals in response thereto, said call signals comprising at least data identifying said airborne telephone and data identifying said ground station, said call signals being transmitted to a plurality of possible aircraft locations;

- forming and communicating an aircraft response signal to said ground station which transmitted said call signal from said airborne telephone in response to receipt of said call signal;

- receiving said aircraft response signal from said airborne telephone; and

- calling said caller in response to said aircraft response signal.
**FIG. 3**

(A) **DATA SIGNAL FORMAT**

- SOH: 1 byte
- HEADER: 12 bytes
- STX: 1 byte
- DATA: N-bytes
- ETX: 1 byte
- CRC: 2 bytes

(B) **HEADER FORMAT**

- DESTINATION ADDRESS: 4 bytes
- INERTIA: 2 bytes
- SOURCE ADDRESS: 4 bytes
- SERIAL NUMBER: 2 bytes

(C) **DATA BLOCK FORMAT**

- DATA BLOCK TYPE: 1 byte
- PAGE TYPE: 1 byte
- PAGE CLASS: 1 byte
- RF CHANNEL DESIGN: 1 byte
- RF ZONE DESIGN: 1 byte
- FUNCTION CODE: 1 byte
- CAP CODE: 8 bytes
- MESSAGE TEXT: M-bytes
- ETB: 1 byte
**FIG. 4(a)**

1. **START**
   - **S100**

2. **CALLER DIALS CONTROL COMPUTER**
   - **S102**

3. **CONTROL COMPUTER REQUESTS USER'S AGRAS #**
   - **S104**

4. **IS AGRAS # VALID?**
   - **S105**
     - **Y**
     - **S116**
     - **REQUEST CALLER'S CALL-BACK NUMBER**

5. **IS # OF RE-REQUESTS > 3?**
   - **S112**
     - **S114**
     - **STOP**

6. **RE-REQUEST VALID USER AGRAS #**
   - **S108**
     - **N**
     - **S110**
     - **IS AGRAS # VALID?**
       - **Y**
       - **GOTO A**
       - **N**

7. **ENTER PAGING SEQUENCE**
   - **S120**
     - **S122**
     - **STOP**

8. **IS USER A PAGING-ONLY USER?**
   - **S118**
     - **Y**
     - **GOTO A**
     - **N**

9. **DOES USER HAVE PAGING?**
   - **S124**
     - **Y**
     - **ENTER PAGING SEQUENCE**
       - **S126**
     - **N**
     - **GOTO A**
**FIG. 4(b)**

A

S129

FORM DATA SIGNAL FROM AGRAS # AND CALL BACK #

S130

UPLINK DATA SIGNAL TO SATELLITE

S132

RECV DATA SIGNAL FROM SATELLITE

S134

DOES DATA SIG. DEST. ADDRESS MATCH GND. STA ?

S136

STOP

Y

UNPACK DATA SIGNAL

S138

IS AGRAS # INVALID ?

STOP S142

Y

N

S144

PLACE CALL-BACK # IN QUEUE

GOTO B
FIG. 4(c)

B

S146

IS GND. STA. BUSY?  →  Y

DECREMENT TIMER 1

N

S148

STOP

S150

X-MIT CALL SIGNAL TO AIRCRAFT

S154

S155

HAS AIRCRAFT RESPONDED?

N

DECREMENT TIMER 2

Y

S158

STOP

S160

S162

S156

N

HAS USER ANSWERED CALL?

Y

DIAL CALLBACK # OVER PSTN

S172

S164

N

DECREMENT TIMER 3

Y

S166

STOP

S168

S170

S174

HAS CALLER ANSWERED?

N

STOP

S176

GOTO C

Y
FIG. 4(d)

BEGIN CLOCK

IS AIRCRAFT PHONE OFF-HOOK?

Y

INCREMENT CLOCK

N

RECORD ELAPSED TIME

STOP
### I. CLASSIFICATION OF SUBJECT MATTER

According to International Patent Classification (IPC) or to both National Classification and IPC
- **IPC (4):** H01J 9/38; H04M 11/00.
- **US Cl.:** 455/12-13; 379/58, 63, 91.

### II. FIELDS SEARCHED

<table>
<thead>
<tr>
<th>Classification System</th>
<th>Classification Symbols</th>
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<tr>
<td>U.S.</td>
<td>455/12-13, 18; 379/56, 58, 63, 91, 144</td>
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Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched.

### III. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
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<tr>
<th>Category</th>
<th>Citation of Document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to Claim No.</th>
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<tbody>
<tr>
<td>Y</td>
<td>US, A, 4,672,655 (KOCH) 09 June 1987, See col. 4, line 26 to col. 5, line 31 and Fig. 1</td>
<td>1, 3-4</td>
</tr>
<tr>
<td>Y, P</td>
<td>US, A, 4,747,122 (BHAGAT ET AL.) 24 May 1988, See col. 2, lines 22-27.</td>
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<td>1-4</td>
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<tr>
<td>A</td>
<td>US, A, 4,616,108 (YAMAGUCHI ET AL.) 07 October 1986, See the entire document.</td>
<td>1-4</td>
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- Special categories of cited documents:
  - **Y** 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
  - **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.
  - **A** document member of the same patent family

### IV. CERTIFICATION

- **Date of the Actual Completion of the International Search:** 15 May 1989
- **Date of Mailing of this International Search Report:** 17 JUL 1989

**International Searching Authority:** ISA/US

**Signature of Authorized Officer:**

*signature*

David H. Kim