



## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

<b>(51) International Patent Classification <sup>5</sup> :</b>  <b>H04B 7/14</b>	<b>A1</b>	<b>(11) International Publication Number:</b> <b>WO 90/04889</b>  <b>(43) International Publication Date:</b> 3 May 1990 (03.05.90)
<b>(21) International Application Number:</b> PCT/US89/04059 <b>(22) International Filing Date:</b> 22 September 1989 (22.09.89)  <b>(30) Priority data:</b> 261,528                      21 October 1988 (21.10.88)      US  <b>(71) Applicant:</b> MOTOROLA, INC. [US/US]; 1303 East Algonquin Road, Schaumburg, IL 60196 (US).  <b>(72) Inventors:</b> EPSOM, Robert, L. ; 560 Burno Drive, Palatine, IL 60067 (US). ERICKSON, Paul, M. ; 842 Yorkshire Drive, Hanover Park, IL 60103 (US). CIZEK, Paul, J. ; 502 N. Everett Drive, Palatine, IL 60067 (US). WILSON, Christopher, H. ; 107 Lorraine Drive, Lake Zurich, IL 60047 (US).		<b>(74) Agents:</b> PARMELEE, Steven, G. et al.; Motorola, Inc., Intellectual Property Dept., 1303 East Algonquin Road, Schaumburg, IL 60196 (US).  <b>(81) Designated States:</b> AT (European patent), AU, BE (European patent), BR, CH (European patent), DE (European patent), FR (European patent), GB (European patent), IT (European patent), LU (European patent), NL (European patent), SE (European patent).  <b>Published</b> <i>With international search report.</i> <i>With amended claims.</i>
<b>(54) Title:</b> IMPROVED SIMULCAST BROADCASTING SYSTEM AND METHOD  <div style="text-align: center;"> </div>		
<b>(57) Abstract</b>  <p>A simulcast broadcast system wherein two signals (103 and 106) intended for simultaneous broadcast are transmitted from a source site (100) to remote sites (200) discrete from one another. At the remote sites, the two signals are separately processed, including the introduction of appropriate delay (305 and 312), prior to combining them for broadcast in conjunction with other remote sites. One or more monitoring sites (400) can also be provided to monitor reception coherence within the system and to provide operating measurement information to allow automatic control of various simulcast system parameters, including delay.</p>		

***FOR THE PURPOSES OF INFORMATION ONLY***

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria	ES	Spain	MG	Madagascar
AU	Australia	FI	Finland	ML	Mali
BB	Barbados	FR	France	MR	Mauritania
BE	Belgium	GA	Gabon	MW	Malawi
BF	Burkina Fasso	GB	United Kingdom	NL	Netherlands
BG	Bulgaria	HU	Hungary	NO	Norway
BJ	Benin	IT	Italy	RO	Romania
BR	Brazil	JP	Japan	SD	Sudan
CA	Canada	KP	Democratic People's Republic of Korea	SE	Sweden
CF	Central African Republic	KR	Republic of Korea	SN	Senegal
CG	Congo	LI	Liechtenstein	SU	Soviet Union
CH	Switzerland	LK	Sri Lanka	TD	Chad
CM	Cameroon	LU	Luxembourg	TG	Togo
DE	Germany, Federal Republic of	MC	Monaco	US	United States of America
DK	Denmark				

- 1 -

5

## IMPROVED SIMULCAST BROADCASTING SYSTEM AND METHOD

10 Technical Field

This invention relates generally to simulcast radio communications systems.

15 Background Art

Simulcast radio communications systems are typically employed to provide wide area one-way or two-way radio communications services. In such a system, a  
20 source site typically originates (or forwards from another originating site) a signal to be generally broadcast. This signal is routed from the source site to a plurality of remote sites. Each remote site then simultaneously broadcasts the signal with other remote  
25 sites to facilitate reception of the signal by receivers within the area covered by the system.

In this way, a receiver outside the operating range of one remote site may still be within the range of one or more other remote sites, thereby reasonably  
30 ensuring that the receiver can receive the signal.

One particularly difficult problem with such simulcast systems involves coordinating the various

35

- 2 -

remote sites to ensure that the signals are in fact substantially simultaneously broadcast by each. A failure to accomplish this will result in instances of unacceptable reception coherence as potentially caused by phase offsets, deviation, distortion and the like.

Another problem arises when more than two signals must be transmitted simultaneously; for example, a voice signal and a data signal. Prior art methods of processing such combined signals in a simulcast environment have not always been adequately conducive to supporting necessary levels of reception coherence.

Finally, even when initially properly adjusted for proper reception coherence, the operating performance of a given simulcast system may vary in response to a number of changing operating and environmental factors. No prior art systems provide for a means of allowing a simulcast system to respond in any convenient or efficacious manner to such circumstances.

A need exists for a simulcast system that provides for the substantially simultaneous broadcast of a signal from a plurality of remote sites, particularly where the signal to be broadcast itself includes at least two signals. A need further exists for a system that can adapt one or more of its operating parameters to continually provide transmissions of acceptable reception coherence even when other operating factors or environmental conditions change.

#### Summary of the Invention

These needs and others are substantially met through provision of the improved simulcast broadcasting system disclosed herein. The system includes generally a source site for providing an original signal to be broadcast, and a plurality of remote sites for substantially simultaneously broadcasting the original signal from the source site.

In one embodiment, the source site provides both a first and a second signal (such as voice and data). The source site provides these two signals to the remote sites discrete from one another. Only after reception and appropriate processing at the remote site will the two signals be combined to facilitate their broadcast.

In one embodiment, the appropriate processing provided to the first and second signals at the remote sites includes introduction of an appropriate time delay to ensure that all of the remote sites broadcast substantially the same signal with substantially the same phase relationship.

In another embodiment, a monitoring device can be provided to monitor broadcast signals from the remote sites, and determine whether the broadcast signals exhibit an acceptable reception coherence. One or more broadcast system parameters can then be automatically varied in response to this determination as appropriate to improve reception coherence.

## Brief Description of the Drawings

Fig. 1 comprises a block diagram depiction of source site structure;

Fig. 2 comprises a block diagram depiction of remote site structure;

Fig. 3 comprises a block diagram depiction of the remote delay module of the remote site; and

Fig. 4 comprises a block diagram depiction of a monitoring site.

## Best Mode for Carrying out the Invention

The invention includes generally a source site unit (SSU) (100) (Fig. 1) and a remote site unit (RSU) (200) (Fig. 2).

- 4 -

Referring to Fig. 1, the SSU (100) includes generally a microwave radio (101) that receives both audio and data input. The microwave radio (101) functions to transmit the two incoming signals in a known multiplexed manner to the RSUs (200) as described below in more detail.

The SSU audio path (102) includes an audio source input (103) (which may be on site or off, as may be appropriate to the application or function) that passes through a transmission block (104) configured in known manner as a double sideband/reduced carrier, the output of which transmitter (104) couples to a transmitter input port of the microwave radio (101). In certain applications, as in trunked communications, this input (103) could alternatively receive high speed data, such as control channel signalling.

The data path (105) includes a data source (106) (which provides, for example, low speed data intended to be ultimately coupled subaudibly with the audio information). The data source (106) passes through an FSK modulator (107) to a single sideband configured transmitter (108). The latter transmitter (108) sums to a transmit port of the microwave radio (101).

For purposes of explanation, the audio signal can be a first signal, and the data signal can be a second signal, with the ultimate intent being to provide a signal to a subscriber unit, such as a mobile, portable or fixed receiver, in a combined format. Upon reception, the radio will render the voice information audible, and will subaudibly process and act accordingly upon the data information or instructions. It should be noted that in this system, contrary to prior art technique, the first and second signals are not combined at the SSU (100). Instead, they are transmitted separately and discrete from one another, in a multiplexed manner, to the RSUs (200).

- 5 -

Referring now to Fig. 2, an example RSU (200) will be described. The RSU (200) includes a repeater structure comprised of two microwave radios (201 and 202). Signals received by the first microwave radio (201) are subsequently repeated and transmitted by the second microwave radio (202), for instance to another RSU. Similarly, signals received from down stream RSUs can be received by the second microwave radio (202) and transmitted to the SSU via the first microwave radio (201). Again, these radios (201 and 202) function in a known manner to receive and transmit multiplexed signals, including the first and second signals provided by the SSU (100).

The RSU (200) also includes a combiner (203) as well understood in the art. The combiner provides a high frequency received information line (204) and a high frequency transmit information line (205). A single sideband configured receiver (206) couples to the receive line (204) and functions to receive the data information as transmitted by the SSU (100). A double sideband/reduced carrier configured receiver (207) also couples to the receive line (204) and functions to receive the audio information as separately transmitted by the SSU (100).

The output of both receivers (206 and 207) is provided to a remote delay module (RDM) (208), the configuration and operation of which will be described in more detail below. The output (209) of the remote delay module includes recovered audio information and recovered data information, appropriately processed, delayed, and combined. This combined signal can then be provided to appropriate transmitter equipment to allow a general broadcast of the information in a known manner.

The RSU (200) also includes a single sideband configured transceiver (210) that couples to both high frequency lines of the combiner (203) and communicates with a processor unit (211) that provides appropriate

- 6 -

control instructions to the RDM (208) as also described in more detail below.

Referring now to Fig. 3, the RDM (208) includes a data path (301) and an audio path (302). The data path (301) couples to the output of the single sideband receiver (206) through a 600 ohm input unit (303), following which the signal is appropriately clipped and squared (304) in a known manner. The data signal is then passed through an appropriate delay unit (305). The delay unit (305) introduces a time delay in any appropriate known manner to accomplish a predetermined delay of propagation of the data signal to the transmitter of the RSU (200). (The purpose of this delay is to ensure that all RSUs (200) transmit a given source signal as provided by the SSU (100) at substantially the same time. Therefore, the delay at any particular RSU (200) will likely be unique to that RSU.) The delayed data signal then passes through an appropriate FSK decoder (306) and subaudible data splatter filter (307) to a digital attenuator unit (308). Following appropriate attenuation as required to provide necessary equalization, the data signal is provided to a summing unit (309), the operation of which will be disclosed in more detail below.

The audio path (302) connects to the output of the double sideband/reduced carrier receiver (207) through an appropriate 600 ohm input (310). The audio signal is then passed through an appropriate anti-alias filter (311) to a delay unit (312), the function and purpose of which is the same as that described above for the data path delay unit (305).

Following introduction of the appropriate delay, the audio signal passes through an appropriate splatter filter (313) and digital attenuator (314) to provide the necessary equalization, following which the signal passes through a highpass filter (315) to the summing unit (309).



- 7 -

The summing unit (309) functions to sum the delayed and properly processed data signals with the delayed and properly processed audio signals to thereby provide a composite signal. This composite signal then  
5 passes through an appropriate 600 ohm output unit (316) for subsequent processing (209) as referenced above. (In a trunked system, as noted earlier the audio path (302) may receive high speed data instead of voice information. To accommodate such an embodiment, the inputs to the  
10 summing unit (309) can be controlled by a number of logic gates (317, 318, and 319) that respond to an appropriate control signal (320). So configured, the summing unit (309) will receive either both high pass filtered audio information and low speed data, or high speed data only  
15 that has not been high pass filtered.)

It should be noted that the signal processing, such as equalization and introduction of delay, occur at the RSU (200) as versus the SSU (100). Also, it should be noted that, at the RSU (200), the first and second  
20 signals are individually and separately provided with the appropriate delay and other signal compensation factors prior to their combination.

In Fig. 3, it can also be seen that the delay units (305 and 312) and the digital attenuators (308 and  
25 314) can be controlled by the processor (211) referenced above. The processor (211) in turn can receive data information and/or instructions from the SSU (100) through the microwave radio link. As a result, instructions regarding the appropriate delay and  
30 attenuation can be formulated at the SSU (100) and transmitted to the various RSUs (200), and implemented without human intervention.

With reference to Fig. 4, a monitoring site (400) in accordance with the invention can be seen as depicted  
35 generally by the numeral 400. A typical monitoring site includes a signal processing unit (401) that could include, for example, a number of directional antennas

- 8 -

(402). Each antenna (402) could be directed to a particular RSU (200). The signal processing unit (401) utilizes that information to develop information regarding reception coherence for signals broadcast by the RSUs (200). A processor (403) can be provided that takes the reception coherence information developed by the signal processing unit (401) and compares it against an appropriate threshold or other criteria. Information regarding the comparisons developed by the processor (403) can be transmitted via an appropriate radio (404) or other link to the SSU (100) or other control location. Based upon information developed by the monitoring site (400) regarding reception coherence, the delay and/or attenuation parameters for a given RSU (200) can be selectively varied to accommodate changing operating or environmental conditions.

20

25

30

35

Claims

1. A method of simulcasting a broadcast signal from at least two remote sites, said broadcast signal comprising at least a combined first signal and second signal, the method comprising the steps of:
- a) transmitting from a source site said first signal to said at least two remote sites;
  - b) separately transmitting from a source site said second signal to said at least two remote sites;
  - c) at said at least two remote sites, delaying said first and second signals by a predetermined amount to provide delayed first and second signals, which predetermined amount may be different for each of said at least two remote sites;
  - d) combining said delayed first and second signals to provide a composite signal;
  - e) broadcasting said composite signal substantially simultaneously with other of said at least two remote sites to provide said broadcast signal.

25

30

35

- 10 -

2. The method of claim 1 and further including are steps of:

f) monitoring, at least from time to time, said broadcast signal as broadcast by at least some of  
5 said at least two remote sites;

g) determining whether said broadcast signal as monitored has acceptable reception coherence;

h) automatically varying at least one of said first signal, said second signal, said composite signal,  
10 and said broadcast signal as required to improve said reception coherence.

15

20

25

30

35

- 11 -

3. In a simulcast broadcast system wherein a broadcast signal is broadcast substantially simultaneously from at least two sites, an improved simulcast broadcasting method comprising the steps of:

- 5           a) monitoring, at least from time to time, said broadcast signal;
- b) determining whether said broadcast signal has acceptable reception coherence;
- 10          c) automatically varying at least one broadcast system parameter to improve said reception coherence.

15

20

25

30

35

## AMENDED CLAIMS

[received by the International Bureau  
on 26 February 1990 (26.02.90);  
original claim 1 amended; other claims  
unchanged(1 page)]

1. A method of simulcasting a distinct broadcast signal from at least two remote sites, said broadcast signal comprising at least a combined first signal and second signal, the method comprising the steps of:

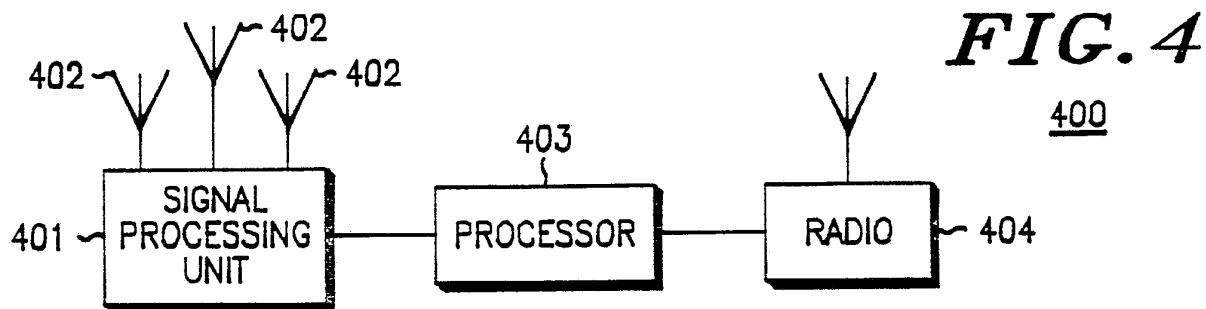
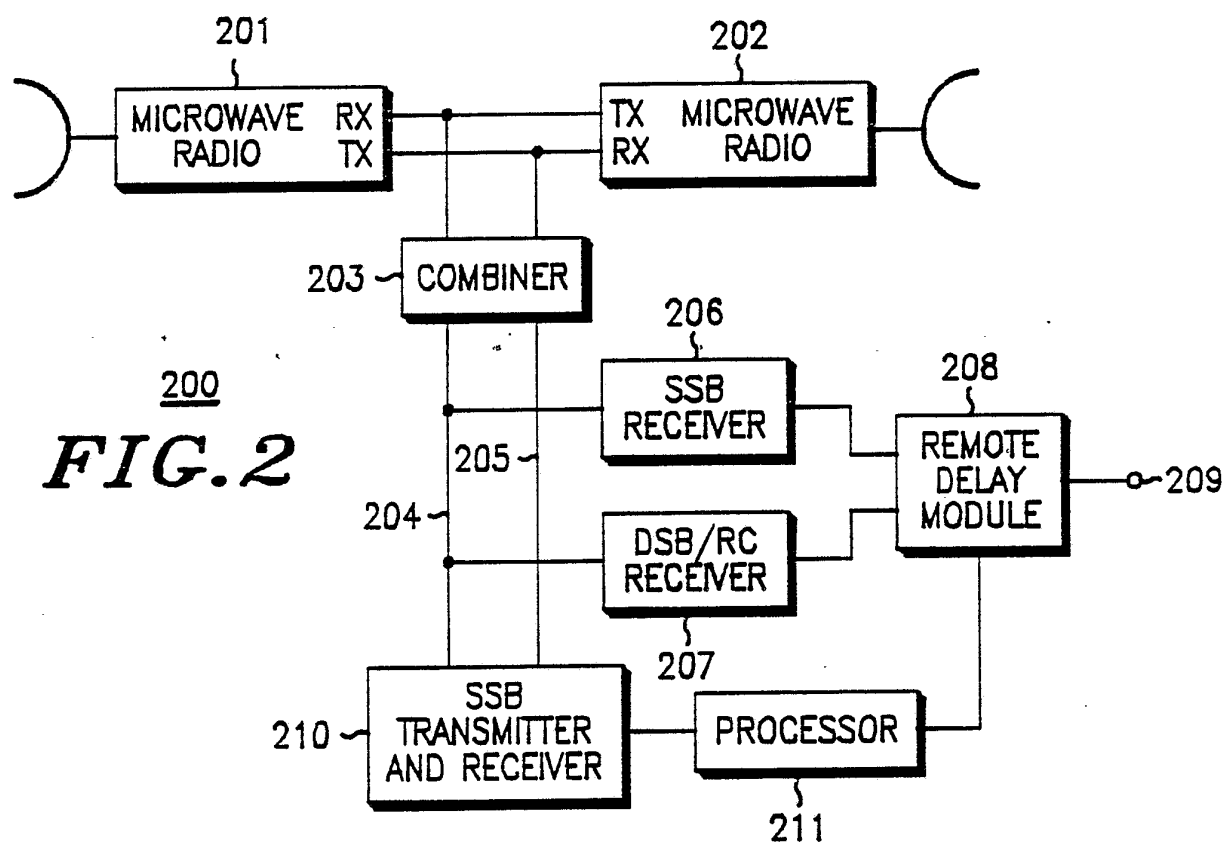
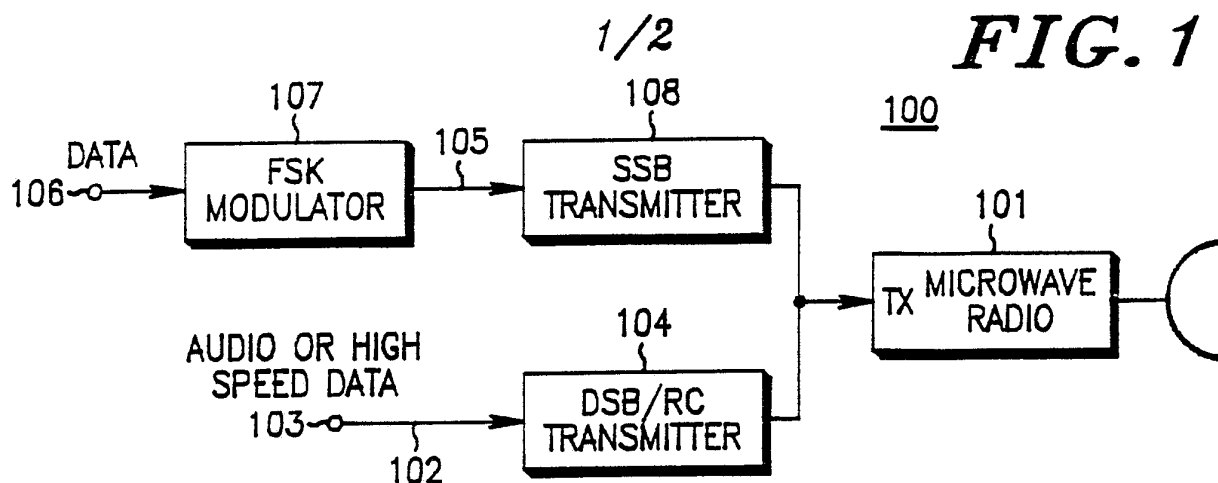
a) transmitting from a source site said first signal to said at least two remote sites;

b) separately transmitting from a source site said second signal to said at least two remote sites;

c) at said at least two remote sites, delaying said first and second signals by a predetermined amount to provide delayed first and second signals, which predetermined amount may be different for each of said at least two remote sites;

d) combining said delayed first and second signals to provide a distinct composite signal;

e) broadcasting said distinct composite signal substantially simultaneously with other of said at least two remote sites to provide said distinct broadcast signal.



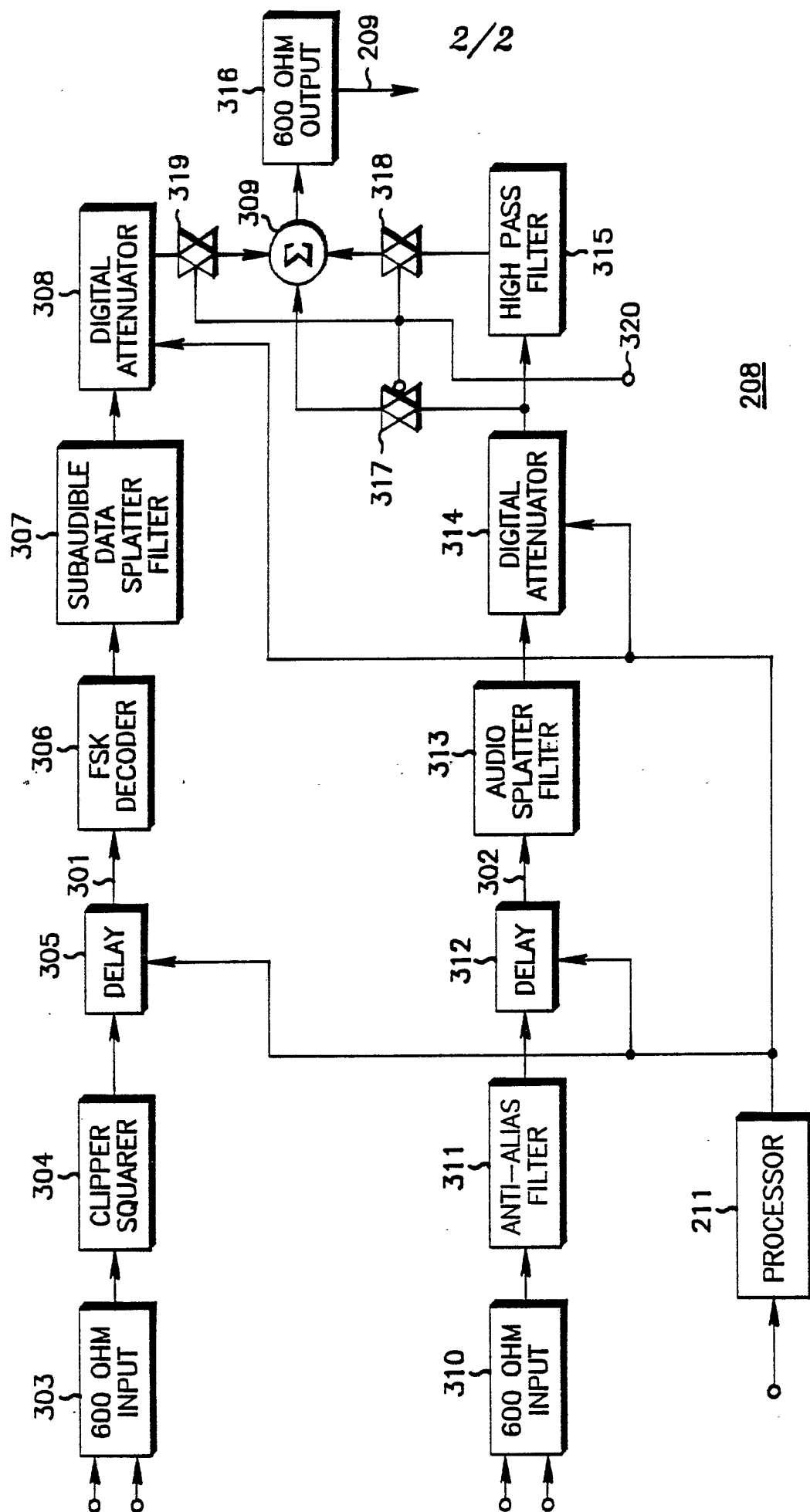


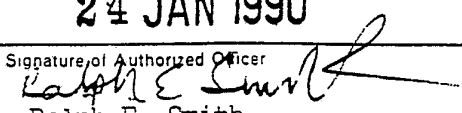
FIG. 3



# INTERNATIONAL SEARCH REPORT

International Application No.

PCT/US89/04059

<b>I. CLASSIFICATION OF SUBJECT MATTER</b> (if several classification symbols apply, indicate all) <sup>6</sup>		
According to International Patent Classification (IPC) or to both National Classification and IPC		
INT CL(5) H04B 7/14 U.S. Cl. 455/51		
<b>II. FIELDS SEARCHED</b>		
Minimum Documentation Searched <sup>7</sup>		
Classification System	Classification Symbols	
U.S.	455/16, 18, 51, 33, 67, 226	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched <sup>8</sup>		
<b>III. DOCUMENTS CONSIDERED TO BE RELEVANT <sup>9</sup></b>		
Category <sup>*</sup>	Citation of Document, <sup>11</sup> with indication, where appropriate, of the relevant passages <sup>12</sup>	Relevant to Claim No <sup>13</sup>
X	US, A, 4,475,246 BATIVALA ET AL. 02 October 1984 See Figs. 2, 3, 4 column 2, lines 38-60 and column 6, lines 32-57	1-3
A	US, A, 4,188,582 CANNALTE ET AL. 12 February 1980	1-3
A	US, A, 4,255,814 OSBORN 10 March 1981	1-3
A	US, A, 4,363,129 COHN ET AL. 07 December 1982	1-3
A	US, A, 4,570,265 THRO 11 February 1986	1-3
A	US, A, 4,578,815 PERSINOTTI 25 March 1986	1-3
A	US, A, 4,696,052 BREEDEN 22 September 1987	1-3
A	US, A, 4,317,217 DAVIDSON ET AL. 23 February 1982	1-3
A	EP, A, 0,197,556 MUSTONEN ET AL. 15 October 1986	1-3
A	SimulComm, September 1987, "Simulcast Control System"	1-3
<div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p><sup>*</sup> Special categories of cited documents: <sup>10</sup></p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> </div> <div style="width: 45%;"> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"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.</p> <p>"&amp;" document member of the same patent family</p> </div> </div>		
<b>IV. CERTIFICATION</b>		
Date of the Actual Completion of the International Search		Date of Filing of this International Search Report
08 January 1990		24 JAN 1990
International Searching Authority		Signature of Authorized Officer
ISA/US		 Ralph E. Smith